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ACTUARIAL STANDARDS BOARD

Actuarial Standard
of Practice
No. 12

Risk Classification (for All Practice Areas)

Revised Edition

Developed by the
Task Force to Revise ASOP No. 12 of the
General Committee of the
Actuarial Standards Board

Adopted by the
Actuarial Standards Board
December 2005
Updated for Deviation Language Effective May 1, 2011

(Doc. No. 132)

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TO: Members of the American Academy of Actuaries and Other Persons Interested in Risk Classification (for All Practice Areas)

FROM: Actuarial Standards Board (ASB)

SUBJ: Actuarial Standard of Practice (ASOP) No. 12

This booklet contains the final version of a revision of ASOP No. 12, now titled *Risk Classification (for All Practice Areas)*.

Background

In 1989, the Actuarial Standards Board adopted the original ASOP No. 12, then titled *Concerning Risk Classification*. The original ASOP No. 12 was developed as the need for more formal guidance on risk classification increased as the selection process became more complex and more subject to public scrutiny. In light of the evolution in practice since then, as well as the adoption of a new format for standards, the ASB believed it was appropriate to revise this standard in order to reflect current generally accepted actuarial practice.

Exposure Draft

The exposure draft of this ASOP was approved for exposure in September 2004 with a comment deadline of March 15, 2005. Twenty-two comment letters were received and considered in developing the final standard. A summary of the substantive issues contained in the exposure draft comment letters and the responses are provided in appendix 2.

The most significant changes from the exposure draft were as follows:

1. The task force clarified language relating to the interaction of applicable law and this standard.

2. The task force revised the definition of “adverse selection.”

3. The task force reworded the definition of “financial or personal security system” and included examples.

4. The words “equitable” and “fair” were added in section 3.2.1 but defined in a very limited context that is applicable only to rates.

5. With respect to the operation of the standard, the task force added language that clarifies that this standard in all respects applies only to professional services with respect to designing, reviewing, or changing risk classification systems.

6. Sections 4.1 and 4.2 were combined into a new section 4.1, Communications and Disclosures, which was revised for clarity. The placement of communication requirements throughout the proposed standard was examined, and a sentence regarding disclosure was removed from section 3.3.3 and incorporated into section 4.1. A similar change was made by adding a new sentence in section 4.1 to correspond to the guidance in section 3.4.1.

   In addition, the disclosure requirement in section 4 for the actuary to consider providing quantitative analyses was removed and replaced by a new section 3.4.4, which guides the actuary to consider performing such analyses, depending on the purpose, nature, and scope of the assignment.

The task force thanks everyone who took the time to contribute comments on the exposure draft.

The ASB voted in December 2005 to adopt this standard.

Task Force to Revise ASOP No. 12

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ASOP No. 12—December 2005

ACTUARIAL STANDARD OF PRACTICE NO. 12

RISK CLASSIFICATION (FOR ALL PRACTICE AREAS)

STANDARD OF PRACTICE

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose—This actuarial standard of practice (ASOP) provides guidance to actuaries when performing professional services with respect to designing, reviewing, or changing risk classification systems.

1.2 Scope—This standard applies to all actuaries when performing professional services with respect to designing, reviewing, or changing risk classification systems used in connection with financial or personal security systems, as defined in section 2.4, regarding the classification of individuals or entities into groups intended to reflect the relative likelihood of expected outcomes. Such professional services may include expert testimony, regulatory activities, legislative activities, or statements concerning public policy, to the extent these activities involve designing, reviewing, or changing a risk classification system used in connection with a specific financial or personal security system.

Throughout this standard, any reference to performing professional services with respect to designing, reviewing, or changing a risk classification system also includes giving advice with respect to that risk classification system.

Risk classification can affect and be affected by many actuarial activities, such as the setting of rates, contributions, reserves, benefits, dividends, or experience refunds; the analysis or projection of quantitative or qualitative experience or results; underwriting actions; and developing assumptions, for example, for pension valuations or optional forms of benefits. This standard applies to actuaries when performing such activities to the extent such activities directly or indirectly involve designing, reviewing, or changing a risk classification system. This standard also applies to actuaries when performing such activities to the extent that such activities directly or indirectly are likely to have a material effect, in the actuary's professional judgment, on the intended purpose or expected outcome of the risk classification system.

If the actuary departs from the guidance set forth in this standard in order to comply with applicable law (statutes, regulations, and other legally binding authority), or for any other reason the actuary deems appropriate, the actuary should refer to section 4.

1.3 Cross References—When this standard refers to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called. If any amended or restated document differs materially from the originally referenced document, the actuary should consider the guidance in this standard to the extent it is applicable and appropriate.

1.4 Effective Date—This standard will be effective for any professional service commenced on or after May 1, 2006.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice.

2.1 Advice—An actuary's communication or other work product in oral, written, or electronic form setting forth the actuary's professional opinion or recommendations concerning work that falls within the scope of this standard.

2.2 Adverse Selection—Actions taken by one party using risk characteristics or other information known to or suspected by that party that cause a financial disadvantage to the financial or personal security system *(sometimes referred to as antiselection)*.

2.3 Credibility—A measure of the predictive value in a given application that the actuary attaches to a particular body of data (predictive is used here in the statistical sense and not in the sense of predicting the future).

2.4 Financial or Personal Security System—A private or governmental entity or program that is intended to mitigate the impact of unfavorable outcomes of contingent events. Examples of financial or personal security systems include auto insurance, homeowners insurance, life insurance, and pension plans, where the mitigation primarily takes the form of financial payments; prepaid health plans and continuing care retirement communities, where the mitigation primarily takes the form of direct service to the individual; and other systems, where the mitigation may be a combination of financial payments and direct services.

2.5 Homogeneity—The degree to which the expected outcomes within a risk class have comparable value.

2.6 Practical—Realistic in approach, given the purpose, nature, and scope of the assignment and any constraints, including cost and time considerations.

2.7 Risk(s)—Individuals or entities covered by financial or personal security systems.

2.8 Risk Characteristics—Measurable or observable factors or characteristics that are used to assign each risk to one of the risk classes of a risk classification system.

2.9 Risk Class—A set of risks grouped together under a risk classification system.

2.10 Risk Classification System—A system used to assign risks to groups based upon the expected cost or benefit of the coverage or services provided.

Section 3. Analysis of Issues and Recommended Practices

3.1 Introduction—This section provides guidance for actuaries when performing professional services with respect to designing, reviewing, or changing a risk classification system. Approaches to risk classification can vary significantly and it is appropriate for the actuary to exercise considerable professional judgment when providing such services, including making appropriate use of statistical tools. Sections 3 and 4 are intended to provide guidance to assist the actuary in exercising professional judgment when applying various acceptable approaches.

3.2 Considerations in the Selection of Risk Characteristics—Risk characteristics are important structural components of a risk classification system. When selecting which risk characteristics to use in a risk classification system, the actuary should consider the following:

3.2.1 Relationship of Risk Characteristics and Expected Outcomes—The actuary should select risk characteristics that are related to expected outcomes. A relationship between a risk characteristic and an expected outcome, such as cost, is demonstrated if it can be shown that the variation in actual or reasonably anticipated experience correlates to the risk characteristic. In demonstrating a relationship, the actuary may use relevant information from any reliable source, including statistical or other mathematical analysis of available data. The actuary may also use clinical experience and expert opinion.

Rates within a risk classification system would be considered equitable if differences in rates reflect material differences in expected cost for risk characteristics. In the context of rates, the word *fair* is often used in place of the word *equitable*.

The actuary should consider the interdependence of risk characteristics. To the extent the actuary expects the interdependence to have a material impact on the operation of the risk classification system, the actuary should make appropriate adjustments.

Sometimes it is appropriate for the actuary to make inferences without specific demonstration. For example, it might not be necessary to demonstrate that persons with seriously impaired, uncorrected vision would represent higher risks as operators of motor vehicles.

3.2.2 Causality—While the actuary should select risk characteristics that are related to expected outcomes, it is not necessary for the actuary to establish a cause and effect relationship between the risk characteristic and expected outcome in order to use a specific risk characteristic.

3.2.3 Objectivity—The actuary should select risk characteristics that are capable of being objectively determined. A risk characteristic is objectively determinable if it is based on readily verifiable observable facts that cannot be easily manipulated. For example, a risk classification of “blindness” is not objective, whereas a risk classification of “vision corrected to no better than 20/100” is objective.

3.2.4 Practicality—The actuary’s selection of a risk characteristic should reflect the tradeoffs between practical and other relevant considerations. Practical considerations that may be relevant include, but are not limited to, the cost, time, and effort needed to evaluate the risk characteristic, the ongoing cost of administration, the acceptability of the usage of the characteristic, and the potential usage of different characteristics that would produce equivalent results.

3.2.5 Applicable Law—The actuary should consider whether compliance with applicable law creates significant limitations on the choice of risk characteristics.

3.2.6 Industry Practices—When selecting risk characteristics, the actuary should consider usual and customary risk classification practices for the type of financial or personal security system under consideration.

3.2.7 Business Practices—When selecting risk characteristics, the actuary should consider limitations created by business practices related to the financial or personal security system as known to the actuary and consider whether such limitations are likely to have a significant impact on the risk classification system.

3.3 Considerations in Establishing Risk Classes—A risk classification system assigns each risk to a risk class based on the results of measuring or observing its risk characteristics. When establishing risk classes for a financial or personal security system, the actuary should consider and document any known significant choices or judgments made, whether by the actuary or by others, with respect to the following:

3.3.1 Intended Use—The actuary should select a risk classification system that is appropriate for the intended use. Different sets of risk classes may be appropriate for different purposes. For example, when setting reserves for an insurance coverage, the actuary may choose to subdivide or combine some of the risk classes used as a basis for rates.

3.3.2 Actuarial Considerations—When establishing risk classes, the actuary should consider the following, which are often interrelated:

a. Adverse Selection—If the variation in expected outcomes within a risk class is too great, adverse selection is likely to occur. To the extent practical, the actuary should establish risk classes such that each has sufficient homogeneity with respect to expected outcomes to satisfy the purpose for which the risk classification system is intended.

b. Credibility—It is desirable that risk classes in a risk classification system be large enough to allow credible statistical inferences regarding expected outcomes. When the available data are not sufficient for this purpose, the actuary should balance considerations of predictability with considerations of homogeneity. The actuary should use professional judgment in achieving this balance.

c. Practicality—The actuary should use professional judgment in balancing the potentially conflicting objectives of accuracy and efficiency, as well as in minimizing the potential effects of adverse selection. The cost, time, and effort needed to assign risks to appropriate risk classes will increase with the number of risk classes.

3.3.3 Other Considerations—When establishing risk classes, the actuary should (a) comply with applicable law; (b) consider industry practices for that type of financial or personal security system as known to the actuary; and (c) consider limitations created by business practices of the financial or personal security system as known to the actuary.

3.3.4 Reasonableness of Results—When establishing risk classes, the actuary should consider the reasonableness of the results that proceed from the intended use of the risk classes (for example, the consistency of the patterns of rates, values, or factors among risk classes).

3.4 Testing the Risk Classification System—Upon the establishment of the risk classification system and upon subsequent review, the actuary should, if appropriate, test the long-term viability of the financial or personal security system. When performing such tests subsequent to the establishment of the risk classification system, the actuary should evaluate emerging experience and determine whether there is any significant need for change.

3.4.1 Effect of Adverse Selection—Adverse selection can potentially threaten the long-term viability of a financial or personal security system. The actuary should assess the potential effects of adverse selection that may result or have resulted from the design or implementation of the risk classification system. Whenever the effects of adverse selection are expected to be material, the actuary should, when practical, estimate the potential impact and recommend appropriate measures to mitigate the impact.

3.4.2 Risk Classes Used for Testing—The actuary should consider using a different set of risk classes for testing long-term viability than was used as the basis for determining the assigned values if this is likely to improve the meaningfulness of the tests. For example, if a risk classification system is gender-neutral, the actuary might separate the classes based on gender when performing a test of long-term viability.

3.4.3 Effect of Changes—If the risk classification system has changed, or if business or industry practices have changed, the actuary should consider testing the effects of such changes in accordance with the guidance of this standard.

3.4.4 Quantitative Analyses—Depending on the purpose, nature, and scope of the assignment, the actuary should consider performing quantitative analyses of the impact of the following to the extent they are generally known and reasonably available to the actuary:

a. significant limitations due to compliance with applicable law;

b. significant departures from industry practices;

c. significant limitations created by business practices of the financial or personal security system;

d. any changes in the risk classes or the assigned values based upon the actuary's determination that experience indicates a significant need for a change; and

e. any expected material effects of adverse selection.

3.5 Reliance on Data or Other Information Supplied by Others—When relying on data or other information supplied by others, the actuary should refer to ASOP No. 23, *Data Quality*, for guidance.

3.6 Documentation—The actuary should document the assumptions and methodologies used in designing, reviewing, or changing a risk classification system in compliance with the requirements of ASOP No. 41, *Actuarial Communications*. The actuary should also prepare and retain documentation to demonstrate compliance with the disclosure requirements of section 4.1.

Section 4. Communications and Disclosures

4.1 Communications and Disclosures—When issuing actuarial communications under this standard, the actuary should comply with ASOP Nos. 23 and 41. In addition, the actuarial communications should disclose any known significant impact resulting from the following to the extent they are generally known and reasonably available to the actuary:

a. significant limitations due to compliance with applicable law;

b. significant departures from industry practices;

c. significant limitations created by business practices related to the financial or personal security system;

d. a determination by the actuary that experience indicates a significant need for change, such as changes in the risk classes or the assigned values; and

e. expected material effects of adverse selection;

f. the disclosure in ASOP No. 41, section 4.2, if any material assumption or method was prescribed by applicable law (statutes, regulations, and other legally binding authority);

g. the disclosure in ASOP No. 41, section 4.3, if the actuary states reliance on other sources and thereby disclaims responsibility for any material assumption or method selected by a party other than the actuary; and

h the disclosure in ASOP No. 41, section 4.4, if, in the actuary's professional judgment, the actuary has otherwise deviated materially from the guidance of this ASOP.

The actuarial communications should also disclose any recommendations developed by the actuary to mitigate the potential impact of adverse selection.

Appendix 1

Background and Current Practices

Note: The following appendix is provided for informational purposes but is not part of the standard of practice.

Background

Risk classification has been a fundamental part of actuarial practice since the beginning of the profession. The financial distress and inequity that can result from ignoring the impact of differences in risk characteristics was dramatically illustrated by the failure of the nineteenth-century assessment societies, where life insurance was provided at rates that disregarded age. Failure to adhere to actuarial principles regarding risk classification for voluntary coverages can result in underutilization of the financial or personal security system by, and thus lack of coverage for, lower risk individuals, and can result in coverage at insufficient rates for higher risk individuals, which threatens the viability of the entire system.

Adverse selection may result from the design of the classification system, or may be the result of externally mandated constraints on risk classification. Classes that are overly broad may produce unexpected changes in the distribution of risk characteristics. For example, if an insurer chooses not to screen for a specific risk characteristic, or a jurisdiction precludes screening for that characteristic, this may result in individuals with the characteristic applying for coverage in greater numbers and/or amounts, leading to increased overall costs.

Risk classification is generally used to treat participants with similar risk characteristics in a consistent manner, to permit economic incentives to operate and thereby encourage widespread availability of coverage, and to protect the soundness of the system.

The following actuarial literature provides additional background and context with respect to risk classification:

1. In 1957, the Society of Actuaries published *Selection of Risks* by Pearce Shepherd and Andrew Webster, which educated several generations of actuaries and is still a useful reference.

2. In 1980, the American Academy of Actuaries published the *Risk Classification Statement of Principles*, which has enjoyed widespread acceptance in the actuarial profession. At the time of this revision of ASOP No. 12, the American Academy of Actuaries was developing a white paper regarding risk classification principles.

3. In 1992, the Committee on Actuarial Principles of the Society of Actuaries published "Principles of Actuarial Science," which discusses risk classification in the context of the principles on which actuarial science is based.

Current Practices

Over the years, a multitude of risk classification systems have been designed, put into use, and modified as a result of experience. Advances in medical science, economics, and other disciplines, as well as in actuarial science itself, are likely to result in continued evolution of these systems. While future developments cannot be foreseen with accuracy, practicing actuaries can take reasonable steps to keep abreast of emerging and current practices. These practices may vary significantly by area of practice. For example, the risk classes for voluntary life insurance may be subdivided to reflect the applicant's state of health, smoking habits, and occupation, while these factors are usually not considered in pension systems.

Innovations in risk classification systems may engender considerable controversy. The potential use of genetic tests to classify risks for life and health insurance is a current example. In some cases, such controversy results in legislation or regulation. The use of postal codes, for example, has been outlawed for some types of coverage. For the most part, however, the legal test for risk classification has remained unchanged for several decades; risk classification is allowed so long as it is "based on sound actuarial principles" and "related to actual or reasonably anticipated experience."

Risk classification issues in some instances may pose a dilemma for an actuary working in the public policy arena when political considerations support a system that contradicts to some degree practices called for in this ASOP. Also, when designing, reviewing, or changing a risk classification system, actuaries may perform professional services related to a designated set of specific assumptions that place certain restraints on the risk classification system.

In such situations, it is important for those requesting such professional services to have the benefit of professional actuarial advice.

This ASOP is not intended to prevent the actuary from performing professional services in the situations described above. In such situations, the communication and disclosure guidance in section 4.1 will be particularly pertinent, and current section 4.1(e), which requires disclosure of any known significant impact resulting from expected material effects of adverse deviation, may well apply. Section 4.1(a), which relates to applicable law, and section 4.1(b), which relates to industry practices, may also be pertinent.

Appendix 2

Comments on the Exposure Draft and Responses

The exposure draft of this revision of ASOP No. 12, *Risk Classification for All Practice Areas*, was issued in September 2004 with a comment deadline of March 15, 2005. Twenty-two comment letters were received, some of which were submitted on behalf of multiple commentators, such as by firms or committees. For purposes of this appendix, the term "commentator" may refer to more than one person associated with a particular comment letter. The task force carefully considered all comments received. Summarized below are the significant issues and questions contained in the comment letters and the responses, which may have resulted from ASB, General Committee, or task force discussion. Unless otherwise noted, the section numbers and titles used below refer to those in the exposure draft.

GENERAL COMMENTS	
Comment	Several commentators suggested various editorial changes in addition to those addressed specifically below.
Response	The task force implemented such suggestions if they enhanced clarity and did not alter the intent of the section.
Comment	One commentator noted that the ASOP should deal with the ability of an insured to misrepresent or manipulate its classification.
Response	The task force believed that the considerations raised by the commentator are adequately addressed by sections 3.2.3 and 3.2.4.
Comment	One commentator thought that a section on public and social policy considerations should be added to the standard.
Response	The task force believed that social and public policy considerations, while essential aspects of the way the public views the profession, did not belong in an ASOP dealing with the actuarial aspects of risk classification.
Comment	One commentator questioned whether the ASOP would apply to company selection criteria (tiering criteria) and schedule-rating criteria that may be part of a rating scheme.
Response	The task force believes that the ASOP applies to the extent the selection or schedule rating criteria, used by a company as part of the risk classification system, creates the potential for adverse selection.
Comment	One commentator believed that the ASOP could conflict with proposed state legislation to ban credit as a rating variable and suggested adding an additional consideration in section 3 that the actuary should select risk characteristics in order to avoid controversy or lawsuits.
Response	The task force believes it has addressed issues regarding applicable law, industry practices, business practices, and testing the risk classification system under various scenarios.
Comment	In the transmittal memorandum of the exposure draft, the task force asked whether the key changes from the previous standard were appropriate.
Response	Several commentators responded that the changes were appropriate and some suggested additional changes that are discussed in this appendix.

Comment	One commentator expressed concern regarding the expansion of scope and the implications in actuarial work that would be otherwise unrelated to risk classification and the expansion of scope to the public policy arena in general.
Response	The task force has added modified wording in the standard to clarify that in all cases the standard applies only in respect to design, reviewing, or changing risk classification systems related to financial or personal security systems.
Comment	Two commentators believed that the revised standard should discuss the purposes of risk classification similar to the discussion in the previous standard. One commentator noted the discussion about encouraging “widespread availability of coverage” in particular.
Response	The task force retained a brief discussion of the purposes of risk classification in appendix 1 but did not believe it was appropriate for the ASOP to provide additional education about the purposes of risk classification. The task force noted that a white paper on risk classification that could contain such material is being developed.
Comment	Several commentators noted that the previous ASOP No. 12 had been very useful in court proceedings and recommended that the task force retain some of the wording in section 5 of the previous ASOP. One commentator suggested strengthening the revised standard so that actuarial testimony would be given greater weight by the courts in interpreting rate standards. Another commentator suggested strengthening the ASOP by adding an explicit statement that one objective during the development and use of risk classification systems is to minimize adverse selection.
Response	The task force reviewed the revised standard with these concerns in mind but concluded that the revised standard represents current generally accepted practice and provides an appropriate level of guidance. The task force considered the specific suggestions with respect to additional wording and incorporated some of the wording regarding adverse selection from the old section 5.5 into appendix 1.
Comment	In the transmittal memorandum of the exposure draft, the task force asked whether it was appropriate for the ASOP not to use the terms “equitable” and “fair.” Two commentators believed that the ASOP should use or define these concepts because they have been used in court proceedings, but the majority of commentators believed that it was appropriate not to define them and that the standard adequately addressed these concepts.
Response	The task force agreed that the ASOP should not define subjective qualities such as “equitable” and “fair.” As the result of ASB deliberation on this issue, language was added to section 3.2.1 to discuss what was meant by the terms “equitable” and “fair.” These terms are intended to apply to a risk classification system only to the extent the risk classification system applies to rates. As such, a formal definition was not added. Court decisions notwithstanding, there is no general agreement as to what characterizes “equitable” classification systems or “fair” discrimination. The task force also considered the possibility that further discussions about such issues might become part of the proposed white paper on risk classification that the American Academy of Actuaries is developing.
Comment	One commentator questioned why the standard offered separate guidance for “risk characteristics” (section 3.2) and “risk classes” (section 3.3). Another commentator believed there should be greater differentiation between the concepts of “risk characteristic” and “risk classification.”
Response	The task force believed that the ASOP uses these terms appropriately and made no change.
Comment	One commentator thought that section 3.3.2 should include guidance on appropriately matching the risk with the outcome when establishing a risk class.
Response	The task force believed that section 3.2.1 addressed this comment and noted that section 3.3.2(a) requires sufficient homogeneity with respect to outcomes.

Section 1.2, Scope	
Comment	In the transmittal memorandum of the exposure draft, the task force asked whether it was appropriate to include the actuary's advice within the scope of the standard. Several commentators agreed that including guidance on actuarial advice was appropriate. One commentator believed that the disclosure requirements in section 4 could be burdensome to an actuary who has provided brief oral advice.
Response	The task force kept actuarial advice within the scope of the standard and intended that the disclosure requirements in section 4 should apply to any actuarial advice that falls within the scope of the standard.
Comment	One commentator questioned what was meant by "legislative activities" as an example of a professional service.
Response	The task force intended that "legislative activities" could include drafting legislation, for example.
Comment	Several commentators questioned the meaning of "personal security system." One commentator questioned whether the definition of "financial or personal security system" would exclude share-based payment systems from the scope of the standard. The commentator recommended that the standard be revised to include such systems.
Response	The task force intended that the ASOP should apply if share-based payment systems or stock options were part of a financial or personal security system, as defined in the section 2.5. If such plans were not part of a financial or personal security system, the ASOP would not apply. The task force chose not to expand the scope to include such plans in all situations but did clarify the definition of "financial or personal security system."
SECTION 2. DEFINITIONS	
Comment	One commentator suggested that a definition of experience be included, citing the definition of "experience" in the previous ASOP (old section 2.5), which includes the wording, "Experience may include estimates where data are incomplete or insufficient."
Response	The task force agreed that experience may include estimates where data are incomplete or insufficient but did not believe that the old definition was necessary in the revised ASOP.
Comment	One commentator suggested that a definition of "reasonable" be included.
Response	The task force disagreed and did not add a definition of "reasonable."
Section 2.1, Advice	
Comment	One commentator suggested that "other work product" was not needed, since the standard already listed "an actuary's oral, written, or electronic communication."
Response	The task force revised the language to clarify that "communication or other work product" was intended.
Comment	One commentator believed that a definition for "advice" is not needed.
Response	The task force disagreed and retained the definition of advice.
Section 2.2, Adverse Selection	
Comment	In the transmittal memorandum of the exposure draft, the task force asked if the definition of "adverse selection" was appropriate or whether an alternative definition (included in the transmittal letter) would be preferable. Many commentators responded, some agreeing with the original, some with the alternative, and some suggested other wording. The other wording was most often to change the phrase, "take financial advantage of."
Response	The task force believed that some of the reasoning on the part of the commentators who preferred the current version did not accurately describe adverse selection. The task force ultimately decided to use the alternative definition in the standard and believed that it better addressed some commentators' concerns that the other definition could have a negative connotation with respect to motivation.

Comment Response	One commentator suggested that "antiselection" is synonymous with adverse selection and that should be made clear in the definition. The task force agreed and added that reference.
Section 2.4, Credibility (now 2.3)	
Comment Response	Two commentators believed that within the definition of "credibility" the language concerning "predictive" was confusing. The task force retained the definition as it is used in several other ASOPs.
Section 2.5, Financial or Personal Security System (now 2.4)	
Comment Response	Several commentators questioned the meaning of "personal security system." The task force clarified the definition.
Comment Response	One commentator suggested that "impact" be modified to read "financial impact." The task force disagreed and revised the definition of "financial and security systems" to delineate the impacts.
Section 2.6, Homogeneity (now 2.5)	
Comment Response	One commentator believed the definition of "homogeneity" needed revisions to include the concept of grouping similar risks. Another commentator found the definition unclear. The task force believes that the current definition is appropriate for this ASOP.
Section 2.7, Practical (now 2.6)	
Comment Response	One commentator believed the definition of "practical" was much too broad and needed to be more actuarial in nature. Alternatively, the commentator suggested dropping it and relying on section 3.2.4. The task force believed the definition was appropriate and made no change. Section 3.2.4 addresses actuarial practice with respect to practicality. While "practical" is used there and in other places, it is always modified by its context.
Section 2.8, Risk(s) (now 2.7)	
Comment Response	One commentator suggested that the definition of risks as individuals or entities seemed too limiting and noted that covered risks can also include pieces of property or events. The task force disagreed, believing that "entity" could encompass property and events.
Comment Response	One commentator suggested that a unit of risk be defined at the basic unit of risk. The task force disagreed and made no change.
Section 2.9, Risk Characteristics (now 2.8)	
Comment Response	One commentator suggested defining risk characteristics as "measurable or observable factors or characteristics, each of which is measured by grouping similar risks into risk classes." The task force disagreed and made no change.
Section 2.11, Risk Classification System (now 2.10)	
Comment Response	One commentator believes the definition of "risk classification system" is circular since "classify" is used in the definition. The task force agreed and revised the wording.
Comment Response	One commentator recommended that the term "risks" be changed to "similar risks" in this definition just as in the old definition of risk classification that used the phrase "grouping risks with similar risk characteristics." The task force disagreed and made no change.
Comment Response	One commentator suggested replacing "groups" with "classes." The task force disagreed and made no change.

SECTION 3. ANALYSIS OF ISSUES AND RECOMMENDED PRACTICES	
Section 3.2.1, Relationship of Risk Characteristics and Expected Outcomes	
Comment Response	One commentator expressed concern with the standard's differentiation between the section's quantitative and subjective factors. The task force did not intend to be prescriptive as to how to quantify the ratings scheme and believed that the ASOP was sufficiently specific. The ASOP does not address rate adequacy. Selection is the focus, not quantification.
Comment Response	One commentator believed that "clinical" was not an appropriate adjective to describe the experience an actuary is allowed to use. The task force intentionally used the term "clinical."
Comment Response	One commentator believed that if the classification cannot be measured by actual insurance data, then it is not really a risk classification system. The task force disagreed and made no change.
Comment Response	One commentator suggested that the three points addressing why risk classification is generally used be moved to background information. The task force agreed that such educational language was more appropriate in an appendix than in the body of the ASOP and has moved it.
Comment Response	One commentator believed that it may be difficult to deal with the process and procedures involved with considering the interdependence of risk characteristics and their potential impact on the operation of the risk classification system. The task force did not change the language to address this comment but notes that section 3.2.4 addresses considerations regarding practicality.
Section 3.2.2, Causality	
Comment Response	A number of commentators expressed concern with establishing a cause-and-effect relationship while others thought the standard did not go far enough in this regard. The task force agreed that, where there is a demonstrable cause-and-effect relationship between a risk characteristic and the expected outcome, it is appropriate for the actuary to include such a demonstration. However, the task force recognized that there can be significant relationships between risk characteristics and expected outcomes where a cause-and-effect relationship cannot be demonstrated.
Section 3.2.4, Practicality	
Comment Response	Two commentators suggested the use of examples of practical considerations. The task force revised the section to indicate that the language shows examples of practical considerations.
Comment Response	One commentator suggested that "theoretical," as used in section 3.2.4, be defined. The task force replaced "theoretical" with "other relevant."
Section 3.2.5, Applicable Law	
Comment Response	One commentator thought that the proposed language in this section was much too broad. The task force disagreed with the comment and made no change.

Section 3.3, Considerations in Establishing Risk Classes	
Comment	One commentator expressed concern that the documentation requirements for these considerations represented an increase from the previous version.
Response	The task force thought the documentation requirements were appropriate and necessary and made no change.
Section 3.3.1, Intended Use	
Comment	One commentator noted that stratifying data sets in loss reserving is different from risk classification, which is done to price risks, and believed that loss reserving permits more flexibility. The commentator stated that the definition of a risk classification system does not apply to loss reserving.
Response	The task force agreed with the first concepts but disagreed with the final sentence and therefore made no change.
Section 3.3.2, Actuarial Considerations	
Comment	With respect to section 3.3.2(a), one commentator suggested replacing the word “for” in the first line with “within” for clarification.
Response	The task force agreed and made the suggested change.
Comment	With respect to section 3.3.2(b), two commentators questioned what was intended by the use of the term “large enough.”
Response	The task force believed the language was sufficiently clear and made no change.
Comment	One commentator pointed out that there are often classes that, individually, have associated experience with low statistical credibility and believed that alternatives to credibility should be included in section 3.3.2(b).
Response	While the task force agreed that there are situations in which actuarially sound classification plans will have individual classes where the experience has low statistical credibility, the task force believed that credibility is a desirable characteristic of risk classes within a risk classification system and that no expansion to include alternatives was necessary.
Comment	One commentator suggested replacing “statistical predictions” with “predictions” in section 3.3.2(b) to avoid the implication that underlying statistics were required. Another commentator suggested that the term “predictions” needed explanation.
Response	The task force agreed with these comments and replaced “predictions” with “inferences” and edited the language to improve its clarity.
Comment	One commentator suggested that the last sentence of section 3.3.2(b), while accurate, was irrelevant.
Response	The task force agreed and eliminated the sentence.
Comment	With respect to section 3.3.2(c), one commentator suggested the need for definitions of “accuracy” and “efficiency.”
Response	The task force believed that the existing language regarding the actuary’s professional judgment was sufficient in determining the meaning of “accuracy” and “efficiency” and did not add a definition of either word.

Comment	Several commentators suggested that section 3.3.2(d) be eliminated. A number of those commentators also pointed out that the language was both inconsistent with current actuarial practice and inappropriate as an implied requirement.
Response	The task force agreed and deleted the section.
Section 3.3.3, Other Considerations	
Comment	Several commentators pointed out that the last sentence of the section was unclear and might inadvertently require a degree of testing and determination that was not intended.
Response	The task force deleted the last sentence of the section. In addition, section 4.1, Communications and Disclosures, was clarified as to what disclosures are appropriate.
Section 3.3.4, Reasonableness of Results	
Comment	One commentator found the parenthetical wording confusing.
Response	The task force believed the examples were appropriate and made no change.
Comment	One commentator found this section ambiguous in the context of establishing risk classes. Another commentator suggested that a cost-based definition of reasonable be added or that the section be deleted entirely.
Response	The task force retained the section but clarified the wording by mentioning the intended use of the risk classes. The task force did not believe additional clarification of "reasonableness" was necessary because reasonableness is a subjective concept that may depend on the actuary's professional judgment. The task force also notes that the *Introduction to the Actuarial Standards of Practice* discusses this concept in further detail.
Section 3.4, Testing the Risk Classification System	
Comment	One commentator indicated that it may be preferable to substitute the word "or" for "and" on the second line so that the sentence reads, "Upon establishment of the risk classification system or upon subsequent review. … "
Response	The task force did not agree and believed the word "and" was appropriate because testing should be carried out both upon establishment and upon subsequent review.
Comment	One commentator wanted to substitute "continuing" for "long-term" viability in the second line. The commentator believed that the usual issue is the current and near-future viability of a system, not its long-term prognosis. Also, another commentator said that the requirement to "test long-term viability" is new and questioned its meaning.
Response	The task force considered alternative wording but ultimately decided that the existing wording best reflected that the actuary should check the risk classification system for viability both in the short-term and in the long-term.

Comment Response	One commentator believed that testing the system is set out as something the actuary should do, if appropriate, rather than as something the actuary should consider. The commentator believed that the paragraph implied a duty to test in some situations, without describing explicitly what those situations would be (i.e., when testing would be "appropriate"). The commentator suspected that the situations described in sections 3.4.1–3.4.3 were the kind of situations that the task force had in mind as situations where long-term testing would be "appropriate." However, as currently written, the commentator thought that a stronger duty could be implied. The commentator suggested that section 3.4 itself should read, "…the actuary should consider testing the long-term viability of the risk classification system. …" The task force believed that the existing wording conveyed the concept that the actuary considers whether testing is appropriate and made no change.
Section 3.5, Reliance on Data Supplied by Others (now Reliance on Data or Other Information Supplied by Others)	
Comment Response	One commentator believed that the provision for reliance on data supplied by others was not needed in this ASOP because ASOP No. 23, *Data Quality*, addresses this. This task force agreed and revised the section to refer to ASOP No. 23, using wording consistent with other recently adopted ASOPs and exposure drafts.
SECTION 4. COMMUNICATIONS AND DISLOSURES	
Section 4.1, Communications (now Communications and Disclosures)	
Comment Response	One commentator suggested changing the phrase "when issuing actuarial communications under this standard" to "when issuing actuarial communications that include elements of actuarial work within the scope of this standard." The task force retained the original language to be consistent with other ASOPs.
Section 4.2, Disclosures (now 4.1, Communications and Disclosures)	
Comment Response	One commentator stated that some of the disclosures, notably section 4.2(a) and 4.2(c) (now 4.1(a) and 4.1(c)), are impractical, since they might require the actuary to begin with the universe and then disclose everything that is not utilized. The commentator suggested replacing these disclosure requirements with a communication that defends the choice of risk classification system and notes in that defense how compliance with applicable law and business practices affected the selection, rather than describing all the alternatives that would have been available in the absence of such constraints. The task force did not agree that the requirement to disclose significant limitations required a discussion of all alternatives that would have been available in the absence of legal or business constraints. The task force noted that the listed disclosures proceed from considerations required in section 3 and modified the wording of the disclosure requirements to be more consistent with that section, including revising the lead-in sentence to require disclosure of the significant impact of such considerations.
Comment Response	One commentator stated that the disclosure issue is heightened by the expansion of scope into the public policy arena and stated that excessive disclosure requirements may weaken the actuary's ability to influence the discussion of public policy. The task force disagreed with the comment and noted that, while the scope of the standard now includes regulatory activities, legislative activities, and statements regarding public policy, the scope does so only in the context of the performance of professional services.

Comment	One commentator suggested deleting section 4.2(a) (now 4.1(a)), which requires disclosure of significant limitations due to compliance with applicable law, noting that other ASOPs have tended not to include this requirement except where the limitations seriously distort the work product.
Response	The task force disagreed with this comment, noting that significant limitations on the choice of risk characteristics are likely to distort the risk classification system and therefore should be disclosed.
Comment	Several commentators expressed opinions regarding the requirement that the actuary should disclose whether quantitative analyses were performed relative to items being disclosed. One commentator expressed strong objection to this requirement, asserting that the requirement would be counter-productive and would reduce the number of quantitative analyses being done. Another commentator agreed and noted that the disclosure issue was heightened by the expansion of scope to the public policy arena, where an advocacy position may be taken. A third commentator objected to the requirement to disclose that quantitative analyses were *not* done but suggested requiring that any analyses that were done be summarized. A fourth commentator suggested exempting certain of the required disclosures from the requirement to consider quantification. A fifth commentator pointed out that, while the actuary was required to disclose whether quantitative analyses were performed, the actuary was only required to consider providing the results of those analyses in the disclosure.
Response	The disclosure requirement for the actuary to consider providing quantitative analyses of the impact of the items being disclosed was removed, and instead similar wording was added as a new section 3.4.4, Quantitative Analyses, which guides the actuary to consider performing such analyses, depending on the purpose, nature, and scope of the assignment.
Comment	In the transmittal letter for the exposure draft in request for comment #6, the task force asked whether there were any situations in which the requirement in section 4.2(c) (now 4.1(c)) to disclose any significant limitations created by business practices of the financial or personal security system would not be appropriate. Two comments were received, both agreeing with the appropriateness of the requirement.
Response	The task force retained the requirement.
Comment	Two commentators suggested substituting “indicates” for “creates” in section 4.2(d) (now 4.1(d)).
Response	The task force agreed, changed the wording as suggested, and made other revisions for clarity.
Comment	In the transmittal letter for the exposure draft in request for comment #7, the task force asked whether the requirement in 4.2(e) (now 4.1(e)) to disclose the effects of adverse selection was appropriate. Three commentators addressed this request for comment, and all agreed the requirement was appropriate. However, one commentator suggested that there be no requirement to quantify the impact.
Response	The task force retained the requirement in what is now 4.1(e) and also removed the requirement to consider providing quantitative analyses. Additionally, the task force deleted section 4.2(f) after determining that it was already covered by ASOP No. 41, Actuarial Communications, to which section 4.1 refers.
APPENDIX (now Appendix 1)	
Comment	One commentator expressed concern with the citing of the textbook *Selection of Risks* by Shepherd and Webster.
Response	The task force believed that citing the Shepherd and Webster book was appropriate but added a new lead-in sentence to the citation to indicate that the references cited provide additional background and context with respect to risk classification.

ACTUARIAL STANDARDS BOARD

Actuarial Standard
of Practice
No. 13

Trending Procedures in Property/Casualty Insurance

Revised Edition

Developed by the
Subcommittee on Ratemaking of the
Casualty Committee of the
Actuarial Standards Board

Adopted by the
Actuarial Standards Board
June 2009
Updated for Deviation Language Effective May 1, 2011

(Doc. No. 133)

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June 2009

TO: Members of Actuarial Organizations Governed by the Standards of the Actuarial Standards Board and Other Persons Interested in Trending Procedures in Property/Casualty Insurance

FROM: Actuarial Standards Board (ASB)

SUBJ: Actuarial Standard of Practice (ASOP) No. 13

This document contains the final version of the revision of ASOP No. 13, *Trending Procedures in Property/Casualty Insurance*.

Background

The existing ASOP No. 13, *Trending Procedures in Property/Casualty Insurance Ratemaking*, was developed by the Subcommittee on Ratemaking of the Casualty Committee in July 1989 and adopted by the ASB in July 1990. Since the promulgation of the original standard, developments in trending procedures have continued, and the use of trending in non ratemaking areas has become more widespread. The Subcommittee prepared this revision of ASOP No. 13 to reflect appropriate actuarial practice with respect to trending procedures in property/casualty insurance and to be consistent with the current ASOP format. Further, this proposed revision expands guidance on the application of trend procedures beyond ratemaking to include reserving, valuations, underwriting, and marketing analyses.

Exposure Draft

The exposure draft of this revision was issued in January 2008 with a comment deadline of May 1, 2008. The Subcommittee on Ratemaking carefully considered the thirteen comment letters received and made changes to the language in several sections in response. For a summary of the substantive issues contained in the exposure draft comment letters and the responses, please see appendix 2.

The most significant changes from the exposure draft were as follows:

1. Section 1.2, Scope and section 2.6, Trending Procedure, were revised to indicate that, for the purpose of this standard, trending does not encompass the process commonly referred to as "development."

2. Section 4.1, Actuarial Communication, and section 4.2, Additional Disclosures, have been revised to indicate that the actuary needs to make specific disclosures when certain aspects of the trend procedure have a material effect on the result or conclusions of the actuary's overall analysis.

The ASB voted in June 2009 to adopt this standard.

The ASB establishes and improves standards of actuarial practice. These ASOPs identify what the actuary should consider, document, and disclose when performing an actuarial assignment. The ASB's goal is to set standards for appropriate practice for the U.S.

ACTUARIAL STANDARD OF PRACTICE NO. 13

TRENDING PROCEDURES IN PROPERTY/CASUALTY INSURANCE

STANDARD OF PRACTICE

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose—This actuarial standard of practice (ASOP) provides guidance to actuaries when performing professional services using trending procedures to estimate future values.

1.2 Scope—This standard applies to actuaries when performing professional services to estimate future values using trending procedures for all property/casualty coverages. This includes work performed for insurance or reinsurance companies, and other property/casualty risk financing systems that provide similar coverage, such as self insurance.

For purposes of this standard, a trending procedure does not encompass the process commonly referred to as "development," which estimates changes over time in losses (or other items) within a given exposure period (for example, accident year or underwriting year).

If the actuary departs from the guidance set forth in this standard in order to comply with applicable law (statutes, regulations, and other legally binding authority), or for any other reason the actuary deems appropriate, the actuary should refer to section 4.

1.3 Cross References—When this standard refers to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called. If any amended or restated document differs materially from the originally referenced document, the actuary should consider the guidance in this standard to the extent it is applicable and appropriate.

1.4 Effective Date—This standard is effective for actuarial services performed on or after November 1, 2009.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice.

2.1 Coverage—The terms and conditions of a plan or contract, or the requirements of applicable law, that create an obligation for claim payment associated with contingent events.

2.2 Experience Period—The period of time to which historical data used for actuarial analysis pertain.

2.3 Forecast Period—The future time period to which the historical data are projected.

2.4 Social Influences—The impact on insurance costs of societal changes such as changes in claim consciousness, court practices, and legal precedents, as well as in other noneconomic factors.

2.5 Trending Period—The time over which trend is applied in projecting from the experience period to the forecast period.

2.6 Trending Procedure—A process by which the actuary evaluates how changes over time affect items such as claim costs, claim frequencies, expenses, exposures, premiums, retention rates, marketing/solicitation response rates, and economic indices. Trending procedures estimate future values by analyzing changes between exposure periods (for example, accident years or underwriting years). A trending procedure does not encompass the process commonly referred to as "development," which estimates changes over time in losses (or other items) within a given exposure period.

Section 3. Analysis of Issues and Recommended Practices

3.1 Purpose or Use of Trending Procedures—Trending is an important component in many analyses performed by actuaries including, but not limited to, ratemaking, reserving, valuations, underwriting, and marketing. The actuary should identify the intended purpose or use of the trending procedure. The actuary should apply trending procedures that are appropriate for the applicable purpose or use.

Where multiple purposes or uses are intended, the actuary should consider the potential conflicts arising from those multiple purposes or uses and should consider adjustments to accommodate the multiple purposes or uses to the extent that, in the actuary's professional judgment, it is appropriate and practical to make such adjustments.

The actuary may present the trend estimate resulting from the trending procedure in a variety of ways, such as a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the trend estimate. The actuary should consider the intended purpose or use of the trend estimate when deciding how to present the trend estimate.

3.2 Historical Insurance and Non-Insurance Data—The actuary should select data appropriate for the trends being analyzed. The data can consist of historical insurance or non-insurance information. When selecting data, the actuary should consider the following:

a. the credibility assigned to the data by the actuary;

b. the time period for which the data is available;

c. the relationship to the items being trended; and

d. the effect of known biases or distortions on the data relied upon (for example, the impact of catastrophic influences, seasonality, coverage changes, nonrecurring events, claim practices, and distributional changes in deductibles, types of risks, and policy limits).

3.3 Economic and Social Influences—The actuary should consider economic and social influences that can have a significant impact on trends in selecting the appropriate data to review, the trending calculation, and the trending procedure. In addition, the actuary should consider the timing of the various influences.

3.4 Selection of Trending Procedures—The actuary should select trending procedures after appropriate consideration of available data. In selecting these procedures, the actuary may consider relevant information such as the following:

a. procedures established by precedent or common usage in the actuarial profession;

b. procedures used in previous analyses;

c. procedures that predict insurance trends based on insurance, econometric, and other non-insurance data; and

d. the context in which the trend estimate is used in the overall analysis.

3.5 Criteria for Determining Trending Period—The actuary should consider both the lengths of the experience and forecast periods, and changes in the mix of data between the experience and forecast periods when determining the trending period. When incorporating non-insurance data in the trending procedure, the actuary should consider the timing relationships among the non-insurance data, historical insurance data, and the future values being estimated.

3.6 Evaluation of Trending Procedures—The actuary should evaluate the results produced by each selected trending procedure for reasonableness and revise the procedure where appropriate.

3.7 Reliance on Data or Other Information Supplied by Others—When relying on data or other information supplied by others, the actuary should refer to ASOP No. 23, *Data Quality*, for guidance.

3.8 Documentation—The actuary should prepare and retain appropriate documentation regarding the methods, assumptions, procedures, and the sources of the data used. The documentation should be in a form such that another actuary qualified in the same practice area could assess the reasonableness of the actuary's work, and should be sufficient to comply with the disclosure requirements in section 4.

Section 4. Communications and Disclosures

4.1 Actuarial Communication—When issuing an actuarial communication subject to this standard, the actuary should refer to ASOP Nos. 23 and 41, *Actuarial Communications*. In addition, the actuary should disclose the following, as applicable, in an actuarial communication:

a. the intended purpose(s) or use(s) of the trending procedure, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses, if any, as described in section 3.1;

b. significant adjustments to the data or assumptions in the trend procedure, that may have a material impact on the result or conclusions of the actuary's overall analysis;

c. the disclosure in ASOP No. 41, *Actuarial Communications*, section 4.2, if any material assumption or method was prescribed by applicable law (statutes, regulations, and other legally binding authority);

d. the disclosure in ASOP No. 41, section 4.3, if the actuary states reliance on other sources and thereby disclaims responsibility for any material assumption or method selected by a party other than the actuary; and

e. the disclosure in ASOP No. 41, section 4.4, if, in the actuary's professional judgment, the actuary has otherwise deviated materially from the guidance of this ASOP.

4.2 Additional Disclosures—In certain cases, consistent with the intended purpose or use, the actuary may need to make the following disclosures in addition to those in section 4.1:

a. When the actuary specifies a range of trend estimates, the actuary should disclose the basis of the range provided.

b. The actuary should disclose changes to assumptions, procedures, methods or models that the actuary believes might materially affect the actuary's results or conclusions as compared to those used in a prior analysis, if any, performed for the same purpose.

Appendix 1

Background and Current Practices

Background

Recognition of the significance of trend in many property/casualty analyses and difficulty of discerning turning points has led to a need for increasingly sophisticated trending procedures. Publications of the CAS such as *Variance* and the *Syllabus of Examinations,* and many other publications such as statistics and economics textbooks, provide extensive information on alternative procedures. The actuary may refer to these or develop other procedures, as appropriate for each situation.

Current Practices

Trending procedures are used in ratemaking, reserving, valuation, underwriting, and marketing for most property/casualty insurance plans or policies. In such procedures, actuaries generally place reliance on (1) data generated by the book of business being analyzed, (2) other insurance data, and (3) non-insurance data, in that order of preference. Mathematical techniques are often used to smooth and extrapolate from historical data. In the absence of strong contrary indications, there is a reliance on extrapolations of historical insurance data. Procedures based on non-insurance data are also used. In trending procedures, judgmental considerations generally include, but are not limited to, the historical data used, the success of these techniques in making prior projections, the statistical goodness of fit of the techniques to the historical data, and the impact of any sudden, nonrecurring changes (for example, tort reform) which had not yet been incorporated in the historical data.

Appendix 2

Comments on the Exposure Draft and Responses

The exposure draft of this ASOP, *Trending Procedures in Property/Casualty Insurance*, was issued in January 2008 with a comment deadline of May 1, 2008. Thirteen comment letters were received, some of which were submitted on behalf of multiple commentators, such as by firms or committees. For purposes of this appendix, the term "commentator" may refer to more than one person associated with a particular comment letter. The Subcommittee on Ratemaking carefully considered all comments received, and the Casualty Committee and ASB reviewed (and modified, where appropriate) the proposed changes.

Summarized below are the significant issues and questions contained in the comment letters and the responses.

The term "reviewers" in appendix 2 includes the subcommittee, the Casualty Committee, and the ASB. Unless otherwise noted, the section numbers and titles used in appendix 2 refer to those in the exposure draft.

GENERAL COMMENTS	
Comment	One commentator stated that the concept of trending is applicable to all actuaries and any ASOP that's created should serve as a single source of professional guidance. The commentator therefore suggested the ASOP title be changed to "Trending Procedures" and that the document be reviewed to make sure it covers all actuarial practice areas (rather than develop separate ASOPs for each area).
Response	The reviewers believe the uses of "trend" can vary among practice areas and that this ASOP is specific to situations that impact property/casualty insurance. The approach taken in other areas has been to incorporate trending as needed in task specific ASOPs.
Comment	Several commentators expressed concern that this standard unintentionally covered reserving practices already subject to ASOP No. 43, *Property/Casualty Unpaid Claim Estimates*. The concern was the inclusion of reserving practices commonly known as "loss development."
Response	The reviewers agreed that there was a need to carve out "loss development." However, the reviewers wanted to ensure that other uses of trend in a reserving context (examples include Cape Cod, Bornhuetter Ferguson, and frequency/severity methods) were included in this standard. The reviewers added language to section 1.2, Scope and section 2.6, Trending Procedure to achieve the goal of carving out "development," but not the other uses of trend in reserving. In other words, changes between exposure periods are included under this standard but not changes within an exposure period. The term "development" is used rather than "loss development" to recognize that development triangles are also applied to premiums and other components.

Comment Response	One commentator stated there are many individual assumptions in actuarial work—the most obvious example being loss development factors—that are not the subject of a separate standard. The commentator also stated he didn't feel "trend" was important enough to warrant its own standard and that consideration should be given to greatly broadening the standard (or combining it with another one) to create one standard encompassing all, for example, "Selection of Actuarial Assumptions in Estimation of Ultimate Losses for Casualty Projections." The reviewers believe that trend is important enough to warrant its own standard, and note that ASOP Nos. 12, 25, 29, 30, 38, and 39, in addition to 13, address many different aspects of ratemaking.
Comment Response	Several commentators requested specific guidance on the many problems facing actuaries when trending, such as selecting regression models, extrapolation, statistical methods, etc. The reviewers believe it is not the purpose of the standard to provide specific procedures and that it is too difficult to keep a standard up to date with specific procedures.
SECTION 2. DEFINITIONS	
Section 2.2, Experience Period	
Comment Response	One commentator suggested changing "to" to "from" and "pertain" to "was obtained" in the definition stating he sees the experience period as being the source of data for the forecast period. The reviewers believe revising the language would make it less clear and did not make the change.
Section 2.5, Trending Period	
Comment Response	One commentator suggested that ASOP No. 13 give a more fundamental definition of the trending period and that the description of the simple calculation of the trending period be moved to section 3.5, Criteria for Determining Trending Period. In addition, the commentator suggested the definition of "trending period" be rewritten to, "the time over which trend is applied in projecting from the experience period to the forecast period." The reviewers modified the definition to reflect the suggested language, but did not agree with the suggestion to move the simple calculation to section 3.5 Criteria for Determining Trending Period.
Section 2.6, Trending Procedure	
Comment Response	One commentator stated that in the definition of "trending procedures," reference is made to "response rates" and "conversion/issue rates," and suggested that these terms be separately defined as they have meaning that may not be readily apparent. The reviewers agreed that these terms may have meaning that is not readily apparent and removed them from the definition as they were meant to be illustrative of items that might be the subject of trend analysis. These examples were replaced by the example of marketing/solicitation response rates.
Comment Response	One commentator suggested modifying the definition to "a process by which the actuary evaluates how changes over time may affect items such as…." The reviewers disagreed with adding the word "may" and left the definition unchanged.

SECTION 3. ANALYSIS OF ISSUES AND RECOMMENDED PRACTICES	
Section 3.1, Purpose or Use of Trending Procedures	
Comment Response	One commentator stated that mention should be made (for example, in section 3.4, Selection of Trending Procedures) of specific situations that may require stochastic trending procedures or, at the very least, consideration of multiple scenarios. In addition, the commentator stated it would not be wise to evaluate reinvestment risk based on a single projection of future interest rates noting that interest rates are an economic index for purposes of section 2.6, Trending Procedures, and thus projection of future interest rates would be subject to this standard. If such was not intended, then the phrase "economic index" should be clarified so as to restrict its meaning. The reviewers added a new paragraph in section 3.1 to recognize that a range or probability distribution of trend estimates may be appropriate.
Comment Response	One commentator was concerned whether a marketing analysis conducted by an actuary is truly an actuarial work product. The reviewers believe if an actuary is applying trending methodologies to marketing, then the standard should apply. This is one of the reasons the standard is being expanded beyond ratemaking.
Section 3.2, Historical Insurance and Non-Insurance Data	
Comment Response	One commentator believed it would be appropriate to add language such as, "In situations where non-insurance data is being used, the actuary should determine and document the causal relationship between the non-insurance data being used and the event or value being forecasted" to clarify this section. The reviewers disagreed and did not change the language because establishing a causal relationship is not a requirement for use of non-insurance data.
Comment Response	One commentator suggested modifying this section to read, "The actuary should select available data appropriate for the trends being analyzed. The data can consist of historical insurance or non-insurance information. Considerations should include…." The reviewers did not add the word "available" to the language but did remove the word "other" per the commentator's suggestion.
Comment Response	One commentator suggested that the proposed revised ASOP suffers from the complete absence of any mention of "operational influences," stating that trends in observed values as a result of operational changes are very common in marketing and reserving, for example, and suggested language to its effect be added. The reviewers considered operational influences, as reflected in the examples given in this section 3.2 and added "claim practices."
Comment Response	One commentator stated that section 3.2(c) was unclear in stating what actuaries are expected to consider. The commentator also stated that he didn't see how the difference between "explanatory value" and "predictive value" of the data might lead to any change in trending procedure and recommended either removing this section or else providing additional clarification as to its intent. The reviewers modified the language in section 3.2(c) to clarify the intent.

Comment Response	One commentator suggested including a section 3.2(e), which would state the following: e. the data that is used for trending and the data that it is being applied to. The reviewers did not add a 3.2 (e) but modified the existing 3.2 (c) to read as follows: c. relationship with items being trended; and
Comment Response	One commentator stated that the first paragraph of this section uses the adjective "historical" to modify "insurance and non-insurance data," which can be interpreted as implicitly prohibiting procedures that blend historic data with projections acquired from external parties and recommend that "historical" be removed. The reviewers did not agree and therefore did not modify the language.
Section 3.3, Economic and Social Influences	
Comment Response	One commentator stated that the sentence, "It is inappropriate to analyze only those factors that have an impact on trend in one direction," be revised to read, "It is inappropriate to consider for analysis only those factors that have an impact on trend in one direction," stating that certain factors do not lend themselves to rigorous analysis, and the remaining factors could potentially impact the trend only in one direction. The reviewers agreed and deleted the sentence instead.
Comment Response	One commentator believed the comment about "avoidance of bias" is oddly placed and believes if such a comment is needed, it should be promoted to a more prominent, generally applicable place so as to indicate that biases should be avoided wherever they are found, not just in the consideration of economic factors. The reviewers agreed, believing that this is a very broad consideration, which is covered elsewhere such as by aspects of the Code of Professional Conduct, and thus deleted the sentence.
Section 3.7, Reliance on Data or Other Information Supplied by Others	
Comment Response	One commentator questioned whether sections 3.7, *Reliance on Data or Other Information Supplied by Others*; 3.8, *Documentation*; 4.1, *Actuarial Communication*; and 4.2, *Additional Disclosures* provided sufficient guidance. The reviewers believe these sections provide sufficient guidance and made no modifications.
SECTION 4. COMMUNICATIONS AND DISCLOSURES	
Section 4.1, Actuarial Communication	
Comment Response	One commentator believed generic commentary about disclosures, communication, appropriateness, judgment, etc. is not unique to trending, and with rewording could be applied to just about any important actuarial assumption. The commentator stated this implies that the standard could be broadened to encompass a variety of assumptions or that these generic guidances could be restricted to a generic ASOP such as ASOP Nos. 23 and 41 (eliminating the need to repeat them in this section). The reviewers did not believe that there was any redundancy in that the introduction of this section is reinforcing that the actuary in making an actuarial communication should first and foremost be guided by ASOP Nos. 23 and 41. The additional material that follows in this section is guidance that is particularly relevant when offering an actuarial communication relating to trending procedures.

Comment Response	One commentator felt that the guidance in section 4.1 was insufficient, stating that reference to ASOP No. 41, *Actuarial Communications*, is an inadequate substitute for the professional expectations established in ASOP No. 9, *Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations*. The ASB has determined that ASOP No. 9 will be repealed when a revised ASOP No. 41 is adopted. The reviewers believe that all relevant guidance that was included in ASOP No. 9 is to be covered in the revised ASOP No. 41.
Comment Response	One commentator believed section 4.1(b) placed an undue burden on the actuary stating the actuary is required not only to assess whether or not there were significant limitations in the data, but also to speculate on what a more in-depth analysis (using data that, presumably, isn't available) might produce. The reviewers agreed and modified the language in section 4.1(b) to address the commentator's concern.
Comment Response	One commentator believed the current wording in section 4.1(c) could potentially require documentation of risks and uncertainties that are not likely to result in a large deviation from the trend estimate and recommended that this paragraph be revised to read as follows: "specific significant risks and uncertainties that might cause the actual trend to vary materially from the trend estimate, if any." The reviewers deleted section 4.1(c) because the language was overly broad, and the requirement to disclose all significant assumptions provided the user of the analysis a sufficient basis to evaluate the actuary's work.
Comment Response	One commentator suggested because ASOP No. 23, *Data Quality*, and ASOP No. 41, are referenced in the first sentence of this section, that sections 4.1(b) and 4.1(c) are not necessary, stating that section 4.1, particularly subsection (g), of ASOP No. 23 adequately addresses this guidance and in a way that is more understandable. The reviewers deleted 4.1(c) and revised 4.1(b).
Section 4.2, Additional Disclosures	
Comment Response	One commentator felt the guidance in section 4.2 was insufficient while another commentator recommended section 4.2(b) be revised to state, "The actuary should disclose changes to assumptions, procedures, methods or models that the actuary believes might materially affect the latest trend estimate from any prior estimates. The actuary should also retain documentation concerning the potential magnitude of the impact of those material changes if those impacts can be reasonably determined." The commentator believed this modification would help limit varying interpretations of the term "update" in the section's lead-in sentence. The reviewers agreed and modified the language.
Comment Response	One commentator recommended that section 4.2(b) be removed from the standard stating that the trigger language seems unclear, particularly the meaning of "update of the previous estimate." The commentator also believed this paragraph to be superfluous since the requirement to document assumptions, procedures, methods or models, or changes to such, already exists. The reviewers revised the language in section 4.2(b) in response to another comment and believe the revision has addressed these concerns.

APPENDIX	
Comment Response	One commentator suggested changing “property casualty” to “property/casualty” to be consistent with other references to the practice area. The reviewers agreed and made the change.
Comment Response	One commentator suggested changing “Proceedings” to “Variance” in the Background section to make it a more generalized term. The reviewers agreed and made the change.

ACTUARIAL STANDARDS BOARD

Actuarial Standard
of Practice
No. 43

Property/Casualty Unpaid Claim Estimates

Developed by the
Subcommittee on Reserving of the
Casualty Committee of the
Actuarial Standards Board

Adopted by the
Actuarial Standards Board
June 2007
Updated for Deviation Language Effective May 1, 2011

(Doc. No. 159)

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APPENDIXES

June 2007

TO: Members of Actuarial Organizations Governed by the Standards of Practice of the Actuarial Standards Board and Other Persons Interested in Property/Casualty Unpaid Claim Estimates

FROM: Actuarial Standards Board (ASB)

SUBJ: Actuarial Standard of Practice (ASOP) No. 43

This booklet contains the final version of ASOP No. 43, *Property/Casualty Unpaid Claim Estimates.*

Background

Currently, no ASOP exists to provide guidance to actuaries developing unpaid claim estimates. ASOP No. 36, *Statements of Actuarial Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves,* provides guidance to the actuary in issuing a written statement of actuarial opinion but not in developing an unpaid claim estimate. The Casualty Actuarial Society's *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves* contains some guidance. However, that document is currently under review and the revised document is expected to contain significantly less guidance than the current version. Therefore, to address this issue, the ASB charged the Subcommittee on Reserving of the ASB Casualty Committee with creating an ASOP to provide guidance to actuaries regarding property/casualty unpaid claim estimates.

First Exposure Draft

The first exposure draft of this ASOP was approved for exposure in February 2006 with a comment deadline of June 30, 2006. Thirty-two comment letters were received and considered in developing modifications that were reflected in the second exposure draft.

Second Exposure Draft

The second exposure draft of this ASOP was approved for exposure in February 2007 with a comment deadline of May 1, 2007. The Subcommittee on Reserving carefully considered the nine comment letters received and made changes to the language in several sections in response. For a summary of the issues contained in these comment letters, please see appendix 2.

Due to the volume of comments received throughout the exposure period on the Actuarial Central Estimate concept, an additional appendix (see appendix 3) was added to address the comments.

The Subcommittee on Reserving thanks everyone who took the time to contribute comments and suggestions on both exposure drafts.

The ASB voted in June 2007 to adopt this standard.

ACTUARIAL STANDARD OF PRACTICE NO. 43

PROPERTY/CASUALTY UNPAID CLAIM ESTIMATES

STANDARD OF PRACTICE

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose—This actuarial standard of practice (ASOP) provides guidance to actuaries when performing professional services relating to the estimation of loss and loss adjustment expense for unpaid claims for property/casualty coverages. Any reference to "unpaid claims" in this standard includes (unless explicitly stated otherwise) the associated unpaid claim adjustment expense even when not accompanied by the estimation of unpaid claims.

1.2 Scope—This standard applies to actuaries when performing professional services related to developing unpaid claim estimates only for events that have already occurred or will have occurred, as of an accounting date, exclusive of estimates developed solely for ratemaking purposes. This standard applies to the actuary when estimating unpaid claims for all classes of entities, including self-insureds, insurance companies, reinsurers, and governmental entities. This standard applies to estimates of gross amounts before recoverables (such as deductibles, ceded reinsurance, and salvage and subrogation), estimates of amounts after such recoverables, and estimates of amounts of such recoverables.

This standard applies to the actuary only with respect to unpaid claim estimates that are communicated as an actuarial finding (as described in ASOP No. 41, *Actuarial Communications*) in written or electronic form. Actions taken by the actuary's principal regarding such estimates are beyond the scope of this standard.

The terms "reserves" and "reserving" are sometimes used to refer to "unpaid claim estimates" and "unpaid claim estimate analysis." In this standard, the term "reserve" is limited to its strict definition as an amount booked in a financial statement. Services described above are covered by this standard, regardless as to whether the actuary refers to the work performed as "reserving," "estimating unpaid claims" or any other term.

This standard does not apply to the estimation of items that may be a function of unpaid claim estimates or claim outcomes, such as (but not limited to) loss-based taxes, contingent commissions and retrospectively rated premiums.

This standard does not apply to unpaid claims under a "health benefit plan" covered by ASOP No. 5, *Incurred Health and Disability Claims*, or included as "health and disability liabilities" under ASOP No. 42, *Determining Health And Disability Liabilities Other Than Liabilities for Incurred Claims*. However, this standard does apply to health benefits associated with state or federal workers compensation statutes and liability policies.

With respect to discounted unpaid claim estimates for property/casualty coverages, this standard addresses the determination of the undiscounted value of such estimates. The actuary should be guided by ASOP No. 20, *Discounting of Property and Casualty Loss and Loss Adjustment Expense Reserves,* to address additional considerations to reflect the effects of discounting.

An actuary may develop an unpaid claim estimate in the context of issuing a written statement of actuarial opinion regarding property/casualty loss and loss adjustment expense reserves. This standard addresses the determination of the unpaid claim estimate. The actuary should be guided by ASOP No. 36, *Statements of Actuarial Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves,* to address additional considerations associated with the issuance of such a statement.

If the actuary departs from the guidance set forth in this standard in order to comply with applicable law (statutes, regulations, and other legally binding authority), or for any other reason the actuary deems appropriate, the actuary should refer to section 4.
.

1.3 Cross References—When this standard refers to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called. If any amended or restated document differs materially from the originally referenced document, the actuary should consider the guidance in this standard to the extent it is applicable and appropriate.

1.4 Effective Date—This standard will be effective for any actuarial work product covered by this standard's scope produced on or after September 1, 2007.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice.

2.1 Actuarial Central Estimate—An estimate that represents an expected value over the range of reasonably possible outcomes.

2.2 Claim Adjustment Expense—The costs of administering, determining coverage for, settling, or defending claims even if it is ultimately determined that the claim is invalid.

2.3 Coverage—The terms and conditions of a plan or contract, or the requirements of applicable law, that create an obligation for claim payment associated with contingent events.

2.4 Event—The incident or activity that triggers potential for claim or claim adjustment expense payment.

2.5 Method—A systematic procedure for estimating the unpaid claims.

2.6 Model—A mathematical or empirical representation of a specified phenomenon.

2.7 Model Risk—The risk that the methods are not appropriate to the circumstances or the models are not representative of the specified phenomenon.

2.8 Parameter Risk—The risk that the parameters used in the methods or models are not representative of future outcomes.

2.9 Principal—The actuary's client or employer. In situations where the actuary has both a client and an employer, as is common for consulting actuaries, the facts and circumstances will determine whether the client or the employer (or both) is the principal with respect to any portion of this standard.

2.10 Process Risk—The risk associated with the projection of future contingencies that are inherently variable, even when the parameters are known with certainty.

2.11 Unpaid Claim Estimate—The actuary's estimate of the obligation for future payment resulting from claims due to past events.

2.12 Unpaid Claim Estimate Analysis—The process of developing an unpaid claim estimate.

Section 3. Analysis of Issues and Recommended Practices

3.1 Purpose or Use of the Unpaid Claim Estimate—The actuary should identify the intended purpose or use of the unpaid claim estimate. Potential purposes or uses of unpaid claim estimates include, but are not limited to, establishing liability estimates for external financial reporting, internal management reporting, and various special purpose uses such as appraisal work and scenario analyses. Where multiple purposes or uses are intended, the actuary should consider the potential conflicts arising from those multiple purposes and uses and should consider adjustments to accommodate the multiple purposes to the extent that, in the actuary's professional judgment, it is appropriate and practical to make such adjustments.

3.2 Constraints on the Unpaid Claim Estimate Analysis—Sometimes constraints exist in the performance of an actuarial analysis, such as those due to limited data, staff, time or other resources. Where, in the actuary's professional judgment, the actuary believes that such constraints create a significant risk that a more in-depth analysis would produce a materially different result, the actuary should notify the principal of that risk and communicate the constraints on the analysis to the principal.

3.3 Scope of the Unpaid Claim Estimate—The actuary should identify the following:

a. the intended measure of the unpaid claim estimate;

1. Examples of various types of measures for the unpaid claim estimate include, but are not limited to, high estimate, low estimate, median, mean, mode, actuarial central estimate, mean plus risk margin, actuarial central estimate plus risk margin, or specified percentile.

   As defined in section 2.1, the actuarial central estimate represents an expected value over the range of reasonably possible outcomes. Such range of reasonably possible outcomes may not include all conceivable outcomes, as, for example, it would not include conceivable extreme events where the contribution of such events to an expected value is not reliably estimable. An actuarial central estimate may or may not be the result of the use of a probability distribution or a statistical analysis. This description is intended to clarify the concept rather than assign a precise statistical measure, as commonly used actuarial methods typically do not result in a statistical mean.

   The terms "best estimate" and "actuarial estimate" are not sufficient identification of the intended measure, as they describe the source or the quality of the estimate but not the objective of the estimate.

2. The actuary should consider whether the intended measure is appropriate to the intended purpose or use of the unpaid claim estimate.

3. The description of the intended measure should include the identification of whether any amounts are discounted.

b. whether the unpaid claim estimate is to be gross or net of specified recoverables;

c. whether and to what extent collectibility risk is to be considered when the unpaid claim estimate is affected by recoverables;

d. the specific types of unpaid claim adjustment expenses covered in the unpaid claim estimate (for example, coverage dispute costs, defense costs, and adjusting costs);

e. the claims to be covered by the unpaid claim estimate (for example, type of loss, line of business, year, and state); and

f. any other items that, in the actuary's professional judgment, are needed to describe the scope sufficiently.

3.4 Materiality—The actuary may choose to disregard items that, in the actuary's professional judgment, are not material to the unpaid claim estimate given the intended purpose and use. The actuary should evaluate materiality based on professional judgment, taking into account the requirements of applicable law and the intended purpose of the unpaid claim estimate.

3.5 Nature of Unpaid Claims—The actuary should have an understanding of the nature of the unpaid claims being estimated. This understanding should be based on what a qualified actuary in the same practice area could reasonably be expected to know or foresee as being relevant and material to the estimate at the time of the unpaid claim estimate analysis, given the same purpose, constraints, and scope. The actuary need not be familiar with every aspect of potential unpaid claims.

Examples of aspects of the unpaid claims (including any material trends and issues associated with such elements) that may require an understanding include the following:

a. coverage;

b. conditions or circumstances that make a claim more or less likely or the cost more or less severe;

c. the underlying claim adjustment process; and

d. potential recoverables.

3.6 Unpaid Claim Estimate Analysis—The actuary should consider factors associated with the unpaid claim estimate analysis that, in the actuary's professional judgment, are material and are reasonably foreseeable to the actuary at the time of estimation. The actuary is not expected to become an expert in every aspect of potential unpaid claims.

The actuary should consider the following items when performing the unpaid claim estimate analysis:

3.6.1 Methods and Models—The actuary should consider methods or models for estimating unpaid claims that, in the actuary's professional judgment, are appropriate. The actuary should select specific methods or models, modify such methods or models, or develop new methods or models based on relevant factors including, but not limited to, the following:

a. the nature of the claims and underlying exposures;

b. the development characteristics associated with these claims;

c. the characteristics of the available data;

d. the applicability of various methods or models to the available data; and

e. the reasonableness of the assumptions underlying each method or model.

The actuary should consider whether a particular method or model is appropriate in light of the purpose, constraints, and scope of the assignment. For example, an unpaid claim estimate produced by a simple methodology may be appropriate for an immediate internal use. The same methodology may be inappropriate for external financial reporting purposes.

The actuary should consider whether, in the actuary's professional judgment, different methods or models should be used for different components of the unpaid claim estimate. For example, different coverages within a line of business may require different methods.

The actuary should consider the use of multiple methods or models appropriate to the purpose, nature and scope of the assignment and the characteristics of the claims unless, in the actuary's professional judgment, reliance upon a single method or model is reasonable given the circumstances. If for any material component of the unpaid claim estimate the actuary does not use multiple methods or models, the actuary should disclose and discuss the rationale for this decision in the actuarial communication.

In the case when the unpaid claim estimate is an update to a previous estimate, the actuary may choose to use the same methods or models as were used in the prior unpaid claim estimate analysis, different methods or models, or a combination of both. The actuary should consider the appropriateness of the chosen methods or models, even when the decision is made not to change from the previously applied methods or models.

3.6.2 Assumptions—The actuary should consider the reasonableness of the assumptions underlying each method or model used. Assumptions generally involve significant professional judgment as to the appropriateness of the methods and models used and the parameters underlying the application of such methods and models. Assumptions may be implicit or explicit and may involve interpreting past data or projecting future trends. The actuary should use assumptions that, in the actuary's professional judgment, have no known significant bias to underestimation or overestimation of the identified intended measure and are not internally inconsistent. Note that bias with regard to an expected value estimate would not necessarily be bias with regard to a measure intended to be higher or lower than an expected value estimate.

The actuary should consider the sensitivity of the unpaid claim estimates to reasonable alternative assumptions. When the actuary determines that the use of reasonable alternative assumptions would have a material effect on the unpaid claim estimates, the actuary should notify the principal and attempt to discuss the anticipated effect of this sensitivity on the analysis with the principal.

When the principal is interested in the value of an unpaid claim estimate under a particular set of assumptions different from the actuary's assumptions, the actuary may provide the principal with the results based on such assumptions, subject to appropriate disclosure.

3.6.3 Data—The actuary should refer to ASOP No. 23, *Data Quality*, with respect to the selection of data to be used, relying on data supplied by others, reviewing data, and using data.

3.6.4 Recoverables—Where the unpaid claim estimate analysis encompasses multiple types of recoverables, the actuary should consider interaction among the different types of recoverables and should adjust the analysis to reflect that interaction in a manner that the actuary deems appropriate.

3.6.5 Gross vs. Net—The scope of the unpaid claim estimate analysis may require estimates both gross and net of recoverables. Gross and net estimates may be viewed as having three components, which are the gross estimate, the estimated recoverables, and the net estimate. The actuary should consider the particular facts and circumstances of the assignment when choosing which components to estimate.

3.6.6 External Conditions—Claim obligations are influenced by external conditions, such as potential economic changes, regulatory actions, judicial decisions, or political or social forces. The actuary should consider relevant external conditions that are generally known by qualified actuaries in the same practice area and that, in the actuary's professional judgment, are likely to have a material effect on the actuary's unpaid claim estimate analysis. However, the actuary is not required to have detailed knowledge of or consider all possible external conditions that may affect the future claim payments.

3.6.7 Changing Conditions—The actuary should consider whether there have been significant changes in conditions, particularly with regard to claims, losses, or exposures, that are likely to be insufficiently reflected in the experience data or in the assumptions used to estimate the unpaid claims. Examples include reinsurance program changes and changes in the practices used by the entity's claims personnel to the extent such changes are likely to have a material effect on the results of the actuary's unpaid claim estimate analysis. Changing conditions can arise from circumstances particular to the entity or from external factors affecting others within an industry. When determining whether there have been known, significant changes in conditions, the actuary should consider obtaining supporting information from the principal or the principal's duly authorized representative and may rely upon their representations unless, in the actuary's professional judgment, they appear to be unreasonable.

3.6.8 Uncertainty—The actuary should consider the uncertainty associated with the unpaid claim estimate analysis. This standard does not require or prohibit the actuary from measuring this uncertainty. The actuary should consider the purpose and use of the unpaid claim estimate in deciding whether or not to measure this uncertainty. When the actuary is measuring uncertainty, the actuary should consider the types and sources of uncertainty being measured and choose the methods, models, and assumptions that are appropriate for the measurement of such uncertainty. For example, when measuring the variability of an unpaid claim estimate covering multiple components, consideration should be given to whether the components are independent of each other or whether they are correlated. Such types and sources of uncertainty surrounding unpaid claim estimates may include uncertainty due to model risk, parameter risk, and process risk.

3.7 Unpaid Claim Estimate—The actuary should take into account the following with respect to the unpaid claim estimate:

3.7.1 Reasonableness—The actuary should assess the reasonableness of the unpaid claim estimate, using appropriate indicators or tests that, in the actuary's professional judgment, provide a validation that the unpaid claim estimate is reasonable. The reasonableness of an unpaid claim estimate should be determined based on facts known to, and circumstances known to or reasonably foreseeable by, the actuary at the time of estimation.

3.7.2 Multiple Components—When the actuary's unpaid claim estimate comprises multiple components, the actuary should consider whether, in the actuary's professional judgment, the estimates of the multiple components are reasonably consistent.

3.7.3 Presentation—The actuary may present the unpaid claim estimate in a variety of ways, such as a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the unpaid claim amount. The actuary should consider the intended purpose or use of the unpaid claim estimate when deciding how to present the unpaid claim estimate.

3.8 Documentation—The actuary should consider the intended purpose or use of the unpaid claim estimate when documenting work, and should refer to ASOP No. 41, *Actuarial Communications*.

Section 4. Communications and Disclosures

4.1 Actuarial Communication—When issuing an actuarial communication subject to this standard, the actuary should consider the intended purpose or use of the unpaid claim estimate and refer to ASOP Nos. 23 and 41.

In addition, consistent with the intended purpose or use, the actuary should disclose the following in an appropriate actuarial communication:

a. the intended purpose(s) or use(s) of the unpaid claim estimate, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses, if any, as described in section 3.1;

b. significant limitations, if any, which constrained the actuary's unpaid claim estimate analysis such that, in the actuary's professional judgment, there is a significant risk that a more in-depth analysis would produce a materially different result, as described in section 3.2;

c. the scope of the unpaid claim estimate, as described in section 3.3;

d. the following dates: (1) the accounting date of the unpaid claim estimate, which is the date used to separate paid versus unpaid claim amounts; (2) the valuation date of the unpaid claim estimate, which is the date through which transactions are included in the data used in the unpaid claim estimate analysis; and (3) the review date of the unpaid claim estimate, which is the cutoff date for including information known to the actuary in the unpaid claim estimate analysis, if appropriate. An example of such communication is as follows: "This unpaid claim estimate as of December 31, 2005 was based on data evaluated as of November 30, 2005 and additional information provided to me through January 17, 2006.";

e. specific significant risks and uncertainties, if any, with respect to whether actual results may vary from the unpaid claim estimate;

f. significant events, assumptions, or reliances, if any, underlying the unpaid claim estimate that, in the actuary's professional judgment, have a material effect on the unpaid claim estimate, including assumptions provided by the actuary's principal or an outside party or assumptions regarding the accounting basis or application of an accounting rule. If the actuary depends upon a material assumption, method, or model that the actuary does not believe is reasonable or cannot determine to be reasonable, the actuary should disclose the dependency of the estimate on that assumption/method/model and the source of that assumption/method/model. The actuary should use professional judgment to determine whether further disclosure would be appropriate in light of the purpose of the assignment and the intended users of the actuarial communication;

g. the disclosure in ASOP No. 41, section 4.2, if any material assumption or method was prescribed by applicable law (statutes, regulations, and other legally binding authority);

h. the disclosure in ASOP No. 41, section 4.3, if the actuary states reliance on other sources and thereby disclaims responsibility for any material assumption or method selected by a party other than the actuary; and

i. the disclosure in ASOP No. 41, section 4.4, if, in the actuary's professional judgment, the actuary has otherwise deviated materially from the guidance of this ASOP.

4.2 Additional Disclosures—In certain cases, consistent with the intended purpose or use, the actuary may need to make the following disclosures in addition to those in section 4.1:

a. In the case when the actuary specifies a range of estimates, the actuary should disclose the basis of the range provided, for example, a range of estimates of the intended measure (each of such estimates considered to be a reasonable estimate on a stand-alone basis); a range representing a confidence interval within the range of outcomes produced by a particular model or models; or a range representing a confidence interval reflecting certain risks, such as process risk and parameter risk.

b. In the case when the unpaid claim estimate is an update of a previous estimate, the actuary should disclose changes in assumptions, procedures, methods or models that the actuary believes to have a material impact on the unpaid claim estimate and the reasons for such changes to the extent known by the actuary. This standard does not require the actuary to measure or quantify the impact of such changes.

Appendix 1

Background and Current Practices

Note: This appendix is provided for informational purposes but is not part of the standard of practice.

Background

This standard defines issues and considerations that an actuary should take into account when estimating unpaid claim and claim adjustment expense for property and casualty coverages or hazard risks. The *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves* was adopted by the Board of Directors of the Casualty Actuarial Society in May 1988. The *Statement of Principles* has served as the primary guidance regarding estimation of unpaid property and casualty claim and claim adjustment expense amounts providing both principles and considerations related to practice. In conjunction with the development of this standard, the *Statement of Principles* is undergoing revision to focus on principles rather than also discussing considerations.

A decision was made to exclude unpaid claim estimates developed for ratemaking purposes from the scope of this standard. This was done to avoid placing inappropriate requirements on unpaid claim estimates in the ratemaking context, and to keep the scope workable by excluding additional considerations only applicable to the ratemaking context. Ratemaking requires more of a hypothetical analysis of possible future events than an analysis of the cost of past events. Hence, the selection and evaluation of assumptions and methods for ratemaking purposes may be different from the selection and evaluation of such for past event unpaid claim estimates.

Current Practices

Actuaries are guided by the *Statement of Principles Regarding Property and Liability Loss and Loss Adjustment Expense Reserves* of the Casualty Actuarial Society. Other ASOPs issued by the Actuarial Standards Board pertaining to claim and claim adjustment expense estimates have included ASOP No. 9, *Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations*; ASOP No. 20, *Discounting of Property and Casualty Loss and Loss Adjustment Expense Reserves*; ASOP No. 23, *Data Quality*; ASOP No. 36, *Statement of Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves,* and ASOP No. 41, *Actuarial Communications*. In addition, since 1993, the Casualty Practice Council of American Academy of Actuaries has published practice notes addressing current National Association of Insurance Commissioners' requirements for the statement of actuarial opinion. The practice notes describe some current practices and show illustrative wording for handling issues and problems. While these practice notes (and future practice notes issued after the effective date of this standard) can be updated to react in a timely manner to new concerns or requirements, they are not binding, and they have not gone through the exposure and adoption process of the standards of actuarial practice promulgated by the Actuarial Standards

Board.

There are also numerous educational papers in the public domain relevant to the topic of unpaid claim estimates, including those published by the Casualty Actuarial Society. Some of these are refereed and others are not. While these may provide useful educational guidance to practicing actuaries, none is an actuarial standard.

Appendix 2

Comments on the Second Exposure Draft and Responses

The second exposure draft of this ASOP, *Property/Casualty Unpaid Claim Estimates*, was issued in February 2007 with a comment deadline of May 1, 2007. Nine comment letters were received, some of which were submitted on behalf of multiple commentators, such as by firms or committees. For purposes of this appendix, the term “commentator” may refer to more than one person associated with a particular comment letter. The Subcommittee on Reserving carefully considered all comments received and the Casualty Committee and ASB reviewed (and modified, where appropriate) the proposed changes.

Summarized below are the significant issues and questions contained in the comment letters and the responses.

The term “reviewers” in appendix 2 includes the subcommittee, the Casualty Committee, and the ASB. Also, unless otherwise noted, the section numbers and titles used in appendix 4 refer to those in the second exposure draft.

GENERAL COMMENTS	
Comment	Two commentators requested that the standard comment on what would constitute reasonable review of a previous estimate. Specifically, they were concerned with actuaries reviewing an earlier estimate with the benefit of hindsight, particularly in a litigation situation.
Response	A sentence has been added to section 3.7.1, Reasonableness, to address this issue.
SECTION 1. PURPOSE, SCOPE, CROSS REFERENCES, AND EFFECTIVE DATE	
Section 1.2, Scope	
Comment	One commentator suggested a clarification to section 1.2, inserting the words “or will have occurred” immediately after the words “for events that have already occurred.”
Response	The reviewers agree and made the change.
Comment	One commentator was concerned that the development of unpaid claim estimates for ratemaking purposes would benefit from much of what is in this standard, despite the ratemaking scope exclusion in this standard. The recommendation was to retain the ratemaking exclusion in this standard but to then begin work on a revision that would remove such an exclusion.
Response	The reviewers agree with retaining the ratemaking scope exclusion for this standard but believe the ratemaking situation is outside their current charge.

Comment Response	One commentator suggested adding the words “specific types of” before the word “recoverables” in the first paragraph of section 1.2, as otherwise it might imply that all types of recoverables are being discussed. The reviewers disagree with the suggestion, as the intent is to potentially include all types of recoverables related to unpaid claims, relying on the actuary in section 3.3, Scope of the Unpaid Claim Estimate, to identify the particular recoverables (if any) applicable to the given purpose or use of the unpaid claim estimate(s) being developed. The reviewers made no change.
Comment Response	Two commentators were concerned that some may be confused by the use of the term “unpaid claim estimates” rather than “reserves.” The reviewers added a paragraph to section 1.2 for clarity.
Comment Response	One commentator was concerned that the scope exclusion for items that “may be a function of unpaid claim estimates” would inadvertently exclude recoverables that are included in unpaid claims. The reviewers believe that the standard is sufficiently clear (as reflected in the first paragraph, last sentence of section 1.2) that such recoverables are covered by the standard.
Comment Response	One commentator suggested adding “pricing” and “premiums” to the list of items that are a function of unpaid claim estimates or claim outcomes but not included in this standard’s scope. The reviewers do not feel this is necessary, as ratemaking is already excluded in the section’s first paragraph, and this list is not meant to be all inclusive.
Comment Response	Two commentators expressed concern that health insurance written by companies filing property/casualty annual statements may be included in the scope. One of these commentators recommended addressing this by explicitly excluding health insurance from the scope. The other commentator recommended that there was no need for a separate property casualty standard on unpaid claim estimates, as the property/casualty perspective could probably be addressed in the current ASOP No. 5, *Incurred Health and Disability Claims*. The latter commentator also suggested a definition of “property/casualty” be provided if a separate property/casualty standard was to be adopted. The reviewers agree that such confusion may exist, and added a paragraph to section 1.2, Scope.
Comment Response	One commentator stated the end of section 1.2 dealing with conflict with applicable law, etc. is not necessary, and that the term “provision” (found in section 1.3, Cross References) is also used in some jurisdictions in place of policy or loss reserves. The reviewers disagree as this wording is standard for all ASOPs and made no change.

SECTION 2. DEFINITIONS	
Section 2.1, Actuarial Central Estimate	
Comment Response	One commentator objected to the term “actuarial central estimate,” due to the concern that it would be a truncated mean in most situations, biased low relative to the expected value, and recommended that if absolutely needed in the standard that it be relabeled without the word “actuarial” as part of the label. The reviewers disagree with the deletion of the term “actuarial” and made no change. Refer to appendix 3.
Comment Response	One commentator was concerned that the use of the term “expected value” in the definition of “actuarial central estimate” would imply a statistical mean. The commentator suggested changing “expected value” to “central tendency…such as an average or an expected value.” The reviewers considered similar wording in the drafting process and made no change. Refer to appendix 3.
Comment Response	One commentator suggested that different terms be used to describe the results from methods vs. models. Specifically, the commentator suggested the term “actuarial central estimate” be limited to describing a result from a method, while the term “actuarial distribution estimate” or some other term be used to describe the results of a model. The reviewers believe the standard allows the actuary to describe the results using whatever term the actuary sees fit to use (the term “actuarial central estimate” is provided as just one of many possible terms that can be used) and made no change.
Section 2.3, Coverage	
Comment Response	One commentator was concerned that the definition of “coverage” did not include self-insured first party claims. The reviewers could not envision a situation where a “liability” or claim would exist with regard to first party self-insured losses. Rather, this was viewed as more of a reduction in asset value. As such, the reviewers did not agree with the need to address self-insured first party claims and made no change.
Section 2.5, Method and 2.6, Model	
Comment Response	One commentator stated, “There are definite differences between ‘methods’ and ‘models’ that are much more substantial and fundamental than” what is in the proposed standard. The commentator suggested that more complete definitions be taken from the CAS Working Party paper on reserve variability. The definitions in the standard are abbreviated versions of what is in the referenced Working Party paper. The reviewers believe that further elaboration is unnecessary, although reference to various CAS publications has been added to appendix 1.
Section 2.7. Model Risk	
Comment Response	One commentator believed that combining reference to methods and models in the definition of “model risk” in section 2.7 caused grammatical problems. The suggested fix was to create a new term, “method risk,” which would also lead to a slight change in paragraph 3.6.8, Uncertainty. The reviewers believe that common usage is to include what was described as “method risk” in the category of “model risk.” Hence, a change was made to the definition, but a separate term (and definition) for “method risk” was not added.

Section 2.8, Parameter Risk	
Comment Response	One commentator objected to the reference to “methods” in the definition of “parameter” risk, due to a belief that “since a ‘method’ does not have an underlying distribution there are no parameters to estimate.” The reviewers believe that this is within the purview of common usage of the terms “methods” and “parameters,” and made no change.
Comment Response	One commentator suggested adding a definition of “parameter” for consistency purposes. The reviewers believe that such a definition is unnecessary and made no change.
Section 2.11, Unpaid Claim Estimates	
Comment Response	One commentator suggested modifying this definition (and the unpaid claim estimate analysis definition) to clarify that unpaid claim estimates are synonymous with loss reserve estimates or unpaid claim liability estimates in financial reporting contexts. The reviewers added language to section 1.2, Scope, for clarity.
SECTION 3. ANALYSIS OF ISSUES AND RECOMMENDED PRACTICES	
Section 3.1, Purpose or Use of the Unpaid Claim Estimate	
Comment Response	One commentator agreed with the use of the term “unpaid claim estimate” rather than “reserve” to avoid the financial reporting context, but believed that reference to the “intended purpose” of the estimate forced the discussion back solely to reserves and financial reporting. The suggested fix was to remove any discussion of “intended purpose” in the standard, and focus solely on estimating the distribution of possible future outcomes in the standard. (This concern also led to minor changes suggested in section 1.2, Scope.) The reviewers disagree that the only “intended purposes” would be those relating to financial reporting. Other “intended purposes” (some of which are listed in section 3.1) include merger/acquisition-related valuations, scenario analyses for risk management purposes, valuations as part of commutation discussions, etc. The reviewers made no change.
Comment Response	The last sentence of this section states “the actuary…should consider adjustments to accommodate the multiple purposes to the extent…it is appropriate and practical” to do so. One commentator asked if the intent was for the actuary to adjust the estimate or to provide different estimates for each purpose/use. The reviewers discussed different possible approaches to addressing this situation and decided that the standard should be silent on whether to produce multiple estimates, produce a single estimate that attempts to accommodate both purposes (assuming that this is possible), or some other option. Instead, the standard requires the actuary to consider some adjustment and leaves it up to the actuary’s professional judgment as to whether or what kind of adjustment to make. The reviewers made no change.

Section 3.2, Constraints on the Unpaid Claim Estimate Analysis	
Comment Response	One commentator suggested replacing “staff” with “resources” in this section as to be more general. The reviewers agree and changed the language.
Comment Response	One commentator suggested replacing “result” with “estimate” in this section so that it is more consistent with the rest of the ASOP. The reviewers disagree. As worded, “result” could incorporate other parts of the analysis beyond the estimate, such as analysis of uncertainty (if included in the assignment’s scope). The reviewers made no change.
Comment Response	Where there is a significant risk of the type described in this section, one commentator recommended that this situation be a required disclosure. The reviewers disagree noting that required disclosure is already addressed in section 4.1(b) and made no change.
Section 3.3, Scope of the Unpaid Claim Estimate	
Comment Response	One commentator was concerned that the wording in 3.3(a)(1) may cause actuaries to limit themselves to only the alternatives listed. Alternate wording was suggested. The reviewers agree and changed the wording in response.
Comment Response	One commentator suggested an editorial change for section 3.3(c), whereby “is to be considered” would be changed to “is considered.” The reviewers disagree with the suggestion, as section 3.3 addresses identification of the scope of the work in advance of the actual analysis. Hence, “is to be” is more appropriate than “is” in this context. The reviewers made no change.
Comment Response	One commentator suggested replacing the phrase “any other items” in section 3.3(f) with “other items” or “any other significant items,” due to a concern that the current wording would be too all inclusive and could result in excessive procedures. The reviewers disagree, as the reference at the end of the paragraph (“needed to describe the scope sufficiently”) already addresses the stated concern, and made no change.
Comment Response	One commentator suggested replacing “material to the actuary” with “material to the estimate” in section 3.5, Nature of Unpaid Claims, first paragraph. The reviewers agree and made the change.
Section 3.6, Unpaid Claim Estimate Analysis	
Comment Response	One commentator was concerned with the possible ambiguity with the term “factors” in this paragraph. The reviewers believe that this possible ambiguity is sufficiently addressed by the discussion in section 3.6.

Comment Response	One commentator suggested that additional guidance on unpaid claim adjustment expenses be provided for situations involving prepaid expenses and third party administrators (TPAs). The standard already includes claim adjustment expenses in its scope, as “unpaid claims” is defined in section 1.1, Purpose, as including the related claim adjustment expenses. The reviewers also believe that prepayments to TPAs for the expense of adjusting claims is a specific situation and, as such, is too detailed for the general guidance in this standard. The reviewers made no change.
Section 3.6.1, Methods and Models	
Comment Response	One commentator stated that “we should be doing all we can to foster the rigorous use of stochastic models in favor of traditional deterministic methods” and objected to the use of “methods” and “models” as essentially interchangeable terms. The reviewers consider judgment to be a major component of the application of both methods and models. As such, the reviewers do not consider one to be clearly superior to the other in all situations. The reviewers made no change.
Comment Response	In section 3.6.1, in the phrase that says, “For example, different coverages within a line of business may require different methods,” one commentator questioned whether the word “require” was appropriate. The reviewers believe that the word “require” is appropriate in this context, given that it is used in the context of an example and not in providing a direct requirement. The reviewers made no change.
Comment Response	One commentator suggested wording with regard to required disclosure if multiple methods were not used for “any component.” The suggestion limited the disclosure to only material components. The same commentator also asked for clarification of the term “component.” The reviewers reworded the section to clarify that the requirement only existed for material components. The suggested clarification of the term “component” was not adopted, as the reviewers felt that it would lead to a list of component examples that would never be complete for all applications.
Section 3.6.3, Data	
Comment Response	One commentator suggested adding guidance that “additional liabilities may be necessary if the data does not balance to recorded claim expenses, i.e., if there is a timing difference between when a claim is shown as paid in the actuarial data and when it is recorded by the principal.” The reviewers believe that this is a specific situation and is covered by the general guidance in section 3.6.1(c). The reviewers made no change.
Section 3.6.6, External Conditions	
Comment Response	One commentator suggested that section 3.6.6, External Conditions, focused on past or current conditions, while section 3.6.7, Changing Conditions, focused on current or future conditions, and that these time horizons might be clarified in the standard. The reviewers do not agree that the time horizons in the two sections are constrained as suggested by the commentator and made no change.

Section 3.6.7, Changing Conditions	
Comment	Two commentators suggested that the actuary should be required to evaluate the reasonableness of management's representations (as referred to in section 3.6.7) under certain circumstances. One of these commentators stated the reference to "reasonable representations" in section 3.6.7 already implies the actuary is required to perform such an evaluation but suggested the standard state this requirement explicitly.
Response	The reviewers disagreed that the standard should require an actuary to perform an evaluation affirming the reasonableness of management's representations and have revised the language to indicate the actuary may rely upon their representations unless, in the actuary's professional judgment, they appear to be unreasonable.
Section 3.6.8, Uncertainty	
Comment	One commentator suggested that examples of uncertainty measures be provided.
Response	The reviewers did not believe that such a list was necessary and made no change.
Comment	One commentator suggested that the original reference to the covariance of multiple component's estimates implied particular statistical tests or relationships that may not be amenable to testing. Replacement wording was suggested.
Response	The reviewers acknowledge the concern and developed new wording that addressed the concern expressed.
Comment	One commentator stated that since the concept of a risk margin is implied by this section, this section should discuss risk margins explicitly.
Response	The reviewers disagree that discussion of uncertainty requires discussion of a risk margin and made no change.
Section 3.7.1, Reasonableness	
Comment	One commentator asked if the actuary should also be assessing the reasonableness of the estimate relative to its intended purpose.
Response	The reviewers believe that the required disclosures in section 4.1, Actuarial Communications, and ASOP No. 41, *Actuarial Communications*, sufficiently address the commentator's concerns and made no change.

Section 3.7.2, Multiple Components	
Comment	One commentator stated, “I am not certain how ‘estimates of the multiple components’ can be consistent. I can see how the assumptions used can be consistent, the methods can be consistent, or they can be consistently developed.” As a result, the commentator suggested that this section be clarified.
Response	The reviewers believe that the correct focus is on consistency of the estimates of the multiple components as stated. It is not always apparent whether or not the assumptions and/or models/methods underlying the estimates are consistent until the results of those assumptions/models/methods are evaluated. For example, an estimate of gross claim liabilities and a separate estimate of net claim liabilities may each seem to be reasonable when evaluated individually based on the underlying assumptions/models/methods used in their estimation, but the resulting relationship between gross and net estimates may be found to be unreasonable, indicating that the estimates were not reasonably consistent. The reviewers made no change.
Section 3.7.3, Presentation	
Comment	One commentator recommended that the standard require that the methods and/or models be appropriate to the intended purpose of the estimate, and that this is more important than requiring such of the estimate presentation.
Response	The wording in section 3.6.1, Methods and Models, already addresses this issue and no change was made.
Section 4. Communications and Disclosures	
Section 4.1, Actuarial Communications	
Comment	One commentator noted that the definition of “valuation date” found in section 4.1(d) differed from that found in ASOP No. 41, *Actuarial Communications*, “the date as of which the liabilities are determined.”
Response	The reviewers believe that the definition in section 4.1(d) of this standard conforms with standard usage of the term among casualty actuaries and made no change.
Comment	One commentator suggested further elaborating on this disclosure requirement by requiring “specific comments regarding the major factors or particular conditions applicable to the unpaid claim estimate.” Otherwise, the commentator was concerned that this would result in too many boilerplate disclosures about the risk.
Response	The reviewers acknowledge the concern and addressed it by adding the word “specific” before “significant” in section 4.1(e).
Section 4.2, Additional Disclosures	
Comment	Where the unpaid claim estimate is an update of a previous estimate, one commentator suggested requiring that the amount of change in estimate be disclosed, with reasons provided whenever the change was significant and the reasons for the change were known.
Response	The reviewers did not agree and made no change.

Appendix	
Appendix 1—Background	
Comment	One commentator suggested a change to appendix 1 regarding the proposed revision to the CAS *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*. The commentator recommended that the wording be changed from “focus more narrowly on principles” to “focus more broadly on principles.”
Response	The reviewers disagree, as the proposed revision would remove various sections in the current Principles statement, including extensive discussion on Considerations, and made no change.

Appendix 3

Note: This appendix is provided for informational purposes but is not part of the standard of practice.

Comments on "Actuarial Central Estimate"

During this standard's development, the "actuarial central estimate" concept and definition elicited the most comments of any of the topics covered. The subcommittee believes that the issues raised by this topic are worthy of expanded discussion. The following is meant to provide additional clarity to these key concepts.

This appendix is organized by first providing a background as to the originally proposed wording regarding the actuarial central estimate, followed by a summary of comments received on the actuarial central estimate proposal and subcommittee responses.

Background

The term "actuarial central estimate" was originally created by the subcommittee due to a desire to have a "default" intended measure for the unpaid claim estimate.

The standard requires that the actuary identify (and disclose) the intended measure. The subcommittee had debated whether or not to require disclosure of the estimate's intended measure in all cases, or to allow for a default intended measure.[1] If a default did exist, the subcommittee felt that it needed to allow for many of the traditional actuarial estimation methods. But many traditional actuarial methods do not explicitly define the intended measure that results from their application. Implicitly, they attempt to produce a central estimate[2] of some sort with regard to the distribution of possible outcomes, but the resulting intended measure does not have a well-defined statistical definition. Hence, if the standard were to include a default intended measure, the subcommittee believed that it would have to create a new term and a corresponding definition.

As to the definition of the term, it is generally agreed that most traditional actuarial methods are meant to produce some measure of central tendency. But what measure? There are several different measures of central tendency, including (for example) mean, median, mode, and truncated mean. The subcommittee believed that "mean" best represented the central tendency measure implicitly underlying most traditional actuarial methods, even if such traditional methods are not statistical in nature. (For further discussion, this will be referred to as a "conceptual mean" rather than a "statistical mean.")

Next, the subcommittee considered the issue of whether this conceptual mean is intended to

1 Note that several accounting frameworks use the term "measurement objective" for this concept, rather than "intended measure."
2 Note that "central estimate" does not imply a midpoint. One respondent suggested using the words "medium or intermediate" estimate to avoid any incorrect interpretation that a "central estimate" must be a midpoint.

incorporate the entire range of all possible outcomes. In some lines of business, the subcommittee felt that this would be problematic due to the potential for doomsday and/or systemic shocks in the tail of the distribution. For example, it is doubtful whether any actuarial estimate (stochastic or deterministic) in 1999 considered the liability for Y2K events to the extent they were forecasted at that time. Many of those Y2K-event liability estimates proved to be overly pessimistic, and most financial statement preparers did not incorporate such estimates in their financial statements prior to January 1, 2000. Similarly, estimates of future mass torts that have yet to be identified (for example, "the next asbestos") are generally viewed as not reliably estimable. Hence, the subcommittee felt that requiring that the entire range of all possible outcomes be considered in the estimation of the mean is unrealistic.

In looking for other approaches for dealing with this situation, the subcommittee looked at developments in other parts of the world. The subcommittee found that the term "central estimate" was being used in various locations to describe the intended measure of traditional methods.[3] [4] Initial drafts of this standard also used the same term, but it was eventually decided that the phrase "central estimate" was too generic, with risk of confusion and misinterpretation due to common meanings of the term "central." The subcommittee felt that a new term needed to be developed that conveyed the same concepts but without the same risk of misinterpretation. This led to the term "Actuarial Central Estimate," which was designed to be non-generic, and hence capable of being defined solely by this standard.

As a result of the deliberations discussed above, the subcommittee had developed a rudimentary definition ("conceptual mean," excluding remote or speculative outcomes) and a name for a default intended measure consistent with the desired default. The resulting paragraph in the first exposure draft was as follows:

2.1 Actuarial Central Estimate—An estimate that represents a mean excluding remote or speculative outcomes that, in the actuary's professional judgment, is neither optimistic nor pessimistic. An actuarial central estimate may or may not be the result of the use of a probability distribution or a statistical analysis. This definition is intended to clarify the concept rather than assign a precise statistical measure, as commonly used actuarial methods typically do not result in a statistical mean.

3 "'Central Estimate': an estimate that contains no deliberate or conscious over or under estimation," from http://www.actuaries.org.nz/publications/PS4%20General%20Insurance.pdf#search=%22central%20estimate%20actuarial%22, September 5, 2006

4 As the recently modified AASB1023 now requires companies to disclose the central estimate of their liabilities (that is the 50% PoS or "best estimate" figure). INFORMATION FOR OBSERVERS, IASB Meeting: 19 April 2005, London, Topic: Insurance Contracts - Education session (Agenda item 3)

Comments and Responses

The comments from this standard’s first exposure draft on “actuarial central estimate” and its later usage could generally be grouped into the following five categories:

- Concern with the use of the term “mean” in the “actuarial central estimate” definition, as doing so may imply statistical approaches and distributions regardless of the caveats of such in the proposed definition.
- Concern with the exclusion of “remote or speculative” outcomes in the “actuarial central estimate” definition, as doing so may lead to an estimate biased low (relative to a mean reflecting the entire distribution of possible outcomes).
- Desire for the default to allow for or possibly even promote conservatism.
- Desire that the standard promote statistical techniques.
- Preference for the term “best estimate” over “actuarial central estimate.”

As a result of the comments that were received, the subcommittee decided to eliminate the concept of prescribing a default measure since opinions differed widely on what the default measure ought to be. It was felt that requiring the actuary to identify the intended measure in all circumstances allowed the actuary to describe the intended measure in the actuary’s own words. However, the subcommittee felt that it was important to have terminology for the measure that results from traditional actuarial methods where the actuary is conceptually aiming for a mean estimate. The subcommittee therefore retained the term ”actuarial central estimate,” revised the definition and included it as an example of an intended measure in the non-exhaustive list that was provided in section 3.3(a)(1).

More detailed responses to the comments are shown below:

Comment:
Some commentators objected to the use of the term “mean” in the definition of “actuarial central estimate,” as they believed that it was impossible to use the term without conveying an implied statistical approach.

Response:
The final definition replaced the term “mean” with “expected value.” Additional clarification is provided in 3.3(a)(1), where it states that the “description [of actuarial central estimate] is intended to clarify the concept rather than assign a precise statistical measure, as commonly used actuarial methods typically do not result in a statistical mean.”

Comment:
Some commentators had a concern with the exclusion of “remote or speculative” outcomes in the originally proposed “actuarial central estimate” definition, as they felt that this would lead to estimates that were biased low (relative to a statistical mean reflecting the entire distribution).

Response:
The subcommittee believes that nearly all methods currently in use for estimating unpaid claims, whether stochastic or deterministic, do not reflect all possible outcomes, nor should they necessarily do so. The major concern of the subcommittee in this area are those outcomes where reliable determination of the outcomes’ contribution to a mean estimate are so problematic as to be speculative and which are not expected to be normal or recurring on a regular basis. Examples include the Y2K concerns prior to January 1, 2000, and estimates of future mass torts that have yet to be identified (for example, “the next asbestos”). This concern is also limited to those outcomes that could be material to an expected value estimate.

The exposure draft did not and the final standard does not require exclusion of such outcomes in the determination of the unpaid claim estimate, but the subcommittee believes that the actuary should consider whether truly all possible outcomes are included in the actuary’s unpaid claim estimate (where the intended measure purports to reflect the entire distribution of possible outcomes). With regard to the “actuarial central estimate” definition, the subcommittee has eliminated the terms “speculative” and “remote,” and has replaced them with wording that focused more directly on the concern that reliable estimates of such outcomes cannot be produced.

Comment:
Some commentators were concerned that the “actuarial central estimate” definition precluded the use of conservatism (described in some instances as a margin for adverse deviation) in the unpaid claim estimate intended measure.

Response:
This standard was meant to apply to work done in a variety of situations. In many of those situations, the purpose and/or use of the unpaid claim estimate will dictate whether a margin for adverse deviation is required, allowed or prohibited. The subcommittee does not believe it is the role of the actuary or ASB to dictate a certain singular treatment of margins for adverse deviation for all unpaid claim estimates. In fact, in certain instances the subcommittee believes that the treatment of such in the unpaid claim estimate is clearly not part of the role of the actuary.

The subcommittee also believes that the actuary should clearly disclose the basis of the unpaid claim estimate regarding all the items listed in section 3.3. Hence, in those instances where the unpaid claim estimate includes a margin for adverse deviation, the presence of such margin should be explicitly disclosed.

Comment:
Some of the commentators wanted the standard to advocate only certain techniques for calculating any unpaid claim estimate, regardless of the intended measure. In particular, these comments wanted the standard to dictate the use of stochastic models.

Response:
The subcommittee believes the choice of methodology should be determined by the actuary.

Casualty
Actuarial
Society

Estimating Unpaid Claims Using Basic Techniques

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KPMG LLP

With significant contributions by Rachel Dutil, FCAS, FCIA and Edward Lam, FCAS
KPMG LLP

Version 3, July 30, 2010

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July 30 2010

Acknowledgments

It has been a true honor and privilege to prepare this new text titled Estimating Unpaid Claims Using Basic Techniques for the Casualty Actuarial Society (CAS). Special thanks go to my KPMG colleagues Rachel Dutil and Edward Lam. Rachel read, proofed, critiqued, modified, and ultimately improved each and every draft version of this text. Her contributions were tremendous at every step of the process. Edward Lam prepared all of the supporting exhibits and assisted with much of the research required for the text. He also reviewed most, if not all, of the draft versions. This text could not have been completed in such a timely manner without their invaluable input.

I also want to thank my KPMG colleagues in Toronto and the United States who assisted in reviewing various versions of the text. Each member of the KPMG Toronto Actuarial Practice was involved at one point or another in reviewing this text. Thanks to members of the CAS Task Force for their input and feedback. Finally, I want to acknowledge the significant contributions of Ralph Blanchard, Edward Y. Yao, Wynand Viljoen, and Eugene van der Westhuizen. Their international experience and knowledge was particularly valuable in ensuring that the text will have relevance for actuaries practicing throughout the world.

The objective of the CAS in creating a new text that addressed the estimation of unpaid claims was to replace a number of readings that existed on the syllabus of basic education as of 2007 with a single educational publication. Thus, candidates preparing for the actuarial exam addressing the estimation of unpaid claims using basic techniques would be able to replace numerous papers, which were written over a 30-year period, with a single text. Two major benefits of one educational publication are (1) consistent definitions of terms and (2) examples that are used with multiple estimation techniques. The CAS specified that the new text would focus on the learning objectives contained within the syllabus as of spring 2007. Furthermore, the CAS specifically requested that the new educational publication be written in a way as to be valuable to actuaries operating around the world.

In preparing Estimating Unpaid Claims Using Basic Techniques, I relied extensively on the following papers:

Adler, M.; and Kline, C.D. Jr., “Evaluating Bodily Injury Liabilities Using a Claims Closure Model,” *Evaluating Insurance Company Liabilities*, Casualty Actuarial Society *Discussion Paper Program*, 1988, pp. 1-66.

Berquist, J.R.; and Sherman, R.E., “Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach,” *Proceedings of the Casualty Actuarial Society* (PCAS) LXIV, 1977, pp. 123-184. Including discussion of paper: Thorne, J.O., *PCAS* LXV, 1978, pp. 10-33.

Bornhuetter, R.L.; and Ferguson, R.E., “The Actuary and IBNR,” *PCAS* LIX, 1972, pp. 181-195. Including discussions of paper: Cooper, W.P., *PCAS* LX, 1973, pp. 161-164; and White, H.G., *PCAS* LX 1973, pp. 165-168.

Casualty Actuarial Society, *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*, May 1988.

Fisher, W.H.; and Lange, J.T., "Loss Reserve Testing: A Report Year Approach," *PCAS* LX, 1973, pp. 189-207. Including discussions of paper: Skurnick, D., *PCAS* LXI, 1974, pp. 73-83; and authors' response, *PCAS* LXI, 1974, pp. 84-85.

Fisher, W.H.; and Lester, E.P., "Loss Reserve Testing in a Changing Environment," *PCAS* LXII, 1975, pp. 154-171.

Mack, T. "Credible Claims Reserve: The Benktander Method," *ASTIN Bulletin*, 2000, pp. 333-337.

Pinto, E.; and Gogol, D.F., "An Analysis of Excess Loss Development," *PCAS* LXXIV, 1987, pp. 227-255. Including discussions of paper: Levine, G.M., *PCAS* LXXIV, 1987, pp. 256-271; and Bear, R.A., *PCAS* LXXIX, 1992, pp. 134-148.

Wiser, R.F.; Cockley, J.E; and Gardner A., "Loss Reserving," *Foundations of Casualty Actuarial Science* (Fourth Edition), Casualty Actuarial Society, 2001, Chapter 5, pp. 197-285.

Throughout this text, I typically refer to these papers and other actuarial papers by the author, publication source, and year of publication.

It is important to recognize that learning objectives can change over time. To the extent that the CAS determines that new or different topics are appropriate for actuarial candidates studying basic estimation techniques for unpaid claims, it is anticipated that this text will need to be modified accordingly.

I have a request of readers of this text. Every effort has been made to ensure that all references and calculations are accurate. If we have inadvertently missed something, please contact me or the CAS so that future editions of the text can be corrected.

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PART 1 – INTRODUCTION

CHAPTER 1 – OVERVIEW

Importance of Accurately Estimating Unpaid Claims

Accuracy in estimating unpaid claims is critical to insurers. Unlike manufacturers, insurers may not know the true cost of goods sold during a financial reporting period until several years later. An insurer sells its promise to pay the policyholder or an injured party on behalf of the policyholder in the event of an occurrence covered by the insurance policy. For some insured events, the insurer is able to quantify the exact costs of settlement quickly and with great precision. For other insured events, the insurer may not know the ultimate cost for years, and possibly decades. Nevertheless, the insurer must report its financial results on a regular basis. Claim reserves (also known as technical provisions in some parts of the world) represent the insurer's estimate of its current liabilities for claims that occurred on or prior to the financial statement reporting date but that have not yet been paid. Actuaries around the world work with insurers and self-insurers to quantify, evaluate, and monitor estimates of unpaid claims.

We can look at the importance of accurately estimating unpaid claims from three viewpoints:

- Internal management
- Investors
- Regulators

Internal Management

From an internal management perspective, accuracy in the estimation of unpaid claims is essential for proper decision-making in virtually every area of an insurance company's operations including, but not limited to, pricing, underwriting, strategic, and financial decisions. An accurate estimate of unpaid claims is particularly important in pricing insurance products as inaccurate estimates could threaten the financial condition of an insurer. For example, an inadequate estimate of unpaid claims could drive an insurer to reduce its rates not realizing that the estimated unpaid claims were insufficient to cover historical claims. In this situation, the new lower rates would likely be insufficient to pay the claims that will arise from the new policies. The problem could be exacerbated if the insurer gains market share as a result of the lower rates, which ultimately would prove to be inadequate to cover future claims. This chain of events could eventually lead to a situation where the future solvency of the insurer is at risk.

We can also envision the reverse situation where an excessive estimate of unpaid claims could be a factor in inappropriate pricing decisions that could put the future financial condition of the insurer at risk. A redundant estimate of unpaid claims may drive an insurer to increase rates unnecessarily. The increased rates could lead to loss of market share, resulting in a loss of premium revenue to the insurer. A significant loss of revenue could negatively impact the financial strength of the insurer.

An inaccurate estimate of unpaid claims can also lead to poor underwriting, strategic, and financial decisions. Financial results often influence an insurer's decision-making process regarding where to increase business and whether to exit a market that is underperforming. If the financial results are misstated due to an excessive estimate of unpaid claims, an insurer may inappropriately choose to exit a particular line of business or region; such a decision could ultimately have a negative impact on the organization's future financial strength. In addition, an inaccurate estimate of unpaid claims can have a negative impact on the insurer's decisions regarding its reinsurance needs as well as its claims management procedures and policies. Finally, the accuracy of the unpaid claims estimate is also important for financial decision-making such as capital management, i.e., which lines of business get a larger proportion of allocated capital.

Investors

From the investors' perspective, accuracy in reserves is also essential to the decision-making process. Inaccurate reserves may lead to misstated balance sheets and income statements for the insurer. If reserves are incorrect, key financial metrics used by investors could be misleading. An insurer with insufficient reserves may present itself in a stronger position than it truly is. Conversely, an insurer with excessive reserves may show a weaker position than its true state. This could affect investors' decisions related to the insurer.

Regulators

Finally, insurance regulators rely on the financial statements of an insurer to carry out their supervisory role. Inaccurate reserves could result in a misstatement of the true financial position of an insurer. If a financially struggling insurer is masking its true state with inadequate reserves, a regulator may not become involved until too late in the process to help the insurer regain its strength.

Further Requirements for Accurate Reserves

State Law

Proper estimating of unpaid claims is more than just a necessity for managing, investing in, and regulating insurers – it is required by law. As early as the 1960s, the New York insurance law specified:

> … every insurer shall maintain reserves in an amount estimated in the aggregate to provide for the payment of all losses or claims incurred on or prior to the date of settlement whether reported or unreported which are unpaid as of such date and for which such insurer may be liable, and also reserves in an amount estimated to provide for the expenses of adjustments or settlement of such claims.

Today, many jurisdictions directly tie the legal requirements for accurate estimation of unpaid claims to the responsibilities of the actuary. The role of the Appointed Actuary has been created through insurance legislation in countries around the world.

National Association of Insurance Commissioners (NAIC)[1]

In the mid-1970s, due to the increasingly litigious environment in the U.S. and in reaction to the insolvencies of a number of property and casualty[2] (P&C) insurance companies, many of which involved inadequate claim reserves, the NAIC recommended that companies include claim reserve opinions (originally called certification of loss reserves) with their annual statements. The first opinion requirements emanated in 1980 from a limited number of state regulations.

In 1990, the NAIC began requiring that most P&C insurers in the U.S. obtain a Statement of Actuarial Opinion signed by a qualified actuary. The statement contains the qualified actuary's opinion regarding the reasonableness of the carried statutory loss and loss adjustment expense (LAE) reserves as shown in the statutory annual statement. In 1993, qualified actuaries signing statements of opinion started using the title of Appointed Actuary because the NAIC required that they must be appointed by the Board of Directors or its equivalent.

Other U.S.-Regulated Entities

Other U.S. non-NAIC regulated entities also require actuarial opinions. For example, many state insurance departments require opinions for captive insurers, self-insurers, and self-insurance pools as well as some underwriting pools and associations.[3]

Canada

In Canada, the Insurance Companies Act requires all federally regulated insurers to have an Appointed Actuary. The first responsibility of the Appointed Actuary, as set out in the Insurance Companies Act, is to value the actuarial and other policy liabilities of the company at the end of a financial year. The Appointed Actuary's valuation must be in accordance with generally accepted actuarial practice, which means complying with the rules and the standards set by the Canadian Institute of Actuaries (CIA). Further responsibilities, including the specific requirements of the Appointed Actuary's report on policy liabilities, are set forth by the Office of the Superintendent of Financial Institutions Canada (OSFI). Most provinces have adopted legislation similar to the federal insurance act, which defines the major responsibilities of the Appointed Actuary; thus, most provincial insurers also have an Appointed Actuary.

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[1] As the organization of insurance regulators from the 50 states, the District of Columbia, and the five territories, the NAIC promotes the development of uniform policy when uniformity is appropriate. State insurance regulators created the NAIC in 1871 to address the need to coordinate the regulation of multi-state insurers.

[2] Property and casualty insurance is a term used most frequently in the U.S. and Canada; the terms non-life and general insurance are often used in other countries.

[3] There are many different types of captive insurers operating around the world. Generally, a captive is a limited purpose, licensed insurance company, the main business purpose of which is to insure or reinsure the risks of the captive's owners. Self-insurance describes a wide range of risk financing arrangements through which organizations pay all or a significant portion of their own losses. Underwriting pools and associations are created in some jurisdictions to provide coverage for specific exposures, such as residual market automobile or aviation, across the insurance industry.

Other Examples – Australia and Slovenia

We offer two additional examples of countries that have enacted insurance legislation that requires an actuary to be involved in the process of developing unpaid claim estimates. Insurance legislation in Australia requires insurance companies to have an Appointed Actuary. According to the Amendment of the Insurance Act (1973), the signed actuary's report must contain a statement of the actuary's opinion about each of the following:

— The adequacy of all or part of the amount specified in the general insurer's accounts in respect of its liabilities, and the amount that the actuary considers would be adequate in the circumstances

— The accuracy of any relevant valuations made by the actuary

— The assumptions used by the actuary in making those valuations

— The relevance, appropriateness, and accuracy of the information on which those valuations were based

— Any other matter in respect of which the prudential standards require a statement of the actuary's opinion to be included in the report

The Insurance Act of Slovenia specifies that every company that is authorized to perform insurance operations is obliged to appoint a certified actuary. The insurance legislation defines the tasks of the certified actuary as follows:

> A certified actuary shall be obliged to examine whether premiums are calculated and technical provisions set aside in accordance with the regulations, and whether they are calculated or set aside so as to ensure the long-term meeting of all the insurance underwriting's obligations arising from the insurance contracts. … A certified actuary shall be obliged to submit to the supervisory boards and boards of directors, together with the opinion on the annual report, a report on the findings of the certified actuary with regard to the supervision carried out in the preceding year pursuant to the first paragraph hereunder. The said report must, in particular, include the reasons for issuing a favorable opinion, an opinion with a reservation or an unfavorable opinion of a certified actuary on the annual statements.

These examples demonstrate the important role of actuaries in determining and opining on claim reserves for insurers around the world.

Organization of This Book

This book focuses solely on the estimation of unpaid claims for P&C insurers, reinsurers, and self-insured entities. It is an introduction to the topic for actuarial candidates who should only consider this text as the beginning of their learning. There is a vast array of literature on the estimation of unpaid claims available throughout the international actuarial community. We direct actuaries who want to expand their knowledge of the topic beyond the scope of this text to:

- Casualty Actuarial Society (CAS) seminars such as the Reserve Variability Limited Attendance Seminar and the Casualty Loss Reserve Seminar

- CAS publications including the *Proceedings of the Casualty Actuarial Society* (PCAS), *Forum*, *Discussion Paper Program*, and *Variance*

- International actuarial organizations such as The Institute of Actuaries of Australia and The Institute of Actuaries / The Faculty of Actuaries (UK)

We organize this book in the following four parts:

- Part 1 – Introduction
- Part 2 – Information Gathering
- Part 3 – Basic Techniques for Estimating Unpaid Claims
- Part 4 – Estimating Unpaid Claim Adjustment Expenses

We also include three appendices following Part 4 that contain the CAS Statement of Principles and specific actuarial Standards of Practice promulgated by the American Academy of Actuaries (Academy), which are related to unpaid claim estimate analysis.

In Part 1, we take a detailed look at the process for estimating unpaid claims from the perspective of the claims department. We follow a claim from its first report to the insurer, through the establishment of an initial case outstanding, to partial payments and changes in the case outstanding, and finally to ultimate claim settlement.

We dedicate Part 2 to the topic of information gathering. Before actuaries can delve into quantitative analysis of unpaid claims, they must gather information. This information includes detailed statistics summarizing the historical claims and exposure experience of the insurer as well as a thorough knowledge of the insurer's environment. We describe the types of data actuaries use and methods for organizing the data. We discuss the importance of meetings with those involved in the claims and underwriting processes and provide extensive details of the types of information the actuary should seek from such meetings. The development triangle is one of the most common tools used by actuaries to evaluate the performance of an insurer and to determine estimates of unpaid claims. In Part 2, Chapter 5, we describe how to create and use development triangles.

In Part 3, we explore basic techniques for estimating unpaid claims. We generally rely on examples based on the actual experience of insurers in the U.S. and Canada. (See further description regarding examples later in this chapter.) We use similar portfolios of insurance in successive chapters to allow a comparison of the results from different techniques. A changing environment, such as an increase in claim ratios, a shift in the strength of case outstanding, and a change in product mix, can have a pronounced effect on the accuracy of the estimation technique. In this part, we demonstrate through detailed examples the impact of various changes on each of the methodologies for estimating unpaid claims. We conclude Part 3 with an evaluation of all the methods presented in the previous chapters. In the final chapter for this part, we also discuss on-going monitoring of unpaid claim estimates.

The purpose of Part 4 is to present techniques for estimating unpaid claim adjustment expenses. Claim adjustment expenses are the costs of administering, determining coverage for, settling, or defending claims even if it is ultimately determined that the claim is invalid. Some claims produce very little adjustment expenses; an example of such a claim is a house fire that is settled with only a few phone calls. Other claims, such as an asbestos claim, may revolve around complex legal and medical issues and may involve many interested parties. Claim adjustment expenses for an asbestos claim often involve litigation which can lead to high defense costs and expert fees and thus, very high expenses. In some cases, the claim adjustment expenses for asbestos claims may be significantly greater than the indemnity payment itself.

Historically, insurers categorized claim adjustment expenses as allocated loss adjustment expenses (ALAE) and unallocated loss adjustment expenses (ULAE).[4] ALAE correspond to those costs the insurer is able to assign to a particular claim, such as legal and expert witness expenses – thus, the name allocated loss adjustment expense. ULAE, on the other hand, is not easily allocated to a specific claim. Examples of ULAE include the payroll, rent, and computer expenses for the claims department of an insurer.

While actuaries in Canada still separate claim adjustment expenses into ALAE and ULAE, the NAIC promulgated two new categorizations of adjustment expenses (effective January 1, 1998) for U.S. insurers reporting on Schedule P[5] of the P&C statutory Annual Statement: defense and cost containment (DCC) and adjusting and other (A&O). Generally, DCC expenses include all defense litigation and medical cost containment expenses regardless of whether internal or external to the insurer; A&O expenses include all claims adjusting expenses, whether internal or external to the insurer.

The material in the appendices addresses some of the key professional obligations of U.S. and Canadian actuaries that are related to the estimation of unpaid claims as promulgated by the CAS and the Academy. The CAS Code of Professional Conduct states:

> It is the professional responsibility of an Actuary to observe applicable standards of practice that have been promulgated by a Recognized Actuarial Organization for the jurisdictions in which the Actuary renders Actuarial Services and to keep current regarding changes in these standards.

The Actuarial Standards Board (ASB) is a U.S. actuarial organization associated with the Academy that promulgates the standards of practice for the U.S. actuarial profession. Because the Academy is a "Recognized Actuarial Organization" and it issues standards of practice with respect to actuarial practice in the U.S., CAS members are required to observe the Academy's standard if they practice in the U.S. The controlling jurisdiction is the one in which the actuary renders the actuarial services. Therefore, CAS members who do not practice in the U.S. are not required to observe the Academy's standards but would instead be required to observe the standards set by any other recognized actuarial organization for the jurisdiction in which they practice (e.g., the CIA in Canada or the Institute/Faculty of Actuaries in the United Kingdom). The requirements for most of these organizations come in the form of standards of practice, educational notes, statements of principles, and other professional guidelines. In the

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[4] In Canada, ULAE is also referred to as internal loss adjustment expense (ILAE).

[5] Schedule P is an important section of the U.S. P&C statutory Annual Statement. In his paper "Completing and Using Schedule P," (*CAS Forum*, 2002) Sholom Feldblum states: "Schedule P is the actuarial portion of the Annual Statement and is critical to monitoring the solvency of insurers." Schedule P includes a ten-year summary, by line of insurance, of earned premiums, claim and claim expense payments, and unpaid claims and expenses; it also contains claim development schedules (also by line of insurance) for incurred net claims, paid net claims, and net bulk and incurred but not reported (IBNR) reserves.

appendices to this book, we provide, in their entirety, selected CAS and Academy documents related to the estimation of unpaid claims.

Ranges of Unpaid Claim Estimates

Throughout the book, we focus on obtaining point estimates for unpaid claims and claim-related expenses. We demonstrate the potential difficulty in obtaining one single estimate of the claims liability through numerous examples applied to the same line of business for the same experience period. Each of the methods presented results in a different value of the unpaid claim estimate. Furthermore, we recognize that, to the extent that we are dealing with the estimation of the mean of a stochastic process, the actual unpaid claims will almost always differ from the estimate.

Clearly, a range of estimates of the unpaid and a statement of our confidence that the actual unpaid claims (as proven at final development) will be within the stated range are valuable to management, regulators, policyholders, investors, and even the general public. However, the insurer's balance sheet requires the insurer to record a point estimate of the unpaid claims.[6]

Actuarial Standard of Practice No. 43 (ASOP 43) adopted in June 2007 by the ASB defines the *actuarial central estimate* as an estimate that represents an expected value over the range of reasonably possible outcomes. It is beyond the scope of this book to address ranges of unpaid claim estimates. We refer the reader to the wealth of material published by the CAS and various other international actuarial organizations on the subject of ranges for unpaid claim estimates.

Background Regarding the Examples

Differences in Coverages and Lines of Business Around the World

There are significant differences in the types of P&C insurance offered around the world. There are also differences in the names that are used for similar coverages throughout the world. For example, in the U.S. and Canada, insurers use the name "automobile insurance" to refer to the P&C coverage for automobiles and trucks; insurers from the U.K. call this coverage "motor insurance"; insurers conducting business in India refer to this coverage as "car insurance"; and in South Africa, insurers use both "car insurance" and "motor insurance." Similarly, the name of the coverage protecting personal homes and possessions is "homeowners insurance" in the U.S. and Canada, "home insurance" in India, and "home insurance" or "homeowners insurance" in Australia. In South Africa, some insurers differentiate between "household content" and "household building" insurance.

Some of the major coverages for U.S. P&C insurers, such as workers compensation or medical malpractice, may not exist at all in other countries, or if they exist, they may operate in a very different way. For example, in Canada, workers compensation insurance is not categorized as a P&C insurance coverage and is not sold by insurers. Instead, Canadian workers compensation coverage is provided by monopolistic provincial funds; pension and life (not P&C) actuaries typically provide actuarial services to the provincial workers compensation funds.

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[6] In a number of countries (e.g., Australia, Singapore, the United Kingdom, and South Africa), insurers are required to hold provisions (i.e., the estimate of unpaid claims) at the 75% confidence level.

Since this text was written with the hope that it would be used by actuaries throughout the world, the differences in both the names of the coverages and the coverages themselves presented a challenge in creating meaningful examples. There was an even greater challenge in finding sources of data representative of the wide range of claims behavior that often exists in different P&C coverages. Due to limitations in readily available global data sources, we rely on claim development data contained in *Best's Aggregates & Averages Property/Casualty United States & Canada – 2008 Edition* (*Best's Aggregates & Averages*)[7] for many of our examples. We also rely on actuarial colleagues at Canadian insurers who volunteered data from their organizations. This data has been disguised through the use of multipliers and adjustments to protect the privacy of the organizations.

While the names of the particular coverages and the patterns inherent in the data used in our examples may be unique to the U.S. or Canadian insurance environments, we believe that actuaries can apply the approaches, issues, and methodologies within the P&C (i.e., general or non-life) insurance market of any country around the world.

Description of Coverages Referred to in This Book

As noted above, we refer to and use examples for U.S. and Canadian lines of insurance. To assist the reader in understanding these types of coverage, we briefly describe each P&C coverage referred to in the text. The insurance *coverages* (also referred to as *lines of business*) listed below are in alphabetical order.

— *Accident benefits* is a Canadian no-fault automobile coverage that provides numerous benefits following a covered accident including: medical and rehabilitation expenses, funeral benefits, death benefits, and loss of income benefits. Because this is a no-fault coverage, it is payable by the insured's insurer regardless of fault for the accident.

— *Automobile property damage* is a subcoverage of automobile liability insurance and provides protection to the insured against a claim or suit for damage to the property of a third-party arising from the operation of an automobile.

— *Collision* is a subcoverage of automobile physical damage coverage providing protection against claims resulting from any damages to the insured's vehicle caused by collision with another vehicle or object. Collision is a first-party coverage and responds to the claims of the insured when he or she is at fault.

— *Commercial automobile liability* is a coverage that provides protection from the liability that can arise from the business use of owned, hired, or borrowed automobiles or from the operation of an employee's automobiles on behalf of the business.

— *Crime insurance* protects individuals and organizations from loss of money, securities, or inventory resulting from crime, including but not limited to: employee dishonesty, embezzlement, forgery, robbery, safe burglary, computer fraud, wire transfer fraud, and counterfeiting.

[7] *Best's Aggregates & Averages* is a comprehensive reference with current and historical statistics on the U.S. and Canadian P&C insurance industries. It provides industry-wide aggregates and long-term statistical studies. It also provides a complete financial overview of the P&C industry based on consolidated industry performance.

- *Direct compensation* is a Canadian automobile coverage that provides for damage to, or loss of use of, an automobile or its contents, to the extent that the driver of another vehicle was at fault for the accident. It is called direct compensation because, even though someone else caused the damage, the insured person collects directly from his or her insurer instead of from the person who caused the accident.

- *General liability* in the U.S. and Canada covers a wide array of insurance products. The principal exposures covered by general liability insurance are: premises liability, operations liability, products liability, completed operations liability, and professional (i.e., errors and omissions) liability.

- *Medical malpractice* is also known as medical professional liability insurance. This coverage is often further separated into hospital professional and physician/surgeon professional liability insurance. Medical malpractice coverage responds to the unique general liability exposures present for insureds (both individuals and organizations) offering medical care and related professional services. We use an example from a pivotal paper, "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach" by James R. Berquist and Richard E. Sherman.[8] While the data for the medical malpractice example is obviously very dated, the methodology, approach, and conclusions remain applicable today.

- *Personal automobile insurance* is also known as private passenger automobile insurance. Automobile insurance (either personal or commercial) can provide a variety of coverages, including first-party and third-party coverages; the available coverages are dependent upon the jurisdiction in which the insurance is written.

- *Primary insurance* refers to the first layer of insurance coverage. Primary insurance pays compensation in the event of claims arising out of an insured event ahead (first) of any other insurance coverages that the policyholder may have.

- *Private passenger automobile liability* provides third-party liability protection to the insured against a claim or suit for bodily injury or property damage arising out of the operation of a private passenger automobile.

- *Private passenger automobile physical damage* is a personal lines coverage providing protection against damage to or theft of a covered private passenger automobile.

- *Property insurance* provides protection against most risks to property, such as fire, theft, and some weather damages. There are many specialized forms of property insurance including fire insurance, flood insurance, earthquake insurance, home insurance, and boiler and machinery insurance.

- *Umbrella and excess insurance* typically refers to liability types of coverage available to individuals and companies protecting them against claims above and beyond the amounts covered by primary insurance policies or in some circumstances for claims not covered by the primary policies.

[8] *PCAS*, 1977.

— *U.S. workers compensation* provides coverage for the benefits the insured (i.e., the employer) becomes legally responsible for due to workplace injury, illness, and/or disease. The complete name for this U.S. coverage is workers compensation and employers liability insurance. U.S. workers compensation also covers the cost to defend against, and possibly pay, liability claims made against the employer (i.e., the insured) on account of bodily injury to an employee.

Key Terminology

We generally use *italics* for the first reference and definition of a new term. Throughout this text, we strive to use definitions contained within Standards of Practice and Statements of Principles of the CAS and the Academy. We indicate where definitions of the CAS or Academy differ from the Standards of Practice of the CIA. We also strive to clearly identify wherever we deviate from definitions of the U.S. and Canadian professional actuarial organizations.

At the end of each chapter, we present exhibits, some of which include multiple sheets, in Roman numeric order. On all these exhibits, we include detailed footnotes supporting the calculations.

Insurer

Throughout this book, we use the term *insurer* to represent any risk bearer for P&C exposures, whether an insurance company, self-insured entity, or other. There are certain situations where a different approach or different factors within a technique may be more appropriate for insurance companies (including reinsurance companies) than self-insurers (including organizations with funded self-insured programs, captive insurers, pooling associations, etc.). When this happens, we clearly identify the appropriate course of action for the specific type of risk bearer.

Reserves

The term *reserves* itself is tricky. The financial statements of insurers in the U.S. and Canada contain many different types of reserves including: case reserves, loss reserves, bulk and IBNR reserves, case LAE reserves, unearned premium reserves, reserves for bad debts, reserves for rate credits and retrospective adjustments, general and contingency reserves, and earthquake reserves. The primary focus of this text, however, is estimating unpaid claims and claim adjustment expenses.

ASOP 43 limits the term reserve to its strict definition as an amount booked in a financial statement. ASOP 43 defines the term *unpaid claim estimate* to be the actuary's estimate of the obligation for future payment resulting from claims due to past events. ASOP 43 further defines *unpaid claim estimate analysis* to be the process of developing an unpaid claim estimate.

In this text, we strive to use terminology consistent with ASOP 43. We acknowledge that many actuaries and the professionals they work with are more familiar with the term reserves than unpaid claim estimate; similarly, the term reserving is more frequently used today than estimating unpaid claims. Nevertheless, we predominantly use the terminology of ASOP 43, in an attempt to be consistent with more recent CAS developments aimed at improving communication and an effort to use terminology that is consistent with actuarial standards of practice throughout the world.

We differentiate between *unpaid claim estimate* and *carried reserve*. The unpaid claim estimate is the result of the application of a particular estimation technique. For the same line of business and the same experience period, different estimation techniques will likely generate different unpaid claim estimates. In addition, the unpaid claim estimate will likely change from one valuation date to another for the same portfolio. The carried reserve for unpaid claims is the amount reported in a published statement or in an internal statement of financial condition.

The unpaid claims estimate includes five components: case outstanding on known claims, provision for future development on known claims, estimate for reopened claims, provision for claims incurred but not reported, and provision for claims in transit (i.e., claims reported but not recorded). We use the terms *case outstanding* or *unpaid case* to refer to the estimates of unpaid claims established by the claims department, third-party adjusters, or independent adjusters for known and reported claims only; case outstanding do not include future development on reported claims. Actuaries refer to the sum of the remaining four components (i.e., provision for future development on known claims, estimate for reopened claims, provision for claims incurred but not reported, and provision for claims in transit) as the broad definition of *incurred but not reported* (*IBNR*).

IBNR claims are often further separated into two components:

- Incurred but not yet reported claims (pure IBNR or narrow definition of IBNR)
- Incurred but not enough reported (IBNER, commonly referred to as development on known claims)

One of the most important reasons for separating IBNR into its components is to test the adequacy of case outstanding over time. This can be an important management tool and a useful tool for the actuary when determining which methods are most appropriate for estimating unpaid claims.

Throughout this book, unless specifically noted otherwise, we use the broad definition of IBNR. We also use the terms *IBNR* and *estimated IBNR* interchangeably.

In Part 2, Chapter 3, we discuss the importance of the actuary completely understanding the different types of data provided for the purpose of estimating unpaid claims. The actuary must understand whether or not the data include or exclude: IBNR, estimates of unpaid claim adjustment expenses, recoverables from salvage and/or subrogation, reinsurance recoveries, and policyholder deductibles.

Claims, Losses, and Claim Counts

The terms *claims* and *losses* are used interchangeably in this text. We purposefully use the term claims rather than losses since claims is used more frequently in standards of practice of the U.S. and Canadian actuarial organizations as well as other international actuarial organizations. The term claims is also more frequently used for financial reporting purposes of insurers. We recognize that the current practice within many U.S. and Canadian insurance organizations is still to use the term losses – particularly when referring to ultimate losses, expected losses, loss ratios, and loss adjustment expenses. Nevertheless, we have specifically selected to use the term claims. Thus, in this text, we refer to ultimate claims, expected claims, claim ratios, and claim adjustment expenses.

We differentiate between claims (dollar values) and *claim counts (*or *number of claims*).

Reported Claims

In this text, we use the term *reported claims* instead of incurred claims (or incurred losses). While the term incurred losses is used by many throughout the P&C insurance industry, it can be misunderstood as to whether or not it includes IBNR. Many actuaries use the labels *case incurred* or *incurred on reported claims* to specifically note that the losses do not include IBNR. For consistency and simplicity throughout this book, we choose the term *reported claims*. Reported claims (both in the text and exhibits of this book) generally refer to the sum of cumulative paid claims and case outstanding estimates at a particular point in time. In certain methods or discussions, which are clearly defined in the text, we will refer to incremental instead of cumulative reported claims.

Ultimate Claims

Ultimate claims represent the total dollar value after all claims are settled and closed without any chance of reopened claims.[9] For some *short-tail* lines of insurance, such as some lines of property insurance and automobile physical damage, insurers generally know the value of ultimate claims within a relatively short period of time, often within one or two years after the end of the accident period. However, for *long-tail* lines of insurance, such as U.S. general liability and workers compensation, it may take many years, and in some situations even decades, before the insurer knows the value of ultimate claims.

A key step in the actuarial process of estimating unpaid claims is the projection of ultimate claims. In this book we present numerous techniques for estimating unpaid claims. While you can mathematically manipulate many of the methods to simply derive the unpaid claim estimate, wherever possible we first present the projection of ultimate claims. Using the projected ultimate claims, we then calculate the estimate of unpaid claims for IBNR and the total unpaid claim estimate (i.e., the sum of IBNR and case outstanding). We believe that the projected ultimate claims are valuable for the purpose of evaluating and selecting the final unpaid claim estimate and for determining the accuracy of the prior estimate of unpaid claims. We address the evaluation of numerous estimation techniques in detail in the last chapter of Part 3.

Claim-Related Expenses

In this text, we use the terms *claim adjustment expenses* and *claim-related expenses* to refer to total claim adjustment expenses (i.e., the sum of ALAE and ULAE, or the sum of DCC and

[9] Some accounting approaches estimate ultimate claims on a policy year basis in a manner that includes losses yet to be incurred. In this book, we address only losses incurred through a specified point in time.

A&O). We continue to use the terms ALAE and ULAE because of their wide-spread use and acceptance. In our examples, unless specifically noted, claims include ALAE and exclude ULAE.

Experience Period

We use the term *experience period* to refer to the years included in a specific technique for estimating unpaid claims.

Emergence

In this book, the term *emergence* is used to refer to the reporting or development of claims and claim counts over time. In Canada, many actuaries use the term emergence to refer to the rate of payment of ultimate claims, particularly in the context of calculating estimates of discounted claim liabilities.

CHAPTER 2 – THE CLAIMS PROCESS

Overview

The financial condition of a P&C insurer cannot be assessed accurately without sound estimates of unpaid claims. But what are unpaid claim estimates and where do they come from? Claim and claim adjustment expense reserves (as reported on an insurer's financial statements) represent an insurer's liability for unpaid claims as of a particular point in time. Both claims professionals and actuaries have responsibilities related to the unpaid claim estimate of an insurer. As previously noted, there are five elements comprising the total unpaid claim estimate:

- Case outstanding
- Provision for future development on known claims
- Estimate for reopened claims
- Provision for claims incurred but not reported
- Provision for claims in transit (incurred and reported but not recorded)

Claims professionals are responsible for estimating case outstanding on claims that are reported to the insurer; these estimates are also known as "unpaid case" and "case estimates." According to consolidated claim development data for the U.S. insurance industry as a whole, unpaid case, net of reinsurance, represent less than 50% of total unpaid claims and claim expenses.[10] (The proportion of unpaid case to total unpaid claims varies tremendously by line of business and from insurer to insurer.) While claims professionals typically estimate case outstanding, actuaries are responsible for estimating the remaining components of total unpaid claims.

In this chapter, we focus on the unpaid claim estimate from the perspective of the claims professional. As we will see in later chapters, actuaries rely on the historical variations in the case outstanding generated by claims professionals as a base for determining the remaining components of total unpaid claims. Therefore, it is important for the actuary to understand the entire claims process. The actuary must understand why the estimated value of a reported claim could vary over time and how changes in case outstanding are processed by an insurer.

Claims Professionals

The claims professional, who is often referred to as a claims examiner or claims adjuster, can be an employee of the insurer or an employee of an organization external to the insurer. Large commercial insurers generally maintain internal claims departments with many claims adjusters managing the claims. Small to mid-sized commercial insurers and self-insurers often hire third-party claims administrators (TPAs) to handle a specific book of claims. TPAs frequently handle the claims from beginning to end (i.e., from the initial report to the final payment). Insurers usually require the TPA to report details of the claims on a predetermined basis (e.g., monthly or quarterly). In certain circumstances, a TPA manages all the claims of an insurer, and the insurer only has a minimal number of claims personnel reviewing the activities of the TPA. The compensation for services of a TPA is generally based on a contract for the entire book of business and not by individual claim, though compensation varies among TPAs.

[10] The source of data is *Best's Aggregates & Averages* (2008 Edition), consolidated annual statement data for the U.S. insurance industry.

An insurer may hire an independent adjuster (IA) to handle an individual claim or a group of claims. The insurer, who may have an active claims department, may need an IA to handle a specific type of claim or a claim in a particular region where the insurer does not have the necessary expertise. Also when a disaster occurs, such as a hurricane or earthquake, the insurer may hire a number of IAs (or a firm of IAs) to handle the large volume of claims. The compensation for the services of IAs is generally based on a fee per claim.

A Claim is Reported

The estimation process for unpaid claims begins when an insured first reports a claim, or notice of an event, to the insurer. Insureds may report claims in several ways, including but not limited to: telephone (often to a call center), Internet (the insurer's Web site), e-mail, in person at an insurer's branch office, notice to an insurance intermediary (such as an insurance agent or broker), or a lawyer's letter with a formal statement of claim. A claims professional of the insurer then reviews the initial claim report.

The first decision a claims adjuster, either internal or external to the insurer, encounters is whether or not the reported claim is covered under the terms of a valid policy. To determine whether the reported incident represents a covered claim and to assist in the establishment of an initial case outstanding estimate, claims professionals generally review the following:

- Effective dates of the policy
- Date of occurrence
- Terms and conditions of the policy
- Policy exclusions
- Policy endorsements
- Policy limits
- Deductibles
- Reinsurance or excess coverage
- Reporting requirements
- Mitigation of loss requirements
- Extent of injury and damages
- Extent of fault
- Potential other parties at fault
- Potential other sources of recovery

Once the claims professional recognizes that a liability exists, or may exist, for a covered incident, he or she will establish an initial case outstanding. For some types of claims, insurers may rely on a formula or tabular value[11] as the basis of the initial case outstanding. For example, an insurer may initially set all automobile physical damage glass claims at $500. For U.S. workers compensation claims, the insurer may use a tabular system where the type of injury dictates the initial case outstanding value. For other types of claims, a claims professional may

[11] Tabular estimates of unpaid claims are used for some lines of insurance whereby initial case outstanding values are set based on specific predetermined formula, which take into account characteristics of the injured party and the insurance benefits. The use of tabular values would be most common for accident benefits and U.S. workers compensation insurance. Not all insurers, however, writing these coverages use tabular systems.

analyze the specific details of the insured event to generate an independent estimate of the initial case outstanding.

It is important to recognize that claims professionals generally estimate case outstanding based on the information known at that time. As additional information about a claim becomes available, the estimated value of the claim will likely change. (We demonstrate this point later in the chapter with a detailed example.)

There are several different approaches commonly used by insurers to set case outstanding. These different approaches may best be understood with an example. Assume a claim is reported under a medical malpractice policy with a policy limit of $1 million. One of the most common approaches is to establish the case outstanding based on the best estimate of the ultimate settlement value of such a claim including consideration of future inflationary forces. Other insurers may set the case outstanding based on the maximum value, which would be the policy limit of $1 million. Another approach is for the claims adjuster to seek the advice of legal counsel. Assume that the legal counsel estimates that there is an 80% chance that the claim will settle without any payment and a 20% chance of a full policy limit claim. Some insurers may then set the case outstanding based on the mode, which would be $0; and others may set the case outstanding based on the expected value calculation or $200,000 [(80% x $0) + (20% x $1 million)].

Insurers differ in their practices with respect to the establishment of case outstanding for claim adjustment expenses. While some insurers establish case outstanding for the estimated claim amount only; others establish case outstanding for the estimated claim amount and all claim-related expenses. Even for those insurers who do establish total estimated claim amount and claim adjustment expense case outstanding, there are differences in whether or not the case outstanding for estimated claim amount and claim-related expenses are recorded and tracked separately. Some insurers may establish case outstanding for ALAE (or DCC) only and other insurers for ULAE (or A&O) only.

There are also different practices for the establishment of case outstanding for salvage and subrogation recoveries. Some insurers set up specific case outstanding based on an estimate of the salvage or subrogation recovery that the insurer expects to receive (i.e., the case outstanding is net of expected salvage and subrogation recoveries). Many insurers, however, simply track the actual salvage and subrogation recoveries but do not establish case outstanding for these types of recoveries.

For many insurers, determining the case outstanding for reinsurance recoveries is a fairly straight-forward exercise. When the reinsurance is proportional (i.e., quota share), insurers determine the ceded case outstanding based on the reinsurer’s share of the total case outstanding. If the reinsurance is excess of loss, the reinsurance ceded case outstanding for a claim that exceeds the insurer’s retention is simply the total case outstanding estimate (provided that the claims adjuster estimates the case outstanding on a total limits basis) less the insurer’s retention.

The Life of a Claim

One single insurance claim may have a life that extends over a number of years. We will use the example of an automobile insurer who issued a policy effective for a one-year term beginning on December 1, 2007 and ending on November 30, 2008. Assume an accident occurred on November 15, 2008, and the insurer did not receive notice of the claim until February 20, 2009, more than two months after the end of the policy year. Starting on February 20, 2009 (the report date of the claim), a claims professional will record a number of transactions related to this claim.

The different types of claim transactions over the life of the claim could include:

- Establishment of the initial case outstanding estimate
- Notification to the reinsurer if the claim is expected to exceed the insurer's retention
- A partial claim payment to injured party
- Expense payment for independent adjuster
- Change in case outstanding estimate
- Claim payment (assumed to be final payment)
- Takedown of case outstanding and closure of claim
- Reopening of the claim and establishment of a new case outstanding estimate
- Partial payment for defense litigation
- Final claim payment
- Final payment for defense litigation
- Closure of claim

We summarize the details for our sample claim in the following table. (We use the abbreviation case O/S for case outstanding in the following table.)

Table 1 – Claim Fact Summary

Policy Period	December 1, 2007 to November 30, 2008
Date of Accident	November 15, 2008
Date of Claim Report	February 20, 2009

Claim Transactions

Date	Transaction	Reported Value of Claim to Date	Cumulative Paid to Date
February 20, 2009	Case O/S of $15,000 established for claim only	$15,000	$0
April 1, 2009	Claim payment of $1,500 – case O/S reduced to $13,500 (case O/S change of -$1,500)	$15,000	$1,500
May 1, 2009	Expense payment to IA of $500 – no change in case O/S	$15,500	$2,000
September 1, 2009	Case O/S for claim increased to $30,000 (case O/S change of +$16,500)	$32,000	$2,000
March 1, 2010	Claim thought to be settled with additional payment of $24,000 – case O/S reduced to $0 and claim closed (case O/S change of -$30,000)	$26,000	$26,000
January 25, 2011	Claim reopened with case O/S of $10,000 for claim and $10,000 for defense costs	$46,000	$26,000
April 15, 2011	Partial payment of $5,000 for defense litigation and case O/S for defense costs reduced to $5,000 – no change in case O/S for claim	$46,000	$31,000
September 1, 2011	Final claim payment for an additional $12,000 – case O/S for claim reduced to $0 (case O/S change of -$10,000)	$48,000	$43,000
March 1, 2012	Final defense cost payment for an additional $6,000 – case O/S for defense costs reduced to $0 and claim closed (case O/S change of -$5,000)	$49,000	$49,000

As explained in Chapter 1, case outstanding represent the sum of the values assigned to specific known claims whether determined by claims adjusters or set by formula. In our example, case outstanding refers to the estimates, for claim and claim-related expenses (e.g., IA and defense costs), for the one claim that occurred on November 15, 2008. The initial case outstanding is the adjuster's estimate of the total amount the insurer will pay on this individual claim at the time of first notice to the insurer (i.e., February 20, 2009).

The example in Table 1 illustrates a number of important characteristics of insured claims. First, claim activity typically extends over a period of time – more than three years for this particular claim. Second, the estimated value of a claim can change over the life of the claim and is not ultimately established until the claim is finally closed. In our example, the insurer initially closes the claim on March 1, 2010, but then reopens it almost one year later on January 25, 2011, with an increase to the case outstanding. The estimated case outstanding value can turn out to be too high or too low, although it is reasonable in light of the information available at the time when the claims professional sets the estimate.

A third characteristic is that an insured claim can have many different types of payments associated with it. In our example, the insurer makes an initial claim payment to the injured party on April 1, 2009. This claim payment provides for out-of-pocket medical expenses reported by the claimant. Since the insurer questioned the validity of the claim, they hired an IA; as a result, there was a payment of $500 for the IA's services on May 1, 2009. (Insurers in the U.S. would classify this type of expense as A&O; in Canada, they would categorize this expense as ALAE.) On March 1, 2010, the insurer makes another payment of $24,000 to the claimant for lost wages and additional medical expenses. At this time, the insurer assumes this to be the final payment. Roughly one year later, a claims professional reopens the claim. Over the course of the following year, the insurer makes further payments for defense litigation, additional lost wages, and medical expenses.

A fourth characteristic of insured claims is that there are many dates associated with each claim:

— *Policy effective date* is the date the insurer issues the insurance policy (December 1, 2007)

— *Accident date*, or date of loss, is the date the covered injury occurs (November 15, 2008)

— *Report date* is the date the insurer receives notice of the claim (February 20, 2009)

— *Transaction date* is the date on which either a case outstanding transaction takes place or a payment is made (see all the dates in the preceding table)

— *Closing dates* are the dates on which the claim is initially closed (March 1, 2010) and finally closed (March 1, 2012)

— *Reopening date* is the date the insurer reopens the claim (January 25, 2011)

This example clearly does not cover every combination of transactions possible. Some claims open and close on the same day with a single payment. Such claims would have only one transaction and would likely never show a case outstanding value. In our example, when the partial payment occurs on April 1, 2009, the insurer reduces the case outstanding estimate by exactly the same amount as the claim payment. However, this chain of events may not happen for all claims. As an insurer makes a specific payment, it may choose to reduce the case outstanding more than the payment, less than the payment, not reduce it at all, or even increase it, depending on the exact circumstances of the particular claim.

The payments on a specific claim are the amounts paid through a given date or over some specified time period. Therefore, when referring to paid claims, it is important to clearly state whether the claims are cumulative or incremental. Cumulative paid claims refer to the sum of all claim payments through the valuation date. Incremental paid claims refer to the sum of all claim payments made during a specified time interval.

In the above example, the cumulative paid claims including claim-related expenses are:

- $1,500 at April 1, 2009
- $2,000 at May 1, 2009
- $26,000 at March 1, 2010
- $31,000 at April 15, 2011
- $43,000 at September 1, 2011
- $49,000 at March 1, 2012

The incremental paid claims during calendar year 2009 (January 1, 2009 to December 31, 2009) are $2,000; the incremental paid claims during calendar years 2010, 2011, and 2012 are $24,000, $17,000, and $6,000, respectively.

The case outstanding is the estimated amount of future payments on a specific claim at any given point in time. In our example, the initial case outstanding recorded on the report date of the claim is $15,000. This amount varies over the life of the claim; just before the claim initially closes in March 2010, the case outstanding is $30,000. When the claim is reopened in January 2011, a new case outstanding is established for both claim amount and defense costs. Ultimately, the claim settles for a greater amount than the case outstanding for both claim amount and defense costs.

Similar to paid claims, it is important to define the time period when referring to reported claims. Generally, when looking at a specific claim, we use the term "reported claims" (or case incurred) to mean the sum of cumulative claim payments through a specific date and the case outstanding at the same point in time. Using the example above, the reported claims are:

- $15,000 at the time of first report (i.e., February 20, 2009)

- $15,500 at May 1, 2009 after a payment of $500 to an IA

- $32,000 at September 1, 2009, when the insurer increases the case outstanding to $30,000 ($2,000 cumulative paid claims + $30,000 case outstanding)

- $26,000 upon initial closing on March 1, 2010 ($26,000 cumulative paid claims + $0 case outstanding)

- $46,000 upon reopening on January 25, 2011 ($26,000 cumulative paid claims + $10,000 claims and $10,000 defense costs case outstanding)

- $48,000 at September 1, 2011 after final claim payment ($43,000 cumulative paid claims and LAE + $5,000 case outstanding for defense costs)

- $49,000 at March 1, 2012 after final defense costs payment ($49,000 cumulative paid claims and LAE + $0 case outstanding)

For a particular claim, we calculate the reported claims over a period of time as the reported claims at the end of the period minus the reported claims at the beginning of the period. Mathematically, this is equivalent to adding the incremental paid claims over the period to the change in case outstanding (ending case outstanding minus beginning case outstanding). In our example, the reported claims for the period beginning on January 1, 2009 and ending on December 31, 2009 are $32,000. As of January 1, 2009, the claim was not yet reported and thus there are $0 reported claims for the claim. The incremental claim payments during 2009 are $2,000 and the change in case outstanding is $30,000 ($30,000 ending case outstanding minus $0 beginning case outstanding). The reported claims over the period January 1, 2010 to December 31, 2010 are -$6,000. The incremental claim payments in 2010 are $24,000 and the change in case outstanding is -$30,000 (ending case outstanding of $0 minus beginning case outstanding of $30,000). You can use similar calculations to derive the reported claims during 2011 and 2012.

As indicated above, we use the term "reported claims" under two contexts, incremental and cumulative, and it is important to look at the time period involved to differentiate between these two contexts. For a particular claim or the aggregate of a group of claims, we can summarize reported claims at a specific point in time. In such a context, reported claims are equal to the sum of cumulative paid claims through a specific date and case outstanding as of that same date. Many actuarial projection techniques rely on this definition of reported claims.

Reported claims can also refer to the claim activity over an interval of time. An example of reported claims used in this context is the insurer's income statement. As previously mentioned, we define the reported claims over a period of time using the following formulae:

Reported claims = reported claims at end of period – reported claims at beginning of period

Reported claims = paid claims during period + case outstanding at end of period
– case outstanding at beginning of period

Further Claim Examples

In Table 2 (on the following page), we present additional illustrations of how claim transactions can affect reported claims. (We use the abbreviation case O/S to refer to case outstanding in Table 2.)

Table 2 – Examples of Changes in Reported Values

	At December 31, 2007			Transactions During 2008			At December 31, 2008		
Example Number	Cumulative Paid Claims	Case O/S	Reported Claims	Paid Claims	Change in Case O/S	Reported Claims	Cumulative Paid Claims	Case O/S	Reported Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	-	-	-	100	-	100	100	-	100
2	200	-	200	50	-	50	250	-	250
(Making payments where there had been no previous case outstanding increases reported claim.)									
3	-	-	-	-	1,000	1,000	-	1,000	1,000
(Establishing a case outstanding increases reported claim by the amount of the case outstanding.)									
4	-	1,000	1,000	100	(100)	-	100	900	1,000
(Payment with offsetting case outstanding reduction has no effect on reported claim.)									
5	500	5,000	5,500	200	(1,000)	(800)	700	4,000	4,700
(If case outstanding is reduced by a larger amount than the claim payment, the impact is a reduction to reported claim.)									
6	5,000	10,000	15,000	12,000	(10,000)	2,000	17,000	-	17,000
(If payment on closing exceeds case outstanding, reported claim transaction is positive.)									
7	5,000	10,000	15,000	6,000	(10,000)	(4,000)	11,000	-	11,000
(If payment on closing is less than case outstanding estimate, reported claim transaction is negative.)									
8	5,000	15,000	20,000	4,500	-	4,500	9,500	15,000	24,500
(Claim payment with no change in case outstanding increases the reported claim.)									
9	3,000	10,000	13,000	-	(4,000)	(4,000)	3,000	6,000	9,000
(No payment and decrease in case outstanding decreases the reported claim.)									
10	2,000	10,000	12,000	1,000	5,000	6,000	3,000	15,000	18,000
(Payment and increase in case outstanding result in increase in reported claim.)									

Columns (4) and (10) of the above table show reported claims as of year-end 2007 and 2008, respectively. Reported claims at a point in time (i.e., year-end 2007 and 2008) are equal to the cumulative claim payments plus the case outstanding at that point in time. However, reported claims shown in Column (7) represent the incremental reported value during the period of time running from January 1, 2008 to December 31, 2008. Reported claims over the year are equal to sum of the payments during the year (Column (5)) and the changes in case outstanding (Column (6)).

The transactions presented in Table 2 vary with respect to the impact on total reported claims. In the first two examples, there are payments made in 2008 on claims where there was no prior existing case outstanding at December 31, 2007; thus total reported claims for both of these claims increase. Such payments could occur when the insurer reopens a claim. In a situation where the payment made during the year is offset by an equal reduction in the case outstanding, there is no change to reported claim (Example Number 4). If the payment is larger than the reduction in case outstanding, then the reported claim will increase (Example Number 6). If the payment is smaller than the reduction in case outstanding, then the reported claim will decrease (Examples Number 5 and 7). A change in case outstanding without any associated payment will also impact the reported claim (Examples Number 3 and 9).

While the reported claims in the interval can be positive or negative, the reported claims at a point in time are rarely negative. Remember that we define the reported claims at a point in time to equal cumulative payments plus case outstanding at that point in time.

PART 2 – INFORMATION GATHERING

INTRODUCTION TO PART 2 – INFORMATION GATHERING

In the chapter "Loss Reserving" in the *Foundations of Casualty Actuarial Science* (2001), Ronald Wiser describes a four-phase approach to the process of estimating unpaid claims:

— Exploring the data to identify its key characteristics and possible anomalies. Balancing data to other verified sources should be undertaken at this point.

— Applying appropriate techniques for estimating unpaid claims.

— Evaluating the conflicting results of the various methods used, with an attempt to reconcile or explain the different outcomes. At this point, the projected ultimate amounts are evaluated in contexts outside their original frame of analysis.

— Monitoring projections of claim development over subsequent calendar periods. Deviations of actual development from projected development of counts or amounts are one of the most useful diagnostic tools in evaluating the accuracy of unpaid claim estimates.

In Chapters 3 through 6 of this book, we focus on Mr. Wiser's first phase, the exploratory analysis of the data. The process for collecting and understanding the data and other relevant information is so critical that we devote four chapters to the topic. We begin Chapter 3 with a description of the types of data that actuaries use for estimating unpaid claims and present various options for organizing the data.

Equally important to collecting quantitative data is developing an understanding of the environment in which the insurer operates. In Chapter 4, we discuss the importance of meeting with the management of both the claims and underwriting departments to gain a more complete understanding of the environment in which the insurer operates. We provide a list of possible questions for actuaries to use in their meetings with management. Changes in the insurer's internal operations as well as changes in the external setting can affect the results of the various techniques for estimating unpaid claims in different ways. (In Part 3, Chapters 7 through 15, we review numerous examples of changing environments and examine the result of such changes on alternative techniques for estimating unpaid claims.)

The development triangle is one of the actuary's most important tools for displaying and analyzing data; it is an important component of many claims projection techniques. In Chapter 5, we describe in depth how to create a development triangle. The development triangle is also a critical tool in the evaluation of the influence of operational and environmental changes on claims. In Chapter 6, we present a detailed example of how actuaries can use development triangles as a diagnostic tool, allowing examination of the consequences of operational and environmental changes on historical claims.

CHAPTER 3 – UNDERSTANDING THE TYPES OF DATA USED IN THE ESTIMATION OF UNPAID CLAIMS

The availability of appropriate data and information is essential for accurately estimating unpaid claims. We can classify data as originating from either internal or external sources.

Sources of Data

Large insurers are usually able to generate the detailed claims and exposure data required by actuaries for the estimation of unpaid claims from their own management information systems. Thus, actuaries working for large insurers often rely solely on data produced internally.

Smaller insurers, however, may be more limited in the internal data that they can generate. The data may be limited in its volume and thus its credibility to the actuary, or the data may be unavailable due to systems limitations of the organization. Such situations may force actuaries to turn to external sources of data. Large insurers who recently entered a new line of insurance or a new geographical region (e.g., a new territory, state, or province) may also need to turn to external sources of information when developing estimates of unpaid claims.

The sources of readily available external data vary by jurisdiction and by product line. The following are examples of external sources of information available in certain jurisdictions:

United States
- Insurance Services Office, Inc. (ISO)
- National Council on Compensation Insurance (NCCI)
- Reinsurance Association of America (RAA)
- The Surety & Fidelity Association of America (SFAA)
- A.M. Best Company (Best)
- NAIC Annual Statement data

Canada
- Best
- General Insurance Statistical Agency (GISA)
- Insurance Bureau of Canada (IBC)
- Reinsurance Research Council (RRC)
- Market-Security Analysis & Research Inc. (MSA)

Many insurers (of all sizes) use a combination of internally-generated data and external industry benchmarks. External information can be particularly valuable when selecting tail development factors, trend rates, and expected claim ratios (i.e., expected loss ratios). We address all of these topics in Part 3 of this book. Incorporating external information can also be useful when the actuary evaluates and attempts to reconcile the results of the various estimation methods in order to make a final selection of ultimate claims and unpaid claim estimate.

It is important that actuaries recognize the potential shortcomings in the use of data generated from external sources. The International Actuarial Association (IAA) strongly believes that entity-specific data is far preferred over external data. There is a risk that external data may be misleading or irrelevant due to differences relating to: insurance products, case outstanding and settlement practices, insurers' operations, coding, geographic areas, and mix of business and product types. Thus, the actuary must carefully evaluate the relevance and value of external data.[12]

Homogeneity and Credibility of Data[13]

Different lines of insurance exhibit different claim behaviors. For example, claims from insurance policies sold to businesses generally do not have the same characteristics as claims from insurance policies sold to individuals, even when the insurance coverages are identical. Likewise, claims for umbrella and excess insurance are different from claims for primary insurance. Even within a single line of insurance, the characteristics of claims by subcoverage can differ significantly. For example, claims involving only property damage for automobile liability policies are generally reported and paid very quickly and have a relatively low severity (i.e., average settlement value). On the other hand, claims arising from automobile accidents involving catastrophic spinal injuries may take years to settle in some jurisdictions and could ultimately cost millions of dollars.

It is often possible to improve the accuracy of estimating unpaid claims by subdividing experience into groups exhibiting similar characteristics, such as comparable claim experience patterns, settlement patterns, or size of claim distributions. As a result, when separating data into groups for an analysis of unpaid claims, actuaries focus on the following key characteristics:

- Consistency of the coverage triggered by the claims in the group (i.e., group claims that will generally be subject to the same or similar laws, policy terms, claims handling, etc.)
- Volume of claim counts in the group
- Length of time to report the claim once an insured event has occurred (i.e., reporting patterns)
- Ability to develop an appropriate case outstanding estimate from earliest report through the life of the claim
- Length of time to settle the claim once it is reported (i.e., settlement, or payment, patterns)
- Likelihood of claim to reopen once it is settled
- Average settlement value (i.e., severity)

[12] The Academy's Risk Management & Financial Reporting Council, Financial Reporting Committee argued to the International Actuarial Standards Board (IASB) that, in general, external data is typically used (and most appropriately used) only as a fallback where internal data is not sufficiently credible.

[13] The following section borrows from the CAS Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves, issued in May 1988.

Actuaries strive to group claims by lines and sublines of business which display similar traits with respect to the characteristics listed above. They may also group claims by policy limits to achieve similar claims attributes within a block of business.

The goal for the actuary is to divide the data into sufficiently homogeneous groupings without compromising the credibility of the data. Credibility refers to the predictive value given to a group of data. Increasing the homogeneity of the group of data or increasing the volume of data in the group tends to increase credibility. If the actuary divides the data into too many homogeneous groupings, however, there is a risk that the volume of data in the individual groups may become insufficient to perform a reliable analysis. This is a frequent challenge for the actuary. In "An Introduction to Credibility Theory," Longley-Cook states:

> We may liken our statistics to a large crumbly loaf cake, which we may cut in slices to obtain easily edible helpings. The method of slicing may be chosen in different ways – across the cake, lengthwise down the cake, or even in horizontal slices – but only one method of slicing may be used at a time. If we try to slice the cake more than one way at a time, we shall be left with a useless collection of crumbs.[14]

Consider automobile accident benefits coverage[15] as an example of how actuaries must decide how to divide the cake. Options include analyzing the claims in total or breaking out the claims into the individual components (e.g., medical/rehabilitation, disability income, death benefits, funeral services, and supplementary benefits). Certainly, the claims behavior is very different for funeral services claims than it is for medical/rehabilitation claims. There are differences in claims reporting patterns, settlement patterns, severity of claims, and frequency of claims between these subcoverages. However, if there is insufficient data by subcoverage, a detailed analysis may not produce a more accurate estimate of unpaid claims than the analysis based on the combined data for all of the accident benefits components. Further considerations for the actuary are efficiency and time and resource requirements of separate versus combined analyses. The funeral benefits may represent a stable portion of the total accident benefit claims and thus may not justify the time and resources required for independent analysis.

We can raise similar questions with regards to many other lines of insurance with a combination of coverages or benefits under one policy. For example, is it preferable to analyze claims for bodily injury and property damage separately or on a combined basis for general liability, or for automobile liability insurance?

Another consideration regarding the homogeneity and the grouping of data relates to changes in the portfolio. In some circumstances, it may be appropriate to combine personal automobile and commercial automobile data even though these lines typically exhibit different underlying claims patterns. However, if the relative volume of business is changing between these two lines of insurance, the grouping may not be appropriate. In Part 3, we present an example of the effect on various projection techniques of analyzing a portfolio where the volume of personal automobile is increasing at 5% per year while the commercial automobile volume is increasing at 30%. We will

[14] *PCAS*, 1962.

[15] As described in Chapter 1 – Overview, accident benefits coverage provides for the medical needs of the driver and passengers arising from an automobile accident. Insurers in the U.S. call this coverage automobile no-fault.

see that the consequence of the changing proportion on the various estimation techniques can be significant.

Types of Data Used by Actuaries

Claims and Claim Count Data

Actuaries rely on many different types of data in the establishment and testing of unpaid claim estimates for an insurer. Some of the most common types of data include:

- Incremental paid claims
- Cumulative paid claims
- Paid claims on closed claims
- Paid claims on open claims
- Case outstanding
- Reported claims (i.e., sum of cumulative paid claims plus case outstanding)
- Incremental reported claims
- Reported claim counts
- Claim counts on closed with payment
- Claim counts on closed with no payment
- Open claim counts
- Reopened claim counts

We can use all of the above data types with claims only (i.e., losses only), claim-related expenses, or claims and claim-related expenses combined.

Claim-Related Expenses

The actuary needs to know how the insurer handles expenses before using the data. Where the claim data and policy limits include claim adjustment expenses, many actuaries combine historical claims and ALAE experience when conducting analyses of unpaid claims. Unless otherwise indicated, we use the term claims to denote both claims and ALAE combined. When the claim analysis includes only ALAE and not ULAE, the actuary needs to perform a separate analysis to evaluate the unpaid ULAE estimate.

There are multiple ways to classify claim-related expenses, not just the one generic ALAE/ULAE split. As mentioned in Chapter 1 – Overview, in the U.S., for statutory reporting purposes, insurers categorize LAE as either *defense and cost containment* (DCC) or as *adjusting and other* (A&O). The DCC versus A&O split depends on the function of the expenses. A&O includes all claim adjuster costs regardless of whether or not they are attributable to internal adjusters (which may be viewed as overhead and difficult to attribute to an individual claim) or external independent adjusters (which are generally easily attributable to an individual claim). Various other reporting requirements may place different demands on how insurers categorize claims expenses. Insurers may also use their own internal approach to categorizing claim expenses, suitable to their own internal claim management processes. It is therefore sometimes necessary for the actuary to investigate which claim expenses are included in the data being used and how the terms are defined. For example, different people working for the same insurer may define the term ALAE in different ways: one way by financial reporting systems so as to meet external reporting requirements and another way to meet internal claim management needs.

Multiple Currencies

Claims data for some insurers may exist in the information systems in different currencies. Depending on the volume of claims in differing currencies, the actuary may need to adjust the data prior to the analysis. One approach is to separate the data by currency and then combine it after translating it using the appropriate exchange rates at a common point in time. For example, assume that claims data are in Euros, pounds sterling, and U.S. dollars; if the actuary is conducting an analysis that requires a final unpaid claim estimate in Euros, the actuary could then convert all amounts to Euros using current exchange rates.

Large Claims

When conducting analyses of unpaid claims, it is important for actuaries to be aware of how *large claims* influence the various estimation techniques. As we will see in a later part of this book, the presence of unusually large claims can distort some of the methods used for estimating unpaid claims. In these situations, the actuary may choose to exclude the large claims from the initial projection and then, at the end of the unpaid claims analysis, add a case specific projection for the reported portion of large claims and a smoothed provision for the IBNR portion of large claims. In Part 3, we discuss alternative approaches that the actuary may use to adjust the estimation techniques for large claims.

The determination of the size criteria of a large claim is not a precise science. It may vary by line of business, by geographic region, and even between analyses of unpaid claims. Actuarial judgment is critical in determining how to adjust the analyses for large claims. Actuaries consider the following in establishing the large claim threshold:

- Number of claims over the threshold each year
- Size of claim relative to policy limits
- Size of claim relative to reinsurance limits
- Credibility of internal data regarding large claims
- Availability of relevant external data

One starting point for the actuary is large claims reports from the insurer’s claims department. Claims departments often maintain reports that routinely track the individual experience of claims exceeding a certain threshold. The definition of a large claim, however, may differ between the claims department and the actuary. For example, the claims department may have set up internal controls that require monthly reporting on all claims greater than $100,000. However, to the actuary, a large claim may be any claim with a reported value (i.e., the sum of cumulative paid claims plus the current estimate of unpaid case) greater than $1 million. The actuary can also seek advice from the reinsurance department when deciding upon the large claim threshold.

Recoveries

There are numerous types of recoveries available to insurers that could affect an insurer's net claims experience. *Deductibles* are one of the most common types of insurer recoveries, and it is important for the actuary to understand how the insurer processes claims with respect to deductibles. For some lines of insurance, such as automobile physical damage, claim payments to insured policyholders are typically reduced due to the application of the deductible. Since this line of insurance is a first-party coverage, it is reasonable to apply the deductible before issuing payment to the insured. However, for general liability, insurers usually make claim payments before the application of the deductible. Since general liability is a third-party line of insurance, the injured party is not the insured party. The insurer normally issues a payment to the injured party and then, following the payment, seeks recovery of the deductible from the insured. Insurers differ in their practices with respect to case outstanding for deductibles. Some insurers establish a case outstanding net of the deductible while other insurers do not consider the deductible in the establishment of the case outstanding. Even within the same insurer, practices may vary between lines of insurance.

Salvage and *subrogation* are two other common forms of recoveries for insurers. When an insurer pays an insured for a claim considered to be a total loss, the insurer acquires the rights to the damaged property. Salvage represents any amount that the insurer is able to collect from the sale of such damaged property. Subrogation refers to an insurer's right to recover the amount of claim payment to a covered insured from a third-party responsible for the injury or damage. It is important for the actuary to understand the insurer's practices with respect to both salvage and subrogation. The actuary needs to know whether the insurer records paid claims net or gross of these recoveries. Questions to consider include:

- Are salvage and subrogation recoveries tracked separately from claim payments?
- Are claim payments only recorded net of salvage or subrogation recoveries?
- Is data for salvage and subrogation recoveries available to the actuary?

Claim operations may separate the responsibilities associated with a claim, such that people other than those responsible for claim adjustment and settlement are involved with the investigation, analysis, and pursuit of potential recoveries. This may have implications to the data the actuary is using.

Reinsurance

It is vital that the actuary understands the reinsurance program of the insurer and the effect of reinsurance on claims when conducting an analysis of ceded or net unpaid claims. Understanding the insurer's reinsurance program may be dictated by statute.[16]

Current and previous reinsurance plans and retentions directly affect an insurer's estimates of unpaid claims. Therefore, the actuary may need to analyze claims both gross and net of reinsurance recoveries (i.e., both before and after taking into account the reinsurance recoveries). Some actuaries separately analyze gross claims and ceded claims (i.e., claims ceded to reinsurers) and then determine the estimate of net unpaid claims as the difference between estimated gross unpaid claims and estimated ceded unpaid claims. Other actuaries separately analyze gross claims and net claims (i.e., gross claims minus claims ceded to reinsurers) and then determine the estimate of ceded unpaid claims as the difference between estimated gross unpaid claims and estimated net unpaid claims. In either situation, the actuary must review the implied net or ceded unpaid claim estimate for reasonableness. For insurers who do not cede claims to a reinsurer, there is no difference between claims net and gross of reinsurance, and in these situations separate analyses are not necessary.

One area that requires the actuary's close attention is the treatment of ALAE in excess of loss reinsurance contracts. Generally, there are three possible treatments of ALAE:

- Included with the claim amount in determining excess of loss coverage (which is the most common treatment today)

- Not included in the coverage

- Included on a pro rata basis; the ratio of the excess portion of the claim to the total claim amount determines coverage for ALAE

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[16] The requirements for actuaries providing Statements of Actuarial Opinion in both the U.S. and Canada demonstrate the importance for the actuary to understand the reinsurance program. According to the NAIC's "Quarterly and Annual Statement Instructions for the year 2007, Property/Casualty," the Appointed Actuary must provide "RELEVANT COMMENT" paragraphs to address the specific topic of reinsurance. The Instructions state:

> RELEVANT COMMENT paragraphs should address retroactive reinsurance, financial reinsurance and reinsurance collectibility. Before commenting on reinsurance collectibility, the actuary should solicit information from management on any actual collectibility problems, review ratings given to reinsurers by a recognized rating service, and examine Schedule F for the current year for indications of regulatory action or reinsurance recoverable on paid losses over 90 days past due. The comment should also reflect any other information the actuary has received from management or that is publicly available about the capability or willingness of reinsurers to pay claims. The actuary's comments do not imply an opinion on the financial condition of any reinsurer.

OSFI, the Canadian regulator for federally registered insurance companies, requires the Appointed Actuary's Report (i.e., the report on policy liabilities) to contain a description of the insurer's reinsurance arrangements during the experience period used in the report. Specifically, the Appointed Actuary is required to report on:

- Types of arrangements
- Significant terms and conditions
- Order of application of treaties
- Changes in the arrangements, including changes in retentions or limits

Appointed Actuaries for Canadian insurers are also required to report on how any changes in reinsurance arrangements were taken into account in the development of unpaid claims for the insurer.

The treatment of ALAE will likely have an effect on data requirements, organization, and potentially the methodology selected for estimating unpaid claims.

Exposure Data

Some techniques used for estimating unpaid claims require a measure of the insurer's *exposure* to claims. Earned premium may be the most common type of exposure used in estimation techniques for both insurers and reinsurers. Other types of exposures used by insurers may include: written premium, policies in force, policy limits by region (for the early estimation of unpaid claims related to a natural catastrophe), the number of vehicles insured (for personal automobile insurance), and payroll (for workers compensation).

It is often valuable for actuaries to adjust historical premiums to current rate levels (i.e., on-level premiums). There are two ways in which actuaries typically derive on-level premiums. The first method essentially requires a re-rating of historical exposures at current rates. This is a computer-intensive exercise and may not be feasible in all situations. A second method is to use a summary of rate level changes over the experience period and adjust the premiums in the aggregate for historical rate changes. There are many instances, however, when the actuary is unable to collect reliable information regarding rate changes and must use the premium data from the insurer on an unadjusted basis.

Self-insured organizations do not generally collect premiums in the same way that an insurance company does. As a result, actuaries working with self-insurers generally use other readily observable and available exposure bases that they believe are closely related to the risk and thus the potential for claims.

The following table summarizes, by line of business, examples of the types of exposures that actuaries often use for the analysis of self-insurers' unpaid claims.

Table 1 – Examples of Exposures for Self-Insurers

Line of Insurance	**Exposure**
U.S. workers compensation	Payroll
Automobile liability	Number of vehicles or miles driven
General liability for public entities	Population or operating expenditures
General liability for corporations	Sales or square footage
Hospital professional liability	Average occupied beds and outpatient visits
Property	Property values
Crime	Number of employees

Exposures are important not only as an input to certain techniques used for estimating unpaid claims but also for evaluating and reconciling the results of the various techniques. We address this further in Part 3, Chapter 15.

Insurer Reporting and Understanding the Data

We cannot emphasize strongly enough how critical it is for the actuary to fully understand the types of data generated by the insurer's information systems. Different insurers, TPAs, IAs, or even different departments within the same organization may use the same term to mean different things. The actuary must know the true meaning of the types of claims data contained in the insurer's claims reports and information systems.

"Incurred loss" is an example of a term that the actuary may initially assume is used fairly consistently throughout the insurance industry. Upon closer examination, however, we see that incurred losses means different things to different people. To someone in the finance department, incurred losses usually refer to the transactional losses incurred during a defined period, usually a calendar (or fiscal) quarter or year. Thus, the incurred losses to someone in finance usually refer to the sum of payments made during the time period plus the change in total unpaid claims. Furthermore, finance departments usually include IBNR in their definition of incurred loss. To an actuary wanting to build an incurred claim development triangle, incurred losses are typically the cumulative claim payments through a valuation date plus the case outstanding at the same valuation date.[17] Some actuaries refer to these losses as case incurred or incurred on reported claims. We have also seen the term incurred losses used in TPA loss reports to refer to case outstanding only. To avoid any confusion, we use the term "reported claims" throughout this book to refer to case incurred losses. (Cumulative and incremental reported claims are introduced in Chapter 2 and are explored further in Chapter 5.)

The terms "unpaid claims" and "reserves" are other examples of terminology that have many different meanings. In a report from the finance department, unpaid claims (or reserves) generally refer to the estimate of total unpaid claims including both case outstanding and IBNR. For the claims department, however, reports showing unpaid claims (or reserves) generally refer to case outstanding only. Some TPA reports use the term reserves in detailed claims listings to represent the total reported value of the claims (i.e., cumulative payments plus current case outstanding estimates). In this situation, the actuary would need to subtract cumulative paid claims from the reserves in order to determine the value of unpaid case. The actuary also needs to understand if the unpaid claim estimate is net or gross of deductibles or other types of recoveries, including salvage, subrogation, and reinsurance recoveries, and where in the claims process those recoveries are included. Finally, the actuary needs to know whether or not case outstanding include claim-related expenses. Some insurers record case outstanding and payments for claim-related expenses separately from claim only case outstanding and payments; other insurers record expense payments separately (from claim payments) but do not carry case outstanding for expense.

Another example of differences in the use of the term "reserves" can be found in the actuarial and accounting professions in South Africa and the United Kingdom. It is typical for accountants in these countries to distinguish between provisions (i.e., unpaid claim estimates) and reserves; actuaries usually use the term "reserves" to refer to the unpaid claim estimates and do not distinguish between different types of reserves.

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[17] In the U.S., the National Council on Compensation Insurance has Financial Data Calls that require incurred losses by accident year that include IBNR. Similarly, the incurred loss triangles in Schedule P of the U.S. statutory annual statement include IBNR. Hence, actuaries also prepare incurred loss triangles that do include IBNR. These provide further examples of why an actuary must seek a full understanding of the data prior to conducting any analysis or drawing any conclusions.

Even paid claims can mean different things to different people. The actuary must understand whether the paid claims are cumulative or incremental, whether they include or exclude claim-related expenses (and what kind of claims expenses), and whether they are net or gross of recoveries.

The actuary must also understand how the insurer's system tracks claim counts. The number of claims is an important type of data for several techniques used to estimate unpaid claims. Claim counts are also critical to several diagnostic analyses that may be appropriate to undertake upon commencing an analysis of unpaid claims. Claim counts may also be important at the conclusion of the estimation process when the actuary evaluates and selects a final value for the unpaid claim estimate. The actuary needs to understand whether the insurer counts an automobile accident with payments for multiple coverages (e.g., bodily injury liability and physical damage) or to multiple parties (i.e., claimants) as one claim or multiple claims. Another important consideration for the actuary is how reopened claims are treated and whether they are considered a new claim. Reopened claims can be particularly important for some lines of business, such as U.S. workers compensation and accident benefits coverages.

It is absolutely essential to the development of appropriate estimates of unpaid claims that actuaries clearly identify the specific data that exists and that they are requesting from the insurer, and that they fully understand the data that they receive.

Verification of the Data

An analysis based on incorrect or incomplete data can produce erroneous results. Therefore, while not requiring a formal audit of the data, actuarial standards of practice generally do require that actuaries establish suitable procedures to verify that the data utilized is reliable and sufficient for the intended purpose. This data review may include the following components:

- *Consistency with financial statement data* – Can the actuary reconcile the data with financial statement data (that may be subject to some form of external audit)?

- *Consistency with prior data* – Is the current data consistent with the data used in the prior analysis? If not, why?

- *Data reasonableness* – Are there certain values that appear questionable, such as large negative paid claims or apparent inconsistencies between data elements? Questionable values are not always incorrect values, but the actuary should generally investigate questionable values before using them, especially if material to the analysis.

- *Data definitions* – Does the actuary know how each of the data items is defined? The actuary should make a reasonable effort to determine the definition of each data element used in the analysis rather than assuming a certain definition given the label or name assigned to the element. As discussed earlier, similar labels do not always imply similar definitions. The actuary may also need to know what the default values are for certain items. If the default is used too often in the absence of true information for that element, the data element may not be sufficiently reliable for analysis purposes.

While data verification is essential to any actuarial analysis, proper documentation of the verification process and findings should also be part of the process. This can include discussions with external auditors and, at times, reliance on their work regarding data verification.

Organizing the Data

Key Dates

Having identified the types of data that actuaries use in determining unpaid claim estimates, we now discuss how to organize the data. Key dates for the organization of the claim data include:

- Policy effective dates
- Accident date
- Report date
- Accounting date
- Valuation date

The *policy effective dates* are the beginning and ending dates of the policy term (i.e., the period for which the policy triggered by the claim was effective). Some systems only capture the policy year (i.e., the year that the policy became effective). Reinsurers refer to the policy date as the underwriting date (or year).

The *accident date* is generally the date that the accident or event occurred that triggered the potential policy coverage. Some systems only capture the accident year (i.e., the year that the triggering event occurred). This term can be ambiguous with regard to certain policies such as claims-made policies. With claims-made policies, the accident date may be defined as the date that the claim was reported as this is the date of the event that triggered coverage. Alternatively, some may define the accident date for a claims-made policy as the date that an injury occurred with the injury not covered by the policy unless the resulting claim was reported during the policy period.

The *report date* is the date on which the claim was reported to the insurer and recorded in its claims system. Some databases may split this into two dates: report date and record date. There is even a potential for a third date – a *notification date*. The notification date is generally defined as the date that the insurer is put on notice that an event occurred that may result in a claim. For example, an insured motorist may notify their insurer that they got in an accident (but that they are not filing a claim); this is the notification date. A week later, the insurer may receive a claim from the other party in the accident; this is the report date, or the date on which the claim was reported. The following day, the claims department records the claim into their system; this is the record date. Notification dates are not commonly used in many actuarial analyses.

The *accounting date* is the date that defines the group of claims for which liability may exist, namely all insured claims incurred on or before the accounting date. The accounting date may be any date selected for a statistical or financial reporting purpose, but generally must follow a date for which the history is frozen in time, such as a month, quarter, or year-end (with the latter two being the more common accounting dates used).

An example may assist in understanding how claim activities relate to the accounting date. Assuming an accounting date for an occurrence-based policy of December 31, 2008, the total unpaid claim estimate as of this accounting date must provide for all incurred claims, whether reported or not, as of December 31, 2008. An insured loss that occurred on December 30, 2008, for a policy written on December 15, 2008, would be included in the estimate of unpaid claims for the accounting date December 31, 2008, regardless of when the claim is reported to the insurer. However, an insured loss that occurred on January 5, 2009, for the same policy that was written on December 15, 2008, would not be included in the unpaid claim estimate for the accounting date December 31, 2008, because this accident occurred after the accounting date.

The *valuation date* is the date through which transactions are included in the database used in the evaluation of the liability, regardless of when the actuary performs the analysis. A valuation date may be prior to, coincident with, or subsequent to the accounting date. Actuaries typically use claims data at month-end, quarter-end, half-year-end, or year-end valuation dates.

Again, examples may assist in understanding the concept of valuation date. To determine total unpaid claims at December 31, 2008, actuaries may use data valued as of December 31, 2008. In this example, the valuation date and the accounting date are the same. For some insurers, however, internal financial reporting requirements at year-end are such that the actuary does not have time to wait for the December 31, 2008 data to be available. In such circumstances, actuaries often use data at an earlier valuation date to estimate what the requirement for unpaid claims at the accounting date of December 31, 2008 will be. For example, some insurers used data as of September 30, 2008 to estimate unpaid claims as of December 31, 2008. In this example, the valuation date is September 30, 2008, and the accounting date is December 31, 2008.

In certain situations, an actuary may conduct an analysis of unpaid claims where the valuation date is later than the accounting date. For example, assume that the actuary wants to re-estimate what the claim liabilities were at December 31, 2006, taking into account the actual experience of 2007 and 2008. The actuary can use a December 31, 2008 valuation date and thus include actual paid and reported claims experience through 2007 and 2008. When estimating the unpaid claims at December 31, 2006 (the accounting date), the actuary subtracts the actual payments at December 31, 2006 from the projected ultimate claims that he or she derives using data through December 31, 2008 (the valuation date).

Aggregation by Calendar Year

Calendar year data is transactional data. For example, calendar year 2008 paid claims refer to the claim payments made by the insurer between January 1, 2008 and December 31, 2008. Similarly, calendar year 2008 reported claims are the 2008 payments plus the change in case outstanding (ending case outstanding at December 31, 2008 minus beginning case outstanding at January 1, 2008[18]). Reported claim counts for the 2008 calendar year represent those claim counts reported during the January 1, 2008 to December 31, 2008 period; and closed claim counts represent the number of claims closed during the year.

The primary uses of calendar year data for the actuary are the aggregation of exposures and diagnostic testing when analyzing accident year claims data. Calendar year 2008 written premium is simply the sum of all written premium reported/recorded in the accounting systems during

[18] The actual accounting equation uses ending case outstanding at December 31, 2007, but this is generally synonymous with beginning reserves at January 1, 2008.

2008. The following formula defines calendar year earned premium:

Written Premium + Beginning Unearned Premium Reserve – Ending Unearned Premium Reserve

Advantages of Calendar Year Data

A major advantage of calendar year data is that there is no future development. The value remains fixed and does not change as time goes by as do claims and exposures aggregated based on accident year, policy year, and even report year bases. Another advantage of calendar year data is that it is readily available. Most insurers conduct financial reporting on a calendar year basis, thus data by calendar year is typically easily accessible to the actuary.

Disadvantages of Calendar Year Data

The fixed nature of calendar year data also presents a disadvantage. The inability to address the critical issue of development is a disadvantage of calendar year statistics. Very few techniques for estimating unpaid claims are based on calendar year claims. Calendar year exposures, on the other hand, are frequently used in estimation techniques along with accident year claims.

Aggregation by Accident Year

Aggregation by accident year is, by far, the most common grouping of claims data for the actuarial analysis of unpaid claims. *Accident year data* refers to claims grouped according to the date of occurrence (i.e., the accident date or the coverage triggering event). For example, accident year 2008 consists of all claims with an occurrence date in 2008.

Caution must be exercised when working with self-insurers' accident year data as their fiscal year ends may not coincide with the calendar year-end. For example, accident year 2008 may be defined to coincide with a self-insurer's August 1, 2007 to July 31, 2008 fiscal year or may include claims occurring during the January 1, 2008 to December 31, 2008 calendar year period. Again, the important message for the actuary is to understand the data, including how it is organized and presented.

Insurers compile claims data according to a variety of accident periods including accident month, accident quarter, accident half-year, and accident year. The insurer groups together all claims with accident dates within the particular time period.

Various financial reporting schedules and statistical organizations for insurers in the U.S. and Canada require claim information by accident year. In some areas, such as Lloyds of London, financial reporting by underwriting year is more common than accident year.

As indicated previously, actuaries often use calendar year exposures with accident year claims. Calendar year earned premiums provide an approximate matching of the claims that occur during the year with the insurance premiums earned by an insurer during the year in which the insurance coverage is effective. We will see below that claims and exposures aggregated by policy year provide an exact match. For self-insurers, however, calendar year exposures do represent an exact match with the accident year claims.

Advantages of Accident Year Aggregation

In many respects, accident year aggregation has become the accepted norm for P&C insurers in the U.S. and Canada. Accident year grouping is easy to achieve and easy to understand. It represents claims occurring over a shorter time frame than for the policy year or underwriting year aggregation, implying that ultimate accident year claims should become reliably estimable sooner than those for a policy or underwriting year. There are numerous industry benchmarks available to actuaries based on accident year experience. Finally, tracking claims by accident year is valuable when there is change due to economic or regulatory forces (such as inflation or law amendments) or major claim events (such as atypical weather or a major catastrophe) which can influence claims experience.

Disadvantages of Accident Year Aggregation

The most significant disadvantage of accident year aggregation is the potential mismatch between claims and exposures for insurers. It also includes claims from policies underwritten and priced at more varied times than policy or underwriting year aggregation. For self-insureds with high deductibles, accident year data can mask changes in retention levels and/or changes in insurers that could have an effect on claim development patterns.

Aggregation by Policy Year or Underwriting Year

Claims can also be grouped according to policy year. For *policy year data*, the actuary sorts claims according to the year in which the policy was written. Policy year aggregation directly matches the premiums and claims arising from a given block of policies.[19] The grouping of claims by policy year for insurers is similar to the grouping of claims by underwriting year frequently used by reinsurers. *Underwriting year data*, which is frequently used by reinsurers, refers to claims data grouped by the year in which the reinsurance policy became effective.

Claims arising from a policy year or underwriting year can extend over a 24-month calendar period if the policy is of a 12-month duration. For example, policy year 2008 refers to all policies with beginning effective dates between January 1, 2008 and December 31, 2008. For annual policies with a January 1, 2008 beginning effective date, covered claims will have accident dates between January 1, 2008 and December 31, 2008. However, claims for annual policies with a beginning effective date of December 31, 2008 will have occurrence dates between December 31, 2008 and December 30, 2009.

[19] The actuary should be aware of the insurer's treatment of multi-year policies. Insurers differ in their practices as to how such policies are coded in the information systems. Some insurers split the single multi-year policy into annual pieces and code this type of policy as multiple annual policies. Other insurers may follow different practices. The important point is that the actuary must understand the process for recording premium and claims associated with multi-year policies (to the extent such policies exist in the insurer's portfolio).

Advantages of Policy Year Aggregation

The greatest advantage of policy year (or underwriting year) aggregation is a true match between claims and exposures (e.g., premiums). Policy year experience can be very important when underwriting or pricing changes occur, such as a shift from full coverage to large deductible policies, a new emphasis on certain classes of business, or an increase/decrease in the price charged leading to a change in expected claim ratios and possibly a change in the type of policyholder insured. Policy year aggregation is particularly useful for self-insureds where only one policy may apply.

Disadvantages of Policy Year Aggregation

The primary disadvantage of policy year (or underwriting year) aggregation is the extended time frame. As seen in our previous example, a policy year can extend over a 24-month time period, generally resulting in a longer time until all the claims are reported and a longer time until the ultimate claims can be reliably estimated. Policy year data can also make it difficult to understand and isolate the effect of a single large event, such as a major catastrophe or a major court ruling, which changes how the insurance contracts are interpreted.

Aggregation by Report Year

For some lines of insurance, such as medical malpractice, products liability, errors and omission, and directors' and officers' liability, coverage may be dependent on the date on which the claim is reported to the insurer (i.e., claims-made coverage). For these lines of business, actuaries often prefer to use *report year data* for developing estimates of unpaid claims. Report year refers to grouping claims according to the date of report to the insurer. For example, report year 2008 consists of all claims with report dates in 2008. Actuaries use this grouping to estimate the ultimate value of known claims. Aggregation of claims by report year can also be used to test the adequacy of case outstanding on known claims over time.

Once again, we highlight that the actuary must understand the systems and procedures for the insurer. For some insurers, the accident date is the date that triggers coverage, which may be the claim report date for some claims-made policies. For some claims-made policies, the notification date rather than the report date triggers the coverage. Also, some claims-made policies have extended reporting endorsements that may not be coded as a new policy, and hence development beyond 12 months may be possible even for annual policies. An actuary must not only determine how to aggregate the data but must truly understand how the data enters and is tracked in the insurer's systems.

Advantages of Report Year Aggregation

A unique feature of report year claims data is that the number of claims is fixed at the close of the year (other than for claims reported but not recorded). As a result, a report year approach will generally result in more stable data and more readily determinable development patterns than an accident year approach in which the number of claims is subject to change at each successive valuation. The report year approach substitutes a known quantity (i.e., the number of reported claim counts) for an estimate.

Disadvantages of Report Year Aggregation

Estimation techniques based on claims aggregated by report year only measure development on known claims and not pure IBNR; and pure IBNR is frequently the more difficult part of the total unpaid claims estimate to determine. Other methods for developing unpaid claim estimates are required to derive the pure IBNR when using report year data.

CHAPTER 4 – MEETING WITH MANAGEMENT

This chapter discusses the interaction between the actuary and those involved with the processes that underlie the data. The dynamics of this interaction will frequently vary based on whether the actuary is an employee of the insurer or an outside consultant. For example, while an actuarial employee may be able to just call or walk over to meet those involved in the insurer's claims operation when a question arises, a consultant may have to go through a more formal process, such as scheduling a meeting with company management involved in the relevant processes. To simplify the discussion, this chapter is written predominately from the perspective of an outside consultant, using the term *management* when referring to discussions with those involved in the underlying claims and underwriting processes.

Understanding the Environment

Before applying mathematical models to develop estimates of unpaid claims for an insurer, the actuary must first understand the dynamics of the environment in which the insurer operates. This includes both the specific circumstances existing within the insurer's organization as well as the economic, social, legal, and regulatory environments that will also affect the liabilities of the insurer. Without a sound understanding of the environment, both internal and external to the insurer, an actuary may not be able to correctly interpret patterns and changes in the data.

There are countless changes that influence the claims experience of an insurer. Claims reporting and payment patterns, frequency, and severity can all be altered by changes in:

- Classes of business written or geographical focus
- Policy provisions such as policy limits and deductibles
- Reinsurance arrangements including limits and attachment points
- Claims management philosophy that often occur when managerial changes occur
- Claims processing lags that may occur when a new technology is implemented within an insurer or department staffing is disrupted, such as in the event of a merger or a major catastrophe that temporarily overwhelms the claim department's capacity
- Legal and social environment such as the introduction of no-fault automobile insurance, back-logs in the court systems, new court rulings, and implementation of tort reform[20] measures
- Economic environment such as an increase in the inflation rate or a decrease in the interest rate

[20] Tort reform refers to legislation designed to reduce liability costs through limits on various kinds of damages and/or through modification of liability rules.

The collection of data and information does not necessarily proceed in a sequential order as presented in this text. Not all actuaries start by gathering data, then meeting with management, and end with conducting an actuarial diagnostic review of the data. Generally the information gathering is an ongoing process with much back-and-forth dialogue between the actuary and management.

For actuaries responsible for estimating unpaid claims who work as employees of an insurer, the information gathering process will likely be continual and ongoing. Conversations with colleagues in various departments (such as claims, underwriting, reinsurance, and systems) may take place on a routine basis. These conversations may be formal through regular monthly or quarterly meetings, or informal and unscheduled. For actuaries who work as independent consultants, the communication with the insurer's employees in various departments tends to be less frequent. Often the consultant will schedule formal meetings at least once a year to review the departments' key activities that can have a significant influence on the estimation of unpaid claims.

There is no one right or wrong approach for the actuary to collect data and information. What is critically important, however, is that the process includes both a review of quantitative data and discussions with key members of the insurer's claim and underwriting departments. Both of these components will assist the actuary in selecting the appropriate techniques for estimating unpaid claims. Discussions with management will help the actuary understand anomalies in the data. The review of the data will help direct the actuary to ask management specific questions concerning issues that manifest themselves in the data. Such questions will help the actuary gain a better understanding of the organization and the specific circumstances of particular books of business, and thus guide the actuary to the most appropriate methodologies for determining unpaid claim estimates.

In 1977, J.R. Berquist and R.E. Sherman published the paper "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach."[21] Among the paper's many valuable contributions was an appendix with a list of possible interview questions for the various departments of an insurer. Actuaries throughout the world have used this list as part of the annual information gathering process in support of the analyses of unpaid claims. In a session entitled "Updating the Berquist-Sherman Paper – Thirty Years Later" presented at the CAS 2007 Casualty Loss Reserving Seminar, Mr. Sherman suggested some additional questions for department executives. We include below a copy of Appendix B from the original Berquist and Sherman paper, updated to incorporate the additional questions presented in 2007.

It is important to recognize that the following questions are presented primarily from the perspective of a consultant interviewing insurance company management. Some changes to these questions would be required for actuaries working with self-insurers as well as for internal actuaries working at insurance and reinsurance companies.

Sample Questions for Department Executives

Questions for a Claims Executive

1) What specific objectives and guidelines does your department have in setting unpaid case? Are unpaid case established on the basis of what it would cost to settle the case today, or has a provision for inflation between now and the estimated time of settlement of the claim been included in the case outstanding?

[21] PCAS, 1977.

2) Have there been any significant changes in the guidelines for setting and reviewing unpaid case during the last five years?

3) Have there been any changes in the definitions of or rules for establishing bulk or formula reserves for reported claims in the last five years?

4) Are any special procedures or guidelines applied in the reserving of large or catastrophic claims? If so, please describe.

5) Has the size of the caseload of the average claims adjuster changed significantly in the past several years?

6) When, in the sequence of events, is a claim file established?

7) Is a claim file established for each claimant or for each accident? What procedures are followed when there are multiple claimants from the same accident? Is a claim file established for each coverage or for all coverages combined?

8) What procedures are followed in recording reopened claims? Are such claims coded to the report date of the original claim or to the date of reopening? How will the reopening of a claim affect aggregate data for paid, open or reported claims and paid, outstanding or incurred losses?

9) Have there been any noticeable shifts in the reporting or non-reporting of very small or trivial claims? In the procedures for the recording of such?

10) Has there been any shift in emphasis in settling large versus small claims? In the relative proportion of such claims? In attitudes in adjusting such claims?

11) Have there been any changes in the guidelines on when to close a claim? For example, is a P.D. (property damage) claim kept open until the associated B.I. (bodily injury) claim is closed, or only until the P.D. portion is settled?

12) Have there been any noticeable changes in the rate of settlement of claims recently?

13) Has there been any shift from the employment of company adjusters to independent adjusters? Or vice versa? If so, how has this affected the operations of the claims department?

14) Has there been any change in the timing of the payment of allocated loss adjustment expenses? For example, are such payments made as these expenses are accrued (or incurred) or when the claim is closed?

15) Has there been any change in the definition and limit for one-shot or fast-track claims in recent years? What is that limit?

16) What safeguards against fraudulent claims are now employed? Are any special procedures followed in the event of the filing of apparently questionable or non-meritorious claims? Have these safeguards changed in recent years?

17) Have there been any shifts toward (or away from) the more vigorous defense of suits in recent years?

18) Could you provide copies of all bulletins to the field issued in the last five years in which details of the changes in claims procedures are provided?

19) Could you provide copies of recent claim audits?

20) For workers compensation, what mortality table was used (year and general population or disabled lives table) to set the unpaid case for permanently disabled claimants?

21) For large open claims, has there been any revision in the reserve since the latest evaluation date of the claims experience?

22) Are unpaid case set at an expected level, the most likely settlement amount, or the minimum possible amount (or some other standard)?

Questions for an Underwriting Executive

1) What significant changes have occurred in your company's book of business and mix of business in the past five to seven years? How are the risks insured today different from those of the past?

2) Do you underwrite any large risks which are not characteristic of your general book of business?

3) Have any significant changes occurred in your underwriting guidelines in recent years?

4) Has the proportion of business attributable to excess coverages for self-insurers changed in recent years? Can a distribution of such business be obtained by line, retention limit, class, etc.? Is a record of self-insured losses and claims available?

5) For how many different programs or types of risk are premium and claims experience tracked and compiled into claim ratio runs?

6) Are there any available summaries of the details of excess policies, such as attachment points, exclusions, per occurrence, sunset clauses, aggregate caps, etc.?

7) What is the frequency of availability of such experience summaries? How far back are these available?

8) How are the new programs priced? If you are relying on another insurer's filings, how similar are the underlying books of business?

Questions for a Data Processing or Accounting Executive

1) Has there been any change in the date on which the books are closed for the quarter? the year?

2) How are claim payments handled for claims which have already been paid, but which have not yet been processed to the point where they can be allocated to accident quarter? Are they excluded from the loss history until they are allocated to accident quarter or are they loaded into an arbitrary quarter?

3) Have new data processing systems been implemented in recent years? Have they had a significant impact on the rate of processing claims or on the length of time required from the reporting to the recording of a claim?

4) To what extent have each of the data sources supplied been crosschecked and audited for accuracy and for balancing to overall company statistics? Comment on the degree of accuracy with which each kind of statistic has been properly allocated to accident quarter, to line of business, to size of loss, etc.

5) Have there been any changes in coding procedures which would affect the data supplied?

6) Would it be possible for partial payments to exceed the case outstanding on a claim? In such an event, what adjustments are made? Are unpaid case taken down by the amount of partial payments?

7) How far back can the claims data be actively re-compiled by various key criteria?

8) What data elements are available for each claim? For each risk?

9) By what key criteria could the historical claims data be freshly compiled? Examples of criteria: size of loss breakdowns, type of claim breakdowns (e.g., liability vs. property for commercial multi-peril or homeowner multi-peril), separate compilations by policy limit, or deductible, or type of claim, or state.

10) Can data be compiled either by claimant or occurrence, if multiple claims are established for one occurrence?

Questions for Actuaries Specializing in Ratemaking

1) Have there been any changes in company operations or procedures which have caused you to depart from standard ratemaking procedures? If so, please describe those changes and how they were treated.

2) What data which is currently used for ratemaking purposes could also be used in testing unpaid claims?

3) Have you noted any significant shifts in the composition of business by type of risk or type of claim within the past several years?

4) Do you have any of the following sources of information which may be of value in reserve testing:

   a) External economic indices,
   b) Combined claims data for several companies (e.g., data obtainable from bureau rate filings),
   c) Special rating bureau studies,
   d) Changes in state laws or regulations, and
   e) Size of loss or cause of loss studies?

5) Could we obtain copies of recent rate filings?

6) Were there any changes in statues, court decisions, extent of coverage that necessitated some reflection in the rate analysis?

7) How are new programs priced? If you are relying on another insurer's filing, how similar are the underlying books of business?

Questions for In-House Actuaries

1) Could we obtain copies of any and all actuarial studies done by consultants, auditors or internal actuaries?

2) What areas of disagreement are there between these different studies?

3) What specific background information did you take into account in making your selections?

Additional Questions

In addition to the questions identified in the Berquist and Sherman paper, we recommend that the following questions be added for meetings with senior management of the insurer.

Questions for Those Managing Reinsurance

— Please provide details of reinsurance treaties and of reinsurance agreements in general, regarding both assumed and ceded business.

— Please provide details of all reinsurance ceded treaties including:

- Retention level or quota share percentage
- Reinsurers involved including participation
- Details of any sliding scale premium, commission, or profit commission including currently booked amounts
- Any problems or delays encountered in collecting reinsurance

- Please provide details of any internal or sister company reinsurance agreements that were not included above (cover notes, relevant amounts, and by-line breakdowns).

- Have you secured the continuation of your reinsurance program for next year? If so, under what terms?

Questions for Senior Management

Please provide a brief description of the company's operations including:

- An organization chart with recent changes highlighted
- Details of ownership
- Description of types of business written including all special programs
- Description of marketing (i.e., direct writer, independent agent, etc.)

CHAPTER 5 – THE DEVELOPMENT TRIANGLE

A *development triangle* is a table that shows changes in the value of various cohorts over time. For example, we create a table that summarizes how the cumulative amounts paid by insurance companies (the values) for claims arising out of automobile accidents that occurred during 2006, 2007, and 2008 (the cohorts) increased from year-end 2006 to year-end 2007 to year-end 2008.

Table 1 – Paid Claims and Expenses ($US Billions)
by Year-End Accounting Date

Accident Year	Year-end 2006	Year-end 2007	Year-end 2008
2006	100	150	170
2007		110	161
2008			115

We define the *development* for any of these cohorts (i.e., the accident year claims mentioned above) as the change in the value for the cohort over time. For example, the paid claims and expense for accident year 2006 in the above triangle were $100 billion through year-end 2006, and increased to $150 billion through year-end 2007; the change from $100 billion to $150 billion is the *development* in this quantity.

Actuaries are frequently interested in the typical development for a cohort over time. This is generally easier to observe by looking at the age (or maturity) of the cohort rather than the accounting date for the cohort. The above triangle reformatted to reflect this approach is presented in Table 2 below.

Table 2 – Paid Claims and Expenses ($US Billions)
by Age

Accident Year	12 Months	24 Months	36 Months
2006	100	150	170
2007	110	161	
2008	115		

The age (or maturity) is generally measured in terms of the time from the start of the cohort period. For example, the age of the 2006 accident year valued at year-end 2006 is 12 months (from the start of the accident year). Similarly, the age of the 2006 accident year valued at year-end 2007 is 24 months (from the start of the accident year).

Both of the above formatting approaches result in data in a triangle shape, hence the term development triangle. However, in the second triangle it is easier to see how the volume (or scale) of the accident year cohort changes from one accident year to the next and how the value of cumulative paid claims for an accident year changes from age to age.

We can show and analyze many different values through the use of development triangles, including but not limited to: reported claims, paid claims, claim-related expenses, and reported claim counts.

Development can be either positive or negative. For example, the number of claims associated with claims occurring in a particular accident year will often increase from one valuation point to another until all claims are reported. There are circumstances, however, when the number of claims decreases from one valuation point to another. In Chapter 11, we use an example with data for private passenger automobile collision coverage organized by accident half-year. The claim count data excludes claims closed without payment. In this particular example, we will observe that the number of claims decreases at successive valuations. Reported claim development can also show downward patterns if the insurer settles claims for a lower value than the case outstanding estimate or if the insurer includes recoveries with the claims data.

The development triangle is one of the most common tools that actuaries use to organize data in order to identify and analyze patterns in historical data. Actuaries use development triangles to quantify historical development. Development patterns are critical inputs to many techniques used to estimate unpaid claims. In this chapter, we demonstrate how to build development triangles for paid claims, case outstanding, reported claims, and reported claim counts. We use payment and case outstanding information for a sample of 15 claims over a four-year time horizon. Our example is not representative of any particular line of insurance. Its sole purpose is to demonstrate how to build development triangles based on detailed claims information.

Rows, Diagonals, and Columns

Table 3 contains a sample reported claim triangle for an organization that began operations in 2005.

Table 3 – Reported Claim Triangle

Accident	Reported Claims as of (months)			
Year	**12**	**24**	**36**	**48**
2005	1,500	2,420	2,720	3,020
2006	1,150	1,840	2,070	
2007	1,650	2,640		
2008	1,740			

There are three important dimensions in a development triangle:

- Rows
- Diagonals
- Columns

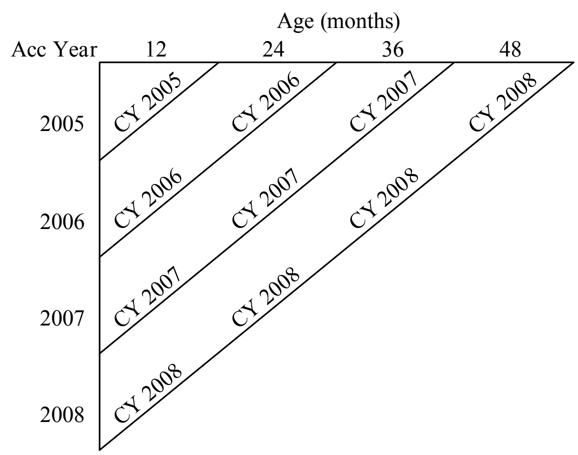
Each row in the triangle above represents one accident year. As we discuss in Chapter 3, organizing data by accident year refers to grouping claims according to the date of occurrence (i.e., the accident date). By grouping the data into accident years, each row consists of a fixed group of claims. In our example, the reported claim development triangle includes the reported claims for accident years 2005 through 2008. The first row of the triangle represents claims occurring in 2005; the second row, claims occurring in 2006; the third row, claims occurring in 2007; and the final row, claims occurring in 2008.

Each subsequent diagonal in the reported claim triangle represents a successive valuation date. There are four diagonals in the triangle shown in Table 3:

- The first diagonal (which is a single point) is the December 31, 2005 valuation
- The next diagonal is the December 31, 2006 valuation for accident years 2005 and 2006
- The next diagonal is the December 31, 2007 valuation for accident years 2005 through 2007
- The last diagonal is the December 31, 2008 valuation for accident years 2005 through 2008

The diagonals and corresponding valuation dates are shown pictorially in Table 4 below. (CY in the diagram below refers to calendar year.)

Table 4 – Diagonals of the Reported Claim Triangle Example



The first diagonal, which starts in the upper left corner of the triangle, is at the December 31, 2005 valuation date and represents accident year 2005 at 12 months of maturity. Again, the standard nomenclature is to count from the beginning of the accident year to the valuation date. Thus accident year 2005, which begins on January 1, 2005, is 12 months old at December 31, 2005.

The second diagonal in the triangle is at the December 31, 2006 valuation date. At December 31, 2006, accident year 2005 is 24 months old and accident year 2006 is 12 months old. To determine these ages, we again count the number of months from the beginning of each accident year (i.e., January 1, 2005 and January 1, 2006) to the valuation date of December 31, 2006. The third diagonal continues in a similar manner.

Concluding our example, the last diagonal of the triangle, at a valuation date of December 31, 2008, represent claims for accident year:

- 2005 as of 48 months (counting from the start of the accident year, January 1, 2005, to the valuation date of December 31, 2008)

- 2006 as of 36 months (counting from January 1, 2006 to December 31, 2008)

- 2007 as of 24 months (counting from January 1, 2007 to December 31, 2008)

- 2008 as of 12 months (counting from January 1, 2008 to December 31, 2008)

Each column in the claim development triangle represents an *age* (or *maturity*) and is directly related to the combination of accident year (row) and valuation date (diagonal) used to create the triangle. In our example, we present accident year data using annual valuations, and thus the ages in the columns are 12 months, 24 months, 36 months, and 48 months. Different valuations can be used by the actuary (e.g., 6 months, 12 months, 18 months, etc.).

Alternative Format of Development Triangles

Throughout this book, we present development triangles with the rows corresponding to the experience period[22] (e.g., accident year in the previous example) and the columns representing the maturity ages.[23] This is by far the most common presentation of development triangles. Some insurers, however, reverse this orientation and present accident years (or policy or underwriting years) as the columns and the maturity ages as the rows. Prior to commencing the analysis of unpaid claims, it is important for the actuary to understand the way in which the insurer aggregates the data and reports the data in the development triangle.

Detailed Example of Claim Development Triangles

Understanding the Data

To better understand how to create a claim development triangle, we turn our attention to the individual claims detail that underlies the reported claim triangle shown in Table 3. In our example, we demonstrate how to integrate the claims amounts shown in the claims listing below into the cells of the various claim development triangles. (In the table below, we use the abbreviation case O/S to mean case outstanding.)

Table 5 – Detailed Example – Claims Transaction Data

			2005 Transactions		**2006 Transactions**		**2007 Transactions**		**2008 Transactions**	
Claim ID	Accident Date	Report Date	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S	Total Payments	Ending Case O/S
1	Jan-5-05	Feb-1-05	400	200	220	0	0	0	0	0
2	May-4-05	May-15-05	200	300	200	0	0	0	0	0
3	Aug-20-05	Dec-15-05	0	400	200	200	300	0	0	0
4	Oct-28-05	May-15-06			0	1,000	0	1,200	300	1,200
5	Mar-3-06	Jul-1-06			260	190	190	0	0	0
6	Sep-18-06	Oct-2-06			200	500	0	500	230	270
7	Dec-1-06	Feb-15-07					270	420	0	650
8	Mar-1-07	Apr-1-07					200	200	200	0
9	Jun-15-07	Sep-9-07					460	390	0	390
10	Sep-30-07	Oct-20-07					0	400	400	400
11	Dec-12-07	Mar-10-08							60	530
12	Apr-12-08	Jun-18-08							400	200
13	May-28-08	Jul-23-08							300	300
14	Nov-12-08	Dec-5-08							0	540
15	Oct-15-08	Feb-2-09								

[22] Also referred to as "origin period."

[23] Also referred to as "development periods."

Table 5 contains detailed information for 15 claims that occurred in accident years 2005 through 2008. The first column of the table is a claim ID number. The next two columns are the accident date and the report date. The accident date is necessary for determining the appropriate row of the triangle. The report date is important for determining when the information about the claim first enters the triangle. The table includes claim payments made in the year and the ending case outstanding value. It is important to recognize that the claim payments in the table do not represent the cumulative paid values but the transactional payments made during the year. The case outstanding values contained in the table are the ending case outstanding values; they are not the transactional change in case outstanding that occurred during the year.

It is absolutely critical when constructing claim development triangles that the actuary fully understands the data available. The information systems used by different insurers vary tremendously. Thus, the types and format of data available to actuaries vary significantly from insurer to insurer. Defining and understanding the available data must be the first step in any actuarial analysis.

Step-by-Step Example

We now demonstrate, step by step, how to create the paid claims, case outstanding, reported claims, and reported claim count triangles. We begin with the incremental paid claim development triangle. Table 6 below summarizes the payment transactions presented in our example. This table is simply an excerpt of Table 5.

Table 6 - Detailed Example – Claims Transaction Paid Claims Data

			Incremental Payments in Calendar Year			
Claim ID	**Accident Date**	**Report Date**	**2005**	**2006**	**2007**	**2008**
1	Jan-5-05	Feb-1-05	400	220	0	0
2	May-4-05	May-15-05	200	200	0	0
3	Aug-20-05	Dec-15-05	0	200	300	0
4	Oct-28-05	May-15-06		0	0	300
5	Mar-3-06	Jul-1-06		260	190	0
6	Sep-18-06	Oct-2-06		200	0	230
7	Dec-1-06	Feb-15-07			270	0
8	Mar-1-07	Apr-1-07			200	200
9	Jun-15-07	Sep-9-07			460	0
10	Sep-30-07	Oct-20-07			0	400
11	Dec-12-07	Mar-10-08				60
12	Apr-12-08	Jun-18-08				400
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				0
15	Oct-15-08	Feb-2-09				

Using the above data, we create a triangle of incremental payments showing the amounts paid in each 12-month calendar period for the fixed group of claims in our example. For claims that occurred during 2005, the insurer paid a total of \$600 during the first 12-month period (2005), \$620 during the second 12-month period (2006), and \$300 in each of the following two 12-month periods (2007 and 2008). For claims that occurred during 2006, the insurer paid $460 during 2006 and 2007 and $230 during 2008. We use the same approach for each accident year grouping of claims to derive the following triangle of incremental paid claims.

Table 7 – Incremental Paid Claim Triangle

Accident	Incremental Paid Claims as of (months)			
Year	**12**	**24**	**36**	**48**
2005	600	620	300	300
2006	460	460	230	
2007	660	660		
2008	700			

The incremental paid claim triangle is important for diagnostic purposes and for some frequency-severity techniques. However, actuaries tend to use cumulative paid claim triangles more often than incremental paid claim triangles. We can readily create the following cumulative paid claim triangle from the incremental paid claim triangle.

Table 8 – Cumulative Paid Claim Triangle

Accident	Cumulative Paid Claims as of (months)			
Year	**12**	**24**	**36**	**48**
2005	600	1,220	1,520	1,820
2006	460	920	1,150	
2007	660	1,320		
2008	700			

We derive the cumulative paid claim triangle by simple arithmetic from the incremental paid claim triangle. The first column in both triangles, age 12 months, is the same for both paid claim triangles (i.e., incremental paid claims are equal to cumulative paid claims at the first maturity age). To derive the second column of the cumulative paid claim triangle, we add the second column (i.e., age 24 months) of the incremental paid claim triangle to the first column of either triangle. The cumulative paid claims at 36 months are equal to the cumulative paid claims at 24 months plus the incremental paid claims at 36 months. Finally, the cumulative paid claims at 48 months are equal to the cumulative paid claims at 36 months plus the incremental paid claims at 48 months.

Before moving on to the other development triangles (e.g., case outstanding, reported claims, and reported claim counts), we stop to explain where the payments in the original summary appear in the cumulative paid claim development triangle. We now describe how to create numerous cells of the cumulative paid claim triangle using the original detailed paid claims information summarized in Table 6 as an alternative to simply cumulating the incremental paid triangle.

The first cell of the accident year cumulative paid claim development triangle is accident year 2005 at a valuation date of December 31, 2005. Actuaries refer to this point in the triangle as accident year 2005 at 12 months. In the claims detail presented in Table 6, we note that there are four claims that occurred in 2005 (Claim IDs 1, 2, 3, and 4). The first three claims (Claim IDs 1, 2, and 3) all occurred and were reported to the insurer during 2005. The last claim (Claim ID 4) occurred on October 28, 2005, but was only reported on May 15, 2006. Thus, when we calculate the value of accident year 2005 paid claims at 12 months, we do not include Claim ID 4 since this claim was not yet reported as of the December 31, 2005 valuation date. We also note that Claim ID 3 did not have any payments as of December 31, 2005. Thus, the $600 paid claims which appear in the first cell of the triangle represent payments for Claim IDs 1 and 2 during the year 2005.

We now construct the second diagonal of the cumulative paid claim triangle; this is the December 31, 2006 valuation. The second diagonal of the triangle contains two points: accident year 2005 at 24 months and accident year 2006 at 12 months. Continuing along the first row, we first calculate the value of paid claims at 24 months for accident year 2005. Total payments made during 2006 for Claim IDs 1, 2, 3, and 4 are $620 ($220 + $200 + $200 + $0). Cumulative claim payments for accident year 2005 through December 31, 2006 are equal to the sum of the payments made during 2005 and the payments made during 2006 for a total of $1,220.

The second point along the December 31, 2006 diagonal is accident year 2006 at 12 months. In the table we observe three claims with 2006 accident dates. However, only Claim IDs 5 and 6 were reported in 2006. Thus, we do not include Claim ID 7 in the calculation for the December 31, 2006 valuation[24]. The paid claims for accident year 2006 as of December 31, 2006 are equal to the sum of claim payments ($260 + $200) for Claim IDs 5 and 6.

Our example continues with the third diagonal, the December 31, 2007 valuation, which is also known as the 2007 diagonal. The third diagonal consists of three points:

— Accident year 2005 at 36 months
— Accident year 2006 at 24 months
— Accident year 2007 at 12 months

We follow a similar procedure of cumulating claim payments made through December 31, 2007. For accident year 2005, there are additional claim payments of $300 made during 2007. Thus, cumulative claim payments for accident year 2005 as of December 31, 2007 are $1,520. For accident year 2006, we cumulate the claim payments ($460 in 2006 plus $460 in 2007) for a total cumulative paid claims of $920. Similar to other accident years in our example, there is one claim for accident year 2007 that is not reported by year-end. Thus, the paid claims for accident year 2007 at 12 months only include Claim IDs 8, 9, and 10. We note that there is no payment for Claim ID 10 as of December 31, 2007. Thus, the paid claims value entered in the triangle is the sum of claim payments for Claim IDs 8 and 9 ($200 + $460).

We leave it to the reader to calculate the final diagonal of the cumulative paid claim triangle.

[24] In some applications, it may be far easier to just include Claim 7 as a zero value than to write programming logic to exclude it from the application.

Case Outstanding Triangle

In the following table, we summarize the detailed case outstanding from our 15-claim example. Table 9 is simply an excerpt from Table 5 presented earlier in this chapter.

Table 9 – Detailed Example – Claims Transaction Ending Case Outstanding Data

			Ending Case Outstanding			
Claim ID	**Accident Date**	**Report Date**	**2005**	**2006**	**2007**	**2008**
1	Jan-5-05	Feb-1-05	200	0	0	0
2	May-4-05	May-15-05	300	0	0	0
3	Aug-20-05	Dec-15-05	400	200	0	0
4	Oct-28-05	May-15-06		1,000	1,200	1,200
5	Mar-3-06	Jul-1-06		190	0	0
6	Sep-18-06	Oct-2-06		500	500	270
7	Dec-1-06	Feb-15-07			420	650
8	Mar-1-07	Apr-1-07			200	0
9	Jun-15-07	Sep-9-07			390	390
10	Sep-30-07	Oct-20-07			400	400
11	Dec-12-07	Mar-10-08				530
12	Apr-12-08	Jun-18-08				200
13	May-28-08	Jul-23-08				300
14	Nov-12-08	Dec-5-08				540
15	Oct-15-08	Feb-2-09				

We use the table above to create the case outstanding development triangle below.

Table 10 – Case Outstanding Triangle

Accident	Case Outstanding as of (months)			
Year	**12**	**24**	**36**	**48**
2005	900	1,200	1,200	1,200
2006	690	920	920	
2007	990	1,320		
2008	1,040			

The first value in the case outstanding development triangle is accident year 2005 at 12 months. We add the ending case outstanding values for Claim IDs 1, 2, and 3 to derive the case outstanding value of $900. We do not include Claim ID 4 since it is not reported until May 15, 2006. Case outstanding for accident year 2005 at 24 months (i.e., valuation date December 31, 2006) are equal to the case outstanding values for Claim IDs 3 and 4 or $1,200 ($200 + $1,000). Case outstanding for Claim IDs 1 and 2 are both $0 at December 31, 2006. For accident year 2005 at 36 months and 48 months, only Claim ID 4 has an ending case outstanding value. For both these valuation dates, December 31, 2007 and December 31, 2008, the ending case outstanding is $1,200.

For accident year 2006 at 12 months (i.e., valuation date December 31, 2006), the case outstanding value of $690 is equal to the sum of the ending case outstanding for Claim IDs 5 and 6 ($190 + $500). Case outstanding at 24 months (i.e., valuation date December 31, 2007) is equal to the sum of case outstanding on all three accident year 2006 claims ($0 + $500 + 420). The final value in the triangle for accident year 2006 is at 36 months (i.e., valuation date December 31, 2008). Claim IDs 6 and 7 have ending case outstanding values of $270 and $650, respectively. Thus, total case outstanding for accident year 2006 at 36 months is $920.

You can continue in a similar manner to build the remainder of the case outstanding development triangle.

Reported Claim Development Triangle

We define reported claims to be equal to cumulative paid claims through the valuation date plus case outstanding at the valuation date. Thus, we are able to build the reported claim development triangle by adding the cumulative paid claim triangle to the case outstanding triangle. Table 11 below presents the reported claim triangle for our sample 15 claims.

Table 11 – Reported Claim Development Triangle

Accident	Reported Claims as of (months)			
Year	12	24	36	48
2005	1,500	2,420	2,720	3,020
2006	1,150	1,840	2,070	
2007	1,650	2,640		
2008	1,740			

It is interesting to return to the original data and observe what happened to accident year 2005 claims over time. Claim ID 1 occurred early in 2005 and was reported shortly thereafter. Through December 31, 2005 (i.e., the first year of development), there were $400 in claim payments and the insurer established a case outstanding of $200. In the following year, this claim settled for slightly more than the case outstanding value. A claim payment of $220 was made during 2006 and the case outstanding was reduced to $0. There was no further activity on this claim through year-end 2008.

Claim ID 2 occurred in May 2005 and was also reported in May 2005. The insurer made a claim payment of $200 in 2005 and established a case outstanding of $300 by year-end 2005. During 2006, the insurer settled Claim ID 2 for $200, which was less than the $300 case outstanding. Thus, on this claim there was a saving from the initial case outstanding estimate.

The final settlement for Claim ID 3, however, was higher than the initial estimate. When the insured reported the claim near the end of 2005, the claims adjuster established an initial case outstanding of $400. During 2006, the insurer made a payment of $200 and reduced the case outstanding to $200. Thus, the reported claim estimate for this particular claim did not change during 2006; the payment of $200 offsets a similar reduction of $200 in the case outstanding. During 2007, there was a final settlement for Claim ID 3 of $300. The final incurred value for this claim was $500, or $100 more than the reported claim estimates at year-ends 2005 and 2006.

We continue looking at the activity of accident year 2005 claims during 2008. There was no activity on Claim IDs 1 through 3. However the reported claim for Claim ID 4 continues to increase. This was a late-reported claim. At December 31, 2006, the case outstanding was $1,000 for this claim. By December 31, 2007, the case outstanding had increased to $1,200. There were no payments in either 2006 or 2007. In 2008, claim payments were $300 but there was no change in the ending case outstanding. Thus, the reported claim for this particular claim increased by $300 during 2008 from $1,200 (the sum of cumulative claim payments through December 31, 2007, $0, and ending unpaid case at December 31, 2007, $1,200) to $1,500 (the sum of cumulative claim payments through December 31, 2008, $300, and ending unpaid case at December 31, 2008, $1,200).

A similar review can take place with the claims experience of each accident year.

Reported Claim Count Development Triangle

We also use the data in Table 5 to build a reported claim count triangle.

Table 12 – Reported Claim Count Development Triangle

Accident	Reported Claim Counts as of (months)			
Year	**12**	**24**	**36**	**48**
2005	3	4	4	4
2006	2	3	3	
2007	3	4		
2008	3			

We describe how to build the claim count development triangle by using accident years 2005 and 2008 as examples. Based on the data in Table 5, we note that while there are 4 claims for 2005, only 3 of the claims were reported as of December 31, 2005. Thus, the first cell in the reported claim count triangle which represents accident year 2005 as of December 31, 2005 shows 3 claims reported. By December 31, 2006, all four claims were reported. No further claims were reported for accident year 2005, and thus the number of reported claims remains unchanged at 4 for ages 36 months and 48 months.

The final row of the reported claim count triangle is for accident year 2008 as of December 31, 2008. As of 12 months, there were 3 claims reported for accident year 2008. Claim ID 15 was not reported until 2009 and thus is not included in the triangle.

Other Types of Development Triangles

As mentioned earlier, actuaries use development triangles with a wide variety of data. The first step in creating triangles is to determine the time interval for organizing the data. The time interval represents the rows of the triangles. In our previous example, we use accident year. Other common intervals include:

- Report year
- Underwriting year

- Treaty year[25]
- Policy year
- Fiscal year

By far, accident year is the most common organization of claims data actuaries in the U.S. and Canada use when creating development triangles. Actuaries also often rely on report year development triangles for the analysis of claims-made coverages such as U.S. medical malpractice and errors and omissions liability. Reinsurers often organize claims data by underwriting year. Policy year is a similar concept to underwriting year.

For self-insurers, the policy year, fiscal year, and accident year are often the same. For example, a self-insured public entity with a fiscal year April 1 to March 31 may issue documents of coverage to covered departments and agencies with an April 1 to March 31 coverage period; such entity may also arrange excess insurance with a policy year of April 1 to March 31. Finally, this public entity may aggregate development triangles using accident year periods of April 1 to March 31.

Claims can be categorized by time intervals other than annual intervals. Actuaries also use monthly, quarterly, and semi-annual data for developing estimates of unpaid claims. When selecting the time interval, important considerations for the actuary include the credibility of the experience or the stability of development or both.

There are numerous possibilities for the types of claims data that are presented in development triangles. Common types of data include:

- Reported claims
- Case outstanding
- Cumulative total paid claims
- Cumulative paid claims on closed claim counts[26]
- Incremental paid claims
- Reported claim counts
- Claim counts on closed with payment
- Claim counts on closed with no payment
- Total closed claim counts
- Outstanding claim counts

Actuaries also use the data types listed previously to create triangles of ratios and average claim values. Examples of these triangles include:

- Ratio of paid-to-reported claims

- Ratio of total closed claim counts-to-reported claim counts

- Ratio of claim counts on closed with payment-to-total closed claim counts

- Ratio of claim counts on closed without payment-to-total closed claim counts

[25] *Treaty year* is defined as a period of twelve months covered by a reinsurance treaty or contract.

[26] These values may be problematic to obtain in cases where interim or pre-closing payments are possible.

- Average case outstanding (case outstanding divided by outstanding claim counts)

- Average paid on closed claims (cumulative paid claims on closed claims divided by claim counts closed with payment)[27]

- Average paid (cumulative total paid claims divided by total closed claim counts)

- Average reported (reported claims divided by reported claim counts)

The triangles of ratios and average values provide useful insight into the relationships that exist between the various types of data at different points in time during the experience period. In Chapter 6, we explain how actuaries use these types of triangles as diagnostic tools.

For some insurers, the actuary analyzes LAE data independently of claims only. In such situations, the actuary may also create development triangles with the ratios of paid LAE-to-paid claims only and the ratios of reported LAE-to-reported claims only.

In our discussion so far, we have not mentioned how many development periods the actuary needs to evaluate. Is it necessary to analyze development through the 3rd maturity year, the 5th maturity year, the 10th or the 20th maturity year? If possible, the actuary should analyze development out to the point at which the development ceases (i.e., until the selected development factors are equal to 1.000). The number of development periods required generally varies by line, jurisdiction, and also by data type. For example, paid claims typically require a greater number of development periods than reported claims, and reported claims often require a greater number of development periods than reported claim counts. Also, automobile physical damage claims settle much more quickly than general liability claims, and therefore an analysis of unpaid claims for automobile physical damage requires fewer development periods than a similar analysis for general liability.

In the following chapters, we use the development triangle both as a diagnostic tool and as the primary input for numerous estimation techniques for unpaid claims.

Naming Convention for Examples

In our examples, we use the terms “reported claims” to refer to cumulative reported claims and “paid claims” to refer to cumulative paid claims. Similarly, we use the terms “reported claim counts” and “closed claim counts” to refer to cumulative reported and closed claim counts, respectively. For some examples in Chapters 11 through 13, we use incremental values of claims and claim counts. Any development triangles containing incremental values, of claims or claim counts, are specifically labeled as incremental.

[27] As noted on the previous page, cumulative paid claims on closed claim counts may be difficult to obtain. In such cases, actuaries may determine that interim or pre-closing payments are immaterial enough to justify the inexact match from including all payments, even those from open claims, divided by closed claim counts.

CHAPTER 6 – THE DEVELOPMENT TRIANGLE AS A DIAGNOSTIC TOOL

Part 2 of this book is about information gathering. We begin Chapter 3 with a description of the types of data and how data is organized. In Chapter 4, we discuss the importance of meeting with those involved with the operations and processes underlying the data (labeled in this text as management) and understanding the environment in which the insurer operates – both the internal and external environments. In Chapter 5, we construct development triangles. We conclude Part 2 with Chapter 6 in which we combine the knowledge we obtain by analyzing the development triangles with the information we receive during meetings with the insurer's claims and underwriting departments. In this chapter, we use the development triangles as a tool to further understand how changes in an insurer's operations and the external environment can influence the claims data. This is the final step before we delve into specific techniques for estimating unpaid claims.

It is very important for the actuary to communicate with the insurer's management if the changes that management reports to have implemented are not supported by the data. It is quite common for an insurer's management to report significant changes in both the claims settlement area and the strength (i.e., adequacy) of its case outstanding. Insurers may try to accomplish such changes through new policies, procedures, and/or information systems. Many times actuaries do see evidence of operational change in the quantitative data that they are reviewing. However, in some situations, the best intentions of senior claims management may not have worked through the organization as planned; in these situations a direct effect on the claims data may not be evident to the actuary. Sometimes, it is just a matter of time before signs of the operational changes start to show in the claims data. Other times, there may be cultural blocks within the organization that are resisting the intended changes. Through open discussions with claims management and staff as well as a detailed review of the claims data, the actuary should be able to gain a clear understanding of the situation and then choose the best technique(s) to match the particular situation at hand.

Detailed Example – Background Information

In the following example, we demonstrate how to use development triangles for diagnostic review. For this purpose, we use the experience of an insurer's private passenger automobile portfolio in one geographic region (e.g., a single state or a province). Specifically, we look at the historical claims experience for automobile bodily injury liability over the 2002 to 2008 experience period. In this chapter and throughout Part 3, we refer to this example as XYZ Insurer.

The purpose of our example is not to raise every possible question or to identify every possible issue that may exist for XYZ Insurer. Instead, our goal is to teach you how to look at relationships and how to begin to develop your own observations and questions.

In this example, we assume that meetings with various members of the insurer's operations have already taken place. At these meetings, we were told that there were significant changes within the claims department over the last several years, including changes at the most senior levels of management. The new Senior Vice President – Claims told us that one of her main priorities is to carry adequate case outstanding. Management insists that the strength of current case outstanding is much greater than in prior years. During our meetings, we also learned that the insurer implemented new information systems in the past three years for the purpose of speeding up the claims reporting and settlement processes. Management at XYZ Insurer believes very strongly in the saying "a good claim is a closed claim" and has instituted policies and procedures to expedite the claim settlement process.

In addition to the changing environment within the insurer's operations, we know that there were significant changes to the automobile insurance product in this geographic region. Major tort reforms were implemented in 2006 resulting in caps on awards as well as pricing restrictions and mandated rate level changes for all insurers operating in the region. As a result of these reforms, management decided to reduce its presence in this market.

Having met with management, it is now time to begin our diagnostic review of the data. One goal of such a review is to determine if we can observe the effect of the changes implemented by management in the claims data provided by the insurer. We expect that our review will likely lead to further questions and result in more discussions with members of the management team. We also hope that based on our diagnostic review, we will be able to determine what types of data and which techniques will be most appropriate to estimate unpaid claims for XYZ Insurer under its current circumstances.

Premium History

In Table 1 below, we summarize earned premium as well as XYZ Insurer's historical rate changes for this line of business. XYZ Insurer provided the earned premium and rate level changes by year. We calculate the cumulative average rate level and annual change in exposures from year to year.[28]

Table 1 – Summary of Earned Premium and Rate Changes

Calendar Year	Earned Premiums ($000)	Rate Changes	Cumulative Average Rate Level	Annual Exposure Change
2002	61,183		0.0%	
2003	69,175	+5.0%	5.0%	7.7%
2004	99,322	+7.5%	12.9%	33.6%
2005	138,151	+15.0%	29.8%	21.0%
2006	107,578	+10.0%	42.8%	-29.2%
2007	62,438	-20.0%	14.2%	-27.5%
2008	47,797	-20.0%	-8.6%	-4.3%

(To simplify the analysis in this chapter and in Part 3, assume that the rate changes in the above table represent the average earned rate level for the year. For further information about

[28] The average rate level is calculated by successive multiplication of the annual rate changes. For example, for 2004, the cumulative average rate level is equal to {[(1.00 + 5.0%) x (1.00 + 7.5%)] – 1.00}, or 12.9%. Similarly, the average rate level change for 2007 is equal to {[(1.00 + 42.8%) x (1.00 – 20.0%)] – 1.00}, or 14.2%. The annual exposure change is equal to the annual change in earned premiums divided by the rate change in the year. For example, the annual exposure change for 2003 is equal to {[(69,175 / 61,183) / (1 + 5.0%)] – 1.00}, or 7.7%. For 2008, the annual exposure change is equal to {[(47,797 / 62,438) / (1 – 20.0%)] – 1.00}, or -4.3%.

adjustments for rate level changes, we refer the reader to C. L. McClenahan, “Ratemaking,” Chapter 3 in *Foundations of Casualty Actuarial Science,* Fourth Edition, CAS, 2001.)

The Reported and Paid Claim Triangles

Reported and paid claim development data are the two most common types of data actuaries have access to. Tables 2 and 3 below present the reported and paid claim development triangles, respectively, for XYZ Insurer.

Table 2 – Reported Claim Development Triangle

Accident	Reported Claims ($000) as of (months)						
Year	12	24	36	48	60	72	84
2002	12,811	20,370	26,656	37,667	44,414	48,701	48,169
2003	9,651	16,995	30,354	40,594	44,231	44,373	
2004	16,995	40,180	58,866	71,707	70,288		
2005	28,674	47,432	70,340	70,655			
2006	27,066	46,783	48,804				
2007	19,477	31,732					
2008	18,632						

Table 3 – Paid Claim Development Triangle

Accident	Paid Claims ($000) as of (months)						
Year	12	24	36	48	60	72	84
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437
2003	1,743	6,240	12,683	22,892	34,505	39,320	
2004	2,221	9,898	25,950	43,439	52,811		
2005	3,043	12,219	27,073	40,026			
2006	3,531	11,778	22,819				
2007	3,529	11,865					
2008	3,409						

When conducting a diagnostic review with claim development triangles, the actuary is generally looking down the columns of the triangle. The actuary is looking at the experience of different accident years at the same age of development (i.e., same maturity age). In a stable environment, the actuary expects to see stability in the claim experience down each column.

We combine the premium data with the claim data and calculate two more diagnostic triangles: the ratio of reported claims to earned premium (also known as the reported claim ratio) and the ratio of reported claims to on-level earned premium. We calculate the on-level premium using the average rate level changes by year and restating the earned premium for each year as if it was written at the 2008 rate level.

Table 4 – Ratio of Reported Claims to Earned Premium

Accident	Ratio of Reported Claims to Earned Premium as of (months)						
Year	12	24	36	48	60	72	84
2002	0.209	0.333	0.436	0.616	0.726	0.796	0.787
2003	0.140	0.246	0.439	0.587	0.639	0.641	
2004	0.171	0.405	0.593	0.722	0.708		
2005	0.208	0.343	0.509	0.511			
2006	0.252	0.435	0.454				
2007	0.312	0.508					
2008	0.390						

Table 5 – Ratio of Reported Claims to On-Level Earned Premium

Accident	Ratio of Reported Claims to On-Level Earned Premium as of (months)						
Year	12	24	36	48	60	72	84
2002	0.229	0.364	0.477	0.674	0.794	0.871	0.862
2003	0.160	0.282	0.504	0.674	0.735	0.737	
2004	0.211	0.500	0.732	0.892	0.874		
2005	0.295	0.488	0.723	0.726			
2006	0.393	0.679	0.709				
2007	0.390	0.635					
2008	0.390						

A thorough review of the above triangles, leads us to the following questions/observations:

- What happened in accident year 2003? Why are the reported claims so low after 12 and 24 months of development? When comparing the changes in claims by year to the changes in premiums by year, we need to first consider the rate level history for the insurer. According to Table 1, we know that the insurer had a 5% higher rate level in 2003 than 2002. Thus, it appears that the insurer experienced an exposure growth of approximately 8% in 2003 ([(($69,175 / 1.05) / $61,183) – 1.00]). Knowing that the insurer actually increased its exposure base, it is surprising to see a 25% drop in reported claims for 2003 after 12 months of development. For the 36-, 48-, and 60-month valuations, reported claims for accident year 2003 appear to return to levels similar to those experienced in 2002. What led to the lower level of reported claims for the first 24 months? Was there a change in systems? Were paid claims or case outstanding driving the decrease in reported claims? If we look at the paid claim triangle for accident year 2003, we observe that paid claims are also down at 12 and 24 months of development and that the reduction is roughly of the same magnitude as for the reported claims.

- What happened in accident year 2004, particularly at and after the 24-month valuation? While we observe that earned premiums are up 44% over 2002 and 34% over 2003 (after adjustment for rate changes), the reported claims for 2004 after 24 months of development are up by 97% [($40,180 / $20,370) – 1.00] over 2002 and 136% [($40,180 / $16,995) – 1.00] over 2003. Are large claims or more claim counts or both driving the increase? Was there a change in case outstanding adequacy that had an effect on the December 31, 2005 valuation? (Remember that the 24-month valuation for accident year 2004 corresponds to the December 31, 2005 valuation.)

- What happened in accident years 2005 and 2006 to drive reported claims up so much at 12 months of development? A quick look at the higher volume of earned premiums for these two years provides some of the explanation for the increase. However, we observe that, at the 12-month valuation, reported claims are again increasing at a rate that is greater than the increase in exposures and our knowledge of the inflationary environment. For example, we compare reported claims between accident years 2004 and 2005:

  $[(AY_{2005} / AY_{2004}) – 1.00] = [(\$28,674 / \$16,995) – 1.00] = 69\%$

  The 69% increase observed in reported claims between 2004 and 2005 is greater than the increase in exposures between these years, which is 21%. Similarly, we compare reported claims between accident years 2004 and 2006:

  $[(AY_{2006} / AY_{2004}) – 1.00] = [(\$27,066 / \$16,995) – 1.00] = 59\%$

  The 59% increase observed in reported claims between 2004 and 2006 is greater than the change in exposures between these years, which is actually a decrease of 14%.

- If we look down the 24-month column, we observe unusually large volumes of reported claims for accident years 2004 through 2006. For each of these years, reported claims are greater than $40 million, and the on-level reported claim ratios are greater than 0.40. For these same three accident years, we see that XYZ experienced larger volumes of paid claims with values of approximately $10 million for 2004 and $12 million for 2005 and 2006. We also note that, at 24 months, accident year 2007 reported claims are lower than the preceding three accident years. Could the lower claims in 2007 be a result of the tort reforms introduced during 2006?

- When we analyze the experience for accident year 2006, we should keep in mind that the insurer experienced a significant reduction in exposures during the year. Earned premiums dropped from $138,151 in 2005 to $107,578 even with a 10% rate increase. This indicates a drop in exposures of almost 30%. However reported claims after 12 months of development differ from 2005 by less than 6% [($27,066 / $28,674) – 1.00] and at 24 months of development by less than 2% [($46,783 / $47,432) – 1.00]. After 36 months, we do see a significant difference between claims for accident years 2005 and 2006.

- Now turning our attention to accident years 2007 and 2008, we see that reported claims are significantly lower than for 2005 and 2006 though the claim ratios are not. We can determine the change in exposures based on the given premium information. While there was another reduction of approximately 30% in the exposures during 2007 (from 2006), the change in earned premiums between 2007 and 2008 was primarily due to the rate change and not due to changes in exposure volume. The volume of reported claims at 12 months for accident years 2007 and 2008 is consistent with the earned premium information.

At this point it is valuable for the actuary to analyze additional development triangles to look for answers to some of the questions raised in this initial review of the claims data.

The Ratio of Paid-to-Reported Claims

There are many situations under which reported and paid claim development triangles are the only triangles available to the actuary. Using these two triangles the actuary can calculate a ratio of the paid claims-to-reported claims (also known as the paid-to-reported ratio). Building a triangle using such ratios allows the actuary to analyze the evolution of this relationship over the experience period.

As a diagnostic tool, this ratio examines the consistency of paid claims relative to reported claims. It is an important tool for testing whether there might have been changes in case outstanding adequacy or in settlement patterns. Since we are analyzing a ratio, we need to investigate further any changes observed to determine if the change is occurring in paid claims (i.e., the numerator) or in the case outstanding, which are a critical component of the reported claims (i.e., the denominator). However, if we do not observe changes in the ratio of paid-to-reported claims, it does not necessarily mean that changes are not occurring. There could be offsetting changes in both claim settlement practices and the adequacy of case outstanding that result in no change to the ratio of paid-to-reported claims.

In our example, claims department management believes that the new claims settlement practices resulted in a speed-up in claims closure. Based on this information, we would expect paid claims to be increasing along the latest diagonals relative to prior years. Management also reported that the new policies related to case outstanding are resulting in stronger unpaid case than in prior years. Therefore, reported claims should also be increasing along the latest diagonals of the triangle. With both paid claims and reported claims increasing, the ratio of paid-to-reported claims may be unchanged along the latest diagonals when compared with prior years' diagonals.

Now, we look at the triangle summarizing the historical ratios of paid-to-reported claims for XYZ Insurer.

Table 6 – Ratio of Paid Claims-to-Reported Claims

Accident	Ratio of Paid Claims-to-Reported Claims as of (months)						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	0.181	0.389	0.519	0.587	0.719	0.834	0.923
2003	0.181	0.367	0.418	0.564	0.780	0.886	
2004	0.131	0.246	0.441	0.606	0.751		
2005	0.106	0.258	0.385	0.567			
2006	0.130	0.252	0.468				
2007	0.181	0.374					
2008	0.183						

We continue to look down each column and to compare the experience from accident year to accident year. Based on the experience in Table 6, it is difficult to discern changes in this ratio. While the ratio was decreasing at 12 months for accident years 2004 through 2006, it has returned to historical levels for accident years 2007 and 2008. Similar observations can be made at 24 months.

We recall that since we are reviewing a ratio, we need to look at the potential for changes in both the numerator and the denominator. A downward trend in the ratio of paid-to-reported claims could be the result of decreasing paid claims or of increasing case outstanding adequacy. We understand from our discussions with management of the claims department that the rate of claims settlement has increased. Is the change in case outstanding adequacy masking the changes in the settlement process? We also ask if the type of claims reported is changing. Different types of claims have different settlement and reporting characteristics. This could have an effect on both paid and reported claims.

The Ratio of Paid Claims to On-Level Earned Premium

Next, we decide to review the ratio of cumulative paid claims to on-level earned premium. We hope that a review of this diagnostic triangle will provide insight as to whether there was a speed-up in claims payment or possibly deterioration in underwriting results.

Table 7 – Ratio of Cumulative Paid Claims to On-Level Earned Premium

Accident	Ratio of Cumulative Paid Claims to On-Level Earned Premium as of (months)						
Year	12	24	36	48	60	72	84
2002	0.041	0.142	0.247	0.395	0.571	0.727	0.795
2003	0.029	0.104	0.211	0.380	0.573	0.653	
2004	0.028	0.123	0.323	0.540	0.657		
2005	0.031	0.126	0.278	0.412			
2006	0.051	0.171	0.331				
2007	0.071	0.238					
2008	0.071						

There does appear to be evidence of a possible speed-up in payments, particularly at 12 and 24 months. The question still remains as to whether or not there has been a shift in the type of claim settled at each age. At this point, we request additional data (reported and closed claim counts) and create new development diagnostic triangles for further review.

Claim Count Triangles

Just as we review the reported and paid claim triangles above, we also review the triangles of reported and closed claim counts.

Table 8 – Reported Claim Count Development Triangle

Accident	Reported Claim Counts as of (months)						
Year	12	24	36	48	60	72	84
2002	1,342	1,514	1,548	1,557	1,549	1,552	1,554
2003	1,373	1,616	1,630	1,626	1,629	1,629	
2004	1,932	2,168	2,234	2,249	2,258		
2005	2,067	2,293	2,367	2,390			
2006	1,473	1,645	1,657				
2007	1,192	1,264					
2008	1,036						

Table 9 – Closed Claim Count Development Triangle

Accident	Closed Claim Counts as of (months)						
Year	12	24	36	48	60	72	84
2002	203	607	841	1,089	1,327	1,464	1,523
2003	181	614	941	1,263	1,507	1,568	
2004	235	848	1,442	1,852	2,029		
2005	295	1,119	1,664	1,946			
2006	307	906	1,201				
2007	329	791					
2008	276						

Before commencing the analysis of the claim count development triangles, it is important that the actuary understand the types of data contained within such triangles. How does the insurer treat reopened claims? Are they coded as a new claim or is a previously closed claim re-opened? If the insurer treats reopened claims in the latter, there could potentially be a decrease across a row in the closed claim count development triangle. Does the insurer include claims closed with no payment (CNP) in the reported and closed claim count triangles? How are claims classified that have only expense payments and no claim payment?

XYZ Insurer indicated that the closed claim count development data excludes CNP claim counts. The reported claim count development data is based on the sum of closed claim counts (excluding CNP) and claims with case outstanding values; thus, the reported claim count development triangle also excludes CNP counts.

Our review of these triangles leads to the following observations and questions:

— At 12 months, we see that the reported claim counts experienced an increase of 40% [(1,932 / 1,373) – 1.00] and closed claim counts had an increase of 30% [(235 / 181) – 1.00] between accident years 2003 and 2004. Over this same time period, we observe a 76% increase in reported claims. Similarly, the increases in claim counts at 24 months for accident year 2005 [(2,293 / 2,168) – 1.00 = 5.8%] are not as significant as the increases in reported claims [($47,432 / $40,180) – 1.00 = 18.0%]. Why are claims increasing so much more than the number of claims? Could large claims be driving the increases?

— Reported claim counts for accident years 2004 and 2005 stand out as the highest values at all ages. This is generally consistent with the experience shown in the reported claim triangle. However, we do not observe a similar increase in the closed claim count triangle where 2006 and 2007 are highest at 12 months. At 24 months, the highest closed claim count values are for accident years 2005 and 2006. Are the higher closed claim counts due to the new systems implemented at the insurer?

— The decrease in reported claim counts for 2006 and 2007 is consistent with the decrease in exposures for these years. We do not see a similar decrease in closed claim counts, however. Perhaps, this is due to the speed-up in claims settlement processes that management discussed in our meetings. It is worth investigating this issue further.

- For accident year 2008, reported and closed claim counts are lower than we would expect given reported claims, paid claims, and the relative steady-state of exposures between 2007 and 2008. This leads us to further investigation of why the number of claims is down for the latest year.

Ratio of Closed-to-Reported Claim Counts

If the actuary suspects that there are changes in the settlement rate of claims, either based on information gained from meetings with management or changes observed in the ratio of paid-to-reported claims, the ratio of closed-to-reported claim counts is an important diagnostic tool to review. Many factors can have an effect on the reporting and closing of claims. For example, a large catastrophic storm, such as a hurricane, has the potential to temporarily limit an insurer's operations with telephone and computer system shutdowns. In such a situation, there may be a one-time blip with a decrease in the ratio of closed-to-reported claim counts. Other forces that could result in a change in the ratio of closed-to-reported claim counts include:

- Change in the guidelines for the establishment of a claim

- Decrease in the statute of limitations, which often accompanies major tort reform

- Delegation of a higher limit for settlement of claims to a TPA

- Restructuring of the claim field offices, such as through the merging of existing offices or the addition of new offices

- Introduction of a new call center to handle claims (This could affect both reported and closed claim counts and thus the actuary would need to further investigate whether changes were affecting the numerator, closed claim counts, the denominator, reported claim counts, or both.[29])

Management at XYZ Insurer told us that they implemented a new claims processing system and that claims are now settling much more quickly than in the past. Management indicated that the new system is having an effect on the entire portfolio of outstanding claims not just claims from the latest accident year. With respect to the ratio of closed-to-reported claim counts, we would then expect to see greater ratios for the latest diagonals than for prior years.

[29] Changes in claims handling procedures can result in decreases and increases in the rate of claim payments. Sometimes, a change in procedures results in a temporary increase in closing patterns, such as when a claim department makes an extra effort to get the backlog as low as possible before making a transition to a new system. Sometimes, the speed-up is due to faster processing under the new system. Sometimes the new system leads to a slowdown in closing, due to a learning curve necessary before the new system is fully operational.

We generate the following triangle based on the claims information presented earlier for XYZ Insurer.

Table 10 – Ratio of Closed-to-Reported Claim Counts

Accident	Ratio of Closed-to-Reported Claim Counts as of (months)						
Year	12	24	36	48	60	72	84
2002	0.151	0.401	0.543	0.699	0.857	0.943	0.980
2003	0.132	0.380	0.577	0.777	0.925	0.963	
2004	0.122	0.391	0.645	0.823	0.899		
2005	0.143	0.488	0.703	0.814			
2006	0.208	0.551	0.725				
2007	0.276	0.626					
2008	0.266						

Change is clearly evident in this diagnostic triangle. For the first four years in the experience period (2002 through 2005) at 12 months of development, the ratio of closed-to-reported claim counts was roughly 0.14. For each of the last three years (at 12 months), the ratio is in excess of 0.20; and for the latest year it is 0.266. We observe the same type of increases for the 24-month through 48-month development periods. At 24 months, the ratio of closed-to-reported claim counts for the latest accident year, 2007, is 0.626 and for the earliest year, 2002, is 0.401; at 36 months, the ratio for the latest accident year, 2006, is 0.725 and for the earliest year, 2002, is 0.543.

The experience of closed and reported claim counts is consistent with management's report of greater emphasis on settling claims faster. After concluding that management's efforts have indeed had an effect on the claims settlement patterns, the actuary must then consider the consequences of such a change. Generally, insurers are able to close the less complicated and less expensive claims the quickest. The closure of more complicated claims, which tend to involve litigation and expert witnesses, are often less in the control of the insurer since third parties play a significant role in the claims settlement process. If the insurer's greater focus on closing claims is having its greatest influence on the settlement of smaller claims, there will likely be a shift in the type of claims closed or open at any particular age in the claim development triangle. We discuss this further in the next section on average claims.

Average Claims

We use the reported and paid claim development triangles as well as the reported and closed claim count triangles to calculate various average values. For XYZ Insurer, we calculate the following:

Table 11 – Definitions of Average Values

Average Value	Definition
Average reported claim	Reported claim triangle / reported claim count triangle
Average paid claim	Paid claim triangle / closed claim count triangle
Average case outstanding	$\frac{\text{Reported claim triangle – paid claim triangle}}{\text{Reported claim count triangle – closed claim count triangle}}$

Before summarizing the observations from XYZ Insurer, we highlight two important issues related to average values. First, it is important for the actuary to have a clear understanding of the definition of closed and reported claim counts. Some insurers include claims with no payment (CNP) in the definition of closed claim counts and other insurers exclude CNP. Similarly, some insurers include claims with no case outstanding and no payments in the definition of reported claim counts, and other insurers define reported claim counts as only those claims with a case outstanding greater than $1 or with a claim payment. The result of including CNPs in closed claim count statistics or claims with no case outstanding or payments in reported claim counts is a much lower average value. For the actuary, what is most important is that he or she knows what definition the insurer uses and that the insurer is consistently using the same definition throughout the experience period. A change in the definition of claim counts can have a significant consequence on the results of diagnostic analyses using claim counts and on estimation techniques that rely on the number of claims. It is also important that the actuary is aware of differences between the insurer's definition of claim counts and any external benchmarks that would be used for comparison purposes.

Second, large claims, both the presence and absence of such claims, can have a distorting effect on average claims. Actuaries may remove unusually large claims from the database before conducting both ratio and average value calculations and handle the unpaid claim estimate required for such large claims separately. Another alternative is to prepare development triangles using limited claims. For example, claims can be limited to $500,000 or $1 million per occurrence in the reported and paid claim development triangles. The determination of the claim limit is a matter of significant actuarial judgment and is beyond the scope of this book. (See previous discussion of determining a large claims threshold in Chapter 3.)

Policy deductibles can also cause a distorting effect on the analysis of average values. Again, the actuary must understand what is included and excluded from the data source, in terms of claims, recoverables, and claim counts. Retentions can also distort severities.

For XYZ Insurer, closed claim counts exclude claims closed without any payment; similarly, reported claim counts exclude claims in which there are no case outstanding and no payments. Paid claims, for XYZ Insurer, include partial payments as well as payments on closed claims. Thus, our average paid claim triangle will be a combination of payments on settled claims as well as payments on claims that are still open.

We present the average reported claim triangle for XYZ Insurer in the following table. The average reported claim triangle is frequently used to detect possible changes in case outstanding adequacy. It is not quite as valuable as the average case outstanding triangle since reported claims include both paid claims and unpaid case. As we discussed previously, changes in paid claims have the potential to mask changes in case outstanding adequacy. However, for some insurers, open claim counts are not available in triangular format and the average reported claim triangle may be all that the actuary has available for diagnostic purposes.

Table 12 – Average Reported Claim Development Triangle

Accident	Average Reported Claims as of (months)						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	9,546	13,455	17,219	24,192	28,673	31,379	30,997
2003	7,029	10,517	18,622	24,966	27,152	27,239	
2004	8,796	18,533	26,350	31,884	31,129		
2005	13,872	20,686	29,717	29,563			
2006	18,375	28,440	29,453				
2007	16,340	25,104					
2008	17,985						

When reviewing triangles of average values for a stable insurer, we expect to see changes down the columns limited to inflationary forces only. As we look down the columns of the average reported claim triangle in our example above we observe changes that are greater than the annual inflation (assumed to be 5% for this region's automobile bodily injury liability).[30] We do not know, however, if the increases are due to greater levels of payments or stronger case outstanding.

In Table 13, we show the average paid claim triangle. We remind you that there is a mismatch in the average paid claim triangle since the numerator (cumulative paid claims) includes partial claim payments and the denominator (closed claim counts) represents only claims with final settlement. We must consider this limitation when drawing any conclusions from this particular diagnostic triangle.

Table 13 – Average Paid Claim Development Triangle

Accident	Average Paid Claims as of (months)						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	11,417	13,067	16,436	20,290	24,073	27,752	29,178
2003	9,631	10,163	13,478	18,125	22,896	25,077	
2004	9,452	11,673	17,996	23,455	26,028		
2005	10,315	10,920	16,270	20,569			
2006	11,502	13,000	19,000				
2007	10,726	15,000					
2008	12,351						

In this diagnostic triangle, we observe that the average values along the latest diagonal are generally the highest value in each column (particularly at 12 to 36 months). Based on the knowledge acquired from our meetings with claims department representatives and our review of other diagnostics, we ask whether or not there has been a change in the type of claim that is being closed at these particular ages. This is an important question for the actuary to discuss with management of the claims department as it could affect the actuary's selection of estimation techniques and claim projection factors.

[30] It is important to recognize that there are many factors that have an effect on severity trends for any particular line of business. Examples include changes in: policy limits purchased, geographic mix, type of policyholders insured, definition of claim counts, etc.

The average paid claim triangle appears relatively stable for ages 48 and older. The evidence of change in average paid claims only at 12, 24, and 36 months is consistent with our earlier comment that insurers typically have the greatest control on closure rates of the less complicated and less expensive claims. Closing more complex claims is usually dependent on the actions of third parties that are not within the insurer's control.

Finally, we review the average case outstanding (or average open claim amount) triangle. The average case outstanding triangle is one of the most important diagnostic tools for testing changes in case outstanding adequacy. In this triangle, a decreasing pattern down the column is an indicator of potential weakening in the case outstanding, and an increasing pattern down the column is an indicator of possible strengthening in the case outstanding.

Table 14 – Average Case Outstanding Development Triangle

Accident	Average Case Outstanding as of (months)						
Year	12	24	36	48	60	72	84
2002	9,213	13,714	18,151	33,273	56,167	91,729	120,366
2003	6,634	10,733	25,647	48,766	79,718	82,826	
2004	8,706	22,941	41,561	71,204	76,320		
2005	14,464	29,994	61,547	68,983			
2006	20,185	47,368	56,984				
2007	18,480	42,002					
2008	20,031						

Before drawing any conclusions, however, it is important that the actuary understands the dynamics of the insurer. Has there been a change in case outstanding practices, policies, philosophy, staff, or senior management of the claims department? Any of these changes could affect case outstanding adequacy. The average case outstanding could also be changing due to changes in the mix of business in the portfolio that have nothing to do with changes in case outstanding strength.

This is why it is so important that the actuary looks at more than one diagnostic tool before drawing conclusions and that the actuary returns to the insurer's claims department for further input regarding his or her observations.

To analyze the data in the average case outstanding triangle for XYZ Insurer, we look down the columns and compare the average case outstanding at the same age by accident year. For an insurer that is operating in a stable environment, we expect that the average case outstanding would be increasing down the column at the relevant annual inflation rate.[31] A quick look at the average case outstanding in our example tells us that the average case outstanding is generally increasing by more than the 5% inflation in this example.

For the earliest years in our experience period (2002 through 2004), the average case outstanding at 12 months of development was less than $10,000. For two of the latest three accident years at 12 months, the average case outstanding is greater than $20,000. We see similar increases at 24 and 36 months. At 24 months, the average case outstanding for accident years 2002 and 2003 was less than $15,000; for accident years 2006 and 2007 at the same development age, the average case outstanding values are both greater than $40,000. At 36 months, the average case

[31] Note that the relevant annual inflation rate may be something other than the overall inflation rate, as it may reflect a different mix of components than found in the overall economy's inflation.

outstanding for accident years 2002 and 2003 was less than $26,000; for accident years 2005 and 2006 at the same age, the average value is close to $60,000. We also observe increasing values of average case outstanding at 48 and 60 months.

We understand from our meetings with XYZ Insurer management that increased case outstanding strength is a priority. We also know that a review of the average case outstanding shows increasing average values for outstanding claims. However, before accepting that there has been a change in the adequacy of case outstanding, we must ask what effect, if any, is the change in claims settlement having on the average case outstanding. If smaller claims are settling more quickly, we are then left with only the more complex and more expensive claims. This, in and of itself, would lead to an increase down the columns in the average case outstanding. It is very important for the actuary to determine how much of the increase in the average case outstanding is truly due to a systemic change in the overall level of case outstanding adequacy and how much is due to a different mix of claims.

Summary Comments for XYZ Insurer

Clearly XYZ Insurer has experienced change over the recent several years. Management communicated these changes in our last meeting and every claim development diagnostic that we review shows that the changes noted by management are evident. It is now up to the actuary to determine how to incorporate all this information in the development of an unpaid claim estimate to be carried on XYZ Insurer's financial statements. The changing environment will have an effect on the actuary's choice of estimation techniques, types of data, and actuarial factors within the techniques. We continue to use this example in Part 3 as we introduce basic techniques for estimating unpaid claims.

Conclusions

In this chapter we present, as an example, an insurer who has the capability of producing development triangles for many types of data, including claims and claim counts. Many insurers do not have this ability. In these situations, actuaries may be limited to development triangles of reported and paid claims only. Actuaries are then faced with the challenge of finding other sources of data and information to ensure that they have sufficient knowledge of the insurer in order to determine the unpaid claims.

In "Loss Reserving," Mr. Wiser states: "Exploring the data begins by understanding the trends and changes affecting the database. Understanding the data is a prerequisite to estimating sound loss reserves. This exploration will help the analyst select appropriate loss reserving methods and interpret the results of the methods."[32]

The goal of this chapter is to demonstrate that the development triangle is an excellent tool for exploring the data. We discuss how important it is for the actuary to take the information obtained during meetings with management and then seek confirmation in the actual claims experience. The actuary should not simply accept reports of change or reports of no change without confirmation. Without some form of verification, management's assertion of changes in the strength of case outstanding or changes in the rate of claims settlement could lead to inaccurate estimates of unpaid claims by the actuary.

[32] *Foundations of Casualty Actuarial Science*, 2001.

The actuary must be able to question management when they see changes in the data that are not consistent with what management says has occurred, is occurring, or will be occurring. The dialogue between the actuary and those involved with the insurer's operations (especially claims operations) must be ongoing. Understanding the data is a complex process that requires the input of many people and ultimately requires the judgment of the actuary to interpret the findings from both quantitative and qualitative information.

PART 3 – BASIC TECHNIQUES FOR ESTIMATING UNPAID CLAIMS

INTRODUCTION TO PART 3 – BASIC TECHNIQUES FOR ESTIMATING UNPAID CLAIMS

The Components of Ultimate Claims

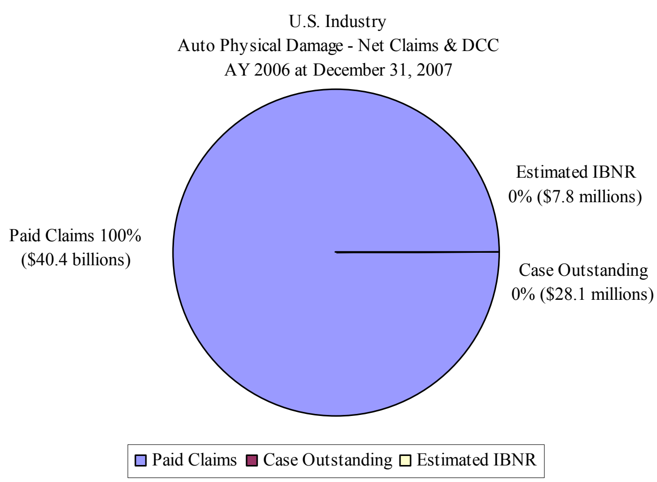
In Part 3, we present numerous methods for projecting ultimate claims. Ultimate claims are the sum of three components: cumulative paid claims, case outstanding, and IBNR. The relationships among these three components vary tremendously by line of insurance, by jurisdiction, and by time interval being reviewed (e.g., recent accident years versus mature accident years). The relationships also vary from insurer to insurer depending on the insurers' claims management philosophies and procedures.

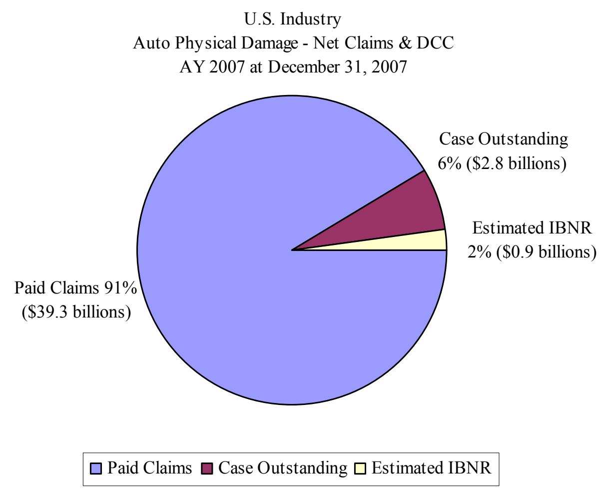
Paid claims and case outstanding typically represent a high proportion of ultimate claims at early maturities for lines of insurance such as automobile physical damage and property. These lines of insurance are characterized as *short-tail* lines of insurance due to the short period of time associated with the claims reporting and settlement processes. In contrast, medical malpractice occurrence is an example of a line of insurance that is classified in the U.S. as a *long-tail* line of insurance due to the lengthy period of time associated with the reporting and settlement of these types of claims. U.S. workers compensation and general liability, including products liability and errors and omissions, are other examples of long-tail lines of insurance in the U.S.

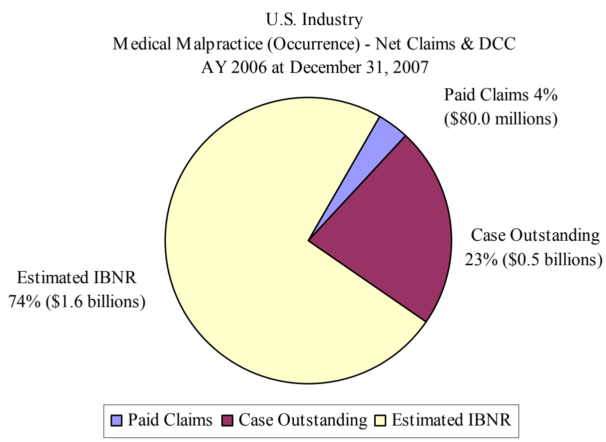
In the four pie charts on the following page, we compare the split between paid claims, case outstanding, and IBNR for accident years 2006 and 2007 as of December 31, 2007,[33] for the consolidated U.S. industry data for automobile physical damage and for medical malpractice occurrence.[34] While the examples refer to specific U.S. coverages, the intent of the pie charts is to demonstrate the significant differences in the proportions between paid, case outstanding, and IBNR for different accident years, and the differences between short-tail lines and long-tail lines of coverage.

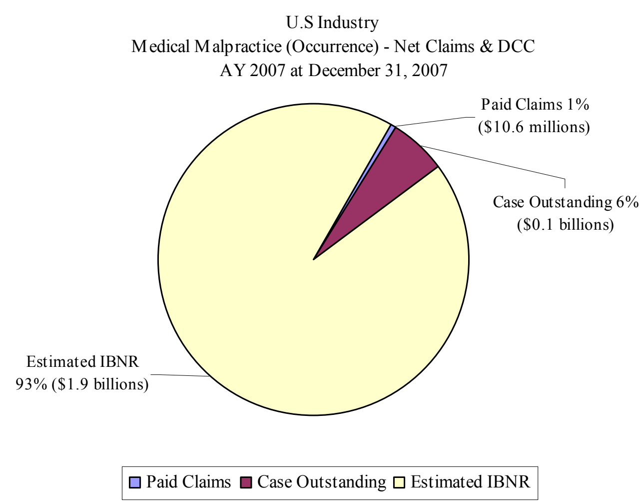
[33] The source of data for the four pie charts in this section is the consolidated U.S. annual statement for the year ending December 31, 2007, Schedule P (a claim development schedule of the U.S. annual statement) contained in *Best's Aggregates & Averages*. The data in the pie charts includes claims and DCC net of reinsurance, gross of salvage and subrogation.

[34] Medical malpractice is the name of the coverage used in *Best's Aggregates & Averages*. This coverage is also known as medical professional liability. In the U.S., there is separate financial reporting for medical malpractice occurrence and medical malpractice claims-made coverages.









Throughout Part 3, we use numerous methods to project ultimate claims. We then derive estimated IBNR as the difference between projected ultimate claims and reported claims as of the valuation date. The total unpaid claim estimate is calculated as the sum of the estimated IBNR and case outstanding; alternatively, we can calculate the estimated total unpaid claims as the difference between projected ultimate claims and cumulative paid claims as of the valuation date.

Actuarial Judgment

In the Berquist and Sherman paper "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach,"[35] there is a discussion of the vital role of actuarial judgment in the analysis of unpaid claims. Berquist and Sherman begin their paper with the following:

> While specific guidelines for reserve adequacy testing may be established and specific examples of an actuarial approach to the testing of loss reserves may be offered for particular situations, loss reserving cannot be reduced to a purely mechanical process or to a "cookbook" of rules and methods. The utilization and interpretation of insurance statistics requires an intimate knowledge of the insurance business as well as the actuary's ability to quantify complex phenomena which are not readily measurable. As in the case of ratemaking, while certain general methods are widely accepted, actuarial judgment is required at many critical junctures to assure that reserve projections are neither distorted nor biased.

Berquist and Sherman identify the following specific areas where actuarial judgment is required:

- Determining the optimal combination of the kinds of claims data to be used in the estimation of unpaid claims
- Assessing the effect of changes in an insurer's operations on the claims data that is used in estimating unpaid claims
- Adjusting the claims data for the influences of known and quantifiable events
- Evaluating the strengths and weaknesses of various estimation techniques
- Making the final selection of the unpaid claim estimate

Part 3 – Basic Techniques for Estimating Unpaid Claims addresses all of these areas. Through the use of numerous examples, which span multiple chapters, we examine different combinations of data and use them with a wide range of actuarial projection methods. We study the influence of changes in case outstanding adequacy, settlement patterns, underlying claims experience, and product mix on the various projection methods. When an insurer has experienced significant changes in operations, we seek alternative methods through data reorganization, selection of alternative data types, and quantitative manipulation of existing data. In the final chapter of Part 3, we bring the results of all the various projection methodologies together for evaluation and final selection of ultimate claims and unpaid claim estimate.

[35] *PCAS*, 1977.

The following table summarizes the examples that we use in Part 3 and the chapters in which they can be found. For ease of reference throughout Part 3, we identify each example by an abbreviated name.

Example Number	Example Name	Description	Chapters
1	U.S. Industry Auto	U.S. private passenger automobile insurance as reported in *Best's Aggregates & Averages*	7, 8, 9, 10, 12
2	XYZ Insurer	Private passenger automobile bodily injury liability portfolio for an insurer who has experienced numerous internal changes in operations, management, and claims philosophy as well as external influences from regulatory reform in the insurance product	7, 8, 9, 10, 11, 12, 13, 15
3	U.S. PP Auto Steady-State	U.S. private passenger automobile insurance in a steady-state environment where claim ratios are stable and there are no changes from historical levels of case outstanding strength	7, 8, 9, 10
4	U.S. PP Auto Increasing Claim Ratios	U.S. private passenger automobile insurance in an environment of increasing claim ratios and no change in case outstanding strength	7, 8, 9, 10
5	U.S. PP Auto Increasing Case Outstanding Strength	U.S. private passenger automobile insurance in an environment of stable claim ratios with an increase in case outstanding strength	7, 8, 9, 10
6	U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength	U.S. private passenger automobile insurance in an environment where there are increases in both claim ratios and case outstanding strength	7, 8, 9, 10
7	U.S. Auto Steady-State	Combined portfolio of U.S. private passenger and commercial automobile insurance in a steady-state environment where there is no change in the product mix	7, 8, 9, 10
8	U.S. Auto Changing Product Mix	Combined portfolio of U.S. private passenger and commercial automobile insurance in an environment where the volume of commercial automobile insurance is increasing at a faster rate than the private passenger automobile insurance	7, 8, 9, 10
9	Auto BI Insurer	Insurer's private passenger automobile bodily injury portfolio in one jurisdiction	8
10	GL Self-Insurer	Self-insurer's general liability program	8
11	Auto Collision Insurer	Insurer's private passenger automobile collision portfolio	11
12	WC Self-Insurer	Self-insurer's U.S. workers compensation program	11
13	GL Insurer	Insurer's occurrence basis general liability insurance portfolio	11
14	Self-Insurer Case Only	Self-insurer with case outstanding only data available for historical years for general liability coverage	12
15	Berq-Sher Med Mal Insurer	Insurer's occurrence basis U.S. medical malpractice insurance portfolio	13, 15
16	Berq-Sher Auto BI Insurer	Insurer's U.S. automobile bodily injury liability insurance portfolio	13, 15
17	Auto Physical Damage Insurer	Salvage and subrogation for auto physical damage insurance portfolio	14
18	DC Insurer	Interim Reporting	15

Readers should be aware that figures in the supporting exhibits for both Parts 3 and 4 are often carried to a greater number of decimals than shown. Thus, totals and calculations may not agree exactly due to rounding differences.

CHAPTER 7 – DEVELOPMENT TECHNIQUE

In Chapter 5, we explain how to create a development triangle. Specifically, we build development triangles for paid claims, case outstanding, reported claims, and reported claim counts based on detailed information for a set of 15 claims observed over a four-year time horizon. In this chapter, we develop estimates of ultimate claims and unpaid claims based on the reported and paid claim development methods. The development technique, also known as the chain ladder technique, is one of the most frequently used methodologies for estimating unpaid claims.

Key Assumptions

The distinguishing characteristic of the development method is that ultimate claims for each accident year are produced from recorded values assuming that future claims' development is similar to prior years' development. In this method, the actuary uses the development triangles to track the development history of a specific group of claims. The underlying assumption in the development technique is that claims recorded to date will continue to develop in a similar manner in the future – that the past is indicative of the future. That is, the development technique assumes that the relative change in a given year's claims from one evaluation point to the next is similar to the relative change in prior years' claims at similar evaluation points.

An implicit assumption in the development technique is that, for an immature accident year, the claims observed thus far tell you something about the claims yet to be observed. This is in contrast to the assumptions underlying the expected claims technique (Chapter 8), the Bornhuetter-Ferguson technique (Chapter 9), and the Cape Cod technique (Chapter 10).

Other important assumptions of the development method include: consistent claim processing, a stable mix of types of claims, stable policy limits, and stable reinsurance (or excess insurance) retention limits throughout the experience period.

Common Uses of the Development Technique

Actuaries apply the development technique to paid and reported claims as well as the number of claims. This technique is used with all lines of insurance including short-tail lines and long-tail lines. In order to use the development method, actuaries organize data in many different time intervals, including:

- Accident year
- Policy year
- Underwriting year
- Report year
- Fiscal year[36]

[36]Actuaries for self-insurers often conduct the actuarial analysis using the organization's fiscal year time frame. For example, for a self-insured public entity with a fiscal year ending March 31, the actuary will likely organize the claim development data by April 1 to March 31 fiscal year.

Actuaries also apply this technique to monthly, quarterly, and semiannual data.

Mechanics of the Development Technique

The development method consists of seven basic steps:

- Step 1 – Compile claims data in a development triangle
- Step 2 – Calculate age-to-age factors
- Step 3 – Calculate averages of the age-to-age factors
- Step 4 – Select claim development factors
- Step 5 – Select tail factor
- Step 6 – Calculate cumulative claim development factors
- Step 7 – Project ultimate claims

To demonstrate these seven steps, we begin with an example based on industry-aggregated accident year claim development data for U.S. private passenger automobile insurance.[37] This example is labeled "U.S. Industry Auto."

Step 1 – Compile Claims Data in a Development Triangle

In Exhibit I, Sheets 1 and 2, we present the cumulative reported and paid claim development triangles, respectively. Each of these sheets contains four parts that follow the first five steps of our description of the development method. Part 1 of each exhibit includes the data triangle. In our example, the data triangles contain reported and paid claim development experience for accident years 1998 through 2007. There are ten diagonals in each triangle with annual valuation dates of December 31, 1998 through December 31, 2007. The reported and paid claims data contained in these exhibits are net of reinsurance and include the defense cost portion of claim adjustment expenses (labeled DCC for U.S. statutory accounting).

Step 2 – Calculate Age-to-Age Factors

The next step is to calculate age-to-age factors. These factors are also known as report-to-report factors or link ratios. They measure the change in recorded claims from one valuation date to the next. In Part 2 of Exhibit I, Sheets 1 and 2, we present the age-to-age factors for U.S. Industry Auto. The standard naming convention for age-to-age factors is *starting month-ending month*. For example, the age-to-age factor for the 12-month period-to-the 24-month period is often referred to as the 12-24 factor (which is read as the 12-to-24 factor) or the 12-24 month factor.

To calculate the age-to-age factors for the 12-month-to-24-month period, we divide the claims as of 24 months by the claims as of 12 months. Therefore, the triangle of age-to-age factors has one less row and one less column than the original data triangle.

[37] The source of data is *Best's Aggregates & Averages*.

Using the reported claims presented in Exhibit I, Sheet 1, we calculate the following:

12-24 factor for accident year 1998

$$= \frac{\text{reported claims at 24 months for accident year 1998}}{\text{reported claims at 12 months for accident year 1998}} = \frac{\$43,169,009}{\$37,017,487}$$

= 1.166

We provide a second example for the 36-month-to-48-month factor for accident year 2002:

36-48 factor for accident year 2002

$$= \frac{\text{reported claims at 48 months for accident year 2002}}{\text{reported claims at 36 months for accident year 2002}} = \frac{\$57,703,851}{\$56,102,312}$$

= 1.029

We proceed in the same manner down the columns and across the rows of both the reported and paid claim triangles.

Step 3 – Calculate Averages of the Age-to-Age Factors

After completing the triangle of age-to-age factors, our next step is to calculate averages of the age-to-age factors. Actuaries use a wide variety of averages for age-to-age factors. Some of the most common averages include:

- Simple (or arithmetic) average
- Medial average (average excluding high and low values)
- Volume-weighted average
- Geometric average (the n^{th} root of the product of n historical age-to-age factors)

In Part 3 of Exhibit I, Sheets 1 and 2, we present the following averages for U.S. Industry Auto:

- Simple averages for the latest five years and the latest three years
- Medial average for the latest five years excluding one high and one low value (medial latest 5x1)[38]
- Volume-weighted averages for the latest five years and the latest three years
- Geometric average for the latest four years

For reported claims, the 12-24 month simple average of the latest five factors is based on the average of the 12-24 month factors for accident years 2002 through 2006 and is equal to 1.168 ((1.184 + 1.162 + 1.159 + 1.160 + 1.173) / 5). The simple average of the latest three factors is

[38] In the examples in this text, the medial average for two data points is the same as the simple average, and the medial average for one data point is simply the value of the data point.

based on the 12-24 month factors for accident years 2004 through 2006 and is 1.164 ((1.159 +1.160 + 1.173) / 3).

To calculate the reported claims 24-36 month medial average development factor of the latest 5x1, we consider the 24-36 month factors for accident years 2001 through 2005; we exclude the highest value (1.062 for accident year 2001) and the lowest value (1.055 for accident year 2004) and take an average of the remaining three values. The 24-36 month medial average of the latest 5x1 is 1.057 ((1.059 + 1.057 + 1.056) / 3).

The volume-weighted average is the weighted average using the amounts of reported claims (or paid claims) as weights. The formula for this type of average uses the sum of the claims for the specific number of years divided by the sum of the claims for the same years at the previous age. For example, the 36-48 month volume-weighted average of the latest three years is equal to the sum of the reported claims for accident years 2002 through 2004 as of 48 months ($57,703,851 + $57,015,411 + $56,976,657 = $171,695,919) divided by the sum of the reported claims for accident years 2002 through 2004 as of 36 months ($56,102,312 + $55,468,551 + $55,553,673 = $167,124,536), or 1.027.

The geometric average (also known as the geometric mean) for the latest four years is equal to the fourth root of the product of the last four age-to-age factors. For example, the geometric average for the latest four years at 12-24 months is equal to $(1.162 \times 1.159 \times 1.160 \times 1.173)^{.25}$, or 1.164. Similarly, for 48-60 months, the geometric average for the latest four years is equal to $(1.010 \times 1.014 \times 1.011 \times 1.010)^{.25}$, or 1.011.

For U.S. Industry Auto, we present various averages for the more recent diagonals. Actuaries often place greater reliance on the most recent experience as this data most likely reflects the effect of the latest changes in the insurer's internal and external environments. The circumstances underlying the specific data grouping (including the nature of the line of business, the credibility of the available claims data, and changes in the insurer's environment) should dictate the number of experience periods to include in the various averages. Similar to many actuarial decisions, there is often a trade-off between stability, which is represented by a greater number of experience periods included in the average values, and responsiveness, where only the most recent experience periods are considered.

Step 4 – Select Claim Development Factors

The selected age-to-age factor (also referred to as the selected claim development factor or selected loss development factor) represents the growth anticipated in the subsequent development interval. When selecting claim development factors, actuaries examine the historical claim development data, the age-to-age factors, and the various averages of the age-to-age factors. It is also common practice to review the prior year's selection of claim development factors.[39]

[39] A comparison to prior factors is important for several reasons. First, the actuary is able to compare his or her expectations at the prior valuation for development in the interval with actual experience. Second, an actuary is often balancing the conflicting goals of stability and responsiveness. By having the prior selected factors as a reference point, the actuary can consider the extent to which he or she wants to change selected claim development factors. Finally, it is valuable information to understand the effect of changes in development factors alone (or methodology) on the projected ultimate claims versus the effect of changes in the actual claim experience.

When the credibility of the insurer's own historical experience is limited, there may be a need to supplement the insurer's own historical experience with certain benchmarks. One possible benchmark includes experience from similar lines with similar claims handling practices within the insurer. Another source of benchmarks is claim development patterns from the insurance industry when observable and considered to be comparable. Any benchmark must be utilized with caution, as there may be significant differences between the line of business being analyzed and the benchmark with regard to claims practices, policy coverages, underwriting, geographic mix, claim coding, policyholder deductibles and/or limits, legal precedents, etc. Such differences could make the development patterns noncomparable and increase the variability in the estimates of unpaid claims. (For further discussion on the use of industry benchmark experience, see Chapter 3.[40])

When selecting claim development factors, actuaries review the claim development experience for the following characteristics:

— *Smooth progression of individual age-to-age factors and average factors across development periods.* Ideally, the pattern should demonstrate steadily decreasing incremental development from valuation to valuation (i.e., as we move further away from the accident period), especially in the later valuations. For U.S. Industry Auto, we observe decreasing values of age-to-age factors in virtually every interval (moving across the columns) for both reported claims and paid claims.

— *Stability of age-to-age factors for the same development period.* Ideally, there should be a relatively small range of factors (small variance) within each development interval (i.e., down the columns). We look for stability of age-to-age factors and within the various averages for the same development period. In our example, there is considerable stability of factors especially for the factors in age intervals of 24-36 months and later. For both reported and paid claims, we observe the greatest variability in age-to-age factors at the 12-24 month period. This is not unexpected as claims at the earlier ages are at their most immature state, when the claims professional has the least amount of information about the circumstances of the insured event as well as the potential damages and injuries of claimants.

— *Credibility of the experience.* Actuaries generally determine credibility based on the volume and the homogeneity of the experience for a given accident year and age. If the claim development experience of the insurer has limited credibility because of the limited volume of claims, organizational changes, or other factors, it may be necessary to use benchmark development factors from the insurance industry. (See the earlier discussion about the use of industry benchmarks.)

— *Changes in patterns.* Actuaries review the age-to-age factors to identify systematic patterns that may suggest changes in the internal operations or external environment. We address this issue at length in Chapter 6.

— *Applicability of the historical experience.* Actuaries determine the appropriateness of historical age-to-age factors for projecting future claim development based on qualitative information regarding changes in the book of business and insurer operations over time. Actuaries also consider the effect of changes in external factors that have not yet manifested themselves in the reported claims experience.

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[40] The Academy is on record for recommending against the reliance and heavy use of insurance industry benchmarks, unless necessary due to low credibility.

In Part 4 of Exhibit I, Sheets 1 and 2, we present our selected claim development factors for each age-to-age interval as well as the selected tail factors. (Tail factors are described in greater detail in the next section.) We use actuarial judgment to select these factors after reviewing all of the age-to-age factors, the various averages, and the prior year's selected factors. In the exhibits, we use the label "To Ult" (i.e., To Ultimate) to designate the tail factor; in the following tables, we label the tail factors "120-Ultimate" (i.e., 120 months-to-ultimate). Both labels are commonly used by actuaries to indicate the selected tail development factor.

We recognize that the selections of development factors are subjective and will likely differ from one actuary to another, perhaps materially, as the selection process involves significant actuarial judgment. When different actuaries apply their own experience and insight to the analysis of the same data, the selected age-to-age factors typically differ – sometimes by a small amount and sometimes by a large amount. It is important to appreciate that there is more than one reasonable selection of age-to-age and tail factors.

Table 1, which is an excerpt from Exhibit I, Sheets 1 and 2, summarizes the selected reported and paid claim development factors by age-to-age interval for U.S. Industry Auto.

Table 1 – Selected Age-to-Age Factors

	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-ultimate
Reported	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	1.000
Paid	1.702	1.186	1.091	1.044	1.019	1.009	1.005	1.002	1.002	1.002

<u>Step 5 – Select Tail Factor</u>

Earlier in this book we introduced the topic of the number of development periods needed for the analysis of unpaid claims. We asked whether it is necessary to analyze development through the 3rd maturity year, the 5th maturity year, the 10th or the 20th maturity year. If the data is available, the actuary should analyze development out to the point at which the development ceases (i.e., until the selected development factors are equal to 1.000). The number of development periods required generally varies by line, jurisdiction, and data type.

Sometimes the data does not provide for enough development periods. This occurs when the development factors for the most mature development periods available are still significantly greater than 1.000.[41] When this occurs, the actuary will need to determine a tail factor to bring the claims from the latest observable development period to an ultimate value.

For some lines of insurance and some types of claims data, the tail factor can be especially difficult to select due to the limited availability of relevant data. The point of development beyond which no tail factor is required varies tremendously by line of business. For short-tail coverages, insurers generally settle claims within months or a few years of the accident date. However, for long-tail lines of business, such as U.S. medical professional liability and workers compensation, some claims can take more than fifteen years to reach final settlement.

[41] There are some cases in which the development at the end of the triangle is often less than one, such as for a line of business with significant subrogation activity after claims are paid. For these lines of business, the desire is still to have sufficient periods in the development triangle so that non-zero development ceases, but in this case the development factors may approach 1.000 from below.

In 1978, Joseph O. Thorne discussed the potential difficulty in selecting tail factors based on historical data in his review of the Berquist and Sherman paper "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach." Mr. Thorne noted:

> Care must be taken in projecting the tail from older accident years to recent accident years. For example, in Workers' Compensation the tail percentage may increase due to trends in cumulative injury, shifts to unlimited medical benefits, and increases in the proportion of pension claims. On the other hand, the percentage may decrease due to trends in settlement practices for lump sum awards of for compromise and release of claims. The effects of certain factors may be quantified by analysis of loss experience (such as claims by size or injury type) or by specific sampling; other factors may require considerable judgment.[42]

Thorne's comments are equally applicable today. The tail factor is crucial as it influences the unpaid claim estimate for all accident years (in the experience period) and can create a disproportionate leverage on the total estimated unpaid claims. The tail factor, or a similar concept, plays an important role not only in the development technique but in almost every technique discussed in Part 3 – Basic Techniques for Estimating Unpaid Claims.

Actuaries use several approaches to evaluate the tail factor. One approach is to rely on industry benchmark development factors. (See previous discussions regarding use of industry benchmarks.) Another common approach is to fit a curve to the selected or observed development factors to extrapolate the tail factors; exponential decay is a common assumption for such curve fitting. A third approach, used for paid development where the comparable reported development is already considered to be at ultimate, is to utilize reported-to-paid ratios at the latest observed paid development period. A more in-depth discussion of this topic is beyond the scope of this text. We recommend that the actuary seek additional information on this topic through the actuarial literature available on the CAS Web Site and the CAS Tail Factors Working Party.

For the U.S. Industry Auto example, we select a reported claim tail factor of 1.000; we also select an age-to-age factor of 1.000 for the 108-120 month interval. This means that we do not expect any further development on reported claims after 108 months. For paid claims, however, we expect future development beyond 108 months; we select a 1.002 age-to-age factor for 108-120 months and a tail factor of 1.002 (based on the typical ratio of reported to paid claims at this age).

Step 6 – Calculate Cumulative Claim Development Factors (CDF)[43]

We calculate cumulative claim development factors by successive multiplications beginning with the tail factor and the oldest age-to-age factor. The cumulative claim development factor projects the total growth over the remaining valuations. Cumulative claim development factors are also known as age-to-ultimate factors and claim development factors to ultimate.

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[42] *PCAS*, 1978.

[43] As noted previously, we specifically choose to use the terminology claims instead of losses in this text. Thus, we use CDF for claim development factor to ultimate. Many actuaries use the term losses and thus LDF to represent the loss development factor to ultimate. In South Africa, actuaries often use LDF to refer to the incremental loss development factor and UDF to refer to the cumulative loss development factor or loss development factor to ultimate. The important message for the actuary is that he or she must understand the terminology, including abbreviations, for any analysis.

Based on the selected age-to-age factors from Step 4 and the tail factor in Step 5, we calculate the following:

Reported CDF at 120 months
= selected tail (120-ultimate) factor
= 1.000

Reported CDF at 108 months
= (selected tail factor) x (selected development factor 108-120 months)
= 1.000 x 1.000
= 1.000

Reported CDF at 96 months
= (selected tail factor) x (selected development factor 108-120 months) x
(selected development factor 96-108 months)
= (CDF at 108 months) x (selected development factor 96-108 months)
= 1.000 x 1.001
= 1.001

And so on, until we get to

Reported CDF at 12 months
= (CDF at 24 months) x (selected development factor 12-24 months)
= 1.110 x 1.164
= 1.292

We calculate cumulative claim development factors for paid claims in the same manner.

Table 2, which is an excerpt from Exhibit I, Sheets 1 and 2, summarizes the cumulative claim development factors based on the selected age-to-age factors.

Table 2 – Cumulative Claim Development Factors

	12	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**
Reported	1.292	1.110	1.051	1.023	1.011	1.006	1.003	1.001	1.000	1.000
Paid	2.390	1.404	1.184	1.085	1.040	1.020	1.011	1.006	1.004	1.002

Tables 1 and 2 demonstrate a typical relationship between reporting and payment patterns for many lines of P&C insurance: cumulative paid claim development factors are usually greater than cumulative reported claim development factors at the same maturity age.

Step 7 – Project Ultimate Claims

Ultimate claims are equal to the product of the latest valuation of claims (the amounts shown on the last diagonal of the claim triangles) and the appropriate cumulative claim development factors. In our example, the latest diagonal of the triangle is the December 31, 2007 valuation. Each accident year has an associated age at December 31, 2007. For example, accident year 2007 as of December 31, 2007 is 12 months old. Accident year 2006 as of December 31, 2007 is 24 months old. Similarly, in this example, the oldest accident year in our experience period is 1998 which, at December 31, 2007, is 120 months old. We determine the appropriate cumulative claim development factor based on the age of each accident year; we then multiply each accident year's reported (and paid) claims at the latest valuation by its age-to-ultimate factor (i.e., cumulative claim development factor).

Detailed calculations are presented in Exhibit I, Sheet 3. The first column of Exhibit I, Sheet 3, is the accident year. Our example for U.S. Industry Auto includes accident years 1998 through 2007. In the second column, we show the age of each accident year as of the latest valuation of claims (i.e., December 31, 2007). Columns (3) and (4) summarize reported and paid claims, respectively, by accident year at December 31, 2007. Column (3) is the last diagonal of the reported claim development triangle in Exhibit I, Sheet 1, and Column (4) is the last diagonal of the paid claim development triangle in Exhibit I, Sheet 2. Columns (5) and (6) are the cumulative claim development factors that are calculated in Step 5. Each cumulative claim development factor refers to a specific age.

Projected ultimate claims based on the reported claim development method are equal to the latest valuation of reported claims multiplied by the cumulative reported claim development factors. (See Column (7) of Exhibit I, Sheet 3.) For example, projected ultimate claims for accident year 1998 are calculated as follows:

> Projected ultimate claims for accident year 1998
> = (reported claims for 1998 as of 12/31/07) x (reported CDF at 120 months)
> = $47,742,304 x 1.000
> = $47,742,304

And for accident year 2007,

> Projected ultimate claims for accident year 2007
> = (reported claims for 2007 as of 12/31/07) x (reported CDF at 12 months)
> = $48,853,563 x 1.292
> = $63,118,803

We perform similar calculations for the projection of ultimate claims using the paid claim development technique (Column (8) of Exhibit I, Sheet 3). For example, projected ultimate claims for accident year 2007 are calculated as follows:

> Projected ultimate claims for accident year 2007
> = (paid claims for 2007 as of 12/31/07) x (paid CDF at 12 months)
> = $27,229,969 x 2.390
> = $65,079,626

Unpaid Claim Estimate Based on the Development Technique

For each technique presented in this text, we derive an unpaid claim estimate. Using the development technique, actuaries calculate the unpaid claim estimate as the difference between projected ultimate claims and actual paid claims. Because we are using accident year data, this value of the unpaid claim estimate represents total unpaid claims including both case outstanding and the broad definition of IBNR. To determine estimated IBNR based on the development technique, we subtract reported claims from the projected ultimate claims. Alternatively, IBNR is equal to the estimate of total unpaid claims less case outstanding.

In Exhibit I, Sheet 4, we summarize the calculations for the unpaid claim estimate based on the example for U.S. Industry Auto. Columns (2) and (3) contain reported and paid claims data as of December 31, 2007, which are the latest diagonals in our claim development triangles. Columns (4) and (5) are the projected ultimate claims, which we developed in Exhibit I, Sheet 3. We summarize case outstanding in Column (6); case outstanding is equal to the difference between reported and paid claims as of December 31, 2007 (Column (2) – Column (3)). Estimated IBNR is equal to projected ultimate claims minus reported claims. Estimated IBNR based on the reported claim development technique is calculated in Column (7), and Column (8) shows the results of the paid claim development technique. The estimate of total unpaid claims is equal to the sum of case outstanding and estimated IBNR. We present the total unpaid claim estimate in Columns (9) and (10) based on the reported and paid claim development techniques, respectively.

Reporting and Payment Patterns

Actuaries describe the reporting pattern of claims as the percentage of ultimate claims that are reported in each year. We can derive implied reporting patterns from the cumulative reported claim development factors.[44] The following table shows the cumulative reported claim development factors and the associated reporting pattern for U.S. Industry Auto.

Table 3 – Reporting Pattern

Age (Months)	Cumulative Reported Claim Development Factors	Cumulative % Reported	Incremental % Reported
12	1.292	77.4%	77.4%
24	1.110	90.1%	12.7%
36	1.051	95.1%	5.0%
48	1.023	97.8%	2.7%
60	1.011	98.9%	1.1%
72	1.006	99.4%	0.5%
84	1.003	99.7%	0.3%
96	1.001	99.9%	0.2%
108	1.000	100.0%	0.1%
120	1.000	100.0%	0.0%

The percentage reported is equal to the inverse of the cumulative claim development factor. For example, at 12 months, the percentage reported is equal to 1.000 divided by 1.292 or 77.4%; in other words, our selected reported claim development factors imply that 77.4% of ultimate claims are reported through 12 months. Similarly at 24 months, the percentage reported is equal to 1.000 divided by 1.110 or 90.1%; the selected reported claim development factors indicate that 90.1% of claims are reported through 24 months.

In the preceding table, we also show the incremental percentage reported. These values are equal to the difference in the cumulative percentage reported at successive ages. For example, the incremental percentage reported for the first 12 months is 77.4%, which is equal to the

[44] In Chapter 15 – Evaluation of Techniques, we present an alternative approach for determining reporting and payment patterns based on a comparison of the reported and paid claim development triangles to selected ultimate claims. This alternative approach is routinely used by actuaries in Canada to determine payment patterns (also known as emergence patterns in Canada) for present value discounting purposes.

cumulative percentage reported at 12 months. The incremental percentage reported for the 12-24 month period is equal to 90.1% minus 77.4%, or 12.7%.

We can also determine an implied payment pattern based on the cumulative paid claim development factors. In the following table, we present the cumulative paid claim development factors and the associated payment patterns (cumulative and incremental) for U.S. Industry Auto.

Table 4 – Payment Pattern

Age (Months)	Cumulative Paid Claim Development Factors	Cumulative % Paid	Incremental % Paid
12	2.390	41.8%	41.8%
24	1.404	71.2%	29.4%
36	1.184	84.5%	13.3%
48	1.085	92.2%	7.7%
60	1.040	96.2%	4.0%
72	1.020	98.0%	1.8%
84	1.011	98.9%	0.9%
96	1.006	99.4%	0.5%
108	1.004	99.6%	0.2%
120	1.002	99.8%	0.2%

In the U.S. Industry Auto example, which contains the aggregated results for U.S. private passenger automobile liability, we observe that the incremental percentages reported and paid in each successive interval are less than or equal to that of the previous age interval. Actuaries often observe such patterns for many lines of P&C insurance, consistent with reasonable expectations for the underlying process of settling a portfolio of claims. Where the underlying development patterns are erratic, actuaries frequently incorporate increased levels of actuarial judgment into the selection process to achieve claim development patterns that exhibit such a steady, decreasing pattern.

It is worthwhile to note that while the above payment and reporting patterns might serve as a reasonable model for the expected payment and reporting of future claims, the development method implies somewhat different patterns for each of the accident years from 1998 through 2007. This is due to the fact that the emerged portion of each accident year does not precisely fit the selected age-to-age factors.

The reporting and payment patterns may be valuable input for other actuarial calculations. They can be used in other techniques for estimating unpaid claims and in monitoring the development of claims during the year. The payment pattern[45] is also often used for present value (i.e., discounting) calculations.

[45] In Canada, actuaries typically refer to an emergence pattern as the payment pattern used for discounting purposes. This is a different terminology from that used by U.S. actuaries who generally use the term emergence to refer to the reporting pattern of either claims or claim counts.

Observations and Common Relationships

Generally, cumulative claim development factors are the greatest for the most recent accident years and the smallest for the oldest accident years. Actuaries refer to the most recent, less-developed accident years as immature and the oldest, most-developed accident years as mature. As a result, it is common to find the highest values of estimated IBNR for the most recent accident years, or the less mature years. As accident years mature and more claims are reported and settled, the estimate of total unpaid claims, which is comprised of case outstanding and estimated IBNR, will gradually approach zero.

Another common phenomenon is that development factors tend to increase as the retention increases. In 1987, E. Pinto and D.F. Gogol published a paper titled "An Analysis of Excess Loss Development."[46] Upon a review of excess claim development experience published by the RAA, they observed:

> Since the data indicates that excess business generally exhibits much slower reporting than that normally associated with primary business, there appears to be a relationship between the layer for which business is written and the resulting development pattern. It is this relationship that we intend to analyze in this paper for both paid and reported losses. Applications to increased limits and excess of loss pricing are also noted.
>
> The protracted development of excess losses reflected in the RAA study suggests that the development is not only caused by late reported claims and increases in the average reported loss per claim but also by changes at successive maturities in the proportion of claims with losses which are large multiples of the average. Thus, the shape of the size of loss distribution changes at successive valuations.

Pinto and Gogol reviewed ISO excess of loss data as well as RAA data, and in both sets of data they observed that claim development increases as the retention increases. They developed a model which illustrates the two influences underlying claim development: the reporting pattern of claims over time and the changing characteristics of the size of claims distribution at successive maturities. Pinto and Gogol noted that without the latter influence, the development factors for claims in excess of different retentions would be identical. They conclude their paper as follows:

> The results that have been produced indicate clearly that loss and ALAE development varies significantly by retention. Accordingly, pricing and reserving estimates incorporating development factors may be substantially in error if this is not taken into account. As this applies to paid as well as reported loss development, recognition of retention is also a major factor in estimating discounted losses using paid development factors.

When the Development Technique Works and When it Does Not

The development technique is based on the premise that we can predict future claims activity for an accident year (or policy year, report year, etc.) based on historical claims activity to date for that accident year. The primary assumption of this technique is that the reporting and payment of future claims will be similar to the patterns observed in the past. When used with reported claims,

[46] *PCAS*, 1987.

there is an implicit assumption that there have been no significant changes in the adequacy of case outstanding during the experience period; when used with paid claims, there is an implicit assumption that there have been no significant changes during the experience period in the speed of claims closure and payment. Thus, the development method is appropriate for insurers in a relatively stable environment. When there are no major organizational changes for the insurer and when there are no major external environmental changes, the development technique is an appropriate method to use in combination with other techniques for estimating unpaid claims.

However, if there are any changes to the insurer's operations (e.g., new claims processing systems; revisions to tabular formulae for case outstanding; or changes in claims management philosophy, policyholder deductibles, or the insurer's reinsurance limits), the assumption that the past will be predictive of the future may not hold true. Environmental changes can also invalidate the primary assumption of the development technique. For example, when a major tort reform occurs (such as a cap on claim settlements or a restriction in the statute of limitations), actuaries may no longer be able to assume that historical claim development experience will be predictive of future claims experience. In such situations, the actuary should consider alternative techniques for estimating unpaid claims, or at the very least, adjust the selected claim development factors.

The development technique requires a large volume of historical claims experience. It works best when the presence or absence of large claims does not greatly distort the data. If the volume of data is not sufficient, large claims could greatly distort the age-to-age factors, the projection of ultimate claims, and finally the estimate of unpaid claims using a development method. As noted in "The Actuary and IBNR" by R.L. Bornhuetter and R.E. Ferguson[47], a strictly fortuitous event such as an unusual large claims should not distort an insurer's estimate of IBNR. There are circumstances, however, such as a large winter storm or other catastrophe, in which the insurer's IBNR should likely increase.

For an insurer entering a new line of business or a new territory, a sufficient volume of credible claim development data may not be available. For some smaller insurers with limited portfolios, historical claim development data may not be sufficiently credible for the actuary to use the development technique. It should be noted that in such situations the development technique is still often used. However, actuaries in these situations typically rely on benchmark patterns (such as from comparable lines of business or available industry data, as discussed earlier) to select claim development factors, which they then apply to the insurer's latest valuation of claims.

The development technique is particularly suitable for high-frequency, low-severity lines with stable and relatively timely reporting of claims, especially where the claims are evenly spread throughout the accident year (or policy year, report year, etc.) – that is, the volume of claims experience is not changing significantly from one year to the next.

Where there is not an even spread of claims throughout the year, the development technique can distort the projected ultimate claims for an accident year. This is a result of the potential for a significant difference in the average claim maturity. To understand why this is the case, it is helpful to think in terms of the individual claims making up the accident year. An accident year includes individual claims that occur throughout the accident year. Some occur in the first month of the year, some in the sixth month, and some in the last month. The average occurrence date of claims (if the exposure is evenly spread throughout the year) occurs in the middle of the year. A cumulative development factor for an accident year at 12 months can be thought of as an average of factors for the January accident month at 12 months, the February accident month at 11

[47] *PCAS*, 1972

months, …, ending with the December accident month at 1 month. If the historic data had an even spread of claims across the months, but the most recent accident year had an uneven spread due to a large storm or other event in the last month or due to an increase in the exposures over the year, the historical data will have an average occurrence date that is not comparable to the most recent accident year.

For long-tail lines of insurance, such as U.S. workers compensation and general liability, the cumulative claim development factors can become very large for the most recent accident years, particularly when using the paid claim development technique. Actuaries often speak of the leveraged effect of claim development factors with high values. For example, if the cumulative reported claim development factor is 4.00, each dollar of reported claims is multiplied by a factor of 4.00 to determine ultimate claims. It is not unusual for long-tail lines of insurance to have cumulative paid claim development factors greater than 10.00. These highly leveraged factors result in projections of ultimate claims that are very sensitive to the current value of paid and reported claims. The presence or absence of large claims as well as any unusual change in the reporting or settlement of claims (or sometimes just a single claim) can result in unreasonable projections of ultimate claims for the most recent accident years. In situations of highly leveraged cumulative claim development factors, actuaries often seek alternative techniques for estimating unpaid claims.

XYZ Insurer

In Exhibit II, Sheets 1 through 4, we continue the example introduced in Chapter 6 for XYZ Insurer. This example is for an insurer of private passenger automobile bodily injury liability in a single jurisdiction that has experienced numerous operational and environmental changes. During meetings, claims department management highlighted changes in the rate of claims settlement and in the strength of case outstanding. During the experience period, this jurisdiction implemented major tort reform aimed at modifying the liability covered by the insurance product. The result of the tort reform was a change in the insurance product as well as a change in the insurer's market presence.

Before we even begin with the calculations, we need to examine whether or not the development technique is appropriate for XYZ Insurer. Again, the underlying premise of the development method is that future claims activity can be projected based on historical claims experience. A primary assumption of the reported claim development method is that there have been no significant changes in the adequacy of case outstanding over the experience period, and a primary assumption of the paid claim development method is that there have been no significant changes in the rate of settlement over the experience period. These methods also assume that the type of claim has not changed during the period and the claim reporting lags (i.e., the time between date of occurrence and date of report) have not changed.

Based on the information we gathered through meetings with management of XYZ Insurer and through our actuarial diagnostic review, we question whether the development technique is in fact appropriate. We know that there have been changes in the case outstanding adequacy as well as changes in the rate at which claims are closed. We also know that there have been changes in the claim environment due to the tort reform. Therefore, the underlying assumptions do not hold true, and we must conclude that some type of adjustment for these changes is necessary for the development technique to be appropriate for XYZ Insurer.

For purposes of demonstration and comparison to other methods that we will present in later chapters, we show the calculations for the development technique in Exhibit II, Sheets 1 through 4, for XYZ Insurer. We organize the exhibits similarly to Exhibit I, Sheets 1 through 4. Exhibit II, Sheets 1 and 2, contain the reported and paid claim development triangles, respectively. The challenge of selecting age-to-age factors is much greater for the actuary in this example than in the prior example. There is significant variability in the age-to-age factors down each column of the triangle. For the reported claim triangle, almost all of the age-to-age factors along the December 31, 2004 diagonal are the highest in each column; the latest diagonal of age-to-age factors is the lowest value in many of the columns. Based on our knowledge of the changing environment, we expect such variability in the age-to-age factors. In our example, we select age-to-age factors based on the volume-weighted average of the latest two years. (Keep in mind other factor selections may also be reasonable.) In a situation of such major change, an actuary would typically need to exercise a higher degree of judgment in selecting the age-to-age factors.

We present projected ultimate claims based on the development technique applied to reported and paid claims in Exhibit II, Sheet 3. In Exhibit II, Sheet 4, we summarize estimated IBNR and the total unpaid claim estimate based on the two development projections. In our first example for U.S. Industry Auto, the estimated IBNR generated by the reported and paid claim development methods differs by approximately 10% and the estimate of total unpaid claims differs by only 4%. In our second example for XYZ Insurer, the estimated IBNR using the paid claim development technique differs by 138% from the reported claims indication; the total unpaid claim estimate differs by almost 50%. These differences suggest that the actuary should review alternative projection methods.

Influence of a Changing Environment on the Claim Development Technique

Changes in Claim Ratios[48] and Case Outstanding Adequacy

To examine the effect of a changing environment on the estimates produced by the development technique, we construct an example based on characteristics seen in the U.S. private passenger automobile example. We use similar reporting and payment patterns as well as a similar ultimate claim ratio. We compare the estimated IBNR generated by the development technique to the "actual IBNR"[49] under the following four scenarios:

- *Scenario 1* is a steady-state environment where claim ratios are stable and there are no changes from historical levels of case outstanding strength (U.S. PP Auto Steady-State)

- *Scenario 2* is an environment of increasing claim ratios and no change in case outstanding strength (U.S. PP Auto Increasing Claim Ratios)

- *Scenario 3* is an environment of stable claim ratios with an increase in case outstanding strength (U.S. PP Auto Increasing Case Outstanding Strength)

- *Scenario 4* is an environment where there are increases in both claim ratios and case outstanding strength (U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength)

[48] Because we specifically chose to use the term claims instead of losses, we refer to a claim ratio instead of a loss ratio. This claim ratio should be understood to refer to dollars of claims and not claim counts.

[49] See the next section, "Key Assumptions," for description of "actual IBNR."

We will continue to use this example with its four scenarios in Chapters 8, 9, and 10. (Note that Scenarios 1 through 4 are labeled Examples 3 through 6 in the summary table in the Introduction to Part 3 – Basic Techniques for Estimating Unpaid Claims.)

Key Assumptions

In real-life situations, actuaries know neither the "actual" claim development patterns nor the "actual" ultimate claim ratios prior to final settlement and closure for any particular accident year. However, for the purpose of demonstrating the effect of a changing environment, we design a model in which we can calculate the "actual" or "true" IBNR requirement. In developing this example, we use a ten-year experience period, accident years 1999 through 2008. We assume that the earned premium for the first year (i.e., 1999) is $1 million. We then assume a 5% annual premium trend to develop earned premium values for each subsequent year in the experience period.

In Exhibit III, Sheet 1, we summarize the key assumptions and calculate the actual IBNR for each scenario. The actual IBNR is equal to the ultimate claims projection, which is based on the given ultimate claim ratio for each accident year, minus the reported claims as of December 31, 2008.

The following table summarizes the assumed reporting and payment patterns for the steady-state environment.

Table 5 – Key Assumptions
Steady-State Environment
Reporting and Payment Patterns

As of Month	% Reported	% Paid
12	77%	42%
24	90%	71%
36	95%	84%
48	98%	92%
60	99%	96%
72	99%	98%
84	100%	99%
96	100%	99%
108	100%	100%
120	100%	100%

In the steady-state environment, we assume an ultimate claim ratio of 70% for all ten accident years in the experience period (i.e., 1999 through 2008). For the increasing claim ratio scenarios, we assume the following claim ratios by accident year:

Table 6 – Key Assumptions
Increasing Claim Ratio Scenarios

Accident Year	Ultimate Claim Ratio
1999-2003	70%
2004	80%
2005	85%
2006	90%
2007	95%
2008	100%

We use the earned premium and ultimate claim ratios as well as the given reporting and payment patterns to create reported and paid claim development triangles for each of the four scenarios previously described. Claim development triangles are presented in Exhibit III, Sheets 2 through 9.

To simplify the presentation of the various scenarios, we always select reported and paid age-to-age factors based on a five-year volume-weighted average. When selecting age-to-age factors, an actuary would typically review several different types of averages as well as various claims diagnostics. Actuaries incorporate significant judgment when selecting age-to-age factors to respond to changes in the environment, both internal and external. By not responding in our examples to the changes in the environment with judgmental adjustments, we further demonstrate how the development technique reacts to a changing situation.

Scenario 1 – U.S. PP Auto Steady-State

Not surprisingly, the projected ultimate claims are the same for both the reported and paid claim development methods in the steady-state environment. Both methods generate estimated IBNR that is equal to the actual IBNR. We present calculations for the steady-state environment in the top section of Exhibit III, Sheet 10.

Scenario 2 – U.S. PP Auto Increasing Claim Ratios

In the bottom section of Exhibit III, Sheet 10, we present the calculations for the second scenario, increasing claim ratios with no change in case outstanding strength. The first thing we notice when comparing the top and bottom sections of Exhibit III, Sheet 10, is the differences between reported and paid claims in Columns (3) and (4). We can also see similar differences in the claim development triangles. The claim development triangles in Exhibit III, Sheets 4 and 5 (increasing claim ratio scenario) are the same as the triangles in Exhibit III, Sheets 2 and 3 (steady-state) for accident years 1999 through 2003. However, beginning in accident year 2004, the reported and paid claims for all remaining years are higher for the increasing claim ratio scenario than the steady-state scenario. This is consistent with our assumption of increasing claim ratios for accident years 2004 through 2008.

It is important to recognize that since we assume no change in the adequacy of case outstanding, there are no changes in the age-to-age factors. Thus, there are no changes in the cumulative claim development factors between the increasing claim ratio scenario and the steady-state environment. (Compare Columns (6) and (7) in the top and bottom sections of Exhibit III, Sheet 10.) In Exhibit III, Sheet 10, we note that the projected ultimate claims are the same for the reported and paid claim development techniques, and that they are significantly greater for the increasing claim ratio scenario ($10,249,350 for all years combined) than for the steady-state environment ($8,804,525 for all years combined). Since the claim development factors to ultimate are the same, the higher value of projected ultimate claims is solely due to higher values of claims reported and paid as of December 31, 2008. We observe that the estimated IBNR, which is the same for both the reported and paid claim development methods, are equal to the actual IBNR in this scenario. Thus, we can conclude that the development technique is responsive to changes in the underlying claim ratios assuming no changes in the underlying claims reporting or payment pattern.

Scenario 3 – U.S. PP Auto Increasing Case Outstanding Strength

Exhibit III, Sheets 6 and 7 contain the claim development triangles for this scenario; we present detailed calculations for projected ultimate claims and estimated IBNR in the top section of Exhibit III, Sheet 11. In building the reported claim development triangle, we assume that the case outstanding adequacy increased by 6% in 2007 and 25% in 2008 over the steady-state case outstanding (for the latest four accident years only). Thus, the next to last diagonal of the case outstanding triangle is 6% greater in this scenario than the steady-state scenario; and the last diagonal of the case outstanding triangle is 25% greater in this scenario than the steady-state scenario. Since reported claims are comprised of the sum of case outstanding and paid claims, a change in the case outstanding triangle will result in changes to the reported claim triangle. These changes result in changes in the age-to-age factors along the latest two diagonals and changes in the cumulative reported claim development factors.

Before we review the detailed calculations, we can discuss conceptually what we expect to see happen with the projections. The true ultimate claims have not changed from the steady-state environment. Ultimate claims for this scenario are equal to 70% of earned premium for each year in the experience period. We should have higher values of reported claims since we know that case outstanding strength has increased. For example, where case outstanding are $380,075 for accident year 2008 in the steady-state environment, they are now $475,094. Given the same value of ultimate claims with higher values of reported claims at December 31, 2008, the IBNR should decrease. The actual IBNR[50] for the scenario of stable claim ratios and increases in case outstanding strength are $253,336 (for all years combined); these are lower than the actual IBNR of the steady-state, which are $438,638.

We now turn to the detailed calculations in the top section of Exhibit III, Sheet 11. When we compare the projections of Scenario 3 with those of the steady-state environment, we observe several differences. First, for accident years 2005 through 2008, reported claims in Column (3) are greater than the reported claims of the steady-state. We also note that the reported claim development factors to ultimate (Column (6)) are higher for the latest three accident years in Scenario 3 than in the steady-state scenario. Projected ultimate claims based on the reported claim

[50] Recall that we are using the broad definition of IBNR that includes both pure IBNR and case development on known claims (incurred but not enough reported or IBNER). The actual pure IBNR remains the same regardless of changes in the adequacy of case outstanding.

development technique are greater in Scenario 3 than the steady-state projection due to both higher reported claims and higher cumulative claim development factors.

This example brings us to the conclusion that without adjustment, the reported claim development method overstates the projected ultimate claims and thus the IBNR in times of increasing case outstanding strength. There are two forces at play in this scenario. First, the reported claims are greater along the latest diagonal due to the increase in case outstanding adequacy. Second, the age-to-age factors are also higher along the latest two diagonals where the insurer strengthened the adequacy of the case outstanding. Unless the actuary mechanically or judgmentally adjusts for such change, an increase in case outstanding adequacy can lead to higher cumulative claim development factors. (We will discuss some methods that the actuary could use for such adjustments in Chapter 13.) We are then multiplying a higher value of reported claims by a higher cumulative claim development factor. The result is a projected value of ultimate claims that likely overstates the estimate of total unpaid claims.

Looking back at the underlying assumptions of the development technique, we recall that the key assumption of this technique is that claims reported to date will continue in a similar manner in the future. That is, the development technique assumes that the relative change in a given year's claims from one evaluation point to the next is similar to the relative change in prior years' claims at similar evaluation points. In times of changing case outstanding adequacy, this assumption no longer holds true for reported claims. Since case outstanding are now more adequate than they have been historically, we actually need a lower CDF-to-ultimate factor not a higher factor. In order to produce the actual value of ultimate claims, the cumulative claim development factors should be lower than that of the steady-state environment, not higher.

Case outstanding at December 31, 2008 are equal to $977,641, which is the difference between total reported claims and total paid claims, and the actual IBNR for Scenario 3 are $253,336. The true total value of unpaid claims at December 31, 2008 is equal to the sum of the actual IBNR and the case outstanding, or $1,230,997. The difference between the actual unpaid claims and the estimate of unpaid claims resulting from the reported claim development technique is significant. The total unpaid claim estimate based on the reported claim development technique is $1,478,573 (projected ultimate claims in Column (8) minus paid claims in Column (4)) which is 20% greater than the actual unpaid claims. The difference between the actual unpaid claims and the estimated unpaid claims generated by the reported claim development method is $247,596. From a calendar year financial reporting perspective, this adds 16 points to the 2008 calendar year claim ratio ($247,596 divided by the 2008 earned premium of $1,551,328). (This assumes that the insurer reports all of the difference in calendar year 2008.)

Because only the case outstanding are affected in Scenario 3, there are no differences between the paid claim development triangles of Scenario 3 and the steady-state environment. Since there are no differences in the paid claim triangles, the age-to-age factors, claim development factors to ultimate, and projected ultimate claims all remain the same as the steady-state scenario. The estimated IBNR, which is equal to projected ultimate claims less reported claims at December 31, 2008, is lower for this scenario than the steady-state scenario, however, since the latest valuation of reported claims is higher now due to the case outstanding strengthening.

Since there has been no change in the settlement of claims, the primary assumption of the development technique still holds true for paid claims. In times of changing case outstanding adequacy, actuaries often turn to the paid claim development method as an alternative to the reported claim development method. However, one common problem with the paid claim development method is the highly leveraged nature of the cumulative development factor for the most recent years in the experience period, particularly for long-tail lines of insurance.

Scenario 4 – U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

We present the fourth scenario in the bottom section of Exhibit III, Sheet 11. The claim ratios are the same as those of the second scenario, and we assume changes in case outstanding strength that are similar to the third scenario. Once again, the paid claim development method produces the actual value for IBNR. The reported claim development method, while responsive to the increasing claim ratios, overstates the estimate of unpaid claims due to the changing case outstanding adequacy. The reported claim development technique produces a total unpaid claim estimate that is more than 20% greater than actual total unpaid claims and adds 22 points to the 2008 calendar year claim ratio.

Changes in Product Mix

In this final example, we focus on the effect of changes in product mix on the development technique. In Chapter 6, we discuss the challenge for the actuary in finding homogeneous groupings of data while maintaining a sufficient volume of claims to be credible. In our final example of this chapter, we look at a portfolio of business in which we combine private passenger and commercial automobile insurance for the purpose of estimating unpaid claims. Typically, these categories of business have different underlying claim development patterns and ultimate claim ratios. We will see that the development technique is an acceptable method for determining estimates of unpaid claims for the combined portfolio as long as there are no changes in the mix of business (i.e., one line of business is not significantly increasing or decreasing in volume relative to the other line of business). However, if the business mix changes over the experience period, the results of the development technique may no longer be appropriate for the determination of the unpaid claim estimate.[51]

Key Assumptions

For the changing product mix example, we review a steady-state environment that has no change in product mix (called U.S. Auto Steady-State) and an environment with a changing product mix (called U.S. Auto Changing Product Mix).

We continue to use a ten-year experience period, accident years 1999 through 2008, for these two final examples. We assume that each of the private passenger and commercial automobile portfolios had $1 million in earned premiums for 1999. For U.S. Auto Steady-State, we assume that the earned premium for both private passenger and commercial automobile is increasing at an annual rate of 5%. For U.S. Auto Changing Product Mix, we assume that the portfolio includes the same private passenger premiums as the steady-state, but commercial automobile insurance premiums increase at 30% instead of 5% per year starting in 2005.

[51] We construct this example for demonstration purposes only. Information regarding product mix is generally available so that the actuary would be able to make modifications to the methodology and/or the key assumptions for the purpose of estimating unpaid claims. Nevertheless, it is important to observe how a change in product mix can affect the results of the various methodologies for estimating unpaid claims presented in this and the following chapters.

We assume that the ultimate claim ratio is 70% for private passenger automobile and 80% for commercial automobile. The following table summarizes reporting and payment patterns for the two categories of business.

Table 7 – Key Assumptions – Product Mix Scenarios
Reporting and Payment Patterns

	Private Passenger Automobile		Commercial Automobile	
As of Month	% Reported	% Paid	% Reported	% Paid
12	77%	42%	59%	22%
24	90%	71%	78%	46%
36	95%	84%	89%	67%
48	98%	92%	96%	82%
60	99%	96%	98%	91%
72	99%	98%	100%	95%
84	100%	99%	100%	97%
96	100%	99%	100%	98%
108	100%	100%	100%	99%
120	100%	100%	100%	100%

We create the claim development triangles using the earned premium and ultimate claim ratios by accident year as well as the given reporting and payment patterns. Exhibit IV, Sheets 2 and 3 present reported and paid claim development triangles assuming no change in product mix; the claim development triangles based on a changing product mix are in Exhibit IV, Sheets 4 and 5. Similar to our prior examples, we rely on the five-year volume-weighted averages to select age-to-age factors. We calculate the actual IBNR in Exhibit IV, Sheet 1 for these two final examples.

U.S. Auto Steady-State (No Change in Product Mix)

For this scenario, both the reported and paid claim development techniques produce estimated IBNR that is equal to the actual IBNR. As long as the distribution between the different categories of business remains consistent (and there are no other operational or environmental changes), the claim development method should produce an accurate estimate of unpaid claims. The top section of Exhibit IV, Sheet 6 contains detailed calculations, similar to those presented earlier in this chapter.

U.S. Auto Changing Product Mix

We present the calculations for the scenario with a change in product mix in the bottom section of Exhibit IV, Sheet 6. We note that there are no differences between the two examples until accident year 2005. This is the year in which commercial automobile insurance began to increase at a 30% annual rate instead of the historical 5% rate. We observe higher reported and paid claims for 2005 through 2008. For accident years 2006, 2007 and 2008, we also note higher cumulative claim development factors for both paid and reported claims. However, even with greater claims and higher claim development factors to ultimate, the development technique falls short of the actual IBNR.

If we turn our attention to the claim development triangles in Exhibit IV, Sheets 4 and 5, we notice the critical issue confronting the actuary. What is the correct age-to-age factor when a portfolio is changing its composition? In our example, commercial automobile has a longer reporting pattern than private passenger automobile and thus requires the selection of higher age-to-age factors. Since the proportion of commercial automobile claims is increasing in the portfolio, we see increasing age-to-age factors in our experience. Changing from a five-year volume-weighted average to a three-year volume-weighted average for selecting age-to-age factors would help move the estimated IBNR closer to the actual IBNR, but we would still fall short by a significant amount.

In this situation, the reported claim development method is more responsive than the paid claim development method due to the shorter time frame in which claims are reported versus paid. However, both methods result in estimated IBNR that are significantly lower than the actual IBNR. This example illustrates how changes in the portfolio could result in serious distortions in the development technique. Within a single line of insurance, changes in the types of claims that are occurring could have a similar effect.

Chapter 7 - Development Technique
U.S. Industry Auto
Reported Claims ($000)

Exhibit I
Sheet 1

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1998	37,017,487	43,169,009	45,568,919	46,784,558	47,337,318	47,533,264	47,634,419	47,689,655	47,724,678	47,742,304
1999	38,954,484	46,045,718	48,882,924	50,219,672	50,729,292	50,926,779	51,069,285	51,163,540	51,185,767	
2000	41,155,776	49,371,478	52,358,476	53,780,322	54,303,086	54,582,950	54,742,188	54,837,929		
2001	42,394,069	50,584,112	53,704,296	55,150,118	55,895,583	56,156,727	56,299,562			
2002	44,755,243	52,971,643	56,102,312	57,703,851	58,363,564	58,592,712				
2003	45,163,102	52,497,731	55,468,551	57,015,411	57,565,344					
2004	45,417,309	52,640,322	55,553,673	56,976,657						
2005	46,360,869	53,790,061	56,786,410							
2006	46,582,684	54,641,339								
2007	48,853,563									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1998	1.166	1.056	1.027	1.012	1.004	1.002	1.001	1.001	1.000	
1999	1.182	1.062	1.027	1.010	1.004	1.003	1.002	1.000		
2000	1.200	1.061	1.027	1.010	1.005	1.003	1.002			
2001	1.193	1.062	1.027	1.014	1.005	1.003				
2002	1.184	1.059	1.029	1.011	1.004					
2003	1.162	1.057	1.028	1.010						
2004	1.159	1.055	1.026							
2005	1.160	1.056								
2006	1.173									
2007										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Simple Average										
Latest 5	1.168	1.058	1.027	1.011	1.004	1.003	1.002	1.001	1.000	
Latest 3	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	
Medial Average*										
Latest 5x1	1.165	1.057	1.027	1.010	1.004	1.003	1.002	1.001	1.000	
Volume-weighted Average										
Latest 5	1.168	1.058	1.027	1.011	1.004	1.003	1.002	1.001	1.000	
Latest 3	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	
Geometric Average										
Latest 4	1.164	1.057	1.027	1.011	1.004	1.003	1.002	1.001	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Prior Selected	1.160	1.057	1.028	1.012	1.005	1.003	1.001	1.001	1.000	1.000
Selected	1.164	1.056	1.027	1.012	1.005	1.003	1.002	1.001	1.000	1.000
CDF to Ultimate	1.292	1.110	1.051	1.023	1.011	1.006	1.003	1.001	1.000	1.000
Percent Reported	77.4%	90.1%	95.1%	97.8%	98.9%	99.4%	99.7%	99.9%	100.0%	100.0%

*In the examples, the medial average for two data points is the same as the simple average, and the medial average for one data point is simply the value of the data point.

Chapter 7 - Development Technique
U.S. Industry Auto
Paid Claims ($000)

Exhibit I
Sheet 2

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1998	18,539,254	33,231,039	40,062,008	43,892,039	45,896,535	46,765,422	47,221,322	47,446,877	47,555,456	47,644,187
1999	20,410,193	36,090,684	43,259,402	47,159,241	49,208,532	50,162,043	50,625,757	50,878,808	51,000,534	
2000	22,120,843	38,976,014	46,389,282	50,562,385	52,735,280	53,740,101	54,284,334	54,533,225		
2001	22,992,259	40,096,198	47,767,835	52,093,916	54,363,436	55,378,801	55,878,421			
2002	24,092,782	41,795,313	49,903,803	54,352,884	56,754,376	57,807,215				
2003	24,084,451	41,399,612	49,070,332	53,584,201	55,930,654					
2004	24,369,770	41,489,863	49,236,678	53,774,672						
2005	25,100,697	42,702,229	50,644,994							
2006	25,608,776	43,606,497								
2007	27,229,969									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1998	1.792	1.206	1.096	1.046	1.019	1.010	1.005	1.002	1.002	
1999	1.768	1.199	1.090	1.043	1.019	1.009	1.005	1.002		
2000	1.762	1.190	1.090	1.043	1.019	1.010	1.005			
2001	1.744	1.191	1.091	1.044	1.019	1.009				
2002	1.735	1.194	1.089	1.044	1.019					
2003	1.719	1.185	1.092	1.044						
2004	1.703	1.187	1.092							
2005	1.701	1.186								
2006	1.703									
2007										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Simple Average										
Latest 5	1.712	1.189	1.091	1.044	1.019	1.010	1.005	1.002	1.002	
Latest 3	1.702	1.186	1.091	1.044	1.019	1.009	1.005	1.002	1.002	
Medial Average										
Latest 5x1	1.708	1.188	1.091	1.044	1.019	1.009	1.005	1.002	1.002	
Volume-weighted Average										
Latest 5	1.712	1.189	1.091	1.044	1.019	1.010	1.005	1.002	1.002	
Latest 3	1.702	1.186	1.091	1.044	1.019	1.009	1.005	1.002	1.002	
Geometric Average										
Latest 4	1.706	1.188	1.091	1.044	1.019	1.010	1.005	1.002	1.002	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Prior Selected	1.707	1.189	1.091	1.044	1.019	1.010	1.005	1.003	1.001	1.002
Selected	1.702	1.186	1.091	1.044	1.019	1.009	1.005	1.002	1.002	1.002
CDF to Ultimate	2.390	1.404	1.184	1.085	1.040	1.020	1.011	1.006	1.004	1.002
Percent Paid	41.8%	71.2%	84.5%	92.2%	96.2%	98.0%	98.9%	99.4%	99.6%	99.8%

Chapter 7 - Development Technique
U.S. Industry Auto
Projection of Ultimate Claims Using Reported and Paid Claims ($000)

Exhibit I
Sheet 3

Accident Year	Age of Accident Year at 12/31/07	Claims at 12/31/07 Reported	Claims at 12/31/07 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	120	47,742,304	47,644,187	1.000	1.002	47,742,304	47,739,475
1999	108	51,185,767	51,000,534	1.000	1.004	51,185,767	51,204,536
2000	96	54,837,929	54,533,225	1.001	1.006	54,892,767	54,860,424
2001	84	56,299,562	55,878,421	1.003	1.011	56,468,461	56,493,084
2002	72	58,592,712	57,807,215	1.006	1.020	58,944,268	58,963,359
2003	60	57,565,344	55,930,654	1.011	1.040	58,198,563	58,167,880
2004	48	56,976,657	53,774,672	1.023	1.085	58,287,120	58,345,519
2005	36	56,786,410	50,644,994	1.051	1.184	59,682,517	59,963,673
2006	24	54,641,339	43,606,497	1.110	1.404	60,651,886	61,223,522
2007	12	48,853,563	27,229,969	1.292	2.390	63,118,803	65,079,626
Total		543,481,587	498,050,368			569,172,456	572,041,099

Column Notes:
(2) Age of accident year in (1) at December 31, 2007.
(3) and (4) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Chapter 7 - Development Technique
U.S. Industry Auto
Development of Unpaid Claim Estimate ($000)

						Unpaid Claim Estimate at 12/31/07			
			Projected Ultimate Claims		Case	IBNR - Based on		Total - Based on	
Accident	Claims at 12/31/07		Using Dev. Method with		Outstanding	Dev. Method with		Dev. Method with	
Year	Reported	Paid	Reported	Paid	at 12/31/07	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	47,742,304	47,644,187	47,742,304	47,739,475	98,117	0	- 2,829	98,117	95,288
1999	51,185,767	51,000,534	51,185,767	51,204,536	185,233	0	18,769	185,233	204,002
2000	54,837,929	54,533,225	54,892,767	54,860,424	304,704	54,838	22,495	359,542	327,199
2001	56,299,562	55,878,421	56,468,461	56,493,084	421,141	168,899	193,522	590,040	614,663
2002	58,592,712	57,807,215	58,944,268	58,963,359	785,497	351,556	370,647	1,137,053	1,156,144
2003	57,565,344	55,930,654	58,198,563	58,167,880	1,634,690	633,219	602,536	2,267,909	2,237,226
2004	56,976,657	53,774,672	58,287,120	58,345,519	3,201,985	1,310,463	1,368,862	4,512,448	4,570,847
2005	56,786,410	50,644,994	59,682,517	59,963,673	6,141,416	2,896,107	3,177,263	9,037,523	9,318,679
2006	54,641,339	43,606,497	60,651,886	61,223,522	11,034,842	6,010,547	6,582,183	17,045,389	17,617,025
2007	48,853,563	27,229,969	63,118,803	65,079,626	21,623,594	14,265,240	16,226,063	35,888,834	37,849,657
Total	543,481,587	498,050,368	569,172,456	572,041,099	45,431,219	25,690,869	28,559,512	71,122,088	73,990,731

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) and (5) Developed in Exhibit I, Sheet 3.
(6) = [(2) - (3)].
(7) = [(4) - (2)].
(8) = [(5) - (2)].
(9) = [(6) + (7)].
(10) = [(6) + (8)].

Chapter 7 - Development Technique
XYZ Insurer - Auto BI
Reported Claims ($000)

Exhibit II
Sheet 1

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998			11,171	12,380	13,216	14,067	14,688	16,366	16,163	15,835	15,822
1999		13,255	16,405	19,639	22,473	23,764	25,094	24,795	25,071	25,107	
2000	15,676	18,749	21,900	27,144	29,488	34,458	36,949	37,505	37,246		
2001	11,827	16,004	21,022	26,578	34,205	37,136	38,541	38,798			
2002	12,811	20,370	26,656	37,667	44,414	48,701	48,169				
2003	9,651	16,995	30,354	40,594	44,231	44,373					
2004	16,995	40,180	58,866	71,707	70,288						
2005	28,674	47,432	70,340	70,655							
2006	27,066	46,783	48,804								
2007	19,477	31,732									
2008	18,632										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998			1.108	1.068	1.064	1.044	1.114	0.988	0.980	0.999	
1999		1.238	1.197	1.144	1.057	1.056	0.988	1.011	1.001		
2000	1.196	1.168	1.239	1.086	1.169	1.072	1.015	0.993			
2001	1.353	1.314	1.264	1.287	1.086	1.038	1.007				
2002	1.590	1.309	1.413	1.179	1.097	0.989					
2003	1.761	1.786	1.337	1.090	1.003						
2004	2.364	1.465	1.218	0.980							
2005	1.654	1.483	1.004								
2006	1.728	1.043									
2007	1.629										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.827	1.417	1.247	1.124	1.082	1.040	1.031	0.997	0.991	0.999	
Latest 3	1.671	1.330	1.187	1.083	1.062	1.033	1.003	0.997	0.991	0.999	
Latest 2	1.679	1.263	1.111	1.035	1.050	1.013	1.011	1.002	0.991	0.999	
Medial Average											
Latest 5x1	1.715	1.419	1.273	1.118	1.080	1.046	1.011	0.993	0.991	0.999	
Volume-weighted Average											
Latest 4	1.802	1.376	1.185	1.094	1.081	1.033	1.019	0.998	0.993	0.999	
Latest 3	1.674	1.325	1.147	1.060	1.060	1.028	1.005	0.998	0.993	0.999	
Latest 2	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	
Geometric Average											
Latest 3	1.670	1.314	1.178	1.080	1.061	1.033	1.003	0.997	0.991	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	1.000
CDF to Ultimate	2.551	1.512	1.196	1.085	1.064	1.013	1.003	0.992	0.992	0.999	1.000
Percent Reported	39.2%	66.1%	83.6%	92.2%	94.0%	98.7%	99.7%	100.8%	100.8%	100.1%	100.0%

Chapter 7 - Development Technique Exhibit II
XYZ Insurer - Auto BI Sheet 2
Paid Claims ($000)

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998			6,309	8,521	10,082	11,620	13,242	14,419	15,311	15,764	15,822
1999		4,666	9,861	13,971	18,127	22,032	23,511	24,146	24,592	24,817	
2000	1,302	6,513	12,139	17,828	24,030	28,853	33,222	35,902	36,782		
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519			
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437				
2003	1,743	6,240	12,683	22,892	34,505	39,320					
2004	2,221	9,898	25,950	43,439	52,811						
2005	3,043	12,219	27,073	40,026							
2006	3,531	11,778	22,819								
2007	3,529	11,865									
2008	3,409										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998			1.351	1.183	1.152	1.140	1.089	1.062	1.030	1.004	
1999		2.114	1.417	1.297	1.215	1.067	1.027	1.018	1.009		
2000	5.000	1.864	1.469	1.348	1.201	1.151	1.081	1.024			
2001	3.867	2.070	1.511	1.311	1.275	1.192	1.039				
2002	3.422	1.743	1.599	1.446	1.272	1.094					
2003	3.580	2.032	1.805	1.507	1.140						
2004	4.456	2.622	1.674	1.216							
2005	4.015	2.216	1.478								
2006	3.336	1.937									
2007	3.362										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	3.750	2.110	1.613	1.365	1.220	1.129	1.059	1.035	1.019	1.004	
Latest 3	3.571	2.258	1.652	1.390	1.229	1.146	1.049	1.035	1.019	1.004	
Latest 2	3.349	2.077	1.576	1.362	1.206	1.143	1.060	1.021	1.019	1.004	
Medial Average											
Latest 5x1	3.652	2.062	1.594	1.368	1.229	1.128	1.060	1.024	1.019	1.004	
Volume-weighted Average											
Latest 4	3.713	2.206	1.615	1.342	1.218	1.128	1.056	1.030	1.017	1.004	
Latest 3	3.550	2.238	1.619	1.349	1.222	1.141	1.051	1.030	1.017	1.004	
Latest 2	3.349	2.079	1.574	1.316	1.203	1.136	1.059	1.022	1.017	1.004	
Geometric Average											
Latest 3	3.558	2.241	1.647	1.384	1.227	1.145	1.049	1.035	1.019	1.004	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	3.349	2.079	1.574	1.316	1.203	1.136	1.059	1.022	1.017	1.004	1.010
CDF to Ultimate	21.999	6.569	3.160	2.007	1.525	1.268	1.116	1.054	1.031	1.014	1.010
Percent Paid	4.5%	15.2%	31.6%	49.8%	65.6%	78.9%	89.6%	94.9%	97.0%	98.6%	99.0%

Projection of Ultimate Claims Using Reported and Paid Claims ($000)

Accident Year	Age of Accident Year at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	15,822	15,822	1.000	1.010	15,822	15,980
1999	120	25,107	24,817	0.999	1.014	25,082	25,164
2000	108	37,246	36,782	0.992	1.031	36,948	37,922
2001	96	38,798	38,519	0.992	1.054	38,487	40,600
2002	84	48,169	44,437	1.003	1.116	48,313	49,592
2003	72	44,373	39,320	1.013	1.268	44,950	49,858
2004	60	70,288	52,811	1.064	1.525	74,787	80,537
2005	48	70,655	40,026	1.085	2.007	76,661	80,333
2006	36	48,804	22,819	1.196	3.160	58,370	72,108
2007	24	31,732	11,865	1.512	6.569	47,979	77,941
2008	12	18,632	3,409	2.551	21.999	47,530	74,995
Total		449,626	330,629			514,929	605,030

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from XYZ Insurer.
(5) and (6) Based on CDF from Exhibit II, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Case Outstanding at 12/31/08	Unpaid Claim Estimate at 12/31/08: IBNR - Based on Dev. Method with Reported	Unpaid Claim Estimate at 12/31/08: IBNR - Based on Dev. Method with Paid	Unpaid Claim Estimate at 12/31/08: Total - Based on Dev. Method with Reported	Unpaid Claim Estimate at 12/31/08: Total - Based on Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	15,822	15,822	15,822	15,980	0	0	158	0	158
1999	25,107	24,817	25,082	25,164	290	- 25	58	265	347
2000	37,246	36,782	36,948	37,922	465	- 298	676	167	1,140
2001	38,798	38,519	38,487	40,600	278	- 310	1,802	- 32	2,080
2002	48,169	44,437	48,313	49,592	3,731	145	1,423	3,876	5,155
2003	44,373	39,320	44,950	49,858	5,052	577	5,485	5,629	10,538
2004	70,288	52,811	74,787	80,537	17,477	4,498	10,249	21,976	27,726
2005	70,655	40,026	76,661	80,333	30,629	6,006	9,678	36,634	40,307
2006	48,804	22,819	58,370	72,108	25,985	9,566	23,304	35,551	49,289
2007	31,732	11,865	47,979	77,941	19,867	16,247	46,209	36,114	66,076
2008	18,632	3,409	47,530	74,995	15,223	28,898	56,363	44,121	71,586
Total	449,626	330,629	514,929	605,030	118,997	65,303	155,405	184,300	274,402

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Exhibit II, Sheet 3.
(6) = [(2) - (3)].
(7) = [(4) - (2)].
(8) = [(5) - (2)].
(9) = [(6) + (7)].
(10) = [(6) + (8)].

Summary of Earned Premium and Claim Ratio Assumptions and Actual IBNR

Accident Year	Earned Premium	Ultimate Claim Ratio	Ultimate Claims	Reported Claims at 12/31/08	Actual IBNR	Ultimate Claim Ratio	Ultimate Claims	Reported Claims at 12/31/08	Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Steady-State				**Increasing Claim Ratios**			
1999	1,000,000	70.0%	700,000	700,000	0	70.0%	700,000	700,000	0
2000	1,050,000	70.0%	735,000	735,000	0	70.0%	735,000	735,000	0
2001	1,102,500	70.0%	771,750	771,750	0	70.0%	771,750	771,750	0
2002	1,157,625	70.0%	810,338	810,338	0	70.0%	810,338	810,338	0
2003	1,215,506	70.0%	850,854	842,346	8,509	70.0%	850,854	842,346	8,509
2004	1,276,282	70.0%	893,397	884,463	8,934	80.0%	1,021,025	1,010,815	10,210
2005	1,340,096	70.0%	938,067	919,306	18,761	85.0%	1,139,081	1,116,300	22,782
2006	1,407,100	70.0%	984,970	935,722	49,249	90.0%	1,266,390	1,203,071	63,320
2007	1,477,455	70.0%	1,034,219	930,797	103,422	95.0%	1,403,583	1,263,224	140,358
2008	1,551,328	70.0%	1,085,930	836,166	249,764	100.0%	1,551,328	1,194,523	356,805
Total	12,577,893		8,804,525	8,365,887	438,638		10,249,350	9,647,366	601,984
		Increasing Case Outstanding Strength				**Increasing Claim Ratios and Case Outstanding Strength**			
1999	1,000,000	70.0%	700,000	700,000	0	70.0%	700,000	700,000	0
2000	1,050,000	70.0%	735,000	735,000	0	70.0%	735,000	735,000	0
2001	1,102,500	70.0%	771,750	771,750	0	70.0%	771,750	771,750	0
2002	1,157,625	70.0%	810,338	810,338	0	70.0%	810,338	810,338	0
2003	1,215,506	70.0%	850,854	842,346	8,509	70.0%	850,854	842,346	8,509
2004	1,276,282	70.0%	893,397	884,463	8,934	80.0%	1,021,025	1,010,815	10,210
2005	1,340,096	70.0%	938,067	933,377	4,690	85.0%	1,139,081	1,133,386	5,695
2006	1,407,100	70.0%	984,970	962,808	22,162	90.0%	1,266,390	1,237,897	28,494
2007	1,477,455	70.0%	1,034,219	979,922	54,296	95.0%	1,403,583	1,329,895	73,688
2008	1,551,328	70.0%	1,085,930	931,185	154,745	100.0%	1,551,328	1,330,264	221,064
Total	12,577,893		8,804,525	8,551,189	253,336		10,249,350	9,901,689	347,660

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) and (7) Ultimate claim ratios assumed to be known for purpose of example.
(4) = [(2) x (3)].
(5) Latest diagonal of reported claim triangles in Exhibit III, Sheets 2 and 6.
(6) = [(4) - (5)].
(8) = [(2) x (7)].
(9) Latest diagonal of reported claim triangles in Exhibit III, Sheets 4 and 8.
(10) = [(8) - (9)].

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months)									
	12	24	36	48	60	72	84	96	108	120
1999	539,000	630,000	665,000	686,000	693,000	693,000	700,000	700,000	700,000	700,000
2000	565,950	661,500	698,250	720,300	727,650	727,650	735,000	735,000	735,000	
2001	594,248	694,575	733,163	756,315	764,033	764,033	771,750	771,750		
2002	623,960	729,304	769,821	794,131	802,234	802,234	810,338			
2003	655,158	765,769	808,312	833,837	842,346	842,346				
2004	687,916	804,057	848,727	875,529	884,463					
2005	722,312	844,260	891,164	919,306						
2006	758,427	886,473	935,722							
2007	796,348	930,797								
2008	836,166									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors									
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	
2000	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000		
2001	1.169	1.056	1.032	1.010	1.000	1.010	1.000			
2002	1.169	1.056	1.032	1.010	1.000	1.010				
2003	1.169	1.056	1.032	1.010	1.000					
2004	1.169	1.056	1.032	1.010						
2005	1.169	1.056	1.032							
2006	1.169	1.056								
2007	1.169									
2008										

PART 3 - Average Age-to-Age Factors

	Averages									
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection									
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	1.000
CDF to Ultimate	1.299	1.111	1.053	1.020	1.010	1.010	1.000	1.000	1.000	1.000
Percent Reported	77.0%	90.0%	95.0%	98.0%	99.0%	99.0%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	294,000	497,000	588,000	644,000	672,000	686,000	693,000	693,000	700,000	700,000
2000	308,700	521,850	617,400	676,200	705,600	720,300	727,650	727,650	735,000	
2001	324,135	547,943	648,270	710,010	740,880	756,315	764,033	764,033		
2002	340,342	575,340	680,684	745,511	777,924	794,131	802,234			
2003	357,359	604,107	714,718	782,786	816,820	833,837				
2004	375,227	634,312	750,454	821,925	857,661					
2005	393,988	666,028	787,976	863,022						
2006	413,688	699,329	827,375							
2007	434,372	734,295								
2008	456,090									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	
2000	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010		
2001	1.690	1.183	1.095	1.043	1.021	1.010	1.000			
2002	1.690	1.183	1.095	1.043	1.021	1.010				
2003	1.690	1.183	1.095	1.043	1.021					
2004	1.690	1.183	1.095	1.043						
2005	1.690	1.183	1.095							
2006	1.690	1.183								
2007	1.690									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	1.000
CDF to Ultimate	2.381	1.408	1.190	1.087	1.042	1.020	1.010	1.010	1.000	1.000
Percent Paid	42.0%	71.0%	84.0%	92.0%	96.0%	98.0%	99.0%	99.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	539,000	630,000	665,000	686,000	693,000	693,000	700,000	700,000	700,000	700,000
2000	565,950	661,500	698,250	720,300	727,650	727,650	735,000	735,000	735,000	
2001	594,248	694,575	733,163	756,315	764,033	764,033	771,750	771,750		
2002	623,960	729,304	769,821	794,131	802,234	802,234	810,338			
2003	655,158	765,769	808,312	833,837	842,346	842,346				
2004	786,189	918,923	969,974	1,000,605	1,010,815					
2005	877,093	1,025,173	1,082,127	1,116,300						
2006	975,121	1,139,751	1,203,071							
2007	1,080,759	1,263,224								
2008	1,194,523									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	
2000	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000		
2001	1.169	1.056	1.032	1.010	1.000	1.010	1.000			
2002	1.169	1.056	1.032	1.010	1.000	1.010				
2003	1.169	1.056	1.032	1.010	1.000					
2004	1.169	1.056	1.032	1.010						
2005	1.169	1.056	1.032							
2006	1.169	1.056								
2007	1.169									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	1.000
CDF to Ultimate	1.299	1.111	1.053	1.020	1.010	1.010	1.000	1.000	1.000	1.000
Percent Reported	77.0%	90.0%	95.0%	98.0%	99.0%	99.0%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	294,000	497,000	588,000	644,000	672,000	686,000	693,000	693,000	700,000	700,000
2000	308,700	521,850	617,400	676,200	705,600	720,300	727,650	727,650	735,000	
2001	324,135	547,943	648,270	710,010	740,880	756,315	764,033	764,033		
2002	340,342	575,340	680,684	745,511	777,924	794,131	802,234			
2003	357,359	604,107	714,718	782,786	816,820	833,837				
2004	428,831	724,928	857,661	939,343	980,184					
2005	478,414	808,748	956,828	1,047,955						
2006	531,884	899,137	1,063,768							
2007	589,505	996,544								
2008	651,558									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	
2000	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010		
2001	1.690	1.183	1.095	1.043	1.021	1.010	1.000			
2002	1.690	1.183	1.095	1.043	1.021	1.010				
2003	1.690	1.183	1.095	1.043	1.021					
2004	1.690	1.183	1.095	1.043						
2005	1.690	1.183	1.095							
2006	1.690	1.183								
2007	1.690									
2008										

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	1.000
CDF to Ultimate	2.381	1.408	1.190	1.087	1.042	1.020	1.010	1.010	1.000	1.000
Percent Paid	42.0%	71.0%	84.0%	92.0%	96.0%	98.0%	99.0%	99.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	539,000	630,000	665,000	686,000	693,000	693,000	700,000	700,000	700,000	700,000
2000	565,950	661,500	698,250	720,300	727,650	727,650	735,000	735,000	735,000	
2001	594,248	694,575	733,163	756,315	764,033	764,033	771,750	771,750		
2002	623,960	729,304	769,821	794,131	802,234	802,234	810,338			
2003	655,158	765,769	808,312	833,837	842,346	842,346				
2004	687,916	804,057	848,727	878,745	884,463					
2005	722,312	844,260	897,355	933,377						
2006	758,427	897,702	962,808							
2007	818,067	979,922								
2008	931,185									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	
2000	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000		
2001	1.169	1.056	1.032	1.010	1.000	1.010	1.000			
2002	1.169	1.056	1.032	1.010	1.000	1.010				
2003	1.169	1.056	1.032	1.010	1.000					
2004	1.169	1.056	1.035	1.007						
2005	1.169	1.063	1.040							
2006	1.184	1.073								
2007	1.198									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.178	1.061	1.034	1.009	1.000	1.010	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.178	1.061	1.034	1.009	1.000	1.010	1.000	1.000	1.000	1.000
CDF to Ultimate	1.318	1.119	1.055	1.020	1.010	1.010	1.000	1.000	1.000	1.000
Percent Reported	75.9%	89.4%	94.8%	98.1%	99.0%	99.0%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	294,000	497,000	588,000	644,000	672,000	686,000	693,000	693,000	700,000	700,000
2000	308,700	521,850	617,400	676,200	705,600	720,300	727,650	727,650	735,000	
2001	324,135	547,943	648,270	710,010	740,880	756,315	764,033	764,033		
2002	340,342	575,340	680,684	745,511	777,924	794,131	802,234			
2003	357,359	604,107	714,718	782,786	816,820	833,837				
2004	375,227	634,312	750,454	821,925	857,661					
2005	393,988	666,028	787,976	863,022						
2006	413,688	699,329	827,375							
2007	434,372	734,295								
2008	456,090									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	
2000	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010		
2001	1.690	1.183	1.095	1.043	1.021	1.010	1.000			
2002	1.690	1.183	1.095	1.043	1.021	1.010				
2003	1.690	1.183	1.095	1.043	1.021					
2004	1.690	1.183	1.095	1.043						
2005	1.690	1.183	1.095							
2006	1.690	1.183								
2007	1.690									
2008										

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	1.000
CDF to Ultimate	2.381	1.408	1.190	1.087	1.042	1.020	1.010	1.010	1.000	1.000
Percent Paid	42.0%	71.0%	84.0%	92.0%	96.0%	98.0%	99.0%	99.0%	100.0%	100.0%

U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength - Reported Claims

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	539,000	630,000	665,000	686,000	693,000	693,000	700,000	700,000	700,000	700,000
2000	565,950	661,500	698,250	720,300	727,650	727,650	735,000	735,000	735,000	
2001	594,248	694,575	733,163	756,315	764,033	764,033	771,750	771,750		
2002	623,960	729,304	769,821	794,131	802,234	802,234	810,338			
2003	655,158	765,769	808,312	833,837	842,346	842,346				
2004	786,189	918,923	969,974	1,004,280	1,010,815					
2005	877,093	1,025,173	1,089,645	1,133,386						
2006	975,121	1,154,188	1,237,897							
2007	1,110,234	1,329,895								
2008	1,330,264									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000	1.000	
2000	1.169	1.056	1.032	1.010	1.000	1.010	1.000	1.000		
2001	1.169	1.056	1.032	1.010	1.000	1.010	1.000			
2002	1.169	1.056	1.032	1.010	1.000	1.010				
2003	1.169	1.056	1.032	1.010	1.000					
2004	1.169	1.056	1.035	1.007						
2005	1.169	1.063	1.040							
2006	1.184	1.073								
2007	1.198									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.179	1.061	1.035	1.009	1.000	1.010	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.179	1.061	1.035	1.009	1.000	1.010	1.000	1.000	1.000	1.000
CDF to Ultimate	1.320	1.120	1.055	1.019	1.010	1.010	1.000	1.000	1.000	1.000
Percent Reported	75.7%	89.3%	94.8%	98.1%	99.0%	99.0%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	294,000	497,000	588,000	644,000	672,000	686,000	693,000	693,000	700,000	700,000
2000	308,700	521,850	617,400	676,200	705,600	720,300	727,650	727,650	735,000	
2001	324,135	547,943	648,270	710,010	740,880	756,315	764,033	764,033		
2002	340,342	575,340	680,684	745,511	777,924	794,131	802,234			
2003	357,359	604,107	714,718	782,786	816,820	833,837				
2004	428,831	724,928	857,661	939,343	980,184					
2005	478,414	808,748	956,828	1,047,955						
2006	531,884	899,137	1,063,768							
2007	589,505	996,544								
2008	651,558									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	
2000	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010		
2001	1.690	1.183	1.095	1.043	1.021	1.010	1.000			
2002	1.690	1.183	1.095	1.043	1.021	1.010				
2003	1.690	1.183	1.095	1.043	1.021					
2004	1.690	1.183	1.095	1.043						
2005	1.690	1.183	1.095							
2006	1.690	1.183								
2007	1.690									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.690	1.183	1.095	1.043	1.021	1.010	1.000	1.010	1.000	1.000
CDF to Ultimate	2.381	1.408	1.190	1.087	1.042	1.020	1.010	1.010	1.000	1.000
Percent Paid	42.0%	71.0%	84.0%	92.0%	96.0%	98.0%	99.0%	99.0%	100.0%	100.0%

Accident Year	Age of Accident Year at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimated IBNR Using Dev. Method with Reported	Estimated IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Using Dev. Method with Reported	Difference from Actual IBNR Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Steady-State													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	0	1.000	1.000	735,000	735,000	0	0	0	0	0
2001	96	771,750	764,033	7,718	1.000	1.010	771,750	771,750	0	0	0	0	0
2002	84	810,338	802,234	8,103	1.000	1.010	810,338	810,338	0	0	0	0	0
2003	72	842,346	833,837	8,509	1.010	1.020	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	884,463	857,661	26,802	1.010	1.042	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	919,306	863,022	56,284	1.020	1.087	938,067	938,067	18,761	18,761	18,761	0	0
2006	36	935,722	827,375	108,347	1.053	1.190	984,970	984,970	49,249	49,249	49,249	0	0
2007	24	930,797	734,295	196,502	1.111	1.408	1,034,219	1,034,219	103,422	103,422	103,422	0	0
2008	12	836,166	456,090	380,075	1.299	2.381	1,085,930	1,085,930	249,764	249,764	249,764	0	0
Total		8,365,887	7,573,548	792,339			8,804,525	8,804,525	438,638	438,638	438,638	0	0
Increasing Claim Ratios													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	0	1.000	1.000	735,000	735,000	0	0	0	0	0
2001	96	771,750	764,033	7,718	1.000	1.010	771,750	771,750	0	0	0	0	0
2002	84	810,338	802,234	8,103	1.000	1.010	810,338	810,338	0	0	0	0	0
2003	72	842,346	833,837	8,509	1.010	1.020	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	1,010,815	980,184	30,631	1.010	1.042	1,021,025	1,021,025	10,210	10,210	10,210	0	0
2005	48	1,116,300	1,047,955	68,345	1.020	1.087	1,139,081	1,139,081	22,782	22,782	22,782	0	0
2006	36	1,203,071	1,063,768	139,303	1.053	1.190	1,266,390	1,266,390	63,320	63,320	63,320	0	0
2007	24	1,263,224	996,544	266,681	1.111	1.408	1,403,583	1,403,583	140,358	140,358	140,358	0	0
2008	12	1,194,523	651,558	542,965	1.299	2.381	1,551,328	1,551,328	356,805	356,805	356,805	0	0
Total		9,647,366	8,575,112	1,072,254			10,249,350	10,249,350	601,984	601,984	601,984	0	0

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) From last diagonal of reported and paid claim triangles in Exhibit III, Sheets 2 through 5.
(5) = [(3) - (4)].
(6) and (7) CDF based on 5-year volume-weighted average age-to-age factors presented in Exhibit III, Sheets 2 through 5.
(8) = [(3) x (6)].
(9) = [(4) x (7)].
(10) = [(8) - (3)].
(11) = [(9) - (3)].
(12) Developed in Exhibit III, Sheet 1.
(13) = [(12) - (10)].
(14) = [(12) - (11)].

Accident Year	Age of Accident Year at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimated IBNR Using Dev. Method with Reported	Estimated IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Using Dev. Method with Reported	Difference from Actual IBNR Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Increasing Case Outstanding Strength													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	0	1.000	1.000	735,000	735,000	0	0	0	0	0
2001	96	771,750	764,033	7,718	1.000	1.010	771,750	771,750	0	0	0	0	0
2002	84	810,338	802,234	8,103	1.000	1.010	810,338	810,338	0	0	0	0	0
2003	72	842,346	833,837	8,509	1.010	1.020	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	884,463	857,661	26,802	1.010	1.042	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	933,377	863,022	70,355	1.020	1.087	951,656	938,067	18,279	4,690	4,690	- 13,589	0
2006	36	962,808	827,375	135,433	1.055	1.190	1,015,302	984,970	52,493	22,162	22,162	- 30,331	0
2007	24	979,922	734,295	245,627	1.119	1.408	1,096,235	1,034,219	116,313	54,296	54,296	- 62,017	0
2008	12	931,185	456,090	475,094	1.318	2.381	1,227,589	1,085,930	296,404	154,745	154,745	- 141,659	0
Total		8,551,189	7,573,548	977,641			9,052,121	8,804,525	500,932	253,336	253,336	- 247,596	0
Increasing Claim Ratios and Case Outstanding Strength													
1999	120	700,000	700,000	0	1.000	1.000	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	0	1.000	1.000	735,000	735,000	0	0	0	0	0
2001	96	771,750	764,033	7,718	1.000	1.010	771,750	771,750	0	0	0	0	0
2002	84	810,338	802,234	8,103	1.000	1.010	810,338	810,338	0	0	0	0	0
2003	72	842,346	833,837	8,509	1.010	1.020	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	1,010,815	980,184	30,631	1.010	1.042	1,021,025	1,021,025	10,210	10,210	10,210	0	0
2005	48	1,133,386	1,047,955	85,431	1.019	1.087	1,155,482	1,139,081	22,096	5,695	5,695	- 16,400	0
2006	36	1,237,897	1,063,768	174,129	1.055	1.190	1,305,639	1,266,390	67,742	28,494	28,494	- 39,248	0
2007	24	1,329,895	996,544	333,351	1.120	1.408	1,488,874	1,403,583	158,980	73,688	73,688	- 85,292	0
2008	12	1,330,264	651,558	678,706	1.320	2.381	1,756,504	1,551,328	426,240	221,064	221,064	- 205,176	0
Total		9,901,689	8,575,112	1,326,577			10,595,466	10,249,350	693,777	347,660	347,660	- 346,116	0

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) From last diagonal of reported and paid claim triangles in Exhibit III, Sheets 6 through 9.
(5) = [(3) - (4)].
(6) and (7) CDF based on 5-year volume-weighted average age-to-age factors presented in Exhibit III, Sheets 6 through 9.
(8) = [(3) x (6)].
(9) = [(4) x (7)].
(10) = [(8) - (3)].
(11) = [(9) - (3)].
(12) Developed in Exhibit III, Sheet 1.
(13) = [(12) - (10)].
(14) = [(12) - (11)].

Chapter 7 - Development Technique
Impact of Change in Product Mix Example
Summary of Assumptions - Earned Premiums and Claim Ratios

	Earned Premium			Ultimate Claim Ratios			Ultimate Claims			Reported	
Accident Year	Priv Pass Auto	Comm Auto	Total Auto	Priv Pass Auto	Comm Auto	Total Auto	Priv Pass Auto	Comm Auto	Total Auto	Claims at 12/31/08	Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Steady-State (No Change in Product Mix)											
1999	1,000,000	1,000,000	2,000,000	70.0%	80.0%	75.0%	700,000	800,000	1,500,000	1,500,000	0
2000	1,050,000	1,050,000	2,100,000	70.0%	80.0%	75.0%	735,000	840,000	1,575,000	1,575,000	0
2001	1,102,500	1,102,500	2,205,000	70.0%	80.0%	75.0%	771,750	882,000	1,653,750	1,653,750	0
2002	1,157,625	1,157,625	2,315,250	70.0%	80.0%	75.0%	810,338	926,100	1,736,438	1,736,438	0
2003	1,215,506	1,215,506	2,431,013	70.0%	80.0%	75.0%	850,854	972,405	1,823,259	1,814,751	8,509
2004	1,276,282	1,276,282	2,552,563	70.0%	80.0%	75.0%	893,397	1,021,025	1,914,422	1,885,068	29,354
2005	1,340,096	1,340,096	2,680,191	70.0%	80.0%	75.0%	938,067	1,072,077	2,010,143	1,948,499	61,644
2006	1,407,100	1,407,100	2,814,201	70.0%	80.0%	75.0%	984,970	1,125,680	2,110,651	1,937,577	173,073
2007	1,477,455	1,477,455	2,954,911	70.0%	80.0%	75.0%	1,034,219	1,181,964	2,216,183	1,852,729	363,454
2008	1,551,328	1,551,328	3,102,656	70.0%	80.0%	75.0%	1,085,930	1,241,063	2,326,992	1,568,393	758,599
Total	12,577,893	12,577,893	25,155,785				8,804,525	10,062,314	18,866,839	17,472,204	1,394,634
Changing Product Mix											
1999	1,000,000	1,000,000	2,000,000	70.0%	80.0%	75.0%	700,000	800,000	1,500,000	1,500,000	0
2000	1,050,000	1,050,000	2,100,000	70.0%	80.0%	75.0%	735,000	840,000	1,575,000	1,575,000	0
2001	1,102,500	1,102,500	2,205,000	70.0%	80.0%	75.0%	771,750	882,000	1,653,750	1,653,750	0
2002	1,157,625	1,157,625	2,315,250	70.0%	80.0%	75.0%	810,338	926,100	1,736,438	1,736,438	0
2003	1,215,506	1,215,506	2,431,013	70.0%	80.0%	75.0%	850,854	972,405	1,823,259	1,814,751	8,509
2004	1,276,282	1,276,282	2,552,563	70.0%	80.0%	75.0%	893,397	1,021,025	1,914,422	1,885,068	29,354
2005	1,340,096	1,659,166	2,999,262	70.0%	80.0%	75.5%	938,067	1,327,333	2,265,400	2,193,545	71,855
2006	1,407,100	2,156,916	3,564,016	70.0%	80.0%	76.1%	984,970	1,725,533	2,710,503	2,471,446	239,057
2007	1,477,455	2,803,991	4,281,446	70.0%	80.0%	76.5%	1,034,219	2,243,192	3,277,411	2,680,487	596,924
2008	1,551,328	3,645,188	5,196,516	70.0%	80.0%	77.0%	1,085,930	2,916,150	4,002,080	2,556,695	1,445,385
Total	12,577,893	17,067,173	29,645,066				8,804,525	13,653,738	22,458,263	20,067,179	2,391,084

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase.
(3) For no change scenario, assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% beginning in 2005.
(4) = [(2) + (3)].
(5) and (6) Ultimate claim ratios assumed to be known for purpose of example.
(7) = [(10) / (4)].
(8) = [(2) x (5)].
(9) = [(3) x (6)].
(10) = [(8) + (9)].
(11) Latest diagonal of reported claim triangles in Exhibit IV, Sheets 2 and 4.
(12) = [(10) - (11)].

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	1,011,000	1,254,000	1,377,000	1,454,000	1,477,000	1,493,000	1,500,000	1,500,000	1,500,000	1,500,000
2000	1,061,550	1,316,700	1,445,850	1,526,700	1,550,850	1,567,650	1,575,000	1,575,000	1,575,000	
2001	1,114,628	1,382,535	1,518,143	1,603,035	1,628,393	1,646,033	1,653,750	1,653,750		
2002	1,170,359	1,451,662	1,594,050	1,683,187	1,709,812	1,728,334	1,736,438			
2003	1,228,877	1,524,245	1,673,752	1,767,346	1,795,303	1,814,751				
2004	1,290,321	1,600,457	1,757,440	1,855,713	1,885,068					
2005	1,354,837	1,680,480	1,845,312	1,948,499						
2006	1,422,579	1,764,504	1,937,577							
2007	1,493,707	1,852,729								
2008	1,568,393									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.240	1.098	1.056	1.016	1.011	1.005	1.000	1.000	1.000	
2000	1.240	1.098	1.056	1.016	1.011	1.005	1.000	1.000		
2001	1.240	1.098	1.056	1.016	1.011	1.005	1.000			
2002	1.240	1.098	1.056	1.016	1.011	1.005				
2003	1.240	1.098	1.056	1.016	1.011					
2004	1.240	1.098	1.056	1.016						
2005	1.240	1.098	1.056							
2006	1.240	1.098								
2007	1.240									
2008										

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.240	1.098	1.056	1.016	1.011	1.005	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.240	1.098	1.056	1.016	1.011	1.005	1.000	1.000	1.000	1.000
CDF to Ultimate	1.484	1.196	1.089	1.032	1.016	1.005	1.000	1.000	1.000	1.000
Percent Reported	67.4%	83.6%	91.8%	96.9%	98.5%	99.5%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	470,000	865,000	1,124,000	1,300,000	1,400,000	1,446,000	1,469,000	1,477,000	1,492,000	1,500,000
2000	493,500	908,250	1,180,200	1,365,000	1,470,000	1,518,300	1,542,450	1,550,850	1,566,600	
2001	518,175	953,663	1,239,210	1,433,250	1,543,500	1,594,215	1,619,573	1,628,393		
2002	544,084	1,001,346	1,301,171	1,504,913	1,620,675	1,673,926	1,700,551			
2003	571,288	1,051,413	1,366,229	1,580,158	1,701,709	1,757,622				
2004	599,852	1,103,984	1,434,540	1,659,166	1,786,794					
2005	629,845	1,159,183	1,506,268	1,742,124						
2006	661,337	1,217,142	1,581,581							
2007	694,404	1,277,999								
2008	729,124									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.840	1.299	1.157	1.077	1.033	1.016	1.005	1.010	1.005	
2000	1.840	1.299	1.157	1.077	1.033	1.016	1.005	1.010		
2001	1.840	1.299	1.157	1.077	1.033	1.016	1.005			
2002	1.840	1.299	1.157	1.077	1.033	1.016				
2003	1.840	1.299	1.157	1.077	1.033					
2004	1.840	1.299	1.157	1.077						
2005	1.840	1.299	1.157							
2006	1.840	1.299								
2007	1.840									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.840	1.299	1.157	1.077	1.033	1.016	1.005	1.010	1.005	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.840	1.299	1.157	1.077	1.033	1.016	1.005	1.010	1.005	1.000
CDF to Ultimate	3.191	1.734	1.335	1.154	1.071	1.037	1.021	1.016	1.005	1.000
Percent Paid	31.3%	57.7%	74.9%	86.7%	93.3%	96.4%	97.9%	98.5%	99.5%	100.0%

Chapter 7 - Development Technique
Impact of Change in Product Mix Example
U.S. Auto Changing Product Mix - Reported Claims

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	1,011,000	1,254,000	1,377,000	1,454,000	1,477,000	1,493,000	1,500,000	1,500,000	1,500,000	1,500,000
2000	1,061,550	1,316,700	1,445,850	1,526,700	1,550,850	1,567,650	1,575,000	1,575,000	1,575,000	
2001	1,114,628	1,382,535	1,518,143	1,603,035	1,628,393	1,646,033	1,653,750	1,653,750		
2002	1,170,359	1,451,662	1,594,050	1,683,187	1,709,812	1,728,334	1,736,438			
2003	1,228,877	1,524,245	1,673,752	1,767,346	1,795,303	1,814,751				
2004	1,290,321	1,600,457	1,757,440	1,855,713	1,885,068					
2005	1,505,438	1,879,580	2,072,490	2,193,545						
2006	1,776,491	2,232,389	2,471,446							
2007	2,119,832	2,680,487								
2008	2,556,695									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.240	1.098	1.056	1.016	1.011	1.005	1.000	1.000	1.000	
2000	1.240	1.098	1.056	1.016	1.011	1.005	1.000	1.000		
2001	1.240	1.098	1.056	1.016	1.011	1.005	1.000			
2002	1.240	1.098	1.056	1.016	1.011	1.005				
2003	1.240	1.098	1.056	1.016	1.011					
2004	1.240	1.098	1.056	1.016						
2005	1.249	1.103	1.058							
2006	1.257	1.107								
2007	1.264									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.252	1.101	1.057	1.016	1.011	1.005	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.252	1.101	1.057	1.016	1.011	1.005	1.000	1.000	1.000	1.000
CDF to Ultimate	1.503	1.200	1.090	1.032	1.016	1.005	1.000	1.000	1.000	1.000
Percent Reported	66.5%	83.3%	91.7%	96.9%	98.5%	99.5%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120
1999	470,000	865,000	1,124,000	1,300,000	1,400,000	1,446,000	1,469,000	1,477,000	1,492,000	1,500,000
2000	493,500	908,250	1,180,200	1,365,000	1,470,000	1,518,300	1,542,450	1,550,850	1,566,600	
2001	518,175	953,663	1,239,210	1,433,250	1,543,500	1,594,215	1,619,573	1,628,393		
2002	544,084	1,001,346	1,301,171	1,504,913	1,620,675	1,673,926	1,700,551			
2003	571,288	1,051,413	1,366,229	1,580,158	1,701,709	1,757,622				
2004	599,852	1,103,984	1,434,540	1,659,166	1,786,794					
2005	686,001	1,276,601	1,677,289	1,951,435						
2006	793,305	1,493,074	1,983,482							
2007	927,874	1,766,164								
2008	1,097,644									

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
1999	1.840	1.299	1.157	1.077	1.033	1.016	1.005	1.010	1.005	
2000	1.840	1.299	1.157	1.077	1.033	1.016	1.005	1.010		
2001	1.840	1.299	1.157	1.077	1.033	1.016	1.005			
2002	1.840	1.299	1.157	1.077	1.033	1.016				
2003	1.840	1.299	1.157	1.077	1.033					
2004	1.840	1.299	1.157	1.077						
2005	1.861	1.314	1.163							
2006	1.882	1.328								
2007	1.903									
2008										

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Volume-weighted Average										
Latest 5	1.870	1.310	1.158	1.077	1.033	1.016	1.005	1.010	1.005	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	To Ult
Selected	1.870	1.310	1.158	1.077	1.033	1.016	1.005	1.010	1.005	1.000
CDF to Ultimate	3.273	1.750	1.336	1.154	1.071	1.037	1.021	1.016	1.005	1.000
Percent Paid	30.6%	57.1%	74.8%	86.7%	93.3%	96.4%	97.9%	98.5%	99.5%	100.0%

Accident Year	Age of Accident Year at 12/31/08	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Case Outstanding	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid	Estimated IBNR Using Dev. Method with Reported	Estimated IBNR Using Dev. Method with Paid	Actual IBNR	Difference from Actual IBNR Using Dev. Method with Reported	Difference from Actual IBNR Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Steady-State (No Change in Product Mix)													
1999	120	1,500,000	1,500,000	0	1.000	1.000	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,566,600	8,400	1.000	1.005	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,628,393	25,358	1.000	1.016	1,653,750	1,653,750	0	0	0	0	0
2002	84	1,736,438	1,700,551	35,886	1.000	1.021	1,736,438	1,736,438	0	0	0	0	0
2003	72	1,814,751	1,757,622	57,129	1.005	1.037	1,823,259	1,823,259	8,509	8,509	8,509	0	0
2004	60	1,885,068	1,786,794	98,274	1.016	1.071	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	1,948,499	1,742,124	206,375	1.032	1.154	2,010,143	2,010,143	61,644	61,644	61,644	0	0
2006	36	1,937,577	1,581,581	355,996	1.089	1.335	2,110,651	2,110,651	173,073	173,073	173,073	0	0
2007	24	1,852,729	1,277,999	574,730	1.196	1.734	2,216,183	2,216,183	363,454	363,454	363,454	0	0
2008	12	1,568,393	729,124	839,269	1.484	3.191	2,326,992	2,326,992	758,599	758,599	758,599	0	0
Total		17,472,204	15,270,788	2,201,416			18,866,839	18,866,839	1,394,634	1,394,634	1,394,634	0	0
Changing Product Mix													
1999	120	1,500,000	1,500,000	0	1.000	1.000	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,566,600	8,400	1.000	1.005	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,628,393	25,358	1.000	1.016	1,653,750	1,653,750	0	0	0	0	0
2002	84	1,736,438	1,700,551	35,886	1.000	1.021	1,736,438	1,736,438	0	0	0	0	0
2003	72	1,814,751	1,757,622	57,129	1.005	1.037	1,823,259	1,823,259	8,509	8,509	8,509	0	0
2004	60	1,885,068	1,786,794	98,274	1.016	1.071	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,193,545	1,951,435	242,111	1.032	1.154	2,262,942	2,251,655	69,397	58,110	71,855	2,458	13,745
2006	36	2,471,446	1,983,482	487,964	1.090	1.336	2,693,735	2,650,749	222,289	179,303	239,057	16,768	59,754
2007	24	2,680,487	1,766,164	914,323	1.200	1.750	3,217,775	3,091,666	537,288	411,179	596,924	59,636	185,746
2008	12	2,556,695	1,097,644	1,459,051	1.503	3.273	3,842,645	3,592,939	1,285,950	1,036,245	1,445,385	159,435	409,141
Total		20,067,179	16,738,684	3,328,495			22,219,966	21,789,878	2,152,787	1,722,699	2,391,084	238,297	668,386

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) From last diagonal of reported and paid claim triangles in Exhibit IV, Sheets 2 through 5.
(5) = [(3) - (4)].
(6) and (7) CDF based on 5-year volume-weighted average age-to-age factors presented in Exhibit IV, Sheets 2 through 5.
(8) = [(3) x (6)].
(9) = [(4) x (7)].
(10) = [(8) - (3)].
(11) = [(9) - (3)].
(12) Developed in Exhibit IV, Sheet 1.
(13) = [(12) - (10)].
(14) = [(12) - (11)].

CHAPTER 8 – EXPECTED CLAIMS TECHNIQUE

Insurers frequently use the expected claims[52] method when entering new lines of business or new territories. Many actuaries also use this method for estimating unpaid claims for the most immature period(s). Expected claims are a critical component of several other methods including the Bornhuetter-Ferguson and Cape Cod techniques, which we discuss in Chapters 9 and 10.

Key Assumption

The key assumption of the expected claims technique is that the actuary can better estimate total unpaid claims based on an a priori (or initial) estimate than from claims experience observed to date. In certain circumstances, the claims experience reported to date may provide little information about ultimate claims, especially when compared to the a priori estimate.

Common Uses of the Expected Claims Method

Actuaries can use the expected claims method with all lines of insurance. However, this method is more commonly used in lines of business with longer emergence patterns and settlement patterns. The method can be used with data organized by accident year, report year, policy year, underwriting year, and even with calendar year data. The expected claims method is often used when:

— An insurer enters a new line of business or a new territory

— Operational or environmental changes make recent historical data irrelevant for projecting future claims activity for that cohort of claims

— The claim development method is not appropriate for less mature periods since the development factors to ultimate are too highly leveraged

— Data is unavailable for other methods

Mechanics of the Expected Claims Technique

There are numerous ways for actuaries to determine the a priori expected claims. Some of the approaches are mathematically simple and some involve complex statistical modeling. The approach most often used by commercial insurers is relatively simple. Actuaries for commercial insurers frequently apply a claim ratio method, where ultimate claims for an experience period are equal to a selected expected claim ratio multiplied by the earned premium. Such an approach implicitly relies on the accuracy of policy pricing and underwriting. An example of the other end

[52] We again remind the reader that we specifically chose the term claims instead of losses. Many actuaries refer to the method described in this chapter as the expected loss method. These actuaries would use the terms expected loss ratios and expected losses instead of the terms expected claim ratios and expected claims that we selected to use. A critical point for the actuary to remember is that he or she must completely understand the terminology used in any situation.

of the spectrum would be a complex simulation model built to project expected claims for a captive insurer covering the errors and omission liability for potential blood-related diseases. The selection of variables for input to this model may require the opinions of an expert panel of doctors, lawyers, and other practitioners from around the world. The complex stochastic model may also require detailed analyses of the frequency rate of claims and the likely cost of each claim if it were to occur.

In this chapter, we focus only on exposure-based methods for determining expected claims. For further information, we refer students to the CAS Research Working Party on Bornhuetter-Ferguson Initial Expected Losses. The goal of this working party is to produce a paper addressing the topic of expected losses (i.e., expected claims).

In many respects, an exposure-based method of determining expected claims consists of very basic calculations. Actuaries calculate expected claims by multiplying a predetermined exposure base by a selected measure of claims per unit of exposure (known as the pure premium or the loss rate). The unpaid claim estimate is simply the projected expected claims less paid claims.

The two challenges of the expected claims method are to determine the appropriate exposure base and to estimate the measurement of claims relative to that exposure base.

For commercial insurers (and reinsurers), the most common exposure base is earned premium and the most common measurement of claims is the claim ratio. Expected claims are then equal to the product of the earned premium and the expected claim ratio.

Self-insured organizations do not generally collect premiums in the same way that an insurer does. As a result, actuaries working with self-insurers generally use other exposure bases that they believe are closely related to the risk and thus the potential for claims and are readily observable and available. The following table provides examples, by line of insurance, of the types of exposures that actuaries often use for the analysis of self-insurers' unpaid claims.

Line of Insurance	**Exposure**
U.S. workers compensation	Payroll
Automobile liability	Number of vehicles or miles driven
General liability for public entities	Population or operating expenditures
General liability for corporations	Sales or square footage
Hospital professional liability	Average occupied beds and outpatient visits
Property	Property values
Crime	Number of employees

For self-insurers, the expected claims are equal to the product of the exposure and a pure premium per unit of exposure.

As noted above, one of the challenges for actuaries working with either insurers (and reinsurers) or self-insurers is to determine the claim ratio or pure premium, respectively. Actuaries often begin with a review of the historical claims and exposure experience. We present two examples of the expected claims method in Exhibit I, Sheets 1 and 2. In these two examples, we use the expected claims method to estimate unpaid claims for accident year 2008 only. We use historical reported and paid claims data as well as exposure data from each organization for our calculations.

Step-by-Step Example – Auto BI Insurer

In Exhibit I, Sheet 1, we develop an estimate of unpaid claims for an insurer writing private passenger automobile bodily injury in one jurisdiction (Auto BI Insurer). For Auto BI Insurer, we have nine years (2000 through 2008) of historical accident year claims and premium data. We summarize the reported and paid claim development projections in Columns (2) through (7). We first present the latest diagonals of the reported and paid claim triangles, claims as of the December 31, 2008 valuation date (Columns (2) and (3)). Cumulative claim development factors, selected based on Auto BI Insurer's historical experience, are summarized in Columns (4) and (5). We then calculate projected ultimate claims in Columns (6) and (7) using the development technique applied to reported and paid claims, respectively. In this example, we develop an initial (a priori) estimate of ultimate claims in Column (8) based on the average of the reported and paid claim development projections.

Up to this point, the analysis is the same as that described in the previous chapter on the development technique. Now, however, we move into new territory. Our goal is to develop an expected claim ratio for accident year 2008. The claim ratio will be based on historical claims and premiums of Auto BI Insurer. In our calculations, we need both the premiums and claims to be at the cost levels expected in 2008. Our first adjustment is to the premiums. We develop on-level premiums to account for rate changes implemented during the nine-year experience period. We require all premiums for each calendar year 2000 to 2007 to be restated as if 2008 rates were effective in each respective year. Such restated premiums are also known as on-level premiums. Column (9) contains the on-level earned premium for Auto BI Insurer.

Next we adjust historical claims for changes that will influence the claims of accident year 2008. The first adjustment in our example is trend. Actuaries often use the term "trend" to describe inflation and other systematic influences on the claims or premiums or both. In this example, the only trend reflected is inflation in claims. Through the use of trend factors we adjust historical claims to the economic value that would be reported if that same claim occurred in accident year 2008. Another way of looking at the trend adjustment is to say that we are restating the value of the historical claims in 2008 dollars.

In our example we use a 14.5% annual claim trend rate for automobile bodily injury liability claims. This trend incorporates both severity and frequency trends for this particular line of insurance in the particular jurisdiction in which the coverage is written. Trend rates can vary significantly by line of business and by geographic region. Trends can be negative for some lines of business and above 20% for other lines of business. Trends can also vary for different periods of time within the experience period. If the actuary is going to use the historical experience of the insurer to determine an expected claim ratio, it is critical to incorporate the effect of claim trends in the analysis.

The second adjustment in our example for Auto BI Insurer is a tort reform adjustment. It is not uncommon for states and provinces to legislate changes to the legal environment for lawsuits arising out of private passenger automobile accidents. In such situations, historical claims need to be restated as if they occurred in the new legal environment. In our example, there was a significant reform implemented during 2004. When multiplying historical claims by a reform adjustment factor of 0.67, we are removing 33% of the claims for the oldest years in the experience period. In essence we are saying that if the same type of claims that occurred in 2000 through 2003 were to occur in 2008, they would cost 33% less. Since the reform was introduced during 2004, the pro rata adjustment factor for 2004 is only 0.75, a 25% reduction. This example demonstrates the significant effect of both trend (e.g., inflation) and tort reform adjustments on the claim costs.

Returning to Exhibit I, the projected claims in Column (12) are adjusted by both the trend factor and the tort reform adjustment. In Column (13), we present the trended adjusted claim ratios, which are equal to the trended adjusted claims divided by the on-level earned premiums. We then take various averages of the claim ratios in Line (14). We observe that the claim development factors to ultimate for both reported and paid claims are highly leveraged for the most recent accident years. The reported claim development factors to ultimate for accident years 2007 and 2008 are 2.90 and 4.00, respectively; and the paid claim development factors to ultimate for accident years 2007 and 2008 are 15.00 and 90.00. Thus, we look at various averages that do not include the experience of the most recent years. In Line (15) we select a claim ratio of 80% based on a review of the individual projected claim ratios in Column (13) and the averages in Line (14).

The final two steps in our example are to project accident year 2008 expected claims and to determine the unpaid claim estimate. The expected claims of $49.6 million (Line (16)) are equal to the selected claim ratio of 80% multiplied by the earned premium of $62 million. We calculate the estimate of unpaid claims by subtracting paid claims for accident year 2008 from the expected claims. The total unpaid claim estimate includes both case outstanding and the broad definition of IBNR. Estimated IBNR is equal to the expected claims less reported claims.

Step-by-Step Example – GL Self-Insurer

In Exhibit I, Sheet 2, we present a similar calculation for a public entity self-insurer's general liability program (GL Self-Insurer). We begin again with the reported and paid claim development methods, and select an initial estimate of ultimate claims based on the average of the two claim development projections (Column (8)). In this example, we use population as our exposure base; historical values are summarized in Column (9) of Exhibit I, Sheet 2. Had we used an inflation-sensitive exposure base, such as payroll or sales, we would need to consider the effect of inflation over the experience period and possibly introduce an exposure trend to adjust all exposures to the common economic value of 2008 exposures.

For GL Self-Insurer, we assume that the only adjustment to claims is for trend, and that the annual claim trend rate is 7.5%. Again this trend incorporates both severity and frequency trends for the jurisdiction in which coverage is provided. An alternative to trending claims and exposures separately when the exposures are inflation-sensitive is to use a residual pure premium trend rate. For example, in U.S. workers compensation, actuaries frequently use a residual pure premium trend that represents the trend in claims that is in excess of the trend in payroll.

After a review of the trended pure premiums in Column (12) and various averages in Line (13), we select a pure premium for accident year 2008 of $3.50 per person. We calculate expected claims of $2,765,000 by multiplying the selected pure premium of $3.50 by the 2008 population (790,000). The total unpaid claim estimate is equal to expected claims less paid claims, and estimated IBNR is equal to expected claims less reported claims.

Step-by-Step Example – U.S. Industry Auto

In Exhibits II through V, we continue with the examples presented in Chapter 7. Exhibit II contains the expected claims projections for the aggregated results of U.S. private passenger automobile insurance (i.e., U.S. Industry Auto). We rely on the selected reported and paid claim development factors from Chapter 7 to develop an initial selection of ultimate claims. Columns (2) through (7) present detailed calculations for the reported and paid claim development projections. We derive the initial selected ultimate claims in Column (8) based on the average of the reported and paid claim development projections.

We then divide the initial selected ultimate claims by earned premium for each year to develop the estimated claim ratios (Column 10). Since the data in Exhibit II represents the consolidated results for the entire U.S. insurance industry, we do not have detailed information regarding rate changes and thus can not adjust the premium to an on-level basis.

The example in Exhibit II differs somewhat from the prior two examples in this chapter in the time period for which the expected claims method is used. In the first two examples, we use historical experience to select an expected claim ratio and an expected pure premium for the 2008 accident year only. Thus, we adjusted the exposures and claims for each year in the experience period to the 2008 cost level. In the example for U.S. Industry Auto, we are projecting ultimate claims for each year in the experience period based on the expected claims technique. Thus, we require a claim ratio at the cost level expected for each year in the experience period. While it is still advisable for the most recent years to review estimated claim ratios from prior years on a trended and adjusted basis, many actuaries use significant judgment when selecting expected claim ratios. In our example, we select expected claim ratios of 75% for accident years 1998 through 2002 and 65% for accident years 2003 through 2007. We incorporate actuarial judgment by selecting two different claim ratios to reflect the change in experience that is apparent between the older accident years and the more recent accident years. (See Column (10) of Exhibit II, Sheet 1.)

In Exhibit II, Sheet 2, we calculate the estimated IBNR and the total unpaid claim estimate. Estimated IBNR in Column (6) is equal to the expected claims in Column (4) less reported claims in Column (2). We then calculate the total unpaid claim estimate as the difference between expected claims and paid claims or the sum of case outstanding plus IBNR. It is interesting to note that in this example the estimated IBNR is negative for accident years 2000, 2001, and 2003. While negative IBNR is possible, particularly for first-party lines of insurance that are subject to salvage and subrogation recoveries, it is not intuitively likely for U.S. Industry Auto. Remember that the key assumption of the expected claims method is that total claims are a function of an a priori estimate and not actual claims activity to date. At times this is a strength of the expected claims method and at times, such as in this example, it proves to be a weakness of the method.

The negative IBNR suggests that the selected a priori claim ratio may be too low for certain accident years. An alternative approach that avoids a negative IBNR is to use the 65% claim ratio assumption for only accident years 2005 through 2007 and to rely on the estimated claim ratios in Column (10) for all prior years (i.e., accident years 1998 through 2004). In other words, limit the use of the expected claims method to accident years 2005 through 2007. Since the expected claims unreported and unpaid for the older years are relatively low, the claim development methods are likely reliable projection methods. (Note, that for accident year 2004, the percentage of claim unreported at December 31, 2007 is only 2% and the percentage unpaid is 8%.)

XYZ Insurer

In Exhibit III, we present the expected claim ratio technique for XYZ Insurer. In the previous chapter, we point out the potential shortcomings of the claim development method for this particular insurer. The primary assumption of the development technique is that future claims will behave in a similar way as historical claims. Due to the various changes experienced by XYZ Insurer, this assumption does not likely hold true. We have several alternatives for consideration in selecting expected claim ratios for XYZ Insurer. First, we can turn to insurance industry experience for benchmark claim ratios. For this particular jurisdiction and coverage, we know that ultimate claim ratios for the aggregated experience of the insurance industry are approximately 50%. Since XYZ Insurer's undeveloped reported claim ratios (i.e., current value of reported claims prior to development divided by earned premiums) are greater than 70% for six of the seven earliest accident years in the experience period, the use of an industry claim ratio does not appear reasonable.

Another alternative is to use the unadjusted reported and paid claim development methods as a starting point. In Exhibit III, we use the reported and paid development methods to determine an initial estimate of ultimate claims. Columns (2) through (8) present these calculations. For accident years 1998 through 2003, which are the most mature years in the experience period, we select the expected claim ratio based on the average of the estimated claim ratios in Column (10).

For the most recent accident years, 2004 through 2008, we select the expected claim ratios in Exhibit III, Sheet 2. Columns (3) through (7) contain trend factors that adjust for inflation; we assume an annual claim trend rate of 3.425% (derived based on an annual frequency trend of -1.50% and an annual severity trend of 5.00%). We adjust the initial ultimate claims for each year in the experience period through the use of these factors to the cost level for each particular year under examination (i.e., 2004 through 2008). For example, the trend factor of 0.874, which appears at the bottom of Column (3), adjusts accident year 2008 claims to the inflation level expected in accident year 2004 ($1.03425^{(2004-2008)}$). Similarly, the trend factor of 1.070, which appears at the top of Column (3), adjusts accident year 2002 claims to the inflation level expected in accident year 2004 ($1.03425^{(2004-2002)}$).

We incorporate a second type of adjustment to ultimate claims through the tort reform adjustment factors in Columns (8) through (12). These factors adjust the ultimate claims of each accident year in the experience period to the tort environment of the particular accident year.

In addition to adjusting claims, we must adjust earned premiums for rate level changes. In Chapter 6, we summarize earned premiums and the historical rate level changes for XYZ Insurer. In Columns (14) through (18) we present the on-level factors that adjust the earned premiums summarized in Column (13) to the rate level for the particular accident year. In other words, this adjustment restates the premium as if the exposures were written at the rate level that was in effect for each particular year.

In Columns (19) through (23) we present trended and adjusted on-level claim ratios. These claim ratios equal the initial estimate of ultimate claims multiplied by the trend factors and the tort reform adjustment factors divided by the earned premiums adjusted to the appropriate rate level for each year. We examine various averages of the claim ratios by year and select expected claim ratios in Line (25) of Exhibit III, Sheet 2.

In Exhibit III, Sheet 1, expected claims in Column (12) are calculated as the product of selected expected claim ratios in Column (11) and the earned premium in Column (9). Estimated IBNR and estimated total unpaid claims are calculated in Exhibit III, Sheet 3. We compare the results of the expected claims method with the claim development method in Exhibit III, Sheet 4 (projected ultimate claims) and in Exhibit III, Sheet 5 (estimated IBNR).

In later chapters, we discuss other approaches for selecting expected claims for XYZ Insurer.

When the Expected Claims Technique Works and When it Does Not

As indicated previously, the expected claims method is often used when an insurer is entering a new line of business or a new territory. If actual historical claims experience is not available for the insurer, the actuary may be able to turn to insurance industry benchmarks for claim ratios, pure premiums, and claim development patterns. Actuaries also use the expected claims technique for the most recent years in the experience period when the cumulative claim development factors are highly leveraged.

In addition, the expected claims method is often relied upon when an insurer has experienced significant change either due to internal factors or external influences. For example, an insurer may decide to use an expected claim ratio method for the latest year in the experience period after major changes in the legal environment. An increase in the statute of limitations for filing claims or expanded coverage due to recent court decisions are examples of changes in the legal environment that can affect insurers' claims liabilities. Of course an important assumption in using the expected claim ratio method is that the actuary can estimate a reliable value of the expected claim ratio that takes into account such a changing legal environment for the insurance coverage.

Since actual claims do not enter into the calculations, the expected claims technique has the advantage of maintaining stability over time. The ultimate claims estimate does not change unless the exposures or claim ratio (or pure premium) assumptions change. While there is a potential advantage in the stability of the projections, there is a potential disadvantage in a lack of responsiveness to recent experience. Because, the technique ignores actual claims experience as reported, the method is not responsive when the actual claims experience differs from the initial expectations. This is evident in the U.S. Industry Auto example presented earlier in this chapter.

There are times, however, when the actuary will judgmentally adjust the claim ratios based on historical experience due to a belief that either the pricing or underwriting or both are changing. In such a situation, the actuary may be able to adjust the a priori expectation in advance of changes being fully manifest in the data. In this circumstance, the expected claims method could prove to be more responsive than data-dependent methods.

Influence of a Changing Environment on the Expected Claims Technique

In the prior chapter on the development technique, we discuss the performance of the development method during times of change. In this section, we continue with these examples using the expected claims technique.

Scenario 1 – U.S. PP Auto Steady-State Environment

In the example for Scenario 1, we assume that the expected claim ratio is equal to 70%, which is the same as the ultimate claim ratio. Thus, the expected claims technique generates an appropriate estimate of IBNR in a steady-state environment. This is also true of the development technique in a steady-state environment. We present detailed calculations for this scenario in the top section of Exhibit IV, Sheet 1.

Scenario 2 – U.S. PP Auto Increasing Claim Ratios

A weakness of the expected claims method is its lack of responsiveness to actual claims experience. The projected value of ultimate claims will only change if the actuary changes the expected claim ratio assumption. Thus, in Scenario 2, unless the actuary changes the 70% expected claim ratio assumption, the projected ultimate claims will be unchanged from Scenario 1. Since claims are increasing in Scenario 2, the estimated IBNR will be lower than the actual IBNR requirements if the actuary estimates unpaid claims using the expected claims method without a revision in the expected claim ratios. This example is particularly severe and it is highly unlikely that an actuary would proceed with this method without a significant change to the claim ratio.

One simple test to assess the adequacy of the expected claim ratio is to compare the reported claim ratio to date to the selected claim ratio. Such a comparison may have alerted the actuary to the fact that for accident years 2004 through 2008, the reported claim ratios are already greater than the expected claim ratio. This simple test would suggest a higher expected claim ratio for more recent accident years and avoid the negative values for IBNR seen in Column (6) of Exhibit IV, Sheet 1 (bottom section).

Scenario 3 – U.S. PP Auto Increasing Case Outstanding Strength

We present the calculations for Scenario 3 in the top section of Exhibit IV, Sheet 2. The expected claims method produces an accurate estimate of IBNR for this scenario. Changes in the adequacy of case outstanding have no effect on the expected claim ratio method since actual claims experience does not enter the calculation.

Scenario 4 – U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

Similar to Scenario 2, IBNR based on the expected claims method for the scenario with increasing claim ratios and case outstanding strength falls short of the actual IBNR requirements, as shown in the bottom section of Exhibit IV, Sheet 2. The actual IBNR and the estimated IBNR differ by the same amount for Scenarios 2 and 4. Without a deliberate change in the expected claim ratio assumption, the expected claims method will not react appropriately to an environment of changing claim ratios.

U.S. Auto Steady-State (No Change in Product Mix)

In the top section of Exhibit V, we summarize the calculations for the example of a combined portfolio of private passenger and commercial automobile insurance with no change in product mix. We assume that we can estimate the expected claim ratio appropriately for the combined portfolio. This is much easier when the proportion of each of the two categories remains consistent over time. We demonstrate in Exhibit V, that the expected claims technique will generate the correct IBNR requirement in times of no change.

U.S. Auto Changing Product Mix

In the final example, we assume that the volume of commercial automobile insurance is increasing at a greater rate than that of private passenger automobile insurance. Since commercial automobile insurance has higher ultimate claim ratios, the actuary will need to modify the expected claim ratio assumption, which is critical to the expected claims technique. The bottom section of Exhibit V demonstrates that without a change in the expected claim ratio, the expected claims technique will produce an inadequate estimate of IBNR.

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Based on Reported	Projected Ultimate Claims Based on Paid	Initial Selected Ultimate Claims	On-Level Earned Premium	Trend at 14.5% to 7/1/08	Adjustment for Tort Reform	Trended Adj. Ultimate Claims	Trended Adjusted Claim Ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2000	10,000,000	9,500,000	1.005	1.050	10,050,000	9,975,000	10,012,500	24,000,000	2.954	0.670	19,816,540	83.0%
2001	8,000,000	7,200,000	1.020	1.150	8,160,000	8,280,000	8,220,000	18,000,000	2.580	0.670	14,209,092	79.0%
2002	9,400,000	7,600,000	1.030	1.250	9,682,000	9,500,000	9,591,000	19,000,000	2.253	0.670	14,477,710	76.0%
2003	15,600,000	7,800,000	1.100	1.350	17,160,000	10,530,000	13,845,000	23,000,000	1.968	0.670	18,255,463	79.0%
2004	16,500,000	11,200,000	1.200	1.750	19,800,000	19,600,000	19,700,000	32,000,000	1.719	0.750	25,398,225	79.0%
2005	18,500,000	10,200,000	1.400	2.500	25,900,000	25,500,000	25,700,000	47,000,000	1.501	1.000	38,575,700	82.0%
2006	16,500,000	6,000,000	1.800	5.000	29,700,000	30,000,000	29,850,000	50,000,000	1.311	1.000	39,133,350	78.0%
2007	14,000,000	3,000,000	2.900	15.000	40,600,000	45,000,000	42,800,000	57,000,000	1.145	1.000	49,006,000	86.0%
2008	8,700,000	750,000	4.000	90.000	34,800,000	67,500,000	51,150,000	62,000,000	1.000	1.000	51,150,000	83.0%

(14) Average Claim Ratio at 7/1/2008 Cost Level	
Average 2000 to 2005	79.7%
Average 2000 to 2005 Excluding High and Low	79.8%
Average 2001 to 2006	78.8%
Average 2001 to 2006 Excluding High and Low	78.8%
(15) Selected Claim Ratio at 7/1/2008 Cost Level	80.0%
(16) Expected Claims for 2008 Accident Year	49,600,000
(17) Unpaid Claim Estimate for 2008 Accident Year	
Total	48,850,000
IBNR	40,900,000

Column and Line Notes:
(2) and (3) Based on data provided by commercial insurer.
(4) and (5) Based on commercial insurer historical claim development experience.
(6) = [(2) x (4)].
(7) = [(3) x (5)].
(8) Based on average of paid and reported claim projections. (8) = [((6) + (7)) / 2].
(9) Based on data provided by commercial insurer.
(10) Assume 14.5% annual trend in private passenger auto bodily injury liability claims. Trend from midpoint of accident year to 7/1/08.
(11) Adjusts for law reforms in private passenger auto implemented during experience period.
(12) = [(8) x (10) x (11)].
(13) = [(12) / (9)].
(14) Various averages of claim ratios in (13).
(15) Selected based on claim ratios by year in (13) and various averages in (14).
(16) Based on selected claim ratio at 2008 cost level and accident year 2008 earned premiums. (16) = [(15) x (9) for 2008].
(17) Total unpaid claim estimate is equal to expected claims in (16) less paid claims for 2008. IBNR is equal to expected claims in (16) less reported claims for 2008.

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Based on Reported	Projected Ultimate Claims Based on Paid	Initial Selected Ultimate Claims	Population	Trend at 7.5% to 7/1/08	Trended Ultimate Claims	Trended Pure Premium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	900,000	890,000	1.015	1.046	913,500	930,940	922,220	709,000	2.061	1,900,695	2.68
1999	1,200,000	1,170,000	1.020	1.067	1,224,000	1,248,390	1,236,195	724,000	1.917	2,369,786	3.27
2000	1,300,000	1,265,000	1.030	1.109	1,339,000	1,402,885	1,370,943	736,000	1.783	2,444,390	3.32
2001	1,800,000	1,600,000	1.051	1.187	1,891,800	1,899,200	1,895,500	740,000	1.659	3,144,635	4.25
2002	1,450,000	1,200,000	1.077	1.306	1,561,650	1,567,200	1,564,425	750,000	1.543	2,413,908	3.22
2003	1,400,000	1,050,000	1.131	1.489	1,583,400	1,563,450	1,573,425	760,000	1.436	2,259,438	2.97
2004	2,400,000	900,000	1.244	1.749	2,985,600	1,574,100	2,279,850	770,000	1.335	3,043,600	3.95
2005	1,800,000	860,000	1.394	2.274	2,509,200	1,955,640	2,232,420	775,000	1.242	2,772,666	3.58
2006	1,500,000	525,000	1.616	3.183	2,424,000	1,671,075	2,047,538	780,000	1.156	2,366,953	3.03
2007	1,200,000	750,000	1.940	5.093	2,328,000	3,819,750	3,073,875	785,000	1.075	3,304,416	4.21
2008	600,000	170,000	3.104	20.373	1,862,400	3,463,410	2,662,905	790,000	1.000	2,662,905	3.37

(13) Average Pure Premium at 7/1/2008 Cost Level	
Average 2000 to 2005	3.55
Average 2000 to 2005 Excluding High and Low	3.52
Average 2001 to 2006	3.50
Average 2001 to 2006 Excluding High and Low	3.45
(14) Selected Pure Premium at 7/1/2008 Cost Level	3.50
(15) Expected Claims for 2008 Accident Year	2,765,000
(16) Unpaid Claim Estimate for 2008 Accident Year	
Total	2,595,000
IBNR	2,165,000

Column and Line Notes:
(2) and (3) Based on data provided by public entity.
(4) and (5) Based on insurance industry benchmark claim development patterns.
(6) = [(2) x (4)].
(7) = [(3) x (5)].
(8) Based on average of paid and reported claim projections. (8) = [((6) + (7)) / 2].
(9) Based on data provided by public entity.
(10) Assume 7.5% annual trend in general liability claims. Trend from midpoint of accident year to 7/1/08.
(11) = [(8) x (10)].
(12) Pure premium based on population. (12) = [(11) / (9)].
(13) Various averages of pure premium in (12).
(14) Selected based on pure premium by year in (12) and various averages in (13).
(15) Based on selected pure premium at 2008 cost level and accident year 2008 population. (15) = [(14) x (9) for 2008].
(16) Total unpaid claim estimate is equal to expected claims in (15) less paid claims for 2008. IBNR is equal to expected claims in (15) less reported claims for 2008.

Projection of Expected Claims ($000)

Accident Year	Claims at 12/31/07		CDF to Ultimate		Projected Ultimate Claims Using Dev. Method with		Initial Selected Ultimate Claims	Earned Premium	Claim Ratio		Expected Claims
	Reported	Paid	Reported	Paid	Reported	Paid			Estimated	Selected	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	47,742,304	47,644,187	1.000	1.002	47,742,304	47,739,475	47,740,890	68,574,209	69.6%	75.0%	51,430,657
1999	51,185,767	51,000,534	1.000	1.004	51,185,767	51,204,536	51,195,152	68,544,981	74.7%	75.0%	51,408,736
2000	54,837,929	54,533,225	1.001	1.006	54,892,767	54,860,424	54,876,596	68,907,977	79.6%	75.0%	51,680,983
2001	56,299,562	55,878,421	1.003	1.011	56,468,461	56,493,084	56,480,772	72,544,955	77.9%	75.0%	54,408,716
2002	58,592,712	57,807,215	1.006	1.020	58,944,268	58,963,359	58,953,814	79,228,887	74.4%	75.0%	59,421,665
2003	57,565,344	55,930,654	1.011	1.040	58,198,563	58,167,880	58,183,221	86,643,542	67.2%	65.0%	56,318,302
2004	56,976,657	53,774,672	1.023	1.085	58,287,120	58,345,519	58,316,320	91,763,523	63.6%	65.0%	59,646,290
2005	56,786,410	50,644,994	1.051	1.184	59,682,517	59,963,673	59,823,095	94,115,312	63.6%	65.0%	61,174,953
2006	54,641,339	43,606,497	1.110	1.404	60,651,886	61,223,522	60,937,704	95,272,279	64.0%	65.0%	61,926,981
2007	48,853,563	27,229,969	1.292	2.390	63,118,803	65,079,626	64,099,215	95,176,240	67.3%	65.0%	61,864,556

Column and Line Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) and (5) Developed in Chapter 7, Exhibit I, Sheets 1 and 2.
(6) = [(2) x (4)].
(7) = [(3) x (5)].
(8) Based on average of paid and reported claim projections. (8) = [((6) + (7)) / 2].
(9) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(10) = [(8) / (9)].
(11) Selected judgmentally based on experience in (10).
(12) = [(9) x (11)].

Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/07 Reported	Claims at 12/31/07 Paid	Expected Claims	Case Outstanding at 12/31/07	Unpaid Claim Estimate Based on Expected Claims Method IBNR	Unpaid Claim Estimate Based on Expected Claims Method Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	47,742,304	47,644,187	51,430,657	98,117	3,688,353	3,786,470
1999	51,185,767	51,000,534	51,408,736	185,233	222,969	408,202
2000	54,837,929	54,533,225	51,680,983	304,704	- 3,156,946	- 2,852,242
2001	56,299,562	55,878,421	54,408,716	421,141	- 1,890,846	- 1,469,705
2002	58,592,712	57,807,215	59,421,665	785,497	828,953	1,614,450
2003	57,565,344	55,930,654	56,318,302	1,634,690	- 1,247,042	387,648
2004	56,976,657	53,774,672	59,646,290	3,201,985	2,669,633	5,871,618
2005	56,786,410	50,644,994	61,174,953	6,141,416	4,388,543	10,529,959
2006	54,641,339	43,606,497	61,926,981	11,034,842	7,285,642	18,320,484
2007	48,853,563	27,229,969	61,864,556	21,623,594	13,010,993	34,634,587
Total	543,481,587	498,050,368	569,281,839	45,431,219	25,800,252	71,231,471

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) Developed in Exhibit II, Sheet 1.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(4) - (3)].

Accident	Claims at 12/31/08		CDF to Ultimate		Projected Ultimate Claims Using Dev. Method with		Initial Selected Ultimate	Earned	Claim Ratio		Expected
Year	Reported	Paid	Reported	Paid	Reported	Paid	Claims	Premium	Estimated	Selected	Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	15,822	15,822	1.000	1.010	15,822	15,980	15,901	20,000	79.5%	78.3%	15,660
1999	25,107	24,817	0.999	1.014	25,082	25,164	25,123	31,500	79.8%	78.3%	24,665
2000	37,246	36,782	0.992	1.031	36,948	37,922	37,435	45,000	83.2%	78.3%	35,235
2001	38,798	38,519	0.992	1.054	38,487	40,600	39,543	50,000	79.1%	78.3%	39,150
2002	48,169	44,437	1.003	1.116	48,313	49,592	48,953	61,183	80.0%	78.3%	47,906
2003	44,373	39,320	1.013	1.268	44,950	49,858	47,404	69,175	68.5%	78.3%	54,164
2004	70,288	52,811	1.064	1.525	74,787	80,537	77,662	99,322	78.2%	87.1%	86,509
2005	70,655	40,026	1.085	2.007	76,661	80,333	78,497	138,151	56.8%	78.3%	108,172
2006	48,804	22,819	1.196	3.160	58,370	72,108	65,239	107,578	60.6%	65.8%	70,786
2007	31,732	11,865	1.512	6.569	47,979	77,941	62,960	62,438	100.8%	63.8%	39,835
2008	18,632	3,409	2.551	21.999	47,530	74,995	61,262	47,797	128.2%	82.5%	39,433

<u>Column and Line Notes:</u>
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheets 1 and 2.
(6) = [(2) x (4)].
(7) = [(3) x (5)].
(8) Based on average of paid and reported claim projections. (8) = [((6) + (7)) / 2].
(9) Based on data from insurer.
(10) = [(8) / (9)].
(11) Selected for 1998 through 2003, based on average of estimated claim ratios in (10) for these years. For 2004 through 2008, selected in Exhibit III, Sheet 2.
(12) = [(9) x (11)].

Chapter 8 - Expected Claims Technique
XYZ Insurer - Auto BI
Selection of Expected Claim Ratios ($000)

Exhibit III
Sheet 2

Accident Year	Initial Selected Ultimate Claims	Trend Adjustment 2004	2005	2006	2007	2008	Tort Reform Adjustment 2004	2005	2006	2007	2008
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2002	48,953	1.070	1.106	1.144	1.183	1.224	1.000	1.000	0.893	0.670	0.670
2003	47,404	1.034	1.070	1.106	1.144	1.183	1.000	1.000	0.893	0.670	0.670
2004	77,662	1.000	1.034	1.070	1.106	1.144	1.000	1.000	0.893	0.670	0.670
2005	78,497	0.967	1.000	1.034	1.070	1.106	1.000	1.000	0.893	0.670	0.670
2006	65,239	0.935	0.967	1.000	1.034	1.070	1.119	1.119	1.000	0.750	0.750
2007	62,960	0.904	0.935	0.967	1.000	1.034	1.493	1.493	1.333	1.000	1.000
2008	61,262	0.874	0.904	0.935	0.967	1.000	1.493	1.493	1.333	1.000	1.000

Accident Year	Earned Premium	Rate Level Adjustment 2004	2005	2006	2007	2008	Trended, Adjusted On-Level Claim Ratios 2004	2005	2006	2007	2008
(1)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
2002	61,183	1.129	1.298	1.428	1.142	0.914	75.8%	68.2%	57.3%	55.5%	71.8%
2003	69,175	1.075	1.236	1.360	1.088	0.870	65.9%	59.3%	49.8%	48.3%	62.4%
2004	99,322	1.000	1.150	1.265	1.012	0.810	78.2%	70.3%	59.1%	57.3%	74.0%
2005	138,151	0.870	1.000	1.100	0.880	0.704	63.2%	56.8%	47.7%	46.3%	59.8%
2006	107,578	0.791	0.909	1.000	0.800	0.640	80.3%	72.2%	60.6%	58.8%	76.0%
2007	62,438	0.988	1.136	1.250	1.000	0.800	137.7%	123.8%	104.0%	100.8%	130.3%
2008	47,797	1.235	1.420	1.563	1.250	1.000	135.4%	121.7%	102.3%	99.2%	128.2%

	2004	2005	2006	2007	2008
(24) Average Claim Ratios					
All Years	90.9%	81.8%	68.7%	66.6%	86.1%
All Years excluding High and Low	87.1%	78.3%	65.8%	63.8%	82.5%
Latest 5 Years	98.9%	89.0%	74.7%	72.5%	93.7%
Latest 3 Years	117.8%	105.9%	89.0%	86.3%	111.5%
(25) Selected Expected Claim Ratio	87.1%	78.3%	65.8%	63.8%	82.5%

Column and Line Notes:
(2) Developed in Exhibit III, Sheet 1.
(3) through (7) Assume annual pure premium trend rate of 3.425%. Adjust all claims in experience period to average cost level of particular accident year.
(8) through (12) Based on independent analysis of tort reform. Adjust all claims in experience period to tort environment of particular accident year.
(13) Based on data from XYZ Insurer.
(14) through (18) Based on rate level changes summarized in Chapter 6. Adjusts earned premium to rate level in effect for particular accident year. Students should refer to ratemaking papers for the on-level factors calculation procedure.
(19) through (23) Equal to [(initial selected ultimate claims x trend adjustment x tort reform adjustment) / (earned premium x rate level adjustment)].
(24) Averages based on claim ratios in (19) through (23).
(25) Selected based on review of claim ratios by year in (19) through (23) and average claim ratios in (24).

Chapter 8 - Expected Claims Technique
XYZ Insurer - Auto BI
Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Expected Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate Based on Expected Claims Method IBNR	Unpaid Claim Estimate Based on Expected Claims Method Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	15,822	15,822	15,660	0	- 162	- 162
1999	25,107	24,817	24,665	290	- 442	- 152
2000	37,246	36,782	35,235	465	- 2,011	- 1,547
2001	38,798	38,519	39,150	278	352	631
2002	48,169	44,437	47,906	3,731	- 262	3,469
2003	44,373	39,320	54,164	5,052	9,791	14,844
2004	70,288	52,811	86,509	17,477	16,221	33,698
2005	70,655	40,026	108,172	30,629	37,517	68,146
2006	48,804	22,819	70,786	25,985	21,982	47,967
2007	31,732	11,865	39,835	19,867	8,103	27,970
2008	18,632	3,409	39,433	15,223	20,801	36,024
Total	449,626	330,629	561,516	118,997	111,890	230,887

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) Developed in Exhibit III, Sheet 1.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(4) - (3)].

Summary of Ultimate Claims ($000)

			Projected Ultimate Claims		
Accident	Claims at 12/31/08		Development Method		Expected
Year	Reported	Paid	Reported	Paid	Claims
(1)	(2)	(3)	(4)	(5)	(6)
1998	15,822	15,822	15,822	15,980	15,660
1999	25,107	24,817	25,082	25,164	24,665
2000	37,246	36,782	36,948	37,922	35,235
2001	38,798	38,519	38,487	40,600	39,150
2002	48,169	44,437	48,313	49,592	47,906
2003	44,373	39,320	44,950	49,858	54,164
2004	70,288	52,811	74,787	80,537	86,509
2005	70,655	40,026	76,661	80,333	108,172
2006	48,804	22,819	58,370	72,108	70,786
2007	31,732	11,865	47,979	77,941	39,835
2008	18,632	3,409	47,530	74,995	39,433
Total	449,626	330,629	514,929	605,030	561,516

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Exhibit III, Sheet 1.

Chapter 8 - Expected Claims Technique Exhibit III
XYZ Insurer - Auto BI Sheet 5
Summary of IBNR ($000)

	Case	Estimated IBNR		
Accident	Outstanding	Development Method		Expected
Year	at 12/31/08	Reported	Paid	Claims
(1)	(2)	(3)	(4)	(5)
1998	0	0	158	- 162
1999	290	- 25	58	- 442
2000	465	- 298	676	- 2,011
2001	278	- 310	1,802	352
2002	3,731	145	1,423	- 262
2003	5,052	577	5,485	9,791
2004	17,477	4,498	10,249	16,221
2005	30,629	6,006	9,678	37,517
2006	25,985	9,566	23,304	21,982
2007	19,867	16,247	46,209	8,103
2008	15,223	28,898	56,363	20,801
Total	118,997	65,303	155,405	111,890

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Exhibit III, Sheet 3.

Chapter 8 - Expected Claims Technique Exhibit IV
Impact of Changing Conditions Sheet 1
U.S. PP Auto - Development of Unpaid Claim Estimate

Accident Year	Earned Premium	Expected Claim Ratio	Expected Claims	Reported Claims at 12/31/08	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	0	0	0
2003	1,215,506	70.0%	850,854	842,346	8,509	8,509	0
2004	1,276,282	70.0%	893,397	884,463	8,934	8,934	0
2005	1,340,096	70.0%	938,067	919,306	18,761	18,761	0
2006	1,407,100	70.0%	984,970	935,722	49,249	49,249	0
2007	1,477,455	70.0%	1,034,219	930,797	103,422	103,422	0
2008	1,551,328	70.0%	1,085,930	836,166	249,764	249,764	0
Total	12,577,893		8,804,525	8,365,887	438,638	438,638	0
Increasing Claim Ratios							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	0	0	0
2003	1,215,506	70.0%	850,854	842,346	8,509	8,509	0
2004	1,276,282	70.0%	893,397	1,010,815	- 117,418	10,210	127,628
2005	1,340,096	70.0%	938,067	1,116,300	- 178,233	22,782	201,014
2006	1,407,100	70.0%	984,970	1,203,071	- 218,101	63,320	281,420
2007	1,477,455	70.0%	1,034,219	1,263,224	- 229,006	140,358	369,364
2008	1,551,328	70.0%	1,085,930	1,194,523	- 108,593	356,805	465,398
Total	12,577,893		8,804,525	9,647,366	- 842,841	601,984	1,444,824

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Assumed equal to 70% for all years.
(4) = [(2) x (3)].
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit III, Sheets 2 and 4.
(6) = [(4) - (5)].
(7) Developed in Chapter 7, Exhibit III, Sheet 1.
(8) = [(7) - (6)].

Chapter 8 - Expected Claims Technique
Impact of Changing Conditions
U.S. PP Auto - Development of Unpaid Claim Estimate

Exhibit IV
Sheet 2

Accident Year	Earned Premium	Expected Claim Ratio	Expected Claims	Reported Claims at 12/31/08	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Increasing Case Outstanding Strength							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	0	0	0
2003	1,215,506	70.0%	850,854	842,346	8,509	8,509	0
2004	1,276,282	70.0%	893,397	884,463	8,934	8,934	0
2005	1,340,096	70.0%	938,067	933,377	4,690	4,690	0
2006	1,407,100	70.0%	984,970	962,808	22,162	22,162	0
2007	1,477,455	70.0%	1,034,219	979,922	54,296	54,296	0
2008	1,551,328	70.0%	1,085,930	931,185	154,745	154,745	0
Total	12,577,893		8,804,525	8,551,189	253,336	253,336	0
Increasing Claim Ratios and Case Outstanding Strength							
1999	1,000,000	70.0%	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	810,338	0	0	0
2003	1,215,506	70.0%	850,854	842,346	8,509	8,509	0
2004	1,276,282	70.0%	893,397	1,010,815	- 117,418	10,210	127,628
2005	1,340,096	70.0%	938,067	1,133,386	- 195,319	5,695	201,014
2006	1,407,100	70.0%	984,970	1,237,897	- 252,926	28,494	281,420
2007	1,477,455	70.0%	1,034,219	1,329,895	- 295,676	73,688	369,364
2008	1,551,328	70.0%	1,085,930	1,330,264	- 244,334	221,064	465,398
Total	12,577,893		8,804,525	9,901,689	- 1,097,165	347,660	1,444,824

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Assumed equal to 70% for all years.
(4) = [(2) x (3)].
(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit III, Sheets 6 and 8.
(6) = [(4) - (5)].
(7) Developed in Chapter 7, Exhibit III, Sheet 1.
(8) = [(7) - (6)].

Chapter 8 - Expected Claims Technique
Impact of Change in Product Mix Example
U.S. Auto - Development of Unpaid Claim Estimate

Exhibit V

Accident Year	Earned Premium	Expected Claim Ratio	Expected Claims	Reported Claims at 12/31/08	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State (No Change in Product Mix)							
1999	2,000,000	75.0%	1,500,000	1,500,000	0	0	0
2000	2,100,000	75.0%	1,575,000	1,575,000	0	0	0
2001	2,205,000	75.0%	1,653,750	1,653,750	0	0	0
2002	2,315,250	75.0%	1,736,438	1,736,438	0	0	0
2003	2,431,013	75.0%	1,823,259	1,814,751	8,509	8,509	0
2004	2,552,563	75.0%	1,914,422	1,885,068	29,354	29,354	0
2005	2,680,191	75.0%	2,010,143	1,948,499	61,644	61,644	0
2006	2,814,201	75.0%	2,110,651	1,937,577	173,073	173,073	0
2007	2,954,911	75.0%	2,216,183	1,852,729	363,454	363,454	0
2008	3,102,656	75.0%	2,326,992	1,568,393	758,599	758,599	0
Total	25,155,785		18,866,839	17,472,204	1,394,634	1,394,634	0
Changing Product Mix							
1999	2,000,000	75.0%	1,500,000	1,500,000	0	0	0
2000	2,100,000	75.0%	1,575,000	1,575,000	0	0	0
2001	2,205,000	75.0%	1,653,750	1,653,750	0	0	0
2002	2,315,250	75.0%	1,736,438	1,736,438	0	0	0
2003	2,431,013	75.0%	1,823,259	1,814,751	8,509	8,509	0
2004	2,552,563	75.0%	1,914,422	1,885,068	29,354	29,354	0
2005	2,999,262	75.0%	2,249,446	2,193,545	55,901	71,855	15,954
2006	3,564,016	75.0%	2,673,012	2,471,446	201,566	239,057	37,491
2007	4,281,446	75.0%	3,211,085	2,680,487	530,597	596,924	66,327
2008	5,196,516	75.0%	3,897,387	2,556,695	1,340,692	1,445,385	104,693
Total	29,645,066		22,233,799	20,067,179	2,166,620	2,391,084	224,465

Column Notes:

(2) For no change scenario, assume $2,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.

(3) Assumed equal to 75% for all years.

(4) = [(2) x (3)].

(5) From last diagonal of reported claim triangles presented in Chapter 7, Exhibit IV, Sheets 2 and 4.

(6) = [(4) - (5)].

(7) Developed in Chapter 7, Exhibit IV, Sheet 1.

(8) = [(7) - (6)].

CHAPTER 9 – BORNHUETTER-FERGUSON TECHNIQUE

Actuaries rely on the Bornhuetter-Ferguson technique almost as often as they rely on the development method. The Bornhuetter-Ferguson technique is essentially a blend of the development and expected claims techniques. In the development technique, we multiply actual claims by a cumulative claim development factor. This technique can lead to erratic, unreliable projections when the cumulative development factor is large because a relatively small swing in reported claims or the reporting of an unusually large claim could result in a very large swing in projected ultimate claims. In the expected claims technique, the unpaid claim estimate is equal to the difference between a predetermined estimate of expected claims and the actual payments. This has the advantage of stability, but it completely ignores actual results as reported. The Bornhuetter-Ferguson technique combines the two techniques by splitting ultimate claims into two components: actual reported (or paid) claims and expected unreported (or unpaid) claims. As experience matures, more weight is given to the actual claims and the expected claims become gradually less important.

In the 1993 paper "Loss Development Using Credibility,"[53] Eric Brosius described the Bornhuetter-Ferguson method as a credibility weighting between the development method and the expected claims method. In the development method, full credibility (i.e., Z = 1) is given to actual claims experience; and in the expected claims method, no credibility (i.e., Z = 0) is given to actual claims. In the Bornhuetter-Ferguson, credibility is equal to the percentage of claims developed at a particular stage of maturity, which is a function of the cumulative claim development factor (i.e., Z = 1.00 / cumulative development factor). Therefore, more weight is given to the expected claims method in less mature years, and more weight is given to the development method in more mature years of the experience period.

Key Assumptions

The key assumption of the Bornhuetter-Ferguson method is that unreported (or unpaid) claims will develop based on expected claims. In other words, the claims reported to date contain no informational value as to the amount of claims yet-to-be reported. This is different from the development method where the primary assumption is that unreported (or unpaid) claims will develop based on reported (or paid) claims to date.

The reporting and payment patterns used in the Bornhuetter-Ferguson methods are the same as those selected in the development method. However, the application of the development factors differs between the two methods. It is also important to note that the expected claims used in the Bornhuetter-Ferguson method using reported claims are the same as those used in the Bornhuetter-Ferguson method using paid claims.

Common Uses of the Bornhuetter-Ferguson Technique

The Bornhuetter-Ferguson technique is most frequently applied to reported and paid claims, yet it can also be used with the number of claims and with ALAE. Actuaries use this technique with all lines of insurance including short-tail lines and long-tail lines. Similar to the development

[53] *CAS Study Note*, 1993

method, the Bornhuetter-Ferguson method is used with data organized in many different time intervals including:

- Accident year
- Policy year
- Underwriting year
- Report year
- Fiscal year

Actuaries also apply this technique to data organized by month, quarter, or half-year.

Mechanics of the Bornhuetter-Ferguson Technique

As indicated previously, the Bornhuetter-Ferguson technique is a blend of two other methods: the development method and the expected claims method. The following two formulae represent the reported and paid Bornhuetter-Ferguson methods, respectively:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims
Ultimate Claims = Actual Reported Claims + (Expected Claims) x (% Unreported)

Ultimate Claims = Actual Paid Claims + Expected Unpaid Claims
Ultimate Claims = Actual Paid Claims + (Expected Claims) x (% Unpaid)

Since actual reported and paid claims are both known quantities, the challenge of the Bornhuetter-Ferguson method is to calculate the expected unreported and expected unpaid claims. In order to complete the Bornhuetter-Ferguson method, the actuary must select claim development patterns and develop an expected claims estimate.

In our step-by-step example of the Bornhuetter-Ferguson method, we use the cumulative claim development patterns presented in Chapter 7 and the expected claims developed in Chapter 8.[54] In Exhibit I, Sheet 1, we present both the reported and paid Bornhuetter-Ferguson projections for U.S. Industry Auto.

The second column of Exhibit I, Sheet 1, contains the expected claims developed in Chapter 8 for U.S. Industry Auto. Columns (3) and (4) are the selected cumulative claim development factors described in Chapter 7. We convert the cumulative claim development patterns to percentage unreported and percentage unpaid in Columns (5) and (6), respectively. The percentage reported is equal to the inverse of the cumulative reported claim development factor. Thus, the percentage unreported is equal to 1.00 minus the inverse of the cumulative reported claim development factor. Similarly, the percentage paid is equal to the inverse of the cumulative paid claim

[54] Recall that expected claims are developed in Chapter 8 based on earned premiums and selected claim ratios. We discussed the importance of adjusting premiums to an on-level basis when selecting expected claim ratios. The purpose of adjusting premiums to an on-level basis is to develop a proxy for the underlying exposures in each year of the experience period. An alternative to the use of premiums and claim ratios for developing expected claims is exposures and pure premiums (also referred to as loss rates or loss costs). Many actuaries who work with self-insurers rely on such an approach. Due to enhancements in many insurers' data systems, historical exposures may become more readily available to actuaries and can thus be directly incorporated into the development of expected claims for the Bornhuetter-Ferguson technique.

development factor; and the percentage unpaid is equal to 1.00 minus the inverse of the cumulative paid claim development factor.

Once again, we summarize the selected claim development factors for reported and paid claims as well as the associated reporting and payment patterns in Table 1 below.

Table 1 – U.S. Industry Auto
Selected Reporting and Payment Patterns

	Reported Claims			Paid Claims		
Age (Month)	**CDF to Ultimate**	**% Reported**	**% Unreported**	**CDF to Ultimate**	**% Paid**	**% Unpaid**
12	1.292	77.4%	22.6%	2.390	41.8%	58.2%
24	1.110	90.1%	9.9%	1.404	71.2%	28.8%
36	1.051	95.1%	4.9%	1.184	84.5%	15.5%
48	1.023	97.8%	2.2%	1.085	92.2%	7.8%
60	1.011	98.9%	1.1%	1.040	96.2%	3.8%
72	1.006	99.4%	0.6%	1.020	98.0%	2.0%
84	1.003	99.7%	0.3%	1.011	98.9%	1.1%
96	1.001	99.9%	0.1%	1.006	99.4%	0.6%
108	1.000	100.0%	0.0%	1.004	99.6%	0.4%
120	1.000	100.0%	0.0%	1.002	99.8%	0.2%

The primary assumption of the reported Bornhuetter-Ferguson method is that unreported claims will emerge in accordance with expected claims. Thus, the next step of this method is to calculate the expected unreported claims. In Column (7), we calculate expected unreported claims by accident year. Expected unreported claims are equal to expected claims in Column (2) multiplied by the percentage unreported in Column (5) for each year. Similarly, expected unpaid claims in Column (8) are equal to expected claims from Column (2) multiplied by the percentage unpaid in Column (6).

Returning to our original formulae for the Bornhuetter-Ferguson method,

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

Ultimate Claims = Actual Paid Claims + Expected Unpaid Claims

We can now calculate the projected ultimate claims. Using the reported Bornhuetter-Ferguson method, projected ultimate claims in Column (11) are equal to the actual reported claims in Column (9) plus the expected unreported claims in Column (7). The projected ultimate claims based on the paid Bornhuetter-Ferguson method are shown in Column (12); they are equal to actual paid claims in Column (10) plus expected unpaid claims in Column (8).

Unpaid Claim Estimate Based on Bornhuetter-Ferguson Technique

We follow a similar procedure for determining the unpaid claim estimate based on the Bornhuetter-Ferguson technique (Exhibit I, Sheet 2) as presented in the prior chapters for the development and expected claims techniques. Estimated IBNR is equal to projected ultimate claims less reported claims[55] and the total unpaid claim estimate is equal to the difference between projected ultimate claims and paid claims.

Exhibit I, Sheet 2, presents the calculations of the unpaid claim estimate for U.S. Industry Auto. Columns (2) and (3) contain reported and paid claims data as of December 31, 2007. The projected ultimate claims, developed in Exhibit I, Sheet 1, are summarized in Columns (4) and (5). Case outstanding, which are equal to the difference between reported claims and paid claims as of December 31, 2007, are presented in Column (6). Estimated IBNR is equal to projected ultimate claims minus reported claims. In Columns (7) and (8), we calculate estimated IBNR based on the reported and paid Bornhuetter-Ferguson techniques, respectively. The total unpaid claim estimate is equal to the sum of case outstanding and estimated IBNR. We present the estimate of total unpaid claims in Columns (9) and (10) based on the reported and paid Bornhuetter-Ferguson techniques, respectively.

When the Bornhuetter-Ferguson Technique Works and When it Does Not

An advantage of the Bornhuetter-Ferguson technique is that random fluctuations early in the life of an accident year (or other defined time interval) do not significantly distort the projections. For example, if several large and unusual claims are reported for an accident year, then the reported claim development technique may produce overly conservative ultimate claims estimates. This situation does not, however, seriously distort the Bornhuetter-Ferguson technique.

Actuaries frequently use the Bornhuetter-Ferguson method for long-tail lines of insurance, particularly for the most immature years, due to the highly leveraged nature of claim development factors for such lines. Actuaries may also use the Bornhuetter-Ferguson technique if the data is extremely thin or volatile or both. For example, when an insurer has recently entered a new line of business or a new territory and there is not yet a credible volume of historical claim development experience, an actuary may use the Bornhuetter-Ferguson technique. In such circumstances, the actuary would likely need to rely on benchmarks, either from similar lines at the same insurer or insurance industry experience, for development patterns and expected claim ratios (or pure premiums). (See previous comments about the use of industry benchmarks.)

In a discussion of when to use the Bornhuetter-Ferguson method in the paper "The Actuary and IBNR," the authors state: "It can be argued that the most prudent course is, when in doubt, to use expected losses, in as much as it is certainly indicated for volatile lines, and in the case of a stable line, the expected loss ratio should be predictable enough so that both techniques produce the same result."[56]

The Bornhuetter-Ferguson technique can be a useful method for very short-tail lines as well as long-tail lines. For very short-tail lines, the IBNR can be set equal to a multiple of the last few months' earned premium; this is essentially an application of the Bornhuetter-Ferguson technique.

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[55] Recall that the formula for the reported Bornhuetter-Ferguson method is:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

Thus, for the reported Bornhuetter-Ferguson projection, the expected unreported claims are equal to the estimated IBNR.

[56] *PCAS*, 1972.

The Bornhuetter-Ferguson Method and Cumulative CDFs Less than 1.00

Downward development (i.e., cumulative development factors that are less than 1.00) does occur for some insurers, for some lines of business. Automobile physical damage and property are examples of coverages in which actuaries can observe this type of development experience. For some insurers, salvage and subrogation recoveries lag the reporting and payment of claims, which can result in report-to-report factors that are less than 1.00. For some insurers, a conservative philosophy regarding case outstanding can also result in an observed downward development of reported claims as payments for claims may be less than the case outstanding set by claims adjusters. For those lines of business for which the actuary derives cumulative claim development factors that are less than 1.00, we revisit the original premise of the Bornhuetter-Ferguson method.

At the beginning of this chapter, we refer to Brosius' description of the Bornhuetter-Ferguson method as a credibility-weighting between the development method and the expected claims method. Credibility is concerned with the combination of the projections from these two methods. The basic formula for calculating the credibility-weighted projection is:

[(Z) x (development method)] + [(1 – Z) x (expected claims method)],

where,

$0 \leq Z \leq 1$,
Z is the credibility assigned to the development method, and
(1 – Z) is the complement of credibility assigned to the expected claims method.

As noted earlier, the credibility is equal to the percentage of claims developed at a particular stage of maturity, which is a function of the cumulative claim development factor (Z = 1.000 / cumulative development factor).

From a theoretical perspective, the credibility-weighting approach of the Bornhuetter-Ferguson method does not hold true if the cumulative development factor is less than 1.00 since the value assigned to credibility, Z, is then greater than 1.00. For example, if the cumulative development factor is 0.93, then the credibility assigned to the development method is equal to 1.075 (1.00 / 0.93). However, as defined above, credibility must be a value between 0 and 1. Thus, a credibility value of 1.075 is outside of the acceptable range.

While cumulative development factors that are less than 1.00 present a theoretical issue for the use of the Bornhuetter-Ferguson method, in practice, many actuaries continue to use this method with such factors. One solution to address this theoretical challenge is to limit the cumulative development factors to a minimum value of 1.00 when applying the Bornhuetter-Ferguson technique. (We follow this approach for the examples in this text.) Alternatively, and what happens quite frequently in practice, is that the actuary will still calculate the reported Bornhuetter-Ferguson projected ultimate claims using cumulative development factors that are less than 1.00 but will rely on another technique to select ultimate claims for the year(s) in question (i.e., years with cumulative development factors less than 1.00). As noted previously in this chapter, actuaries frequently use the Bornhuetter-Ferguson method for long-tail lines of insurance, particularly for the most immature years. Cumulative development factors for these lines and years are typically much greater than 1.00. Nevertheless, it is worthwhile to note that some actuaries continue to include the Bornhuetter-Ferguson method as part of their analyses even in the presence of cumulative development factors that are less than 1.00.

XYZ Insurer

In Exhibit II, Sheets 1 and 2, we present the results of the reported and paid Bornhuetter-Ferguson methods based on the expected claims developed in Chapter 8 for XYZ Insurer. The presentation and calculations are identical to the previous example for U.S. Industry Auto (Exhibit I). We will not examine the results of this projection in detail because we know that the expected claims estimates underlying the projections are likely inaccurate. Remember that the primary assumption of the development method does not hold true for XYZ Insurer as a result of the operational and environmental changes that took place during the experience period. Nevertheless, we derive the current estimates of expected claims using unadjusted reported and paid claim development methods. We compare the results of the Bornhuetter-Ferguson method with the expected claims method and the development method in Exhibit II, Sheet 3 (projected ultimate claims) and in Exhibit II, Sheet 4 (estimated IBNR). In later chapters, we look at alternative methods that can be used for developing expected claims for use in a revised Bornhuetter-Ferguson method.

Influence of a Changing Environment on the Bornhuetter-Ferguson Method[57]

In Chapters 7 and 8, we discuss the performance of the development technique and the expected claims technique, respectively, during times of change. We continue with these examples using the Bornhuetter-Ferguson technique. Since the Bornhuetter-Ferguson method is a combination of the development method and the expected claims method, we will refer you to these prior chapters for critical input. For example, refer to Chapter 7 for the reported and paid claim development triangles and the selection of age-to-age factors, and refer to Chapter 8 for the calculation of expected claims.

Scenario 1 – U.S. PP Auto Steady-State

For Scenarios 1 through 4, we use an expected claim ratio of 70%. Since the steady-state environment also has a 70% ultimate claim ratio, the Bornhuetter-Ferguson technique generates an accurate estimate of IBNR. We see in Chapters 7 and 8, that the development and expected claims techniques also generate accurate IBNR values in a steady-state environment. Detailed calculations are presented for the Bornhuetter-Ferguson method in the top section of Exhibit III, Sheet 1.

[57] We present the following examples to demonstrate the effect of not changing assumptions on the resulting projections of ultimate claims and the estimate of unpaid claims. We recognize that the examples are not necessarily representative of real-life applications of the Bornhuetter-Ferguson method since we assume that there are no adjustments in expected claims in anticipation of the events that caused higher claim ratios or changes in business mix. Most insurers have a feel for whether a market is getting softer or harder, so they would have a sense as to the direction to adjust the expected claims, if not the absolute amount of adjustment. In addition, actuaries typically use the Bornhuetter-Ferguson technique where development data is sparse and erratic, which is exactly where the development approaches are very weak. Hence, we note that the PP Auto examples are biased against a Bornhuetter-Ferguson approach.

Scenario 2 – U.S. PP Auto Increasing Claim Ratios

The weakness of the expected claims method is also a weakness of the Bornhuetter-Ferguson method. Remember the original formulae for the reported and paid Bornhuetter-Ferguson method:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

Ultimate Claims = Actual Paid Claims + Expected Unpaid Claims

While projected ultimate claims are increasing between Scenarios 1 and 2, the increases are due to higher values of actual reported and paid claims and not higher estimates of the expected unreported and unpaid claims. Since the expected claims estimate does not change in this example, the expected unreported and unpaid claims do not change in Scenario 2 from the steady-state values of Scenario 1.

For the reported Bornhuetter-Ferguson technique, the estimated IBNR is identical between the steady-state environment and the environment with increasing claim ratios. Without a deliberate change in the expected claim ratio, this method will not respond to a situation with increasing claim ratios. The paid Bornhuetter-Ferguson performs even worse than the reported Bornhuetter-Ferguson technique for Scenario 2. The estimate of expected unpaid claims is understated to an even greater degree than the expected unreported claims. This is due to the longer-term nature of the payment pattern than the reporting pattern, which implies that the percentage unpaid cannot be less than the percentage unreported at any age. (See Table 5 of Chapter 7, which summarizes the reporting and payment patterns.)

Scenario 3 – U.S. PP Auto Increasing Case Outstanding Strength

We present the calculations for Scenario 3 in the top section of Exhibit III, Sheet 2. The reported Bornhuetter-Ferguson technique produces an estimate of IBNR that is greater than the actual IBNR for this scenario. Similar to the paid claim development technique, the paid Bornhuetter-Ferguson method is unaffected by changes only in case outstanding strength.

In Chapter 7, we saw how increases in case outstanding strength led to increases in age-to-age factors and in cumulative claim development factors. The cumulative claim development factors are an important input to the Bornhuetter-Ferguson method. Thus, if the cumulative claim development factors are changing due to increases in case outstanding strength, it will also have an effect on the Bornhuetter-Ferguson projection. The expected claims, on the other hand, remain unchanged.

The estimated IBNR, in this scenario, based on the reported Bornhuetter-Ferguson method is greater than the actual IBNR requirement. However, the overstatement is less for the reported Bornhuetter-Ferguson method than for the reported claim development method because we did not increase the expected claims. In Chapter 7, we discuss how there are two forces that contribute to the excessive estimate of IBNR in the development technique. First, age-to-age factors increase due to the change in case outstanding adequacy. Second, we then multiply the resulting higher cumulative claim development factors by the latest valuation of reported claims, which contains higher reported values due to the increase in case outstanding strength. There is, in essence, a leveraging effect of higher factors and higher claims in the development technique. In the Bornhuetter-Ferguson method, the higher cumulative claim development factors result in greater percentages of expected unreported claims. However, the same leveraging effect does not exist since expected claims, not actual claims, are the basis for determining unreported claims in the Bornhuetter-Ferguson method, and the expected claims did not change in our example.

Scenario 4 – U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

We present the detailed calculations for Scenario 4 in the bottom section of Exhibit III, Sheet 2. We see that the estimated IBNR based on the reported Bornhuetter-Ferguson method is overstated while the paid Bornhuetter-Ferguson projection is understated, absent a change in the expected claims assumption.

For both projections, the expected claims used in the example are too low. This is the reason that the paid Bornhuetter-Ferguson method produces an estimate of IBNR that is $443,260 lower than the actual IBNR. This is the same difference between estimated and actual IBNR that we saw in Scenario 2, where claim ratios increased and case outstanding strength remained stable. Since the payment pattern is unaffected by changes in case outstanding adequacy, there is no effect on the paid Bornhuetter-Ferguson method. The sole reason for the inadequacy of the paid Bornhuetter-Ferguson method is the understatement of expected claims.

In Scenario 2 (increasing claim ratios and stable case outstanding strength), we see that the reported Bornhuetter-Ferguson technique produces an estimated IBNR that is lower than the actual IBNR. In Scenario 3 (stable claim ratio and increasing case outstanding strength), the estimated IBNR based on the reported Bornhuetter-Ferguson method is too high. These two factors work in opposition in Scenario 4, in which both claim ratios and case outstanding strength are increasing. Even though expected claims are too low for Scenario 4, there is more than an offsetting effect from the higher cumulative development factors leading to an estimated IBNR for the reported Bornhuetter-Ferguson technique that is $112,773 higher than the actual IBNR.

In Scenario 4, with increasing claim ratios and case outstanding strengthening, the difference from the actual IBNR using the Bornhuetter-Ferguson method could be positive or negative depending on the extent of case outstanding strengthening and deteriorating claim ratio.

U.S. Auto Steady-State (No Change in Product Mix)

In the last two examples, we present the projections for a combined portfolio of private passenger and commercial automobile. In the top section of Exhibit IV, we summarize the calculations assuming a steady-state (i.e., no change in product mix). Similar to our projections using the claim development and expected claims techniques, we demonstrate in Exhibit IV, that the Bornhuetter-Ferguson technique will generate the correct IBNR requirement if there is no change in the product mix.

U.S. Auto Changing Product Mix

In the final example, we assume that the volume of commercial automobile insurance is increasing at a greater rate than that of private passenger automobile insurance. In the bottom section of Exhibit IV, we quickly observe that both the reported and paid Bornhuetter-Ferguson methods produce estimated IBNR that is lower than the actual IBNR. This is due to the expected claim ratio assumption that is unchanged from the U.S. Auto Steady-State.

Since the commercial automobile segment is growing at a greater rate than the private passenger auto segment, and since commercial automobile has a higher ultimate claim ratio, the actuary needs to modify the expected claim ratio assumption. Without such modification, the estimated IBNR from both the expected claims and the Bornhuetter-Ferguson methods proves inadequate. The reporting and payment patterns also require change. With an increasing proportion of commercial automobile, the reporting and payment patterns lengthen, and thus result in the requirement for a higher IBNR value.

Benktander Technique

An often-cited advantage of the Bornhuetter-Ferguson technique versus the development technique is stability in the presence of sparse data. However, since the estimate of unpaid claims for the most recent accident years using the Bornhuetter-Ferguson technique is heavily dependant on the actuary's judgment when determining the expected claims, actual claims emergence for these years may be ignored to some extent.

The Benktander method, introduced in 1976, is a credibility-weighted average of the Bornhuetter-Ferguson technique and the development technique. The advantage cited by the authors is that this method will prove more responsive than the Bornhuetter-Ferguson technique and more stable than the development technique. (For further information on the development of the technique and underlying proofs of the methodology, see Thomas Mack's 2000 *ASTIN Bulletin* paper "Credible Claims Reserves: The Benktander Method.")

The Benktander method is often considered an iterative Bornhuetter-Ferguson method. The only difference in the two methods is the derivation of the expected claims. As we discuss in Chapter 8 – Expected Claims Technique, most insurers use an expected claim ratio and earned premium to determine expected claims and many self-insurers use pure premiums and exposures. Such expected claims become the input for the Bornhuetter-Ferguson technique. In the Benktander technique, the expected claims are the projected ultimate claims from an initial Bornhuetter-Ferguson projection – thus, the reference to the Benktander method as an iterative Bornhuetter-Ferguson method. It is interesting to note that the Benktander projection of ultimate claims will approach the projected ultimate claims produced by the development technique after sufficient iterations. (See Thomas Mack's 2000 ASTIN paper for the detailed proof.)

In Exhibits V and VI, we present the Benktander technique using our six examples of changing environments. We follow the same exhibit format that was presented earlier in this chapter for the Bornhuetter-Ferguson technique. The only difference between the Bornhuetter-Ferguson projections in Exhibits III and IV and the Benktander projections in Exhibits V and VI are the expected claims. In the Bornhuetter-Ferguson projections, we derive the expected claims based on the initial expected claim ratio multiplied by the earned premium. In the Benktander projections, the expected claims are based on the Bornhuetter-Ferguson projections (from Exhibits III and IV).

In the following table, we summarize the differences from the true unpaid claims, in thousands of dollars, based on the Bornhuetter-Ferguson technique and the Benktander technique for the six examples related to changing environments.

Example Name	Difference from True IBNR ($000) Using			
	Bornhuetter-Ferguson Method		Benktander Method	
	Reported	Paid	Reported	Paid
U.S. PP Auto Steady-State	0	0	0	0
U.S. PP Auto Increasing Claim Ratios	163	443	29	196
U.S. PP Auto Increasing Case Outstanding Strength	-205	0	-239	0
U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength	-113	443	-300	196
U.S. Auto Steady-State	0	0	0	0
U.S. Auto Changing Product Mix	223	400	233	498

The Benktander technique is significantly more responsive to changes in the underlying claim ratio but is less responsive to changes in the case outstanding adequacy. The Benktander technique is also less responsive to changes in the product mix than the Bornhuetter-Ferguson technique.

Note that the Benktander method always gives greater credibility to the development technique. Thus, where there are no changes in the underlying claim development patterns, we expect the Benktander method to be more responsive than the Bornhuetter-Ferguson method. Where claim development patterns are changing, the Benktander method may not produce the most appropriate estimate as seen in the examples with changing case outstanding adequacy and changes in product mix. With the changing product mix, the Benktander method would have proven responsive to the changing claim ratio but not to the changes in the underlying development patterns.

Projection of Ultimate Claims Using Reported and Paid Claims ($000)

Accident Year	Expected Claims	CDF to Ultimate		Percentage		Expected Claims		Claims at 12/31/07		Projected Ultimate Claims Using B-F Method with	
		Reported	Paid	Unreported	Unpaid	Unreported	Unpaid	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	51,430,657	1.000	1.002	0.0%	0.2%	0	102,656	47,742,304	47,644,187	47,742,304	47,746,843
1999	51,408,736	1.000	1.004	0.0%	0.4%	0	204,816	51,185,767	51,000,534	51,185,767	51,205,350
2000	51,680,983	1.001	1.006	0.1%	0.6%	51,629	308,236	54,837,929	54,533,225	54,889,558	54,841,461
2001	54,408,716	1.003	1.011	0.3%	1.1%	162,738	591,984	56,299,562	55,878,421	56,462,300	56,470,405
2002	59,421,665	1.006	1.020	0.6%	2.0%	354,404	1,165,131	58,592,712	57,807,215	58,947,116	58,972,346
2003	56,318,302	1.011	1.040	1.1%	3.8%	612,761	2,166,089	57,565,344	55,930,654	58,178,105	58,096,743
2004	59,646,290	1.023	1.085	2.2%	7.8%	1,341,021	4,672,751	56,976,657	53,774,672	58,317,678	58,447,423
2005	61,174,953	1.051	1.184	4.9%	15.5%	2,968,528	9,506,918	56,786,410	50,644,994	59,754,938	60,151,912
2006	61,926,981	1.110	1.404	9.9%	28.8%	6,136,908	17,819,445	54,641,339	43,606,497	60,778,247	61,425,942
2007	61,864,556	1.292	2.390	22.6%	58.2%	13,981,773	35,979,805	48,853,563	27,229,969	62,835,336	63,209,774
Total	569,281,839					25,609,761	72,517,830	543,481,587	498,050,368	569,091,348	570,568,198

Column Notes:
(2) Developed in Chapter 8, Exhibit II, Sheet 1.
(3) and (4) Developed in Chapter 7, Exhibit I, Sheets 1 and 2.
(5) = [1.00 - (1.00 / (3))].
(6) = [1.00 - (1.00 / (4))].
(7) = [(2) x (5)].
(8) = [(2) x (6)].
(9) and (10) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(11) = [(7) + (9)].
(12) = [(8) + (10)].

Accident Year	Claims at 12/31/07		Projected Ultimate Claims Using B-F Method with		Case Outstanding at 12/31/07	Unpaid Claim Estimate at 12/31/07: IBNR - Based on B-F Method with		Unpaid Claim Estimate at 12/31/07: Total - Based on B-F Method with	
	Reported	Paid	Reported	Paid		Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	47,742,304	47,644,187	47,742,304	47,746,843	98,117	0	4,539	98,117	102,656
1999	51,185,767	51,000,534	51,185,767	51,205,350	185,233	0	19,583	185,233	204,816
2000	54,837,929	54,533,225	54,889,558	54,841,461	304,704	51,629	3,532	356,333	308,236
2001	56,299,562	55,878,421	56,462,300	56,470,405	421,141	162,738	170,843	583,879	591,984
2002	58,592,712	57,807,215	58,947,116	58,972,346	785,497	354,404	379,634	1,139,901	1,165,131
2003	57,565,344	55,930,654	58,178,105	58,096,743	1,634,690	612,761	531,399	2,247,451	2,166,089
2004	56,976,657	53,774,672	58,317,678	58,447,423	3,201,985	1,341,021	1,470,766	4,543,006	4,672,751
2005	56,786,410	50,644,994	59,754,938	60,151,912	6,141,416	2,968,528	3,365,502	9,109,944	9,506,918
2006	54,641,339	43,606,497	60,778,247	61,425,942	11,034,842	6,136,908	6,784,603	17,171,750	17,819,445
2007	48,853,563	27,229,969	62,835,336	63,209,774	21,623,594	13,981,773	14,356,211	35,605,367	35,979,805
Total	543,481,587	498,050,368	569,091,348	570,568,198	45,431,219	25,609,761	27,086,611	71,040,980	72,517,830

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) and (5) Developed in Exhibit I, Sheet 1.
(6) = [(2) - (3)].
(7) = [(4) - (2)].
(8) = [(5) - (2)].
(9) = [(6) + (7)].
(10) = [(6) + (8)].

Projection of Ultimate Claims Using Reported and Paid Claims ($000)

Accident	Expected	CDF to Ultimate		Percentage		Expected Claims		Claims at 12/31/08		Projected Ultimate Claims Using B-F Method with	
Year	Claims	Reported	Paid	Unreported	Unpaid	Unreported	Unpaid	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	15,660	1.000	1.010	0.0%	1.0%	0	155	15,822	15,822	15,822	15,977
1999	24,665	1.000	1.014	0.0%	1.4%	0	341	25,107	24,817	25,107	25,158
2000	35,235	1.000	1.031	0.0%	3.0%	0	1,059	37,246	36,782	37,246	37,841
2001	39,150	1.000	1.054	0.0%	5.1%	0	2,006	38,798	38,519	38,798	40,525
2002	47,906	1.003	1.116	0.3%	10.4%	143	4,980	48,169	44,437	48,312	49,417
2003	54,164	1.013	1.268	1.3%	21.1%	695	11,448	44,373	39,320	45,068	50,768
2004	86,509	1.064	1.525	6.0%	34.4%	5,204	29,782	70,288	52,811	75,492	82,593
2005	108,172	1.085	2.007	7.8%	50.2%	8,474	54,275	70,655	40,026	79,129	94,301
2006	70,786	1.196	3.160	16.4%	68.4%	11,600	48,386	48,804	22,819	60,404	71,205
2007	39,835	1.512	6.569	33.9%	84.8%	13,489	33,771	31,732	11,865	45,221	45,636
2008	39,433	2.551	21.999	60.8%	95.5%	23,975	37,640	18,632	3,409	42,607	41,049
Total	561,516					63,581	223,842	449,626	330,629	513,207	554,471

Column Notes:
(2) Developed in Chapter 8, Exhibit III, Sheet 1.
(3) and (4) Developed in Chapter 7, Exhibit II, Sheets 1 and 2, capped at a minimum of 1.00.
(5) = [1.00 - (1.00 / (3))].
(6) = [1.00 - (1.00 / (4))].
(7) = [(2) x (5)].
(8) = [(2) x (6)].
(9) and (10) Based on data from XYZ Insurer.
(11) = [(7) + (9)].
(12) = [(8) + (10)].

						Unpaid Claim Estimate at 12/31/08			
			Projected Ultimate Claims		Case	IBNR - Based on		Total - Based on	
Accident	Claims at 12/31/08		Using B-F Method with		Outstanding	B-F Method with		B-F Method with	
Year	Reported	Paid	Reported	Paid	at 12/31/08	Reported	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	15,822	15,822	15,822	15,977	0	0	155	0	155
1999	25,107	24,817	25,107	25,158	290	0	51	290	341
2000	37,246	36,782	37,246	37,841	465	0	595	465	1,059
2001	38,798	38,519	38,798	40,525	278	0	1,728	278	2,006
2002	48,169	44,437	48,312	49,417	3,731	143	1,248	3,875	4,980
2003	44,373	39,320	45,068	50,768	5,052	695	6,396	5,747	11,448
2004	70,288	52,811	75,492	82,593	17,477	5,204	12,305	22,681	29,782
2005	70,655	40,026	79,129	94,301	30,629	8,474	23,646	39,103	54,275
2006	48,804	22,819	60,404	71,205	25,985	11,600	22,401	37,585	48,386
2007	31,732	11,865	45,221	45,636	19,867	13,489	13,904	33,356	33,771
2008	18,632	3,409	42,607	41,049	15,223	23,975	22,417	39,198	37,640
Total	449,626	330,629	513,207	554,471	118,997	63,581	104,845	182,578	223,842

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Exhibit II, Sheet 1.
(6) = [(2) - (3)].
(7) = [(4) - (2)].
(8) = [(5) - (2)].
(9) = [(6) + (7)].
(10) = [(6) + (8)].

Chapter 9 - Bornhuetter-Ferguson Technique
XYZ Insurer - Auto BI
Summary of Ultimate Claims ($000)

			Projected Ultimate Claims				
Accident	Claims at 12/31/08		Development Method		Expected	B-F Method	
Year	Reported	Paid	Reported	Paid	Claims	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977
1999	25,107	24,817	25,082	25,164	24,665	25,107	25,158
2000	37,246	36,782	36,948	37,922	35,235	37,246	37,841
2001	38,798	38,519	38,487	40,600	39,150	38,798	40,525
2002	48,169	44,437	48,313	49,592	47,906	48,312	49,417
2003	44,373	39,320	44,950	49,858	54,164	45,068	50,768
2004	70,288	52,811	74,787	80,537	86,509	75,492	82,593
2005	70,655	40,026	76,661	80,333	108,172	79,129	94,301
2006	48,804	22,819	58,370	72,108	70,786	60,404	71,205
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049
Total	449,626	330,629	514,929	605,030	561,516	513,207	554,471

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Exhibit II, Sheet 1.

Chapter 9 - Bornhuetter-Ferguson Technique
XYZ Insurer - Auto BI
Summary of IBNR ($000)

Exhibit II
Sheet 4

	Case	Estimated IBNR				
Accident	Outstanding	Development Method		Expected	B-F Method	
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	0	0	158	- 162	0	155
1999	290	- 25	58	- 442	0	51
2000	465	- 298	676	- 2,011	0	595
2001	278	- 310	1,802	352	0	1,728
2002	3,731	145	1,423	- 262	143	1,248
2003	5,052	577	5,485	9,791	695	6,396
2004	17,477	4,498	10,249	16,221	5,204	12,305
2005	30,629	6,006	9,678	37,517	8,474	23,646
2006	25,985	9,566	23,304	21,982	11,600	22,401
2007	19,867	16,247	46,209	8,103	13,489	13,904
2008	15,223	28,898	56,363	20,801	23,975	22,417
Total	118,997	65,303	155,405	111,890	63,581	104,845

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Exhibit II, Sheet 2.

	Age of								Projected Ultimate Claims		Estimated IBNR			Diff from Actual IBNR	
Accident	Accident Year	Expected	Claims at 12/31/08		CDF to Ultimate		Expected Percentage		Using B-F Method with		Using B-F Method with		Actual	Using B-F Method with	
Year	at 12/31/08	Claims	Reported	Paid	Reported	Paid	Unreported	Unpaid	Reported	Paid	Reported	Paid	IBNR	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Steady-State															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	893,397	884,463	857,661	1.010	1.042	1.0%	4.0%	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	938,067	919,306	863,022	1.020	1.087	2.0%	8.0%	938,067	938,067	18,761	18,761	18,761	0	0
2006	36	984,970	935,722	827,375	1.053	1.190	5.0%	16.0%	984,970	984,970	49,249	49,249	49,249	0	- 0
2007	24	1,034,219	930,797	734,295	1.111	1.408	10.0%	29.0%	1,034,219	1,034,219	103,422	103,422	103,422	0	0
2008	12	1,085,930	836,166	456,090	1.299	2.381	23.0%	58.0%	1,085,930	1,085,930	249,764	249,764	249,764	0	- 0
Total		8,804,525	8,365,887	7,573,548					8,804,525	8,804,525	438,638	438,638	438,638	0	0
Increasing Claim Ratios															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	893,397	1,010,815	980,184	1.010	1.042	1.0%	4.0%	1,019,749	1,015,920	8,934	5,105	10,210	1,276	5,105
2005	48	938,067	1,116,300	1,047,955	1.020	1.087	2.0%	8.0%	1,135,061	1,123,000	18,761	6,700	22,782	4,020	16,081
2006	36	984,970	1,203,071	1,063,768	1.053	1.190	5.0%	16.0%	1,252,319	1,221,363	49,249	18,292	63,320	14,071	45,027
2007	24	1,034,219	1,263,224	996,544	1.111	1.408	10.0%	29.0%	1,366,646	1,296,467	103,422	33,243	140,358	36,936	107,116
2008	12	1,085,930	1,194,523	651,558	1.299	2.381	23.0%	58.0%	1,444,287	1,281,397	249,764	86,874	356,805	107,042	269,931
Total		8,804,525	9,647,366	8,575,112					10,086,004	9,806,090	438,638	158,724	601,984	163,346	443,260

<u>Column Notes:</u>
(2) Age of accident year at December 31, 2008.
(3) See Chapter 8, Exhibit IV, Sheet 1.
(4) and (5) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 2 through 5.
(6) and (7) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 2 through 5.
(8) = [1.00 - (1.00 / (6))].
(9) = [1.00 - (1.00 / (7))].
(10) = [((3) x (8)) + (4)].
(11) = [((3) x (9)) + (5)].
(12) = [(10) - (4)].
(13) = [(11) - (4)].
(14) Developed in Chapter 7, Exhibit III, Sheet 1.
(15) = [(14) - (12)].
(16) = [(14) - (13)].

Chapter 9 - Bornhuetter-Ferguson Technique
Impact of Changing Conditions
U.S. PP Auto - Development of Unpaid Claim Estimate

Accident Year	Age of Accident Year at 12/31/08	Expected Claims	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using B-F Method with Reported	Projected Ultimate Claims Using B-F Method with Paid	Estimated IBNR Using B-F Method with Reported	Estimated IBNR Using B-F Method with Paid	Actual IBNR	Diff from Actual IBNR Using B-F Method with Reported	Diff from Actual IBNR Using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Increasing Case Outstanding Strength															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	893,397	884,463	857,661	1.010	1.042	1.0%	4.0%	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	938,067	933,377	863,022	1.020	1.087	1.9%	8.0%	951,395	938,067	18,018	4,690	4,690	- 13,328	0
2006	36	984,970	962,808	827,375	1.055	1.190	5.2%	16.0%	1,013,733	984,970	50,925	22,162	22,162	- 28,763	- 0
2007	24	1,034,219	979,922	734,295	1.119	1.408	10.6%	29.0%	1,089,655	1,034,219	109,733	54,296	54,296	- 55,437	0
2008	12	1,085,930	931,185	456,090	1.318	2.381	24.1%	58.0%	1,193,385	1,085,930	262,200	154,745	154,745	- 107,455	- 0
Total		8,804,525	8,551,189	7,573,548					9,009,508	8,804,525	458,319	253,336	253,336	- 204,983	0
Increasing Claim Ratios and Case Outstanding Strength															
1999	120	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	893,397	1,010,815	980,184	1.010	1.042	1.0%	4.0%	1,019,749	1,015,920	8,934	5,105	10,210	1,276	5,105
2005	48	938,067	1,133,386	1,047,955	1.019	1.087	1.9%	8.0%	1,151,324	1,123,000	17,938	- 10,386	5,695	- 12,243	16,081
2006	36	984,970	1,237,897	1,063,768	1.055	1.190	5.2%	16.0%	1,289,001	1,221,363	51,105	- 16,533	28,494	- 22,611	45,027
2007	24	1,034,219	1,329,895	996,544	1.120	1.408	10.7%	29.0%	1,440,327	1,296,467	110,432	- 33,427	73,688	- 36,744	107,116
2008	12	1,085,930	1,330,264	651,558	1.320	2.381	24.3%	58.0%	1,593,780	1,281,397	263,516	- 48,867	221,064	- 42,452	269,931
Total		8,804,525	9,901,689	8,575,112					10,362,123	9,806,090	460,434	- 95,600	347,660	- 112,773	443,260

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) See Chapter 8, Exhibit IV, Sheet 2.
(4) and (5) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 6 through 9.
(6) and (7) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 6 through 9.
(8) = [1.00 - (1.00 / (6))].
(9) = [1.00 - (1.00 / (7))].
(10) = [((3) x (8)) + (4)].
(11) = [((3) x (9)) + (5)].
(12) = [(10) - (4)].
(13) = [(11) - (4)].
(14) Developed in Chapter 7, Exhibit III, Sheet 1.
(15) = [(14) - (12)].
(16) = [(14) - (13)].

Chapter 9 - Bornhuetter-Ferguson Technique
Impact of Change in Product Mix Example
U.S. Auto - Development of Unpaid Claim Estimate

Exhibit IV

Accident Year	Age of Accident Year at 12/31/08	Expected Claims	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using B-F Method with Reported	Projected Ultimate Claims Using B-F Method with Paid	Estimated IBNR Using B-F Method with Reported	Estimated IBNR Using B-F Method with Paid	Actual IBNR	Diff from Actual IBNR Using B-F Method with Reported	Diff from Actual IBNR Using B-F Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Steady-State (No Change in Product Mix)															
1999	120	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,750	0	0	0	0	0
2002	84	1,736,438	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,438	0	0	0	0	0
2003	72	1,823,259	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,259	1,823,259	8,509	8,509	8,509	0	0
2004	60	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,010,143	1,948,499	1,742,124	1.032	1.154	3.1%	13.3%	2,010,143	2,010,143	61,644	61,644	61,644	0	0
2006	36	2,110,651	1,937,577	1,581,581	1.089	1.335	8.2%	25.1%	2,110,651	2,110,651	173,073	173,073	173,073	0	0
2007	24	2,216,183	1,852,729	1,277,999	1.196	1.734	16.4%	42.3%	2,216,183	2,216,183	363,454	363,454	363,454	0	0
2008	12	2,326,992	1,568,393	729,124	1.484	3.191	32.6%	68.7%	2,326,992	2,326,992	758,599	758,599	758,599	0	0
Total		18,866,839	17,472,204	15,270,788					18,866,839	18,866,839	1,394,634	1,394,634	1,394,634	0	0
Changing Product Mix															
1999	120	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,750	0	0	0	0	0
2002	84	1,736,438	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,438	0	0	0	0	0
2003	72	1,823,259	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,259	1,823,259	8,509	8,509	8,509	0	0
2004	60	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,249,446	2,193,545	1,951,435	1.032	1.154	3.1%	13.3%	2,262,528	2,251,361	68,983	57,816	71,855	2,872	14,039
2006	36	2,673,012	2,471,446	1,983,482	1.090	1.336	8.3%	25.2%	2,692,025	2,656,353	220,579	184,907	239,057	18,478	54,150
2007	24	3,211,085	2,680,487	1,766,164	1.200	1.750	16.7%	42.9%	3,216,658	3,142,865	536,171	462,378	596,924	60,753	134,547
2008	12	3,897,387	2,556,695	1,097,644	1.503	3.273	33.5%	69.4%	3,860,964	3,804,378	1,304,270	1,247,684	1,445,385	141,115	197,702
Total		22,233,799	20,067,179	16,738,684					22,235,045	22,057,826	2,167,866	1,990,647	2,391,084	223,219	400,438

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) See Chapter 8, Exhibit V.
(4) and (5) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit IV, Sheets 2 through 5.
(6) and (7) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit IV, Sheets 2 through 5.
(8) = [1.00 - (1.00 / (6))].
(9) = [1.00 - (1.00 / (7))].
(10) = [((3) x (8)) + (4)].
(11) = [((3) x (9)) + (5)].
(12) = [(10) - (4)].
(13) = [(11) - (4)].
(14) Developed in Chapter 7, Exhibit IV, Sheet 1.
(15) = [(14) - (12)].
(16) = [(14) - (13)].

Accident Year	Age of Accident Year at 12/31/08	Expected Ultimate Claims Using B-F Method with Reported	Expected Ultimate Claims Using B-F Method with Paid	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using G-B Method with Reported	Projected Ultimate Claims Using G-B Method with Paid	Estimated IBNR Using G-B Method with Reported	Estimated IBNR Using G-B Method with Paid	Actual IBNR	Diff from Actual IBNR Using G-B Method with Reported	Diff from Actual IBNR Using G-B Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Steady-State																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	893,397	893,397	884,463	857,661	1.010	1.042	1.0%	4.0%	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	938,067	938,067	919,306	863,022	1.020	1.087	2.0%	8.0%	938,067	938,067	18,761	18,761	18,761	0	0
2006	36	984,970	984,970	935,722	827,375	1.053	1.190	5.0%	16.0%	984,970	984,970	49,249	49,249	49,249	0	- 0
2007	24	1,034,219	1,034,219	930,797	734,295	1.111	1.408	10.0%	29.0%	1,034,219	1,034,219	103,422	103,422	103,422	0	0
2008	12	1,085,930	1,085,930	836,166	456,090	1.299	2.381	23.0%	58.0%	1,085,930	1,085,930	249,764	249,764	249,764	0	- 0
Total		8,804,525	8,804,525	8,365,887	7,573,548					8,804,525	8,804,525	438,638	438,638	438,638	0	- 0
Increasing Claim Ratios																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	1,019,749	1,015,920	1,010,815	980,184	1.010	1.042	1.0%	4.0%	1,021,012	1,020,821	10,197	10,006	10,210	13	204
2005	48	1,135,061	1,123,000	1,116,300	1,047,955	1.020	1.087	2.0%	8.0%	1,139,001	1,137,795	22,701	21,495	22,782	80	1,286
2006	36	1,252,319	1,221,363	1,203,071	1,063,768	1.053	1.190	5.0%	16.0%	1,265,687	1,259,186	62,616	56,115	63,320	704	7,204
2007	24	1,366,646	1,296,467	1,263,224	996,544	1.111	1.408	10.0%	29.0%	1,399,889	1,372,519	136,665	109,295	140,358	3,694	31,064
2008	12	1,444,287	1,281,397	1,194,523	651,558	1.299	2.381	23.0%	58.0%	1,526,709	1,394,768	332,186	200,245	356,805	24,620	156,560
Total		10,086,004	9,806,090	9,647,366	8,575,112					10,220,240	10,053,031	572,874	405,665	601,984	29,110	196,319

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) Developed in Exhibit III, Sheet 1.
(5) and (6) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 2 through 5.
(7) and (8) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 2 through 5.
(9) = [1.00 - (1.00 / (7))].
(10) = [1.00 - (1.00 / (8))].
(11) = [((3) x (9)) + (5)].
(12) = [((4) x (10)) + (6)].
(13) = [(11) - (5)].
(14) = [(12) - (5)].
(15) Developed in Chapter 7, Exhibit III, Sheet 1.
(16) = [(15) - (13)].
(17) = [(15) - (14)].

Accident	Age of Accident Year	Expected Ultimate Claims Using B-F Method with		Claims at 12/31/08		CDF to Ultimate		Expected Percentage		Projected Ultimate Claims Using G-B Method with		Estimated IBNR Using G-B Method with		Actual	Diff from Actual IBNR Using G-B Method with	
Year	at 12/31/08	Reported	Paid	Reported	Paid	Reported	Paid	Unreported	Unpaid	Reported	Paid	Reported	Paid	IBNR	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Increasing Case Outstanding Strength																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	893,397	893,397	884,463	857,661	1.010	1.042	1.0%	4.0%	893,397	893,397	8,934	8,934	8,934	0	0
2005	48	951,395	938,067	933,377	863,022	1.020	1.087	1.9%	8.0%	951,651	938,067	18,274	4,690	4,690	- 13,584	0
2006	36	1,013,733	984,970	962,808	827,375	1.055	1.190	5.2%	16.0%	1,015,221	984,970	52,412	22,162	22,162	- 30,250	- 0
2007	24	1,089,655	1,034,219	979,922	734,295	1.119	1.408	10.6%	29.0%	1,095,537	1,034,219	115,615	54,296	54,296	- 61,319	0
2008	12	1,193,385	1,085,930	931,185	456,090	1.318	2.381	24.1%	58.0%	1,219,330	1,085,930	288,146	154,745	154,745	- 133,401	- 0
Total		9,009,508	8,804,525	8,551,189	7,573,548					9,043,078	8,804,525	491,890	253,336	253,336	- 238,553	- 0
Increasing Claim Ratios and Case Outstanding Strength																
1999	120	700,000	700,000	700,000	700,000	1.000	1.000	0.0%	0.0%	700,000	700,000	0	0	0	0	0
2000	108	735,000	735,000	735,000	735,000	1.000	1.000	0.0%	0.0%	735,000	735,000	0	0	0	0	0
2001	96	771,750	771,750	771,750	764,033	1.000	1.010	0.0%	1.0%	771,750	771,750	0	0	0	0	0
2002	84	810,338	810,338	810,338	802,234	1.000	1.010	0.0%	1.0%	810,338	810,338	0	0	0	0	0
2003	72	850,854	850,854	842,346	833,837	1.010	1.020	1.0%	2.0%	850,854	850,854	8,509	8,509	8,509	0	0
2004	60	1,019,749	1,015,920	1,010,815	980,184	1.010	1.042	1.0%	4.0%	1,021,012	1,020,821	10,197	10,006	10,210	13	204
2005	48	1,151,324	1,123,000	1,133,386	1,047,955	1.019	1.087	1.9%	8.0%	1,155,402	1,137,795	22,016	4,409	5,695	- 16,321	1,286
2006	36	1,289,001	1,221,363	1,237,897	1,063,768	1.055	1.190	5.2%	16.0%	1,304,776	1,259,186	66,879	21,289	28,494	- 38,385	7,204
2007	24	1,440,327	1,296,467	1,329,895	996,544	1.120	1.408	10.7%	29.0%	1,483,691	1,372,519	153,796	42,625	73,688	- 80,108	31,064
2008	12	1,593,780	1,281,397	1,330,264	651,558	1.320	2.381	24.3%	58.0%	1,717,017	1,394,768	386,753	64,504	221,064	- 165,689	156,560
Total		10,362,123	9,806,090	9,901,689	8,575,112					10,549,840	10,053,031	648,150	151,342	347,660	- 300,490	196,319

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) Developed in Exhibit III, Sheet 2.
(5) and (6) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit III, Sheets 6 through 9.
(7) and (8) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit III, Sheets 6 through 9.
(9) = [1.00 - (1.00 / (7))].
(10) = [1.00 - (1.00 / (8))].
(11) = [((3) x (9)) + (5)].
(12) = [((4) x (10)) + (6)].
(13) = [(11) - (5)].
(14) = [(12) - (5)].
(15) Developed in Chapter 7, Exhibit III, Sheet 1.
(16) = [(15) - (13)].
(17) = [(15) - (14)].

Chapter 9 - Bornhuetter-Ferguson Technique
Impact of Change in Product Mix Example
U.S. Auto - Development of Unpaid Claim Estimate Using Gunnar Benktander Method

Exhibit VI

Accident Year	Age of Accident Year at 12/31/08	Expected Ultimate Claims Using B-F Method with Reported	Expected Ultimate Claims Using B-F Method with Paid	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Expected Percentage Unreported	Expected Percentage Unpaid	Projected Ultimate Claims Using G-B Method with Reported	Projected Ultimate Claims Using G-B Method with Paid	Estimated IBNR Using G-B Method with Reported	Estimated IBNR Using G-B Method with Paid	Actual IBNR	Diff from Actual IBNR Using G-B Method with Reported	Diff from Actual IBNR Using G-B Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Steady-State (No Change in Product Mix)																
1999	120	1,500,000	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,750	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,750	0	0	0	0	0
2002	84	1,736,438	1,736,438	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,438	0	0	0	0	0
2003	72	1,823,259	1,823,259	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,259	1,823,259	8,509	8,509	8,509	0	0
2004	60	1,914,422	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,010,143	2,010,143	1,948,499	1,742,124	1.032	1.154	3.1%	13.3%	2,010,143	2,010,143	61,644	61,644	61,644	0	0
2006	36	2,110,651	2,110,651	1,937,577	1,581,581	1.089	1.335	8.2%	25.1%	2,110,651	2,110,651	173,073	173,073	173,073	0	0
2007	24	2,216,183	2,216,183	1,852,729	1,277,999	1.196	1.734	16.4%	42.3%	2,216,183	2,216,183	363,454	363,454	363,454	0	0
2008	12	2,326,992	2,326,992	1,568,393	729,124	1.484	3.191	32.6%	68.7%	2,326,992	2,326,992	758,599	758,599	758,599	- 0	0
Total		18,866,839	18,866,839	17,472,204	15,270,788					18,866,839	18,866,839	1,394,634	1,394,634	1,394,634	0	0
Changing Product Mix																
1999	120	1,500,000	1,500,000	1,500,000	1,500,000	1.000	1.000	0.0%	0.0%	1,500,000	1,500,000	0	0	0	0	0
2000	108	1,575,000	1,575,000	1,575,000	1,566,600	1.000	1.005	0.0%	0.5%	1,575,000	1,575,000	0	0	0	0	0
2001	96	1,653,750	1,653,750	1,653,750	1,628,393	1.000	1.016	0.0%	1.5%	1,653,750	1,653,750	0	0	0	0	0
2002	84	1,736,438	1,736,438	1,736,438	1,700,551	1.000	1.021	0.0%	2.1%	1,736,438	1,736,438	0	0	0	0	0
2003	72	1,823,259	1,823,259	1,814,751	1,757,622	1.005	1.037	0.5%	3.6%	1,823,259	1,823,259	8,509	8,509	8,509	0	0
2004	60	1,914,422	1,914,422	1,885,068	1,786,794	1.016	1.071	1.5%	6.7%	1,914,422	1,914,422	29,354	29,354	29,354	0	0
2005	48	2,262,528	2,251,361	2,193,545	1,951,435	1.032	1.154	3.1%	13.3%	2,262,929	2,251,616	69,384	58,071	71,855	2,470	13,784
2006	36	2,692,025	2,656,353	2,471,446	1,983,482	1.090	1.336	8.3%	25.2%	2,693,594	2,652,159	222,148	180,713	239,057	16,909	58,344
2007	24	3,216,658	3,142,865	2,680,487	1,766,164	1.200	1.750	16.7%	42.9%	3,217,588	3,113,616	537,101	433,129	596,924	59,823	163,795
2008	12	3,860,964	3,804,378	2,556,695	1,097,644	1.503	3.273	33.5%	69.4%	3,848,776	3,739,784	1,292,081	1,183,089	1,445,385	153,304	262,296
Total		22,235,045	22,057,826	20,067,179	16,738,684					22,225,757	21,960,044	2,158,578	1,892,866	2,391,084	232,507	498,219

Column Notes:
(2) Age of accident year at December 31, 2008.
(3) and (4) Developed in Exhibit IV.
(5) and (6) From last diagonal of reported and paid claim triangles in Chapter 7, Exhibit IV, Sheets 2 through 5.
(7) and (8) CDF based on 5-year simple average age-to-age factors presented in Chapter 7, Exhibit IV, Sheets 2 through 5.
(9) = [1.00 - (1.00 / (7))].
(10) = [1.00 - (1.00 / (8))].
(11) = [((3) x (9)) + (5)].
(12) = [((4) x (10)) + (6)].
(13) = [(11) - (5)].
(14) = [(12) - (5)].
(15) Developed in Chapter 7, Exhibit IV, Sheet 1.
(16) = [(15) - (13)].
(17) = [(15) - (14)].

CHAPTER 10 – CAPE COD TECHNIQUE

The Cape Cod method, also known as the Stanard-Buhlmann method, is similar to the Bornhuetter-Ferguson technique. As in the Bornhuetter-Ferguson technique, the Cape Cod method splits ultimate claims into two components: actual reported (or paid) and expected unreported (or unpaid). As an accident year (or other time interval) matures, the actual reported claims replace the expected unreported claims and the initial expected claims assumption becomes gradually less important. The primary difference between the two methods is the derivation of the expected claim ratio. In the Cape Cod technique, the expected claim ratio is obtained from the reported claims experience instead of an independent and often judgmental selection as in the Bornhuetter-Ferguson technique.

Key Assumptions

The key assumption of the Cape Cod method is that unreported claims will develop based on expected claims, which are derived using reported (or paid) claims and earned premium. Both the Cape Cod and Bornhuetter-Ferguson methods differ from the development method where the primary assumption is that unreported claims will develop based on reported claims to date (not expected claims).

Common Uses of the Cape Cod Technique

Reinsurers are among the most frequent users of the Cape Cod technique. Actuaries generally use the Cape Cod method in a reported claims application, but they can also use it with paid claims. The technique is appropriate for all lines of insurance including short-tail lines and long-tail lines. Similar to the development and Bornhuetter-Ferguson methods, actuaries using the Cape Cod method can organize data in a variety of different time intervals:

- Accident year
- Policy year
- Underwriting year
- Report year
- Fiscal year

Actuaries can also apply this technique with monthly, quarterly, or semiannual data.

Mechanics of the Cape Cod Technique

Similar to the Bornhuetter-Ferguson technique, the Cape Cod method is a blend of two other methods: the claim development method and the expected claims method. We restate below the formula of the reported Bornhuetter-Ferguson method, which is the same as the Cape Cod method:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims

Again, the major difference between the Cape Cod technique and the Bornhuetter-Ferguson is the source of the expected claims. In "Reinsurance" Patrik states:

> The key innovation of the *SB* (Stanard-Buhlmann) Method is that the ultimate expected loss ratio for all years combined is estimated from the overall reported claims experience, instead of being selected judgmentally, as in the *BF* (Bornhuetter-Ferguson) Method. A problem with the *SB* Method is that the *IBNR* by year is highly dependent upon the rate level adjusted premium by year. The user must adjust each year's premium to reflect the rate level cycle on a relative basis. But this is also a problem with the *BF* Method.[58]

In our step-by step example of the Cape Cod method, we use the cumulative claim development patterns presented in Chapter 7. We begin in Exhibit I, Sheet 1, with the development of the estimated claim ratio. In our U.S. Industry Auto example, we do not have details of historical rate level changes. Thus, in both the Bornhuetter-Ferguson method and the Cape Cod method, we rely on unadjusted earned premium data.

In Column (2) of Exhibit I, Sheet 1, we summarize the unadjusted earned premiums by year. Column (3) contains the age of each accident year as of the latest valuation date, December 31, 2007. The reported claims in Column (4) are the latest diagonal in the reported claim development triangle presented in Chapter 7. We also derive the claim development factor to ultimate, Column (5), in Chapter 7. In Column (6), we show the reporting pattern. The percentage reported is equal to the inverse of the cumulative reported claim development factor.

A new concept of the Cape Cod method is the "used-up premium." The used-up premium is the denominator in our determination of the expected claim ratio. This allocation of premium represents the premium corresponding to the claims that are expected to be reported through the valuation date. The used-up premium in Column (7) is equal to the earned premium in Column (2) multiplied by the percentage of claims reported in Column (6). Reinsurers often use ultimate premiums in Column (2) instead of earned premium. In Column (8), we calculate estimated claim ratios, by accident year, by dividing actual reported claims from Column (4) by the used-up premium in Column (7). (An alternative to the use of premium and claim ratios is exposures and pure premiums. Instead of calculating used-up premium, the actuary could calculate used-up exposures and calculate estimated pure premiums instead of estimated claim ratios for each year in the experience period.)

In our U.S. Industry Auto example, we observe a change in the claim ratios for the latest accident years when compared with the earliest years (i.e., 1998 through 2002). The average estimated claim ratio for accident years 1998 through 2002 is 75.2%. For this period of time, the claim ratios vary from a low of 69.6% to a high of 79.7%. We contrast this with the more recent years' experience, which has an average claim ratio of 64.8%. For each year, 2003 through 2007, the estimated claim ratio is less than 67.5%. In the expected claims technique and the Bornhuetter-Ferguson technique, we rely on different claim ratios for the earlier years and the latest years in the experience period to best reflect our expectation of expected claims for each year. In contrast, the Cape Cod method requires the use of the weighted average claim ratio from all years. Thus, one can distinguish the mechanical approach of developing expected claims in the Cape Cod method from the Bornhuetter-Ferguson method in which actuarial judgment plays an important role in the development of the a priori expected claim estimate.

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[58] *Foundations of Casualty Actuarial Science*, 2001. We refer the reader to "Reinsurance" (Chapter 7) for Patrik's complete development of the formulae underlying the Cape Cod technique.

Unpaid Claim Estimate Based on Cape Cod Technique

We follow a similar procedure for determining the unpaid claim estimate based on the Cape Cod technique as presented in the prior chapters. Estimated IBNR is equal to projected ultimate claims less reported claims and the total unpaid claim estimate is equal to the difference between projected ultimate claims and paid claims.

Exhibit I, Sheet 3 displays the calculations for the estimated unpaid claims of U.S. Industry Auto. Columns (2) and (3) contain reported and paid claims data as of December 31, 2007. We summarize the projected ultimate claims from Exhibit I, Sheet 2 in Column (4). Case outstanding, which are equal to the difference between reported claims and paid claims as of December 31, 2007, are presented in Column (5). Estimated IBNR is equal to projected ultimate claims minus reported claims. We calculate the estimated IBNR based on the Cape Cod technique in Column (6). The total unpaid claim estimate (Column (7)) is equal to the sum of case outstanding and estimated IBNR.

When the Cape Cod Technique Works and When it Does Not

Similar comments apply to the Cape Cod method as to the Bornhuetter-Ferguson technique. The only difference between the two methods is the derivation of the expected claims. Thus, an advantage of the Cape Cod method, when compared to the development technique, is that it may not be distorted by random fluctuations early in the development of an accident year (or other time interval). A determining factor influencing the fluctuations, in either the Bornhuetter-Ferguson or Cape Cod methods, is the extent to which actual claims for the most recent years affect the derivation of expected claims for such years.

The Cape Cod method is not necessarily as appropriate as the Bornhuetter-Ferguson technique if the data is extremely thin or volatile or both. Since the expected claims are based on reported claims to date, there must be a sufficient volume of credible reported claims in order to derive a reliable expected claims estimate.

It is worthwhile to note that in an ideal situation, the actuary would have the history of rate level changes and would be able to adjust historical premiums to an on-level basis for both the Cape Cod and Bornhuetter-Ferguson projections. The actuary would also adjust claims for trend, benefit-level changes, and other similar factors. From a theoretical perspective, these methods require such adjustment. From a practical perspective, however, such information is often unavailable. In these situations, many actuaries continue to use both the Bornhuetter-Ferguson and Cape Cod methods for the purpose of developing the unpaid claim estimate without the adjustment of premiums or claims. Under such circumstances, it would be prudent for the actuary, when evaluating the results of various techniques and selecting final ultimate claims values, to take into consideration where simplifying assumptions (such as not adjusting premium for rate level changes) were required.

XYZ Insurer

In Exhibit II, Sheets 1 through 3, we use the Cape Cod technique for XYZ Insurer. There are weaknesses in this projection technique due to the uncertainty in the selected development patterns for reported claims. Due to the numerous changes the insurer has faced, we are uncertain as to the applicability of historical claim development patterns. Since the Cape Cod method uses claim development patterns to calculate the used-up premium, which is a critical component in the expected claim ratio determination, this method may not be appropriate for this example. (Similar to the Bornhuetter-Ferguson method, we limit the reported cumulative claim development factors to a minimum of 1.00 for the Cape Cod technique.)

We have detailed rate change information for XYZ Insurer as well as information regarding the effect of legal reform on the insurance product. We incorporate this information into the Cape Cod projection method presented in Exhibit II. The first adjustment is to restate earned premium for each accident year as if it were at the 2008 rate level. These calculations are contained within Columns (2) through (4) of Exhibit II, Sheet 1. In Columns (6) through (9), we adjust the current reported claims for the influences of inflation (through claims trend factors) and tort reform. Once we have on-level earned premium and adjusted claims, we proceed to calculate estimated claim ratios as described in the previous example for U.S. Industry Auto. We divide the adjusted claims by used-up, on-level premium to derive the claim ratios shown in Column (13). We use the label "Estimated Adjusted Claim Ratios" to indicate that the reported claims are adjusted for inflation and tort reform. We rely on the claim ratio for all years combined, 70.8%, from Column (13) (also shown in Column (14) for each year) as our starting point for developing estimated unadjusted claim ratios in Column (15). These claim ratios, which are adjusted back to the rate level, inflationary level, and tort environment for each accident year, become our starting point for projecting expected claims in Exhibit II, Sheet 2.

We follow the same format as the example for U.S. Industry Auto in Exhibit II, Sheets 2 and 3. We compare the results of the Cape Cod method with the Bornhuetter-Ferguson method, the expected claims method, and the claim development method in Exhibit II, Sheet 4 (projected ultimate claims) and in Exhibit II, Sheet 5 (estimated IBNR).

Influence of a Changing Environment on the Cape Cod Method[59]

In prior chapters, we discuss the performance of each of the estimation techniques during times of change. We continue these examples using the Cape Cod method.

Scenario 1 – U.S. PP Auto Steady-State

We see in Chapters 7 through 9 that the development technique, expected claims technique, and Bornhuetter-Ferguson techniques all generate an accurate IBNR value in a steady-state environment. It is not surprising to find that the Cape Cod method also generates the actual IBNR in a steady-state environment. The top section of Exhibit III, Sheets 1 and 3, contains detailed calculations for the Cape Cod method.

[59] We present the following examples to demonstrate the effect of not changing assumption on the resulting projections of ultimate claims and the estimate of unpaid claims. We recognize that the examples are not necessarily representative of real-life applications of the Cape Cod method since we assume that there are no adjustments in expected claims in anticipation of the events that caused higher claim ratios or changes in business mix. Most insurers have a feel for whether a market is getting softer or harder, so they would have a sense as to the direction to adjust the expected claims, if not the absolute amount of adjustment.

Scenario 2 – U.S. PP Auto Increasing Claim Ratios

Recall that the weakness of the expected claims method, which is the lack of responsiveness to actual emerging claims, is also a weakness of the Bornhuetter-Ferguson method. The Cape Cod method, which derives the expected claim ratio based on reported claims through the valuation date, does not have this same weakness. In Exhibit III, Sheet 1, we see that the estimated claim ratios in Column (8) respond to the changing environment in claims experience. The total all years combined estimated claim ratio is 80.7% for this scenario; this compares to the 70% expected claim ratio for the steady-state.

In the Bornhuetter-Ferguson reported claim projection, there is no change in the estimated IBNR of $438,638 between Scenario 1 and Scenario 2 since the expected claim ratio does not change. However, using the Cape Cod method, the estimated IBNR is $505,828 for Scenario 2. While this value is still short of the actual IBNR requirements of $601,984, the Cape Cod technique is more responsive than the Bornhuetter-Ferguson method when the claim ratios are increasing.

Scenario 3 – U.S. PP Auto Increasing Case Outstanding Strength

We present the calculations for Scenario 3 in the top section of Exhibit III, Sheets 2 and 4. In this example, we see that the Cape Cod method results in an estimated IBNR that overstates the actual IBNR by an even greater amount than the reported Bornhuetter-Ferguson technique. In the previous chapters, we discuss how the increase in case outstanding strength leads to an increase in the cumulative claim development factors. Whereas the expected claims for Scenario 3 of the Bornhuetter-Ferguson method remain unchanged, the expected claims increase using the Cape Cod method because the method reflects the higher level of reported claims. The projected ultimate claims are increasing for the Cape Cod method under Scenario 3 due to both increasing expected claims and higher claim development factors to ultimate.

Scenario 4 – U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength

In times of increasing claim ratios and increasing case outstanding strength, the Cape Cod method can overstate the actual IBNR. In this example, the method responds effectively to the change in claim ratios, however it overreacts to the change in case outstanding adequacy. In our example, the Cape Cod method significantly overstates the actual IBNR needed, indicating that the effect of increasing case outstanding strength exceeds the influence of increasing claim ratios. The estimated claim ratios are driven higher than their true values by the combined effects of both increasing claims and greater adequacy in case outstanding. We present the detailed calculations for Scenario 4 in the bottom section of Exhibit III, Sheets 2 and 4.

U.S. Auto Steady-State (No Change in Product Mix)

In the last two examples, we present projections for a combined portfolio of private passenger and commercial automobile. In the top section of Exhibit IV, Sheets 1 and 2, we summarize the calculations for the steady-state environment where there is no change in product mix. Similar to our projections using the development and expected claims techniques, we demonstrate in Exhibit IV, Sheet 2 that the Cape Cod technique generates the correct IBNR requirement when there is no change in the product mix.

U.S. Auto Changing Product Mix

In the final example, we assume that the volume of commercial automobile insurance is increasing at a greater rate than private passenger automobile insurance. In the bottom section of Exhibit IV, Sheet 2, we observe that the Cape Cod method produces estimated IBNR that is lower than the actual IBNR. Even though reported claims are increasing in this scenario when compared to the prior scenario, there are also changes in the reporting pattern. Thus, the Cape Cod method is not responding appropriately to the changing product mix. Detailed calculations are contained within the bottom section of Exhibit IV, Sheets 1 and 2.

Chapter 10 - Cape Cod Technique
U.S. Industry Auto
Development of Expected Claim Ratio

Accident Year	Earned Premium	Age of Accident Year at 12/31/07	Reported Claims at 12/31/07	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	68,574,209	120	47,742,304	1.000	100.0%	68,574,209	69.6%
1999	68,544,981	108	51,185,767	1.000	100.0%	68,544,981	74.7%
2000	68,907,977	96	54,837,929	1.001	99.9%	68,839,138	79.7%
2001	72,544,955	84	56,299,562	1.003	99.7%	72,327,971	77.8%
2002	79,228,887	72	58,592,712	1.006	99.4%	78,756,349	74.4%
2003	86,643,542	60	57,565,344	1.011	98.9%	85,700,833	67.2%
2004	91,763,523	48	56,976,657	1.023	97.8%	89,700,413	63.5%
2005	94,115,312	36	56,786,410	1.051	95.1%	89,548,346	63.4%
2006	95,272,279	24	54,641,339	1.110	90.1%	85,830,882	63.7%
2007	95,176,240	12	48,853,563	1.292	77.4%	73,665,820	66.3%
Total	820,771,905		543,481,587			781,488,943	69.5%

Column and Line Notes:
(2) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(3) Age of accident year in (1) at December 31, 2007.
(4) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(5) Developed in Chapter 7, Exhibit I, Sheet 1.
(6) = [1.00 / (5)].
(7) = [(2) x (6)].
(8) = [(4) / (7)].

Chapter 10 - Cape Cod Technique
U.S. Industry Auto
Projection of Ultimate Claims Using Reported Claims ($000)

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/07	Projected Ultimate Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	68,574,209	69.5%	47,689,504	1.000	0.0%	0	47,742,304	47,742,304
1999	68,544,981	69.5%	47,669,177	1.000	0.0%	0	51,185,767	51,185,767
2000	68,907,977	69.5%	47,921,621	1.001	0.1%	47,874	54,837,929	54,885,803
2001	72,544,955	69.5%	50,450,934	1.003	0.3%	150,900	56,299,562	56,450,462
2002	79,228,887	69.5%	55,099,233	1.006	0.6%	328,624	58,592,712	58,921,336
2003	86,643,542	69.5%	60,255,708	1.011	1.1%	655,601	57,565,344	58,220,945
2004	91,763,523	69.5%	63,816,367	1.023	2.2%	1,434,777	56,976,657	58,411,434
2005	94,115,312	69.5%	65,451,904	1.051	4.9%	3,176,068	56,786,410	59,962,478
2006	95,272,279	69.5%	66,256,509	1.110	9.9%	6,565,960	54,641,339	61,207,299
2007	95,176,240	69.5%	66,189,720	1.292	22.6%	14,959,286	48,853,563	63,812,849
Total	820,771,905		570,800,677			27,319,090	543,481,587	570,800,677

Column Notes:
(2) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(3) Based on total weighted estimated claim ratios developed in Exhibit I, Sheet 1.
(4) = [(2) x (3)].
(5) Developed in Chapter 7, Exhibit I, Sheet 1.
(6) = [1.00 - (1.00 / (5))].
(7) = [(4) x (6)].
(8) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(9) = [(7) + (8)].

Chapter 10 - Cape Cod Technique
U.S. Industry Auto
Development of Unpaid Claim Estimate ($000)

Exhibit I
Sheet 3

Accident Year	Claims at 12/31/07 Reported	Claims at 12/31/07 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/07	Unpaid Claim Estimate Based on Cape Cod Method IBNR	Unpaid Claim Estimate Based on Cape Cod Method Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	47,742,304	47,644,187	47,742,304	98,117	0	98,117
1999	51,185,767	51,000,534	51,185,767	185,233	0	185,233
2000	54,837,929	54,533,225	54,885,803	304,704	47,874	352,578
2001	56,299,562	55,878,421	56,450,462	421,141	150,900	572,041
2002	58,592,712	57,807,215	58,921,336	785,497	328,624	1,114,121
2003	57,565,344	55,930,654	58,220,945	1,634,690	655,601	2,290,291
2004	56,976,657	53,774,672	58,411,434	3,201,985	1,434,777	4,636,762
2005	56,786,410	50,644,994	59,962,478	6,141,416	3,176,068	9,317,484
2006	54,641,339	43,606,497	61,207,299	11,034,842	6,565,960	17,600,802
2007	48,853,563	27,229,969	63,812,849	21,623,594	14,959,286	36,582,880
Total	543,481,587	498,050,368	570,800,677	45,431,219	27,319,090	72,750,309

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) Developed in Exhibit I, Sheet 2.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(5) + (6)].

Development of Expected Claim Ratio

Accident Year	Earned Premium	On-Level Adjustment	On-Level Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/08	Pure Premium Trend	Tort Reform Factors	Adjusted Claims at 12/31/08	Reported CDF to Ultimate	% of Ultimate Reported	Used Up On-Level Premium	Claim Ratios Estimated Adjusted	Claim Ratios Selected Adjusted	Claim Ratios Estimated Unadjusted
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1998	20,000	0.989	19,783	132	15,822	1.400	0.670	14,846	1.000	100.0%	19,783	75.0%	70.8%	74.6%
1999	31,500	0.970	30,548	120	25,107	1.354	0.670	22,777	1.000	100.0%	30,548	74.6%	70.8%	75.7%
2000	45,000	0.951	42,784	108	37,246	1.309	0.670	32,671	1.000	100.0%	42,784	76.4%	70.8%	76.7%
2001	50,000	0.932	46,606	96	38,798	1.266	0.670	32,905	1.000	100.0%	46,606	70.6%	70.8%	77.8%
2002	61,183	0.914	55,911	84	48,169	1.224	0.670	39,500	1.003	99.7%	55,744	70.9%	70.8%	78.9%
2003	69,175	0.870	60,204	72	44,373	1.183	0.670	35,182	1.013	98.7%	59,432	59.2%	70.8%	77.7%
2004	99,322	0.810	80,411	60	70,288	1.144	0.670	53,884	1.064	94.0%	75,574	71.3%	70.8%	74.7%
2005	138,151	0.704	97,258	48	70,655	1.106	0.670	52,371	1.085	92.2%	89,639	58.4%	70.8%	67.2%
2006	107,578	0.640	68,850	36	48,804	1.070	0.750	39,153	1.196	83.6%	57,567	68.0%	70.8%	56.5%
2007	62,438	0.800	49,950	24	31,732	1.034	1.000	32,819	1.512	66.1%	33,036	99.3%	70.8%	54.7%
2008	47,797	1.000	47,797	12	18,632	1.000	1.000	18,632	2.551	39.2%	18,737	99.4%	70.8%	70.8%
Total	732,144		600,103		449,626			374,739			529,449	70.8%		

Column and Line Notes:
(2) Based on data from insurer.
(3) For 2002 and after, based on Chapter 8, Exhibit III, Sheet 2. For 1998-2001, assume a 2% rate change per annum.
(4) = [(2) x (3)].
(5) Age of accident year in (1) at December 31, 2008.
(6) Based on data from insurer.
(7) Assume an annual pure premium trend rate of 3.425%.
(8) Based on independent analysis of tort reform.
(9) = [(6) x (7) x (8)].
(10) Developed in Chapter 7, Exhibit II, Sheet 1, in which the CDF are limited to a minimum of 1.00.
(11) = [1.00 / (10)].
(12) = [(4) x (11)].
(13) = [(9) / (12)].
(14) = [Total in (13)].
(15) = [(14) x (3) / (7) / (8)].

Projection of Ultimate Claims Using Reported Claims ($000)

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/08	Projected Ultimate Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	20,000	74.6%	14,924	1.000	0.0%	0	15,822	15,822
1999	31,500	75.7%	23,833	1.000	0.0%	0	25,107	25,107
2000	45,000	76.7%	34,523	1.000	0.0%	0	37,246	37,246
2001	50,000	77.8%	38,895	1.000	0.0%	0	38,798	38,798
2002	61,183	78.9%	48,259	1.003	0.3%	144	48,169	48,313
2003	69,175	77.7%	53,744	1.013	1.3%	690	44,373	45,062
2004	99,322	74.7%	74,241	1.064	6.0%	4,466	70,288	74,754
2005	138,151	67.2%	92,871	1.085	7.8%	7,276	70,655	77,931
2006	107,578	56.5%	60,743	1.196	16.4%	9,955	48,804	58,759
2007	62,438	54.7%	34,184	1.512	33.9%	11,575	31,732	43,307
2008	47,797	70.8%	33,830	2.551	60.8%	20,569	18,632	39,201
Total	732,144		510,046			54,674	449,626	504,300

Column Notes:

(2) Based on data from XYZ Insurer.
(3) Selected based on estimated claim ratios developed in Exhibit II, Sheet 1.
(4) = [(2) x (3)].
(5) Developed in Chapter 7, Exhibit II, Sheet 1, limited to a minimum of 1.00.
(6) = [1.00 - (1.00 / (5))].
(7) = [(4) x (6)].
(8) Based on data from insurer.
(9) = [(7) + (8)].

Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate Based on Cape Cod Method IBNR	Unpaid Claim Estimate Based on Cape Cod Method Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	15,822	15,822	15,822	0	0	0
1999	25,107	24,817	25,107	290	0	290
2000	37,246	36,782	37,246	465	0	465
2001	38,798	38,519	38,798	278	0	278
2002	48,169	44,437	48,313	3,731	144	3,876
2003	44,373	39,320	45,062	5,052	690	5,742
2004	70,288	52,811	74,754	17,477	4,466	21,943
2005	70,655	40,026	77,931	30,629	7,276	37,904
2006	48,804	22,819	58,759	25,985	9,955	35,940
2007	31,732	11,865	43,307	19,867	11,575	31,442
2008	18,632	3,409	39,201	15,223	20,569	35,792
Total	449,626	330,629	504,300	118,997	54,674	173,671

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) Developed in Exhibit II, Sheet 2.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(4) - (3)].

Summary of Ultimate Claims ($000)

			Projected Ultimate Claims					
Accident	Claims at 12/31/08		Development Method		Expected	B-F Method		Cape
Year	Reported	Paid	Reported	Paid	Claims	Reported	Paid	Cod
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977	15,822
1999	25,107	24,817	25,082	25,164	24,665	25,107	25,158	25,107
2000	37,246	36,782	36,948	37,922	35,235	37,246	37,841	37,246
2001	38,798	38,519	38,487	40,600	39,150	38,798	40,525	38,798
2002	48,169	44,437	48,313	49,592	47,906	48,312	49,417	48,313
2003	44,373	39,320	44,950	49,858	54,164	45,068	50,768	45,062
2004	70,288	52,811	74,787	80,537	86,509	75,492	82,593	74,754
2005	70,655	40,026	76,661	80,333	108,172	79,129	94,301	77,931
2006	48,804	22,819	58,370	72,108	70,786	60,404	71,205	58,759
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636	43,307
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049	39,201
Total	449,626	330,629	514,929	605,030	561,516	513,207	554,471	504,300

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Chapter 9, Exhibit II, Sheet 1.
(9) Developed in Exhibit II, Sheet 2.

Summary of IBNR ($000)

	Case	Estimated IBNR					
Accident	Outstanding	Development Method		Expected	B-F Method		Cape
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid	Cod
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	0	0	158	- 162	0	155	0
1999	290	- 25	58	- 442	0	51	0
2000	465	- 298	676	- 2,011	0	595	0
2001	278	- 310	1,802	352	0	1,728	0
2002	3,731	145	1,423	- 262	143	1,248	144
2003	5,052	577	5,485	9,791	695	6,396	690
2004	17,477	4,498	10,249	16,221	5,204	12,305	4,466
2005	30,629	6,006	9,678	37,517	8,474	23,646	7,276
2006	25,985	9,566	23,304	21,982	11,600	22,401	9,955
2007	19,867	16,247	46,209	8,103	13,489	13,904	11,575
2008	15,223	28,898	56,363	20,801	23,975	22,417	20,569
Total	118,997	65,303	155,405	111,890	63,581	104,845	54,674

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Chapter 9, Exhibit II, Sheet 2.
(8) Estimated in Exhibit II, Sheet 3.

Chapter 10 - Cape Cod Technique
Impact of Changing Conditions
Scenarios 1 and 2 - Development of Expected Claim Ratio

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/08	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
2000	1,050,000	108	735,000	1.000	100.0%	1,050,000	70.0%
2001	1,102,500	96	771,750	1.000	100.0%	1,102,500	70.0%
2002	1,157,625	84	810,338	1.000	100.0%	1,157,625	70.0%
2003	1,215,506	72	842,346	1.010	99.0%	1,203,351	70.0%
2004	1,276,282	60	884,463	1.010	99.0%	1,263,519	70.0%
2005	1,340,096	48	919,306	1.020	98.0%	1,313,294	70.0%
2006	1,407,100	36	935,722	1.053	95.0%	1,336,745	70.0%
2007	1,477,455	24	930,797	1.111	90.0%	1,329,710	70.0%
2008	1,551,328	12	836,166	1.299	77.0%	1,194,523	70.0%
Total	12,577,893		8,365,887			11,951,267	70.0%
Increasing Claim Ratios							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
2000	1,050,000	108	735,000	1.000	100.0%	1,050,000	70.0%
2001	1,102,500	96	771,750	1.000	100.0%	1,102,500	70.0%
2002	1,157,625	84	810,338	1.000	100.0%	1,157,625	70.0%
2003	1,215,506	72	842,346	1.010	99.0%	1,203,351	70.0%
2004	1,276,282	60	1,010,815	1.010	99.0%	1,263,519	80.0%
2005	1,340,096	48	1,116,300	1.020	98.0%	1,313,294	85.0%
2006	1,407,100	36	1,203,071	1.053	95.0%	1,336,745	90.0%
2007	1,477,455	24	1,263,224	1.111	90.0%	1,329,710	95.0%
2008	1,551,328	12	1,194,523	1.299	77.0%	1,194,523	100.0%
Total	12,577,893		9,647,366			11,951,267	80.7%

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Age of accident year at December 31, 2008.
(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 2 and 4.
(5) Developed in Chapter 7, Exhibit III, Sheets 2 and 4.
(6) = [1.00 / (5)].
(7) = [(2) x (6)].
(8) = [(4) / (7)].

Chapter 10 - Cape Cod Technique
Impact of Changing Conditions
Scenarios 3 and 4 - Development of Expected Claim Ratio

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/08	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Increasing Case Outstanding Strength							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
2000	1,050,000	108	735,000	1.000	100.0%	1,050,000	70.0%
2001	1,102,500	96	771,750	1.000	100.0%	1,102,500	70.0%
2002	1,157,625	84	810,338	1.000	100.0%	1,157,625	70.0%
2003	1,215,506	72	842,346	1.010	99.0%	1,203,351	70.0%
2004	1,276,282	60	884,463	1.010	99.0%	1,263,519	70.0%
2005	1,340,096	48	933,377	1.020	98.1%	1,314,355	71.0%
2006	1,407,100	36	962,808	1.055	94.8%	1,334,350	72.2%
2007	1,477,455	24	979,922	1.119	89.4%	1,320,694	74.2%
2008	1,551,328	12	931,185	1.318	75.9%	1,176,756	79.1%
Total	12,577,893		8,551,189			11,923,151	71.7%
Increasing Claim Ratios and Case Outstanding Strength							
1999	1,000,000	120	700,000	1.000	100.0%	1,000,000	70.0%
2000	1,050,000	108	735,000	1.000	100.0%	1,050,000	70.0%
2001	1,102,500	96	771,750	1.000	100.0%	1,102,500	70.0%
2002	1,157,625	84	810,338	1.000	100.0%	1,157,625	70.0%
2003	1,215,506	72	842,346	1.010	99.0%	1,203,351	70.0%
2004	1,276,282	60	1,010,815	1.010	99.0%	1,263,519	80.0%
2005	1,340,096	48	1,133,386	1.019	98.1%	1,314,470	86.2%
2006	1,407,100	36	1,237,897	1.055	94.8%	1,334,094	92.8%
2007	1,477,455	24	1,329,895	1.120	89.3%	1,319,695	100.8%
2008	1,551,328	12	1,330,264	1.320	75.7%	1,174,877	113.2%
Total	12,577,893		9,901,689			11,920,130	83.1%

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Age of accident year at December 31, 2008.
(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 6 and 8.
(5) Developed in Chapter 7, Exhibit III, Sheets 6 and 8.
(6) = [1.00 / (5)].
(7) = [(2) x (6)].
(8) = [(4) / (7)].

Chapter 10 - Cape Cod Technique
Impact of Changing Conditions
U.S. PP Auto - Development of Unpaid Claim Estimate

Exhibit III
Sheet 3

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/08	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Steady-State											
1999	1,000,000	70.0%	700,000	1.000	0.0%	0	700,000	700,000	0	0	0
2000	1,050,000	70.0%	735,000	1.000	0.0%	0	735,000	735,000	0	0	0
2001	1,102,500	70.0%	771,750	1.000	0.0%	0	771,750	771,750	0	0	0
2002	1,157,625	70.0%	810,338	1.000	0.0%	0	810,338	810,338	0	0	0
2003	1,215,506	70.0%	850,854	1.010	1.0%	8,509	842,346	850,854	8,509	8,509	0
2004	1,276,282	70.0%	893,397	1.010	1.0%	8,934	884,463	893,397	8,934	8,934	0
2005	1,340,096	70.0%	938,067	1.020	2.0%	18,761	919,306	938,067	18,761	18,761	0
2006	1,407,100	70.0%	984,970	1.053	5.0%	49,249	935,722	984,970	49,249	49,249	0
2007	1,477,455	70.0%	1,034,219	1.111	10.0%	103,422	930,797	1,034,219	103,422	103,422	0
2008	1,551,328	70.0%	1,085,930	1.299	23.0%	249,764	836,166	1,085,930	249,764	249,764	0
Total	12,577,893		8,804,525			438,638	8,365,887	8,804,525	438,638	438,638	0
Increasing Claim Ratios											
1999	1,000,000	80.7%	807,225	1.000	0.0%	0	700,000	700,000	0	0	0
2000	1,050,000	80.7%	847,587	1.000	0.0%	0	735,000	735,000	0	0	0
2001	1,102,500	80.7%	889,966	1.000	0.0%	0	771,750	771,750	0	0	0
2002	1,157,625	80.7%	934,464	1.000	0.0%	0	810,338	810,338	0	0	0
2003	1,215,506	80.7%	981,188	1.010	1.0%	9,812	842,346	852,158	9,812	8,509	- 1,303
2004	1,276,282	80.7%	1,030,247	1.010	1.0%	10,302	1,010,815	1,021,117	10,302	10,210	- 92
2005	1,340,096	80.7%	1,081,759	1.020	2.0%	21,635	1,116,300	1,137,935	21,635	22,782	1,146
2006	1,407,100	80.7%	1,135,847	1.053	5.0%	56,792	1,203,071	1,259,863	56,792	63,320	6,527
2007	1,477,455	80.7%	1,192,640	1.111	10.0%	119,264	1,263,224	1,382,488	119,264	140,358	21,094
2008	1,551,328	80.7%	1,252,272	1.299	23.0%	288,022	1,194,523	1,482,545	288,022	356,805	68,783
Total	12,577,893		10,153,194			505,828	9,647,366	10,153,194	505,828	601,984	96,155

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Selected based on estimated overall claim ratio developed in Exhibit III, Sheet 1.
(4) = [(2) x (3)].
(5) Developed in Chapter 7, Exhibit III, Sheets 2 and 4.
(6) = [1.00 - (1.00 / (5))].
(7) = [(4) x (6)].
(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 2 and 4.
(9) = [(7) + (8)].
(10) = [(9) - (8)].
(11) Developed in Chapter 7, Exhibit III, Sheet 1.
(12) = [(11) - (10)].

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/08	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Increasing Case Outstanding Strength											
1999	1,000,000	71.7%	717,192	1.000	0.0%	0	700,000	700,000	0	0	0
2000	1,050,000	71.7%	753,052	1.000	0.0%	0	735,000	735,000	0	0	0
2001	1,102,500	71.7%	790,704	1.000	0.0%	0	771,750	771,750	0	0	0
2002	1,157,625	71.7%	830,239	1.000	0.0%	0	810,338	810,338	0	0	0
2003	1,215,506	71.7%	871,751	1.010	1.0%	8,718	842,346	851,063	8,718	8,509	- 209
2004	1,276,282	71.7%	915,339	1.010	1.0%	9,153	884,463	893,617	9,153	8,934	- 219
2005	1,340,096	71.7%	961,106	1.020	1.9%	18,461	933,377	951,838	18,461	4,690	- 13,771
2006	1,407,100	71.7%	1,009,161	1.055	5.2%	52,176	962,808	1,014,984	52,176	22,162	- 30,014
2007	1,477,455	71.7%	1,059,619	1.119	10.6%	112,428	979,922	1,092,350	112,428	54,296	- 58,132
2008	1,551,328	71.7%	1,112,600	1.318	24.1%	268,640	931,185	1,199,825	268,640	154,745	- 113,895
Total	12,577,893		9,020,764			469,576	8,551,189	9,020,764	469,576	253,336	- 216,240
Increasing Claim Ratios and Case Outstanding Strength											
1999	1,000,000	83.1%	830,670	1.000	0.0%	0	700,000	700,000	0	0	0
2000	1,050,000	83.1%	872,203	1.000	0.0%	0	735,000	735,000	0	0	0
2001	1,102,500	83.1%	915,813	1.000	0.0%	0	771,750	771,750	0	0	0
2002	1,157,625	83.1%	961,604	1.000	0.0%	0	810,338	810,338	0	0	0
2003	1,215,506	83.1%	1,009,684	1.010	1.0%	10,097	842,346	852,443	10,097	8,509	- 1,588
2004	1,276,282	83.1%	1,060,168	1.010	1.0%	10,602	1,010,815	1,021,417	10,602	10,210	- 391
2005	1,340,096	83.1%	1,113,177	1.019	1.9%	21,287	1,133,386	1,154,673	21,287	5,695	- 15,591
2006	1,407,100	83.1%	1,168,835	1.055	5.2%	60,644	1,237,897	1,298,541	60,644	28,494	- 32,150
2007	1,477,455	83.1%	1,227,277	1.120	10.7%	131,047	1,329,895	1,460,941	131,047	73,688	- 57,359
2008	1,551,328	83.1%	1,288,641	1.320	24.3%	312,707	1,330,264	1,642,971	312,707	221,064	- 91,642
Total	12,577,893		10,448,073			546,383	9,901,689	10,448,073	546,383	347,660	- 198,721

Column Notes:
(2) Assume $1,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
(3) Selected based on estimated overall claim ratio developed in Exhibit III, Sheet 2.
(4) = [(2) x (3)].
(5) Developed in Chapter 7, Exhibit III, Sheets 6 and 8.
(6) = [1.00 - (1.00 / (5))].
(7) = [(4) x (6)].
(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit III, Sheets 6 and 8.
(9) = [(7) + (8)].
(10) = [(9) - (8)].
(11) Developed in Chapter 7, Exhibit III, Sheet 1.
(12) = [(11) - (10)].

Chapter 10 - Cape Cod Technique
Impact of Change in Product Mix Example
Scenarios 5 and 6 - Development of Expected Claim Ratio

Exhibit IV
Sheet 1

Accident Year	Earned Premium	Age of Accident Year at 12/31/08	Reported Claims at 12/31/08	Reported CDF to Ultimate	% of Ultimate Reported	Used Up Premium	Estimated Claim Ratios
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steady-State (No Change in Product Mix)							
1999	2,000,000	120	1,500,000	1.000	100.0%	2,000,000	75.0%
2000	2,100,000	108	1,575,000	1.000	100.0%	2,100,000	75.0%
2001	2,205,000	96	1,653,750	1.000	100.0%	2,205,000	75.0%
2002	2,315,250	84	1,736,438	1.000	100.0%	2,315,250	75.0%
2003	2,431,013	72	1,814,751	1.005	99.5%	2,419,668	75.0%
2004	2,552,563	60	1,885,068	1.016	98.5%	2,513,424	75.0%
2005	2,680,191	48	1,948,499	1.032	96.9%	2,597,999	75.0%
2006	2,814,201	36	1,937,577	1.089	91.8%	2,583,436	75.0%
2007	2,954,911	24	1,852,729	1.196	83.6%	2,470,306	75.0%
2008	3,102,656	12	1,568,393	1.484	67.4%	2,091,190	75.0%
Total	25,155,785		17,472,204			23,296,273	75.0%
Changing Product Mix							
1999	2,000,000	120	1,500,000	1.000	100.0%	2,000,000	75.0%
2000	2,100,000	108	1,575,000	1.000	100.0%	2,100,000	75.0%
2001	2,205,000	96	1,653,750	1.000	100.0%	2,205,000	75.0%
2002	2,315,250	84	1,736,438	1.000	100.0%	2,315,250	75.0%
2003	2,431,013	72	1,814,751	1.005	99.5%	2,419,668	75.0%
2004	2,552,563	60	1,885,068	1.016	98.5%	2,513,424	75.0%
2005	2,999,262	48	2,193,545	1.032	96.9%	2,907,284	75.4%
2006	3,564,016	36	2,471,446	1.090	91.7%	3,269,911	75.6%
2007	4,281,446	24	2,680,487	1.200	83.3%	3,566,552	75.2%
2008	5,196,516	12	2,556,695	1.503	66.5%	3,457,489	73.9%
Total	29,645,066		20,067,179			26,754,578	75.0%

Column and Line Notes:
(2) For no change scenario, assume $2,000,000 for first year in experience period (1999) and 5% annual increase thereafter. For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.
(3) Age of accident year at December 31, 2008.
(4) From last diagonal of reported claim triangles in Chapter 7, Exhibit IV, Sheets 2 and 4.
(5) Developed in Chapter 7, Exhibit IV, Sheets 2 and 4.
(6) = [1.00 / (5)].
(7) = [(2) x (6)].
(8) = [(4) / (7)].

U.S. Auto - Development of Unpaid Claim Estimate

Accident Year	Earned Premium	Expected Claim Ratio	Estimated Expected Claims	Reported CDF to Ultimate	Percentage Unreported	Expected Unreported Claims	Reported Claims at 12/31/08	Projected Ultimate Claims	Estimated IBNR	Actual IBNR	Difference from Actual IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Steady-State (No Change in Product Mix)											
1999	2,000,000	75.0%	1,500,000	1.000	0.0%	0	1,500,000	1,500,000	0	0	0
2000	2,100,000	75.0%	1,575,000	1.000	0.0%	0	1,575,000	1,575,000	0	0	0
2001	2,205,000	75.0%	1,653,750	1.000	0.0%	0	1,653,750	1,653,750	0	0	0
2002	2,315,250	75.0%	1,736,438	1.000	0.0%	0	1,736,438	1,736,438	0	0	0
2003	2,431,013	75.0%	1,823,259	1.005	0.5%	8,509	1,814,751	1,823,259	8,509	8,509	0
2004	2,552,563	75.0%	1,914,422	1.016	1.5%	29,354	1,885,068	1,914,422	29,354	29,354	0
2005	2,680,191	75.0%	2,010,143	1.032	3.1%	61,644	1,948,499	2,010,143	61,644	61,644	0
2006	2,814,201	75.0%	2,110,651	1.089	8.2%	173,073	1,937,577	2,110,651	173,073	173,073	0
2007	2,954,911	75.0%	2,216,183	1.196	16.4%	363,454	1,852,729	2,216,183	363,454	363,454	0
2008	3,102,656	75.0%	2,326,992	1.484	32.6%	758,599	1,568,393	2,326,992	758,599	758,599	0
Total	25,155,785		18,866,839			1,394,634	17,472,204	18,866,839	1,394,634	1,394,634	0
Changing Product Mix											
1999	2,000,000	75.0%	1,500,093	1.000	0.0%	0	1,500,000	1,500,000	0	0	0
2000	2,100,000	75.0%	1,575,098	1.000	0.0%	0	1,575,000	1,575,000	0	0	0
2001	2,205,000	75.0%	1,653,853	1.000	0.0%	0	1,653,750	1,653,750	0	0	0
2002	2,315,250	75.0%	1,736,545	1.000	0.0%	0	1,736,438	1,736,438	0	0	0
2003	2,431,013	75.0%	1,823,373	1.005	0.5%	8,509	1,814,751	1,823,260	8,509	8,509	- 1
2004	2,552,563	75.0%	1,914,541	1.016	1.5%	29,356	1,885,068	1,914,424	29,356	29,354	- 2
2005	2,999,262	75.0%	2,249,586	1.032	3.1%	68,987	2,193,545	2,262,532	68,987	71,855	2,867
2006	3,564,016	75.0%	2,673,178	1.090	8.3%	220,593	2,471,446	2,692,039	220,593	239,057	18,464
2007	4,281,446	75.0%	3,211,284	1.200	16.7%	536,204	2,680,487	3,216,691	536,204	596,924	60,720
2008	5,196,516	75.0%	3,897,629	1.503	33.5%	1,304,351	2,556,695	3,861,045	1,304,351	1,445,385	141,035
Total	29,645,066		22,235,179			2,168,000	20,067,179	22,235,179	2,168,000	2,391,084	223,083

Column Notes:
(2) For no change scenario, assume $2,000,000 for first year in experience period (1999) and 5% annual increase thereafter.
For change scenario, assume annual increase of 30% for commercial auto beginning in 2005.
(3) Selected based on estimated overall claim ratios developed in Exhibit IV, Sheet 1.
(4) = [(2) x (3)].
(5) Developed in Chapter 7, Exhibit IV, Sheets 2 and 4.
(6) = [1.00 - (1.00 / (5))].
(7) = [(4) x (6)].
(8) From last diagonal of reported claim triangles in Chapter 7, Exhibit IV, Sheets 2 and 4.
(9) = [(7) + (8)].
(10) = [(9) - (8)].
(11) Developed in Chapter 7, Exhibit IV, Sheet 1.
(12) = [(11) - (10)].

CHAPTER 11 – FREQUENCY-SEVERITY TECHNIQUES

Projections based on frequency-severity techniques can be extremely valuable, not only in providing additional estimates of unpaid claims, but also in understanding the drivers in claims activity. In the paper "Evaluating Bodily Injury Liabilities Using a Claims Closure Model," Martin Adler and Charles D. Kline discuss the rhythm in the claims settlement process:

> Claims emerge at an identifiable rate, they are settled at an identifiable rate, the payments grow at an identifiable rate and the accuracy of individual case estimates improves at an identifiable rate.[60]

When actuaries use frequency-severity techniques in their simplest form, they project ultimate claims by multiplying the estimated ultimate number of claims (i.e., frequency) by the estimated ultimate average value (i.e., severity). By analyzing claims experience by its frequency and severity components, actuaries are able to examine trends and patterns in the rates of claims emergence (i.e., reporting) and settlement (i.e., closure) as well as in the average values of claims. This can be particularly valuable when an organization is undergoing change in operations, philosophy, or management. Frequency-severity methods can also be important to validate or reject the findings from other actuarial projection techniques.

Common Uses of Frequency-Severity Techniques

Actuaries can use frequency-severity techniques for projecting unpaid claim estimates in a wide variety of situations. They can use them with accident year, policy year, report year, and calendar year data. Generally reinsurers do not use frequency-severity methods with underwriting year data simply because they do not have access to detailed statistics regarding the number of claims. Frequency-severity techniques are appropriate for all lines of insurance but are more often used for long-tail lines. Furthermore, actuaries can use frequency-severity methods for projecting unpaid claims for both primary layers of coverage and excess layers of insurance.

Technically, *frequency* refers to the number of claims per unit of exposure, and *severity* refers to the average cost per claim. Thus, for a true frequency-severity projection method, the actuary would require historical data for the claims, number of claims, and exposures. In practice, many actuaries use the term "frequency-severity methods" to refer to projections of ultimate claim counts multiplied by ultimate severities without the direct incorporation of an exposure measurement.

Types of Frequency-Severity Techniques

There are many different types of projection methods that fall under the classification of frequency-severity techniques. In this chapter, we examine three different types of frequency-severity projection methods. Since the number of claims is not available from our source of the consolidated industry data in the U.S., which is *Best's Aggregates & Averages*, we are not able to carry forward most of the examples contained in the preceding chapters. We do, however, continue with our example for XYZ Insurer.

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[60] *CAS Discussion Paper Program*, 1988.

The first and simplest frequency-severity approach is the development technique applied separately to claim counts and average values. We present this approach in Exhibit I for a Canadian portfolio of private passenger automobile collision coverage (Auto Collision Insurer) and in Exhibit II for XYZ Insurer.

In the second frequency-severity approach, we focus on projecting ultimate claims for the most recent two accident years. The development method can often result in substantial development factors to ultimate for the most recent accident years. Highly leveraged factors typically lead to greater uncertainty in actuarial projections of ultimate claims; this, in turn, results in greater uncertainty for the estimate of unpaid claims. It is important for actuaries to consider alternative projection techniques in such situations. The expected claims and Bornhuetter-Ferguson techniques are two of the most commonly used methods to supplement claim development methods, particularly for the most recent accident years. Frequency-severity methods are also a valuable alternative for the actuary.

In the second frequency-severity approach, we compare, by accident year, the projected ultimate number of claims to an exposure base. The selected frequency rate (i.e., ultimate number of claims per exposure unit) is then used to project the ultimate number of claims for the most recent two accident years. The severities for the most recent accident years are based on the development technique applied to reported severities after adjustment for inflation. We use this approach in Exhibit III for a self-insurer of U.S. workers compensation (WC Self-Insurer) and in Exhibit IV for XYZ Insurer.

Our third frequency-severity approach is based on a disposal rate analysis. This final approach builds upon the basic development triangle used with both claims and claim counts. In this method, we examine the rate of claim count closure at each maturity age and the incremental paid severity by maturity age. In Exhibit V, we present an example of this approach for a portfolio of general liability insurance (GL Insurer) and in Exhibit VI for XYZ Insurer.

In the following sections, we describe each of the three frequency-severity approaches in detail including the key assumptions and the mechanics of each technique.

Frequency-Severity Approach #1 – Development Technique with Claim Counts and Severities

Key Assumptions

Two of the major requirements of frequency-severity techniques are that the individual claim counts being grouped are defined in a consistent manner over the experience period and that the claim counts are reasonably homogenous. For example, it is not appropriate to group together claimant counts and occurrence counts, which record all claimants under the occurrence as a single claim, unless the mix of the two ways of counting a claim is consistent. It is also important that the type of claim be reasonably homogenous. For example, it is not reasonable to combine the average values for slip-and-fall claims with those resulting from class action proceedings in which thousands of injured parties are grouped together; such average values would have little meaning. Likewise, it is not appropriate to analyze first-dollar, low-limit claims with high-layer, multi-million dollar, excess claims.

As indicated previously, many frequency-severity methods rely on the development technique applied separately to claim counts and average values. Thus, a key assumption of the development technique is also applicable to this type of frequency-severity analysis. Recall that the underlying assumption in the development technique is that claims reported (or paid) to date will continue to develop in a similar manner in the future. In a frequency-severity method where reported (or closed) claim counts are used to project the ultimate number of claims, the actuary assumes that the claim counts reported (or closed) to date will continue to develop in a similar manner in the future. Similarly, the actuary using the development technique on severities assumes that the relative change in a given year's severities from one evaluation point to the next is similar to the relative change in prior years' severities at similar evaluation points.

Mechanics of the Technique

In Exhibit I, Sheets 1 through 8, we present our first frequency-severity example for Auto Collision Insurer. This first example has four basic steps:

- Project and select ultimate claim counts
- Project ultimate severity
- Project ultimate claims
- Develop unpaid claim estimate

In this example, we use semi-annual accident periods and valuations in intervals of six months.[61]

Project and Select Ultimate Claim Counts

In Exhibit I, Sheets 1 through 3, we use the development technique to project both closed and reported claim counts to an ultimate basis. (We describe the development technique in detail in Chapter 7 – Development Technique.) For Auto Collision Insurer, the closed claim counts include claim counts closed with payments or claim-related expense payments or both, but do not include claim counts closed with no payment (CNP). Reported claim counts include the number of closed claims in addition to the number of open claims with a case outstanding (for claim only or claim-related expense) greater than $0.

Since the reported claim counts in this example exclude CNP counts, it is not surprising to observe negative (or downward) development (i.e., age-to-age factors of less than 1.00) in Exhibit I, Sheet 2. Recall that private passenger collision is a very fast reporting and settling coverage of automobile insurance. In our example, the reported claim counts at six months include many open claims with case outstanding values. However, as time passes and these claims mature, many will close without any payment. Due to the fast-reporting nature of this coverage, for a particular accident half-year, there are more claim counts closed without payment in subsequent valuations than new claim counts reported. Thus, we see age-to-age factors of less than 1.00 for every accident half-year at 6-to-12 months. Similar behavior is evident through 36 months for the reported claim count triangle of age-to-age factors.

[61] We present this example using data at six-month evaluations for two reasons. First, to demonstrate to the reader that the estimation of unpaid claims is often conducted using data at valuations other than 12-month intervals. Second, this example demonstrates the potential influence of seasonality on claim development factors.

We again stress the importance of understanding the type of data provided by the insurer. If the closed counts exclude CNP counts but reported counts include the CNP counts, the actuary will not be able to use both the closed and reported counts to produce comparable estimates of the ultimate number of claims. If claims include all claim adjustment expense (with or without claim payments or case outstanding) but counts do not include claims with claim adjustment expense only, there will not be an appropriate match of the number of claims and the dollars that are spent on the claims. Another important issue related to the number of claims is claimant count versus occurrence count. A single occurrence, such as an automobile accident may result in multiple injured parties or damaged vehicles or both. Does the insurer record one count or multiple counts for such an occurrence? The actuary must understand how the insurer defines and records claim counts and whether or not there have been changes in the insurer's practices during the experience period. There may also be different practices with respect to recording claim counts on the insurer's systems when the payment is below the deductible. As we note continually through this book, the important point is that the actuary must understand the data that he or she is working with.

In Exhibit I, Sheets 1 and 2, we present the development triangles for closed and reported claim counts, respectively. We judgmentally select age-to-age factors based on the simple average for the latest three half-years for both closed and reported counts. At first glance, we note that there is variability from accident half-year to accident half-year at 6-to-12 months for the closed claim counts, but the averages appear relatively close to one another. We will further investigate this particular age-to-age maturity (6-to-12 months) later in this example.

In Exhibit I, Sheet 3, we project the ultimate number of claims by accident half-year. Note, that accident half-year 2008-1, which represents the period from January 1, 2008 through June 30, 2008, is six months old as of June 30, 2008; and accident half-year 2007-2, which represents the period from July 1, 2007 to December 31, 2007, is 12 months old at June 30, 2008. (We begin counting with the beginning of the accident half-year period.)

Exhibit I, Sheet 3, where we project the claim counts to ultimate, is similar to the development projections contained in preceding chapters. We present the age of the accident half-year in Column (2) of Exhibit I, Sheet 3. Columns (3) and (4) show closed and reported claim counts, respectively, as of June 30, 2008. The next two columns are the development factors to ultimate. The projected ultimate claim counts based on closed counts are shown in Column (7), and the projected ultimate claim counts based on the reported counts are in Column (8). It is obvious after a quick examination of Columns (7) and (8) that the two projection methods produce similar results for all accident half-years except for the latest period (i.e., 2008-1).

We now return to the claim count triangles to determine if there is something taking place that we missed upon our first review. One quick way to look for changes or patterns in the triangular data is to use a development diagnostic. In Exhibit I, Sheet 4, we present the ratio of closed-to-reported claim counts. Looking down the column at age six months, we immediately see evidence of seasonality in the relationship between closed and reported counts. For accident half-years ending with a 2 (i.e., July 1 through December 31), the average ratio of closed-to-reported counts is 0.71, and there is minimal variability from period to period around this average. Similarly, there is minimal variability in the ratio of closed-to-reported claim counts for accident half-years ending with a 1 (i.e., January 1 to June 30); they have an average ratio of 0.81.

There are numerous factors that could result in a lower proportion of claim counts closed at six months for the accident half-years ending December 31 than for those ending June 30. For example, there may be a higher number of claims reported in Canada in November and December due to the beginning of winter weather and the resulting more hazardous driving conditions. There is also less time to settle the November and December winter claims with a December 31 closing date than the winter claims occurring in January and February with a half-year closing date of June 30. There may also be less time available to process and close the November and December claims due to the shorter work period for many companies that close over the Christmas holidays. The actuary should speak to claims department management to understand the reasons for such patterns in the data. We also observe that there are no material differences or patterns evident in any maturities beyond six months.

Since we observe a distinctive pattern in the ratio of closed-to-reported claim counts at six months, the next step is to see if we can discern any patterns in either the closed count triangle or the reported count triangle or both. Upon a second examination of the age-to-age factors for closed claim counts (Part 2 of Exhibit I, Sheet 1), we note differences in the age-to-age factors for accident half-years ending June versus December. We do not see obvious patterns in the reported claim count triangle at the 6-to-12 month interval. In the table below we summarize the 6-to-12 month factors for both closed and reported counts. We also present the simple averages for all years and the latest three years.

	Age-to-Age Factors at 6-12 Months	
Accident Half-Year	**Closed Claim Counts**	**Reported Claim Counts**
2003-2	1.281	0.932
2004-1	1.153	0.934
2004-2	1.275	0.910
2005-1	1.154	0.956
2005-2	1.327	0.942
2006-1	1.181	0.966
2006-2	1.353	0.956
2007-1	1.212	0.983
2007-2	1.312	0.995
Accident Half-Years – 1		
Simple Average All Years	1.175	0.960
Simple Average Latest 3 Years	1.183	0.968
Accident Half-Years – 2		
Simple Average All Years	1.310	0.947
Simple Average Latest 3 Years	1.331	0.964

Now that we are aware of the difference in 6-to-12 month development factors for closed claim counts, we revise our selected age-to-age factor from 1.292, which is the simple average of the latest three accident half-years, to 1.183, which is the simple average latest three accident half-years ending at June 30. We choose the factors based on accident half-years ending June because the latest point in our six-month data ends June 30. Since we do not notice any material differences in the development factors for reported claim counts, we do not change our original selected factor.

The new projected ultimate claim counts for accident half-year 2008-1 based on closed counts are:

[(closed claim counts at June 30, 2008) x (development factor to ultimate)] =

[(2,533) x (1.001 x 1.009 x 1.183)] = [(2,533) x (1.195)] = 3,027

The projected number of ultimate claims based on reported claim counts for accident half-year 2008-1 is 3,061; this is very close to our new projected value of 3,027, which is based on closed claim counts.

Project Ultimate Severity

The development technique is also used to project reported severities to an ultimate basis. In Exhibit I, Sheet 5, we summarize the triangles of reported claims (in thousands of dollars) and reported severities (i.e., average reported claim). We analyze the reported severity triangle and select development factors in Exhibit I, Sheet 6. Since we note some seasonality in the claim count triangle, we also check for seasonality differences between the half-years in the triangle of reported severities. There does appear to be greater development for accident half-years ending December rather than June, particularly for the older periods in the triangle. In such a situation, the actuary should seek further explanation from claims management professionals to fully understand the factors influencing the claim development patterns. In our example, we select a 6-to-12 month factor of 1.039 based on the medial average (i.e., average excluding high and low values) and the assumption that the experience of the most recent few years is more representative of future experience than the earliest periods in the triangle. We also use the medial average to select the age-to-age factors for the remaining maturities.

Project Ultimate Claims

In Exhibit I, Sheet 7, we multiply the projected ultimate severities by the projected ultimate claim counts to determine the projected ultimate claims by accident half-year period.

Develop Unpaid Claim Estimate

The steps involved in the calculation of the unpaid claim estimate are similar to all the previous methods presented. Estimated IBNR is equal to the difference between projected ultimate claims and reported claims. For Auto Collision Insurer, the estimated IBNR is negative for all accident half-years except the latest period, 2008-1. Negative IBNR is often a result of either salvage and subrogation recoveries, which are included with the claim development data, or a conservative philosophy towards setting case outstanding. In this particular example, the negative IBNR is a result of the downward (i.e., favorable) development of claim counts and not salvage or subrogation recoveries. The total unpaid claim estimate is equal to the sum of case outstanding and estimated IBNR and is shown in Column (6) of Exhibit I, Sheet 8.

Analysis for XYZ Insurer

In Exhibit II, we use the same frequency-severity approach for XYZ Insurer. This example has been addressed in each of the preceding chapters of Part 3. We know, based on interviews with management of XYZ Insurer and reviews of the diagnostic development triangles, that there have been significant changes in both their internal and external environments. (It may be valuable to review the diagnostic triangles presented in Chapter 6 for XYZ Insurer.) The only adjustment we make to the severity methodology to reflect these recent changes is in our selection of the development factors. We select the volume-weighted average of the age-to-age factors for the latest two years; we use the latest two years in an attempt to reflect the most recent operating environment at XYZ Insurer.

In Exhibit II, Sheet 3, we project the ultimate number of claims based on closed and reported claim counts. While the two projections of claim counts are somewhat close for accident years 1998 through 2005, we observe significant differences in the projected number of ultimate claims for 2006 through 2008. For every year starting in 2000 through 2008, the ultimate count projections based on closed counts are greater than the ultimate projections based on reported counts.

Similar to the previous collision example, the next step is to project the ultimate severities by accident year. We analyze the triangle of reported severities in Exhibit II, Sheet 5. We observe that within the triangle of age-to-age factors, the latest point in each column is usually the lowest point in the column. This is consistent with management's assertion that there has been a significant increase in case outstanding strength, particularly in calendar year 2007. Again, we use the latest two years for our selected development factors in an attempt to best reflect the current environment at this insurer.

In Exhibit II, Sheet 6, we multiply the projected ultimate severities by the projected number of ultimate claims for each accident year to project ultimate claims. We calculate estimated IBNR and the total unpaid claim estimate in Exhibit II, Sheet 7.

We observe that the estimated IBNR and total unpaid claim estimate from this type of frequency-severity projection are higher than the estimated unpaid claims generated from the reported claim development technique and lower than the estimate generated from the paid claim development technique. At XYZ Insurer, we know that there have been changes in case outstanding adequacy and claims settlement procedures. Without appropriate adjustment to our projection techniques, either in the types of data that are used or the methodological adjustments, we may exacerbate problems in our projected results. For an example, return to the projected number of ultimate claims in Exhibit II, Sheet 3. Projected ultimate claim counts based on closed counts are significantly greater than projected ultimate claim counts based on reported counts. This is consistent with our conclusions regarding an increased rate of claims settlement. Thus, it may be more appropriate to rely on the reported claim count projection which is not affected by changes in claims closure patterns. This change alone reduces the estimated IBNR by more than $30 million.

Frequency-Severity Approach #2 – Incorporation of Exposures and Inflation into the Methodology

Key Assumptions

This second frequency-severity approach also relies on the development technique applied to historical closed and reported claim counts and average reported claims. Thus, critical assumptions include:

— Claim counts and reported claim activity to date will continue to develop in a similar manner in the future

— Claim counts are defined consistently over time

— The mix by claim type is reasonably consistent (to the extent that the potential claims can vary significantly by type of claim)

In this second approach, however, we also incorporate trend rates into the analysis of both frequency and severity parameters. In our examples, we examine three specific trend rates: exposure trend, frequency trend, and severity trend.

When selecting trend rates, there are numerous considerations for the actuary. The selection of frequency and severity trends often reflects not only economic inflationary factors but also societal factors that tend to increase both the number and the size of claims over time. Trend rates typically vary by line of business and even by subcoverage within a line of business. In addition, there can be significant variation in trend rates for exposures, frequency, and severity by geographic region (e.g., country, state/province within a country, and even subdivisions within a state/province). Severity and frequency trend rates can also vary based on the limits (i.e., retention) carried by the insurer or self-insurer. For U.S. workers compensation, it is often appropriate to incorporate adjustments for statutory benefit changes into the analysis as well as inflationary trend factors.

There are various sources actuaries turn to when selecting trend assumptions, including general insurance industry data, government statistical organizations, economic indices, and insurer-specific experience. Later in this chapter, we present examples in which regression analysis of the insurer's own claims experience is used to determine trend rates. The accuracy and appropriateness of the assumed trend rates is critical for many frequency-severity methods that are used to project ultimate claims.[62] The longer the projection period, the greater the uncertainty as trend factors can become very large and thus highly leveraged.

[62] For example, there have been times when the inflation rate for many of the items covered by U.S. auto insurance was positive, but the observed average claim severity trend was negative. Two possible reasons for this disparity of inflation rates include a change in the mix of claim types and the impact of various safety features added to new cars.

Mechanics of the Approach

In our second frequency-severity approach, we use historical claim counts and severities to project ultimate claims for the latest two accident years. We present two examples: a self-insurer of U.S. workers compensation (WC Self-Insurer) and XYZ Insurer. As we discuss previously, the claim development factor to ultimate can be highly leveraged for the most recent accident years, which can lead to a greater degree of uncertainty in the estimate of unpaid claims. Therefore, actuaries can turn to this type of frequency-severity approach as an alternative method for projecting ultimate claims.

This second approach to frequency-severity has five basic steps:

- Project and select ultimate claim counts
- Compare ultimate claim counts to exposures and select frequency
- Project ultimate severity
- Project ultimate claims
- Develop unpaid claim estimate

Project and Select Ultimate Claim Counts

Similar to our examples based on approach #1, we begin with projecting both closed and reported claim counts to an ultimate basis and selecting the ultimate claim counts by accident year (Exhibit III, Sheets 1 through 3). In this example, we select development factors based on the volume-weighted average for the latest five years. For the oldest maturity periods in the closed claim count triangle (84-to-96 months), we judgmentally select a development factor of 1.003, which results in a smoother pattern than the one data point of 1.008. We also judgmentally select a tail factor for closed claim counts of 1.007, which is based on a review of the relationship between closed and reported claim counts at ages of 72, 84, and 96 months. In Exhibit III, Sheet 3, we summarize the projected ultimate claim count projections; the selected ultimate claim counts are based on the average of the two projections, which are very similar for each year.

Compare Ultimate Claim Counts to Exposures and Select Frequency

In this approach, we take the frequency analysis one step further by comparing the ultimate claim counts by accident year to an exposure base. (See Exhibit III, Sheet 4.) For U.S. workers compensation, the most common exposure base is payroll (in hundreds of dollars). Our goal is to determine the appropriate frequency (i.e., number of claims per exposure unit) for the latest two accident years. Since payroll is an inflation-sensitive exposure base, we must adjust the payroll for each accident year to a common time period. For simplification purposes, we assume a 2.5% annual inflation rate for payroll for all years in the experience period and trend all historical payroll to the cost level of accident year 2008. (Columns (5) through (7) of Exhibit III, Sheet 4, contain these calculations.)

Similarly, the claim counts should be adjusted using trend factors to reflect changes in counts. Ideally, the actuary can analyze the self-insurer's own historical experience to determine the frequency trend rate. In our example, however, sufficient historical data is not available. Thus, we rely on our knowledge of U.S. workers compensation in general and the specific industry of this self-insured organization; we assume a -1.0% annual trend in the number of claims.[63] (See calculations in Columns (2) through (4) of Exhibit III, Sheet 4.)

We divide the ultimate trended claim counts in Column (4) of Exhibit III, Sheet 4, by the trended payroll in Column (7). After examining the frequency rates by accident year in Column (8), we recognize a change in frequency between the earliest years in the experience period (2001 through 2004) and the most recent years (2006 through 2008).

It is important for the actuary to speak to management at WC Self-Insurer to understand what caused the dramatic change in frequency. Has there been a new cost containment program introduced? Has there been a change in the definition of a claim? Has there been a change in third-party administrators? Was there a change in the type of work performed by employees? We note a large increase in both claims and payroll between 2005 and 2006. Was this the result of a corporate acquisition? Any of these changes could have an effect on the frequency analysis. In our example, we assume that the change in frequency is due to a major acquisition, which resulted in the hiring of a new risk manager and the introduction of new safety and risk control procedures. Thus, we select a 2008 frequency rate of 0.36%, which is reflective of the new and improved environment with respect to claims at this organization. We derive the 2007 frequency rate of 0.37% by multiplying 0.36% by 1.025, which represents the adjustment for payroll inflation, and dividing by 0.99, which represents the adjustment for claims trend.

Project Ultimate Severity

We now turn our attention to the analysis of severity. We begin with projecting paid severities and reported severities to an ultimate value (Exhibit III, Sheets 5 through 8). The development analysis is presented in Exhibit III, Sheet 6 for paid severities and in Exhibit III, Sheet 7 for reported severities. For both paid and reported severities, we select development factors based on the medial average (i.e., average excluding high and low values) for the latest five years. We select a tail factor at 96 months of 1.025 for the reported severities and 1.15 for the paid severities. These selections are based on our analysis of insurance industry benchmark development patterns for U.S. workers compensation.

In Exhibit III, Sheet 8, we compare these two projections and select ultimate severities for accident years 2001 through 2006. The next step is to adjust the severities for each historical accident year to the cost level of accident year 2008. For simplicity purposes, we assume a 7.5% annual severity trend rate for WC Self-Insurer. This self-insurer operates throughout the U.S., and for illustration purposes, we chose to simplify the model by not incorporating an adjustment of claims by year to the 2008 statutory benefits level. Many actuaries would likely incorporate such an adjustment when selecting the 2008 severity value, particularly if the entity operated in a single state. In Exhibit III, Sheet 9, we select a 2008 severity value of $7,100. We then derive the 2007 severity value of $6,605 by dividing the selected 2008 severity by the trend factor or 1.075.

[63] Potential factors that may cause a negative claim count trend for U.S. workers compensation include improvements in workplace safety or changes in the mix of job types (e.g., a shift from less construction and manufacturing to lower risk “white collar” type of work).

Project Ultimate Claims

We can now calculate (in Exhibit III, Sheet 10) the projected ultimate claims for accident years 2007 and 2008. The self-insured organization provided us with the payroll for both accident years. We multiply the payroll by the selected frequency rates to determine the projected ultimate number of claims (Line (3)). We then multiply the ultimate number of claims by the selected severities to derive the projected ultimate claims (Line (5)).

Develop Unpaid Claim Estimate

Estimated IBNR is equal to projected ultimate claims less reported claims; and the total unpaid claim estimate is equal to estimated IBNR plus case outstanding.

Analysis for XYZ Insurer

We continue the example presented in Exhibit II for XYZ Insurer. (See Exhibit IV, Sheets 1 through 3.) We use the second frequency-severity approach to review the experience of older, more mature accident years for the purpose of determining estimates of both frequency and severity for 2007 and 2008. In this second approach, we incorporate adjustments for rate level changes, inflation, and tort reform.

In Exhibit IV, Sheet 1, we first summarize the selected ultimate claim counts for accident years 2002 through 2006. In this example, we rely on the reported claim count projection instead of the average of the reported and closed count projections. (See Exhibit II, Sheet 3.) Based on our analysis of insurance industry trends, we assume an annual -1.5% claims frequency trend for this portfolio.

Ideally, the actuary would have vehicle or policy count available as an exposure base when conducting an analysis of unpaid claims for automobile liability insurance. However, there are numerous situations in which reliable exposure and policy count data is not available. For XYZ Insurer, earned premium is the only exposure data available. We recall from Chapter 6, that the insurer provided us with a rate level history for the period 2002 through 2008. Thus, in Columns (5) through (7) of Exhibit IV, Sheet 1, we adjust historical earned premiums to the 2008 rate level. We divide the trended claim counts by the on-level earned premium to determine frequency rates at the 2008 level. We select a 2008 frequency of 2.36%. To determine the 2007 frequency, we adjust the selected frequency for 2008 (2.36%) by the annual claim count trend (-1.5%) and the rate level change that took place in 2008 (20%). Thus, the 2007 frequency is 1.92%.

In Exhibit IV, Sheet 2, we adjust the projected ultimate severities from Exhibit II, Sheet 6 by trend factors to reflect the accident year 2008 cost level. For this example, we assume a 5% annual severity trend. We also include an adjustment for the regulatory reforms that took place in recent years. After a review of various averages and the adjusted severity indications by year in Column (5), we select a 2008 severity value of $26,720. We derive the 2007 severity value of $25,448 by adjusting the selected 2008 for one less year of trend.

In Exhibit IV, Sheet 3, we derive projections of ultimate claims for 2007 and 2008 based on the earned premium provided by XYZ Insurer and the selected frequency and severity values derived in Exhibit IV, Sheets 1 and 2, respectively. We also calculate the estimated IBNR and the estimate of total unpaid claims for accident years 2007 and 2008.

It is interesting to compare the projection of ultimate claim counts, severities, and claims using this frequency-severity approach and the first approach. The following table summarizes these values. Ultimate claims from the second approach are roughly half of the projections from the first approach due to lower projections of both ultimate claim counts and average values per claim.

	Approach # 1	**Approach # 2**
2007 Ultimate Claim Counts		
Closed Counts Projection	1,804	
Reported Counts Projection	1,308	
Selected Value	1,556	1,199
2007 Severity	37,606	25,448
2008 Ultimate Claim Counts		
Closed Counts Projection	1,679	
Reported Counts Projection	1,172	
Selected Value	1,426	1,128
2008 Severity	41,544	26,720
Projected Ultimate Claims ($000)		
Accident Year 2007	58,516	30,512
Accident Year 2008	59,242	30,140

In Chapter 15, we compare and contrast the various projection methods for this example.

Frequency-Severity Approach #3 – Disposal Rate Technique

Key Assumptions

Similar to the previous two frequency-severity approaches, we begin this final method by projecting reported and closed claim counts to an ultimate value using the development technique. Thus, we assume that historical patterns of claims emergence and settlement are predictive of future patterns of reported and closed claim counts. An implicit assumption of this method is that there are no significant partial (i.e., interim) payments.

In this method, we also explicitly incorporate an inflation adjustment for severity. The selected trend rate is an important assumption as a slight change in trend can result in a material change in the estimated of unpaid claims, and therefore the trend rate must be selected carefully.

Mechanics of the Approach

We present this final frequency-severity method in seven steps:

— Project ultimate claim counts and select ultimate claim counts by accident year
— Develop disposal rate triangle and select disposal rate by maturity age
— Project claim counts by accident year and maturity (complete the square)
— Analyze severities and select severities by maturity
— Calculate severities by maturity age and accident year (complete the square)
— Multiply claim counts by severities to determine projected claims
— Determine unpaid claim estimate

Project Ultimate Claim Counts and Select Ultimate Claim Counts by Accident Year

For this example, we use a portfolio of occurrence basis, general liability insurance data (GL Insurer). We start by following the same approach as the previous two frequency-severity techniques: project ultimate claim counts based on development projections of closed and reported claim counts. (See Exhibit V, Sheets 1 through 3.) Our data excludes CNP counts, which helps to explain why we observe downward (i.e., negative) development in the age-to-age factors for reported claim counts (Exhibit V, Sheet 2). For GL Insurer, we select development factors based on the volume-weighted averages for the latest three years. We judgmentally select tail factors based on the observed experience for the oldest maturities, including the ratio of closed-to-reported claim counts, and benchmark patterns for a similar portfolio of coverage. In Exhibit V, Sheet 3, we summarize the projection of ultimate closed and reported claim counts; for each accident year, we then select the ultimate number of claims, based on the average of the two projections.

Develop Disposal Rate Triangle and Select Disposal Rate by Maturity Age

The next step is to derive the disposal rate triangle. We define the *disposal rate* as the cumulative closed claim counts for each accident year-maturity age cell divided by the selected ultimate claim count for the particular accident year. We present this triangle in the top part of Exhibit V, Sheet 4. Each ratio represents the percentage of ultimate claim counts that are closed at a given stage of maturity for a given accident year.

In the middle part of Exhibit V, Sheet 4, we calculate various averages of the disposal rates by maturity age; we use the medial five-year average to select a disposal rate at each maturity age. For our example, we observe considerable stability in the disposal rates at each maturity. The following table summarizes the selected disposal rates at maturities 12 months through 96 months. We generally expect disposal rates to monotonically increase over time, as evidenced by the disposal rates in the following table.

Maturity Age (Months)	Selected Disposal Rate
12	0.200
24	0.433
36	0.585
48	0.710
60	0.791
72	0.862
84	0.882
96	0.912

Project Claim Counts by Accident Year and Maturity (Complete the Square)

In Exhibit V, Sheet 5, we use the selected disposal rates by maturity and the selected ultimate claim counts by accident year to complete the square of the incremental closed claim count triangle. Incremental claim counts in the column labeled 12 represent counts that are closed in the first 12 months from the start of the accident year. Incremental claim counts in the column labeled 24 represent the counts that are closed in the period between 12 months and 24 months. The rest of the triangle follows a similar naming pattern. (We use similar labeling in the triangle of incremental paid claims and incremental paid severities that are presented later in this chapter.)

We calculate the top left part of the "completed square" based on the differences between successive columns of the cumulative closed claim count triangle. This part of the completed square is simply the incremental closed claim count triangle based on the actual experience for GL Insurer. To calculate the bottom-right, highlighted part of the incremental closed claim count square, we first adjust the cumulative closed claim counts at the latest valuation to an ultimate basis and then apply the selected disposal rates for each age interval.

For example, for accident year *x* at age *y*, we calculate projected incremental closed claim counts as follows:

> [(ultimate claim counts for accident year *x* – cumulative closed claim counts for accident year *x* along latest diagonal) / (1.00 – selected disposal rate at maturity of latest diagonal)] x [disposal rate at *y* – disposal rate at *y-12*]

For example, the estimated incremental closed claim counts for accident year 2008 at 24 months are equal to:

[(609 – 127) / (1.000 - 0.200)] x [0.433 – 0.200] = 140

The estimated incremental closed claim counts for accident year 2005 at 84 months are:

[(588 – 403) / (1.000 – 0.710)] x [0.882 – 0.862] = 13

To differentiate the actual values from the calculated values, we highlight the bottom part of the completed square in Exhibit V, Sheet 5. In this frequency-severity approach, we derive projected ultimate claims by multiplying incremental closed claim counts by average incremental paid claims. The use of incremental claim counts and incremental severities differentiates this frequency-severity method from the other methods presented in this chapter.

Analyze Severities and Select Severities by Maturity

The next step is an analysis of paid severities. We first derive the incremental paid claim triangle from the cumulative paid claim triangle (Exhibit V, Sheet 6). We then divide the incremental paid claim triangle by the incremental closed claim count triangle to produce incremental paid severities. It is worthwhile to pause and observe the patterns in this incremental triangle of paid severities. There are significant differences in the incremental paid severities at each maturity age. In general, the paid severities increase as the claims mature. This is consistent with the common belief that smaller claims settle at a quicker rate than more complicated and costly claims. Such patterns are particularly common for long-tail lines of insurance such as U.S. general liability.

Since the paid severities for each accident year are at different cost levels, we adjust the severities to a common time period (i.e., common cost level) before we analyze the severities and make selections. For decades, actuaries have used exponential regression analyses to determine annual trend rates. One reason for the use of exponential regression analysis is because it implies a constant percentage increase in inflation. Many actuaries believe such trends tend to be most indicative of the normal inflation process. Actuaries also use weighted exponential least squares fit in order to give greater weight to more recent experience. Linear projections are rarely used due to the implied decreasing percentage trend.

In Exhibit V, Sheet 7, we summarize the results of numerous regression analyses for the incremental paid severities. To determine a severity trend, we fit many exponential curves to the incremental paid severities at each maturity age. We run a variety of combinations of years and test for the goodness-of-fit of the regression. In this exhibit, we summarize the estimated annual rate of change (i.e., trend rate) and the goodness-of-fit test (i.e., *R-squared*).[64] Based on GL Insurer's experience alone, we do not find a particularly good fit to the data. However, based on our knowledge of industry-wide experience for this particular product type, supplemented with this insurer's limited data, we select a 5% annual severity trend rate.[65] There is some evidence, based on our example, that trend rates may differ and may be greater for the older maturities. However, to simplify our example we use a single trend rate for all maturities. We recommend that you test the sensitivity of alternative trend rate assumptions at different maturities.

[64] It is important to recognize that regression with only a few data points may not be very meaningful and certainly is not very robust. The parameter estimate and *R-squared* can change dramatically by using different segments of the data, as in our example with all years versus latest six years or latest four years. An extreme example is when there are only two data points to fit; in such situations there will always be a perfect fit and 100% *R-squared*. In our example, there are only two points at 84 months. We note that the actuary must take care in interpreting the results of any regression analysis when there are limited data points.

[65] We have already addressed the challenges of using benchmark data several times in this book. We further point out that the potential difficulties in using industry-wide severity trends for general liability. The general liability line of business can include a very diverse mixture of coverages including but not limited to: excess health, employers' liability, first-dollar premises and operations, personal umbrella, contractors' liability, and environmental. Thus, it is an extremely heterogeneous line with extreme problems in claim count definition consistency and comparability due to class actions, asbestos (accounting files and account files versus claimant files), casualty deductibles, etc. When reviewing industry benchmarks for trend (or any other purpose), it is important to narrow the review to comparison with data representing similar product types and claim characteristics.

In the middle part of Exhibit V, Sheet 8, we restate all the incremental paid severities at the 2008 cost level. For example, the incremental paid severity for accident year 2007 at 12 months is \$10,086; after adjustment for trend to the 2008 cost level, the severity is \$10,590 (\$10,086 x 1.05^1). The incremental paid severity for accident year 2003 at 72 months is \$46,648; after adjustment for trend to the accident year 2008 cost level, the severity is \$59,536 (\$46,648 x 1.05^5).

We calculate various averages of the trended severities at the bottom of Exhibit V, Sheet 8. As noted, we observe an increasing pattern in the paid severities by age from 12 months through 96 months. At the bottom of Exhibit V, Sheet 8, we select incremental paid severities at the 2008 cost level for maturity ages 12 months through 60 months. Beyond this point, the data become sparse and unreliable for trending purposes. We rely on the simple average of the latest three years for our selections.

Where we begin to see variability in the trended severities, we consider combining the experience of several maturity ages. Such variability may be the result of one or more large claims that were closed at older ages. Variability is also often related to a smaller number of claims in the data set at the oldest maturity ages. By combining the experience of multiple years we seek to limit the influence of random large claims or other factors that can easily distort patterns in the severities.

In Exhibit V, Sheet 9, we review the combined experience of maturity ages 60 and older and 72 and older. We first present the triangle of incremental closed claim counts for maturities 60 through 96 months. We then summarize the incremental paid claims for these same maturities. Since the paid claims represent different cost levels, the next step is an adjustment based on the selected 5% annual severity trend to bring all payments to the 2008 cost level. The estimated trended tail severity is equal to the sum of trended claim payments divided by the sum of the incremental closed claim counts.

The importance of the selection of the tail severity (i.e., the average value for the oldest years) is similar to the selection of a tail factor for the development technique; tail factors and tail severities require substantial judgment. Considerations as to the maturity age at which to combine data for analysis of the tail factor depend on:

- The age(s) at which the results become erratic
- The influence on the total projections of selecting a particular age
- The percentage of claims expected to be closed beyond the selected maturity age

In our example, we observe greater variability in the trended severities beginning at age 60. The selected disposal rate at 60 months is 0.791; in other words, we expect more than 20% of the claim counts to remain open at this age. There are 227 incremental closed claim counts in our data set at 60 months that can be compared with only 124 at age 72 months. It is quite clear that for ages 72 months and older, the experience should be combined for the purpose of selecting an incremental tail severity. However, it is less obvious what the actuary should do at 60 months. In our example, we select an incremental trended severity of \$140,802 at 60 months based on the experience of 60-month data only. This is not very different from the estimated severity of \$144,160 for ages 60 and older developed in Exhibit V, Sheet 9. We select a trended tail severity of \$175,816 based on the combined experience of ages 72 and greater. The effect of selecting a tail severity based on the experience of 60 months and greater, would be a reduction of the unpaid claim estimate of more than 10%. This demonstrates the importance of selecting the appropriate point at which data should be combined for determining a tail severity.

In the following table, we summarize the selected severities, at the 2008 cost level, by maturity.

Maturity Age (Months)	Selected Severity at 2008 Cost Level
12	11,259
24	32,980
36	65,523
48	80,544
60	140,802
72 and older	175,816

While we have selected increasingly greater severities for GL Insurer for all maturities through 72 months, it is important to recognize that at some point in time, the average value will likely not continue to increase.

When selecting severity values, it is important for the actuary to consider the potential influence of large claims on the incremental average paid values. To avoid potential distortions due to spurious large claims, the actuary may want to consider capping claims to a predetermined value or excluding large claims in their entirety. In either case, the actuary will then need to add a provision for large claims to the estimate of unpaid claims.

Calculate Severities by Maturity Age and Accident Year (Complete the Square)

Once we have selected severity values at the 2008 accident year cost level, we are ready to complete the square for incremental paid severities. The top part of the square is equivalent to the incremental paid severity triangle. The bottom part of the square is a function of the selected severities at each particular age at the 2008 cost level and the selected trend rate. To complete the matrix shown on the bottom part of Exhibit V, Sheet 10, we must adjust the selected severities at each age to the cost level expected for each accident year. For example, for accident year 2006 at age 48 months, the severity of $73,056 is equal to the selected 2008 cost level severity at 48 months of $80,544 divided by 1.05^2. Similarly, for accident year 2002 at 96 months, the severity of $131,197[66] is equal to the selected 2008 cost level severity of $175,816 divided by 1.05^6.

Multiply Claim Counts by Severities to Determine Projected Claims

We now can multiply each accident year-maturity age cell of the two completed squares, the incremental closed claim counts and the incremental paid severities, to produce projected incremental paid claims. We cumulate the projected incremental paid claims to derive projected cumulative paid claims (i.e., projected ultimate claims). (See bottom part of Exhibit V, Sheet 11.)

Determine Unpaid Claim Estimate

In Exhibit V, Sheet 12, we calculate unpaid claim estimates in the same way that we have for all the previous methods. Estimated IBNR is equal to projected ultimate claims by accident year less

[66] Note, slight differences which exist between values in the text and values in the exhibits are due to the fact that the exhibits carry a greater number of decimals than shown.

reported claims by accident year. The total unpaid claims estimate is equal to estimated IBNR plus case outstanding.

We observe an unusually low value of IBNR for accident year 2004 (-$1,950) when compared with the immediate preceding year ($3,611) and immediate following year ($9,340). Thus, we return to the data to see if we can identify anything unusual in either the claims or the severity for this particular year. The closed claim counts in Exhibit V, Sheet 1 seem reasonable when compared with other years. We do note, however, that the paid severity for accident year 2004 at 60 months is low when compared to prior accident years at 60 months and compared to accident year 2005 at 48 months. We also note an unusually high case outstanding for accident year 2004 in comparison with other years. The estimate of total unpaid claims for 2004, however, is reasonable when compared to other years. Accident year 2003 seems to have similar issues. The incremental paid severity for accident year 2003 is unusually low when compared to other accident years, and the IBNR is lower than usual when compared to accident years 2002 and 2005.

This exemplifies the type of questioning and probing that the actuary should undertake when reviewing the results of any technique used for estimating unpaid claims. The actuary should turn to claims department management of the insurer to understand the reasons for the high value of case outstanding and the low values for average payments, and to determine if there are any factors that might preclude the use of this type of projection methodology.

Analysis for XYZ Insurer

Before we begin this frequency-severity analysis for XYZ Insurer, we recall from Chapter 6, that the closed claim counts for XYZ Insurer exclude claims closed with no payment (CNP) and that paid claims include partial payments as well as payments on closed claims. Thus, our average paid claim triangle is a combination of payments on settled claims as well as payments on claims that are still open. We must consider whether or not the volume of partial payments is significant enough such that this mismatch of dollars and claim counts results in severity values that are inappropriate for use in this type of methodology. Based on our discussions with claims department management, it is our understanding that there is not a large volume of partial payments and thus, we proceed with the analysis.[67]

In Exhibit VI, Sheets 1 through 8, we present the disposal rate method for XYZ Insurer. Similar to Approach #2, we rely on the projected ultimate claim counts derived from the reported claim count experience. In Exhibit VI, Sheet 1, we select disposal rates based on the simple average of the latest two years. We see evidence of change in the disposal rates for the latest valuations, particularly at 12, 24 and 36 months. In Exhibit VI, Sheet 2, we complete the square of projected incremental claim counts. The next step is to determine the incremental paid severities; we show this process in Exhibit VI, Sheet 3.

In Exhibit VI, Sheet 4, we select severity values at the 2008 cost level (after adjustment for trend and tort reform) by maturity age. We assume 5% severity trend for XYZ Insurer. Similar to the prior example for GL Insurer, we observe increasing severity values for each successive maturity age. As we look at the triangle of incremental paid severities, we observe that the severities along

[67] The actuary may also use paid claims on closed claims instead of total paid claims, if such data is available. Another option is to use the paid claims in the interval divided by the number of claims open at the start of the interval.

the latest diagonal are the highest value in each column for six of the eight accident years in our experience period. If we return to the questions raised in Chapter 6, we wonder whether or not the speed-up in settlement has resulted in a shift in the type of claim now being closed at each maturity age. The actuary must consider the effect of this phenomenon on the projection methodology and the true unpaid claims requirement for XYZ Insurer.

We perform a review of the tail severity in Exhibit VI, Sheet 5. We select a tail severity of $70,432 for ages 84 and 96. In Exhibit VI, Sheets 6 and 7, we present the development of projected ultimate claims by accident year-maturity age cell. Exhibit VI, Sheet 8 displays the calculation of estimated IBNR and the total unpaid claim estimate.

We compare the results of the three frequency-severity projections for XYZ Insurer with the results of the Cape Cod method, the Bornhuetter-Ferguson method, the expected claims method, and the development method in Exhibit VI, Sheet 9 (projected ultimate claims) and in Exhibit VI, Sheet 10 (estimated IBNR).

When the Frequency-Severity Techniques Work and When they Do Not

Frequency-severity techniques can be valuable in many situations. Both paid and reported claim development methods can prove unstable and inaccurate for the more recent accident years. We can address the weaknesses of these methods by separating the estimates of ultimate claims into the components of frequency and severity. For many lines of insurance, the number of claims reported is stable, and thus the projection of ultimate claim counts based on a development approach generally produces reliable estimates. Similarly, we can often estimate the severity, particularly for the more mature accident years, with greater certainty. By adjusting severities from older years by trend factors, the actuary may be able to readily develop estimates of severities for the most recent accident years. Frequency-severity projections can provide a valuable alternative for the actuary, particularly for the most recent accident years.

One of the most important advantages of a frequency-severity approach is the potential to gain greater insight into the claims process, both with respect to the rate of claims reporting and settlement and the average dollar value of claims. Another important strength of many frequency-severity methods is that they can be used with paid claims data only so that they are independent of case outstanding. Thus, changes in case outstanding philosophy or procedures will not affect the results of such techniques.

An often-cited advantage of frequency-severity based techniques is the ability to explicitly reflect inflation in the projection methodology instead of assuming that past development patterns will properly account for inflationary forces. However, the advantage of directly incorporating inflation can also be a disadvantage as the method is highly sensitive to the inflation assumption. If the inflation assumption proves incorrect, then the estimate of unpaid claims will likely also prove incorrect. We suggest that you test the sensitivity of the inflation assumption in several of the examples presented in this chapter.

One of the most common reasons that actuaries do not use frequency-severity methods is simply the unavailability of data. Another reason that many actuaries do not use these methods is because changes in the definition of claim counts, claims processing, or both can invalidate the underlying assumption that future claim count development will be similar to historical claim count development. Joseph O. Thorne discusses the influence of changes in the definition of a claim in his review of the Berquist and Sherman paper “Loss Reserve Adequacy Testing: A

Comprehensive, Systematic Approach." Mr. Thorne states: "A change in the meaning of a 'claim' can cause substantial errors in the resulting reserve estimates when relying on the projection of ultimate severity for recent accident years. These changes need not even be internal to the company. For example, changes in the waiting periods, statutes of limitation, and no-fault coverage can have a significant effect on the meaning of a 'claim' and thus on ultimate severity."[68]

These methods also rely on the mix of claims to be relatively consistent. For example, if an unusually stormy season results in numerous but minor slip-and-fall accidents, then a general liability insurer may see a significant increase in claim counts but at significantly lower average values than typically seen at that accident year maturity. This will distort a frequency-severity analysis unless an adjustment is made for the change in the mix of claim types or claim causes.

Enhancements for Frequency-Severity Techniques

We already address the importance of seasonality in one of the examples presented earlier in this chapter. The actuary should consider the influence of seasonality on both the frequency and the severity of claims. We also discuss the influence of inflation on both the number of claims and the average value of claims. Our discussions of trend with respect to the frequency-severity projection methods are intended to be an introduction to the topic only. There is a considerable body of literature within the actuarial community that addresses the topic of trend. We recommend that the actuary further his or her knowledge on this important topic and incorporate more sophisticated trending analyses into the frequency-severity techniques presented in this chapter.

As we note previously in this chapter (and other chapters), it is important to understand the data underlying the analysis of unpaid claims. This is particularly vital with respect to the type of paid claims and claim count statistics that are used in frequency-severity methods. Does the paid claims data include significant partial payments? Do you have claim count statistics for the number of paid claims or only closed claim counts? If only closed counts are available, is it reasonable to calculate an average paid value using paid claims that contain substantial partial payments? How are reopened claims treated in the claims database? In some systems, they may appear as a negative reported claim count or as a new claim. The actuary must determine, based on his or her knowledge of the claims data available and the consistency of such data over time, what types of data are most appropriate for each of the different methods.

The examples presented in this chapter ignore the effect of reopened claims. Depending on how reopened claims are handled within the insurer's systems (e.g., is the claim assigned the original claim identification number or a new claim identification number?) there could be distortions in the claim count statistics due to reopened claims. This could affect both frequency and severity indications. Reopened claims are more prevalent in some lines of insurance, such as U.S. workers compensation and Canadian automobile accident benefits, than other lines. Depending on the method in which the insurer's claims and information reporting systems handles reopened claims and the volume of reopenings, the actuary may choose to segregate reopened claims from other claims and analyze reopened claims separately.

[68] *PCAS*, 1978.

Frequency-Severity Projection as Input to Bornhuetter-Ferguson Technique

The projected ultimate claims from a frequency-severity technique are often valuable to the actuary as an alternative expected claims estimate for the Bornhuetter-Ferguson technique. An actuary working closely with management and in particular with representatives from the claims department may feel more comfortable selecting frequency and severity values than an expected claim ratio (or pure premium) value. We suggest that you calculate the unpaid claim estimate for XYZ Insurer using one of the frequency-severity projections as the expected claims with the Bornhuetter-Ferguson technique.

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 1 - Auto Collision Insurer
Closed Claim Counts

Exhibit I
Sheet 1

PART 1 - Data Triangle

Accident Half - Year	Closed Claim Counts as of (months)									
	6	12	18	24	30	36	42	48	54	60
2003-2	2,547	3,262	3,287	3,291	3,292	3,292	3,292	3,292	3,292	3,292
2004-1	2,791	3,217	3,240	3,242	3,243	3,243	3,243	3,243	3,242	
2004-2	2,099	2,677	2,695	2,697	2,697	2,698	2,698	2,698		
2005-1	2,370	2,735	2,751	2,754	2,755	2,755	2,756			
2005-2	1,966	2,609	2,630	2,634	2,634	2,634				
2006-1	2,261	2,671	2,694	2,696	2,697					
2006-2	1,949	2,637	2,659	2,662						
2007-1	2,059	2,496	2,520							
2007-2	2,083	2,732								
2008-1	2,533									

PART 2 - Age-to-Age Factors

Accident Half - Year	Age-to-Age Factors									
	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
2003-2	1.281	1.008	1.001	1.000	1.000	1.000	1.000	1.000	1.000	
2004-1	1.153	1.007	1.001	1.000	1.000	1.000	1.000	1.000		
2004-2	1.275	1.007	1.001	1.000	1.000	1.000	1.000			
2005-1	1.154	1.006	1.001	1.000	1.000	1.000				
2005-2	1.327	1.008	1.002	1.000	1.000					
2006-1	1.181	1.009	1.001	1.000						
2006-2	1.353	1.008	1.001							
2007-1	1.212	1.010								
2007-2	1.312									
2008-1										

PART 3 - Average Age-to-Age Factors

	Averages									
	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
Simple Average										
Latest 5	1.277	1.008	1.001	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.292	1.009	1.001	1.000	1.000	1.000	1.000	1.000	1.000	
Medial Average										
Latest 5x1	1.284	1.008	1.001	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average										
Latest 5	1.274	1.008	1.001	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.291	1.009	1.001	1.000	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection									
	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
Selected	1.292	1.009	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.305	1.010	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Percent Closed	76.6%	99.0%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

PART 1 - Data Triangle

Accident Half - Year	Reported Claim Counts as of (months) 6	12	18	24	30	36	42	48	54	60
2003-2	3,556	3,314	3,301	3,299	3,295	3,294	3,293	3,293	3,293	3,292
2004-1	3,492	3,262	3,250	3,247	3,247	3,245	3,245	3,244	3,243	
2004-2	2,980	2,712	2,704	2,702	2,700	2,700	2,699	2,699		
2005-1	2,896	2,768	2,761	2,758	2,758	2,758	2,757			
2005-2	2,814	2,650	2,640	2,639	2,638	2,636				
2006-1	2,808	2,712	2,704	2,701	2,700					
2006-2	2,799	2,675	2,670	2,668						
2007-1	2,578	2,533	2,529							
2007-2	2,791	2,778								
2008-1	3,139									

PART 2 - Age-to-Age Factors

Accident Half - Year	Age-to-Age Factors 6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
2003-2	0.932	0.996	0.999	0.999	1.000	1.000	1.000	1.000	1.000	
2004-1	0.934	0.996	0.999	1.000	0.999	1.000	1.000	1.000		
2004-2	0.910	0.997	0.999	0.999	1.000	1.000	1.000			
2005-1	0.956	0.997	0.999	1.000	1.000	1.000				
2005-2	0.942	0.996	1.000	1.000	0.999					
2006-1	0.966	0.997	0.999	1.000						
2006-2	0.956	0.998	0.999							
2007-1	0.983	0.998								
2007-2	0.995									
2008-1										

PART 3 - Average Age-to-Age Factors

	Averages 6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
Simple Average										
Latest 5	0.968	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	0.978	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000	
Medial Average										
Latest 5x1	0.968	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average										
Latest 5	0.968	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	0.978	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
Selected	0.978	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	0.975	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Percent Reported	102.6%	100.3%	100.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 1 - Auto Collision Insurer
Projection of Ultimate Claim Counts

Accident Half-Year	Age of Acc. Half-Year at 6/30/08	Claim Counts at 6/30/08		CDF to Ultimate		Proj. Ult. Claim Counts Using Dev Method with		Selected Ult. Claim Counts
		Closed	Reported	Closed	Reported	Closed	Reported	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2003-2	60	3,292	3,292	1.000	1.000	3,292	3,292	3,292
2004-1	54	3,242	3,243	1.000	1.000	3,242	3,243	3,243
2004-2	48	2,698	2,699	1.000	1.000	2,698	2,699	2,699
2005-1	42	2,756	2,757	1.000	1.000	2,756	2,757	2,757
2005-2	36	2,634	2,636	1.000	1.000	2,634	2,636	2,635
2006-1	30	2,697	2,700	1.000	1.000	2,697	2,700	2,699
2006-2	24	2,662	2,668	1.000	1.000	2,662	2,668	2,665
2007-1	18	2,520	2,529	1.001	0.999	2,523	2,526	2,524
2007-2	12	2,732	2,778	1.010	0.997	2,759	2,770	2,764
2008-1	6	2,533	3,139	1.305	0.975	3,306	3,061	3,061
Total		27,766	28,441			28,568	28,352	28,339

Column Notes:
(2) Age of accident half-year in (1) at June 30, 2008.
(3) and (4) Based on portfolio of private passenger automobile collision experience.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = Average of (7) and (8) for all accident half-years other than 2008-1. For 2008-1, (9) = (8).

Accident Half - Year	Ratio of Closed to Reported Claim Counts as of (months)									
	6	12	18	24	30	36	42	48	54	60
2003-2	0.716	0.984	0.996	0.998	0.999	0.999	1.000	1.000	1.000	1.000
2004-1	0.799	0.986	0.997	0.998	0.999	0.999	0.999	1.000	1.000	
2004-2	0.704	0.987	0.997	0.998	0.999	0.999	1.000	1.000		
2005-1	0.818	0.988	0.996	0.999	0.999	0.999	1.000			
2005-2	0.699	0.985	0.996	0.998	0.998	0.999				
2006-1	0.805	0.985	0.996	0.998	0.999					
2006-2	0.696	0.986	0.996	0.998						
2007-1	0.799	0.985	0.996							
2007-2	0.746	0.983								
2008-1	0.807									

Reported Claims and Severities

Accident Half - Year	Reported Claims ($000) as of (months)									
	6	12	18	24	30	36	42	48	54	60
2003-2	14,235	14,960	14,921	14,911	14,926	14,864	14,860	14,854	14,850	14,847
2004-1	14,548	14,674	14,643	14,626	14,621	14,610	14,610	14,611	14,617	
2004-2	12,129	12,576	12,541	12,531	12,523	12,523	12,510	12,502		
2005-1	11,980	11,921	11,882	11,862	11,854	11,844	11,841			
2005-2	11,283	11,843	11,805	11,789	11,772	11,770				
2006-1	11,947	11,856	11,820	11,772	11,760					
2006-2	12,503	12,762	12,706	12,697						
2007-1	11,662	11,523	11,492							
2007-2	12,647	12,854								
2008-1	14,071									

Accident Half - Year	Reported Severity = (Reported Claims x 1000) / Reported Claim Counts									
	6	12	18	24	30	36	42	48	54	60
2003-2	4,003	4,514	4,520	4,520	4,530	4,512	4,513	4,511	4,510	4,510
2004-1	4,166	4,498	4,506	4,505	4,503	4,502	4,502	4,504	4,507	
2004-2	4,070	4,637	4,638	4,638	4,638	4,638	4,635	4,632		
2005-1	4,137	4,307	4,304	4,301	4,298	4,294	4,295			
2005-2	4,010	4,469	4,472	4,467	4,462	4,465				
2006-1	4,254	4,372	4,371	4,359	4,356					
2006-2	4,467	4,771	4,759	4,759						
2007-1	4,524	4,549	4,544							
2007-2	4,531	4,627								
2008-1	4,483									

PART 1 - Data Triangle

Accident Half - Year	Reported Severities as of (months) 6	12	18	24	30	36	42	48	54	60
2003-2	4,003	4,514	4,520	4,520	4,530	4,512	4,513	4,511	4,510	4,510
2004-1	4,166	4,498	4,506	4,505	4,503	4,502	4,502	4,504	4,507	
2004-2	4,070	4,637	4,638	4,638	4,638	4,638	4,635	4,632		
2005-1	4,137	4,307	4,304	4,301	4,298	4,294	4,295			
2005-2	4,010	4,469	4,472	4,467	4,462	4,465				
2006-1	4,254	4,372	4,371	4,359	4,356					
2006-2	4,467	4,771	4,759	4,759						
2007-1	4,524	4,549	4,544							
2007-2	4,531	4,627								
2008-1	4,483									

PART 2 - Age-to-Age Factors

Accident Half - Year	Age-to-Age Factors 6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
2003-2	1.128	1.001	1.000	1.002	0.996	1.000	1.000	1.000	1.000	
2004-1	1.080	1.002	1.000	1.000	1.000	1.000	1.000	1.001		
2004-2	1.139	1.000	1.000	1.000	1.000	0.999	0.999			
2005-1	1.041	0.999	0.999	0.999	0.999	1.000				
2005-2	1.115	1.001	0.999	0.999	1.001					
2006-1	1.028	1.000	0.997	0.999						
2006-2	1.068	0.997	1.000							
2007-1	1.006	0.999								
2007-2	1.021									
2008-1										

PART 3 - Average Age-to-Age Factors

	Averages 6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
Simple Average										
Latest 5	1.047	0.999	0.999	0.999	0.999	1.000	1.000	1.000	1.000	
Latest 3	1.032	0.999	0.999	0.999	1.000	1.000	1.000	1.000	1.000	
Medial Average										
Latest 5x1	1.039	0.999	0.999	0.999	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42 - 48	48 - 54	54 - 60	To Ult
Selected	1.039	0.999	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.036	0.997	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000

Projection of Ultimate Claims

Accident Half-Year	Age of Acc. Half-Year at 6/30/08	Reported Severities at 6/30/08	CDF to Ultimate	Projected Ultimate Using Frequency-Severity Method: Severities	Claim Counts	Ult. Claims ($000)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2003-2	60	4,510	1.000	4,510	3,292	14,847
2004-1	54	4,507	1.000	4,507	3,243	14,617
2004-2	48	4,632	1.000	4,632	2,699	12,502
2005-1	42	4,295	1.000	4,295	2,757	11,841
2005-2	36	4,465	1.000	4,465	2,635	11,766
2006-1	30	4,356	1.000	4,356	2,699	11,756
2006-2	24	4,759	0.999	4,754	2,665	12,670
2007-1	18	4,544	0.998	4,535	2,524	11,446
2007-2	12	4,627	0.997	4,613	2,764	12,751
2008-1	6	4,483	1.036	4,644	3,061	14,216
Total					28,339	128,413

<u>Column Notes:</u>
(2) Age of accident half-year in (1) at June 30, 2008.
(3) Based on portfolio of private passenger automobile collision experience.
(4) Based on CDF from Exhibit I, Sheet 6.
(5) = [(3) x (4)].
(6) Developed in Exhibit I, Sheet 3.
(7) = [(5) x (6) / 1000].

Accident Half-Year	Claims at 6/30/08 Reported	Claims at 6/30/08 Paid	Projected Ultimate Claims	Case Outstanding at 6/30/08	Unpaid Claim Estimate at 6/30/08 IBNR	Unpaid Claim Estimate at 6/30/08 Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2003-2	14,847	14,846	14,847	1	0	1
2004-1	14,617	14,614	14,617	3	0	3
2004-2	12,502	12,502	12,502	0	0	0
2005-1	11,841	11,840	11,841	1	0	1
2005-2	11,770	11,765	11,766	5	- 4	0
2006-1	11,760	11,755	11,756	6	- 4	1
2006-2	12,697	12,679	12,670	18	- 27	- 9
2007-1	11,492	11,406	11,446	86	- 46	40
2007-2	12,854	12,648	12,751	206	- 103	103
2008-1	14,071	11,833	14,216	2,239	144	2,383
Total	128,453		128,413	2,565	- 40	2,524

Column Notes:
(2) and (3) Based on portfolio of private passenger automobile collision experience.
(4) Developed in Exhibit I, Sheet 7.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(5) + (6)].

Closed Claim Counts

PART 1 - Data Triangle

Accident	Closed Claim Counts as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				510	547	575	598	612	620	635	637
1999			686	819	910	980	1,007	1,036	1,039	1,044	
2000		650	932	1,095	1,216	1,292	1,367	1,391	1,402		
2001	304	681	936	1,092	1,225	1,357	1,432	1,446			
2002	203	607	841	1,089	1,327	1,464	1,523				
2003	181	614	941	1,263	1,507	1,568					
2004	235	848	1,442	1,852	2,029						
2005	295	1,119	1,664	1,946							
2006	307	906	1,201								
2007	329	791									
2008	276										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.073	1.051	1.040	1.023	1.013	1.024	1.003	
1999			1.194	1.111	1.077	1.028	1.029	1.003	1.005		
2000		1.434	1.175	1.111	1.063	1.058	1.018	1.008			
2001	2.240	1.374	1.167	1.122	1.108	1.055	1.010				
2002	2.990	1.386	1.295	1.219	1.103	1.040					
2003	3.392	1.533	1.342	1.193	1.040						
2004	3.609	1.700	1.284	1.096							
2005	3.793	1.487	1.169								
2006	2.951	1.326									
2007	2.404										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 3	3.050	1.504	1.265	1.169	1.084	1.051	1.019	1.008	1.015	1.003	
Latest 2	2.678	1.406	1.227	1.144	1.072	1.048	1.014	1.005	1.015	1.003	
Medial Average											
Latest 5x1	3.317	1.468	1.250	1.142	1.081	1.045	1.020	1.008	1.015	1.003	
Volume-weighted Average											
Latest 3	3.025	1.499	1.251	1.157	1.081	1.051	1.018	1.007	1.012	1.003	
Latest 2	2.668	1.415	1.223	1.135	1.070	1.048	1.014	1.006	1.012	1.003	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	2.668	1.415	1.223	1.135	1.070	1.048	1.014	1.006	1.012	1.003	1.000
CDF to Ultimate	6.085	2.281	1.612	1.318	1.161	1.085	1.035	1.021	1.015	1.003	1.000
Percent Closed	16.4%	43.8%	62.0%	75.9%	86.1%	92.2%	96.6%	97.9%	98.5%	99.7%	100.0%

PART 1 - Data Triangle

Accident	Reported Claim Counts as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				634	635	635	637	637	637	637	637
1999			1,026	1,039	1,047	1,050	1,053	1,047	1,047	1,047	
2000		1,354	1,397	1,411	1,410	1,408	1,408	1,408	1,408		
2001	1,305	1,421	1,449	1,458	1,458	1,455	1,455	1,455			
2002	1,342	1,514	1,548	1,557	1,549	1,552	1,554				
2003	1,373	1,616	1,630	1,626	1,629	1,629					
2004	1,932	2,168	2,234	2,249	2,258						
2005	2,067	2,293	2,367	2,390							
2006	1,473	1,645	1,657								
2007	1,192	1,264									
2008	1,036										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.002	1.000	1.003	1.000	1.000	1.000	1.000	
1999			1.013	1.008	1.003	1.003	0.994	1.000	1.000		
2000		1.032	1.010	0.999	0.999	1.000	1.000	1.000			
2001	1.089	1.020	1.006	1.000	0.998	1.000	1.000				
2002	1.128	1.022	1.006	0.995	1.002	1.001					
2003	1.177	1.009	0.998	1.002	1.000						
2004	1.122	1.030	1.007	1.004							
2005	1.109	1.032	1.010								
2006	1.117	1.007									
2007	1.060										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 3	1.096	1.023	1.005	1.000	1.000	1.000	0.998	1.000	1.000	1.000	
Latest 2	1.089	1.020	1.008	1.003	1.001	1.001	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.116	1.021	1.006	1.000	1.000	1.001	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 3	1.099	1.025	1.005	1.001	1.000	1.000	0.998	1.000	1.000	1.000	
Latest 2	1.092	1.022	1.008	1.003	1.001	1.001	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.092	1.022	1.008	1.003	1.001	1.001	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.131	1.035	1.013	1.005	1.002	1.001	1.000	1.000	1.000	1.000	1.000
Percent Reported	88.4%	96.6%	98.7%	99.5%	99.8%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%

Projection of Ultimate Claim Counts

	Age of	Claim Counts				Proj. Ult. Claim Counts		Selected
Accident	Accident Year	at 12/31/08		CDF to Ultimate		Using Dev Method with		Ult. Claim
Year	at 12/31/08	Closed	Reported	Closed	Reported	Closed	Reported	Counts
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	132	637	637	1.000	1.000	637	637	637
1999	120	1,044	1,047	1.003	1.000	1,047	1,047	1,047
2000	108	1,402	1,408	1.015	1.000	1,423	1,408	1,416
2001	96	1,446	1,455	1.021	1.000	1,476	1,455	1,466
2002	84	1,523	1,554	1.035	1.000	1,576	1,554	1,565
2003	72	1,568	1,629	1.085	1.001	1,701	1,631	1,666
2004	60	2,029	2,258	1.161	1.002	2,356	2,263	2,309
2005	48	1,946	2,390	1.318	1.005	2,565	2,402	2,483
2006	36	1,201	1,657	1.612	1.013	1,936	1,679	1,807
2007	24	791	1,264	2.281	1.035	1,804	1,308	1,556
2008	12	276	1,036	6.085	1.131	1,679	1,172	1,426
Total		13,863	16,335			18,201	16,555	17,378

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from XYZ Insurer.
(5) and (6) Based on CDF from Exhibit II, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 1 - XYZ Insurer - Auto BI
Reported Claims and Severities

Accident Year	Reported Claims ($000) as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998			11,171	12,380	13,216	14,067	14,688	16,366	16,163	15,835	15,822
1999		13,255	16,405	19,639	22,473	23,764	25,094	24,795	25,071	25,107	
2000	15,676	18,749	21,900	27,144	29,488	34,458	36,949	37,505	37,246		
2001	11,827	16,004	21,022	26,578	34,205	37,136	38,541	38,798			
2002	12,811	20,370	26,656	37,667	44,414	48,701	48,169				
2003	9,651	16,995	30,354	40,594	44,231	44,373					
2004	16,995	40,180	58,866	71,707	70,288						
2005	28,674	47,432	70,340	70,655							
2006	27,066	46,783	48,804								
2007	19,477	31,732									
2008	18,632										

Accident Year	Reported Severities = (Reported Claims x 1000) / Reported Claim Counts										
	12	24	36	48	60	72	84	96	108	120	132
1998				19,526	20,813	22,152	23,058	25,692	25,374	24,859	24,839
1999			15,989	18,902	21,464	22,632	23,831	23,682	23,946	23,980	
2000		13,847	15,676	19,237	20,914	24,473	26,242	26,637	26,453		
2001	9,063	11,262	14,508	18,229	23,460	25,523	26,489	26,665			
2002	9,546	13,455	17,219	24,192	28,673	31,379	30,997				
2003	7,029	10,517	18,622	24,966	27,152	27,239					
2004	8,796	18,533	26,350	31,884	31,129						
2005	13,872	20,686	29,717	29,563							
2006	18,375	28,440	29,453								
2007	16,340	25,104									
2008	17,985										

PART 1 - Data Triangle

Accident	Reported Severities as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998				19,526	20,813	22,152	23,058	25,692	25,374	24,859	24,839
1999			15,989	18,902	21,464	22,632	23,831	23,682	23,946	23,980	
2000		13,847	15,676	19,237	20,914	24,473	26,242	26,637	26,453		
2001	9,063	11,262	14,508	18,229	23,460	25,523	26,489	26,665			
2002	9,546	13,455	17,219	24,192	28,673	31,379	30,997				
2003	7,029	10,517	18,622	24,966	27,152	27,239					
2004	8,796	18,533	26,350	31,884	31,129						
2005	13,872	20,686	29,717	29,563							
2006	18,375	28,440	29,453								
2007	16,340	25,104									
2008	17,985										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.066	1.064	1.041	1.114	0.988	0.980	0.999	
1999			1.182	1.136	1.054	1.053	0.994	1.011	1.001		
2000		1.132	1.227	1.087	1.170	1.072	1.015	0.993			
2001	1.243	1.288	1.256	1.287	1.088	1.038	1.007				
2002	1.409	1.280	1.405	1.185	1.094	0.988					
2003	1.496	1.771	1.341	1.088	1.003						
2004	2.107	1.422	1.210	0.976							
2005	1.491	1.437	0.995								
2006	1.548	1.036									
2007	1.536										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 3	1.525	1.298	1.182	1.083	1.062	1.033	1.005	0.997	0.991	0.999	
Latest 2	1.542	1.236	1.102	1.032	1.049	1.013	1.011	1.002	0.991	0.999	
Medial Average											
Latest 5x1	1.527	1.379	1.269	1.120	1.079	1.044	1.011	0.993	0.991	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.542	1.236	1.102	1.032	1.049	1.013	1.011	1.002	0.991	0.999	1.000
CDF to Ultimate	2.310	1.498	1.212	1.100	1.066	1.016	1.003	0.992	0.990	0.999	1.000

Frequency-Severity Approach 1 - XYZ Insurer - Auto BI

Projection of Ultimate Claims

				Projected Ultimate Using Frequency-Severity Method		
Accident Year	Age of Accident Year at 12/31/08	Reported Severities at 12/31/08	CDF to Ultimate	Severities	Claim Counts	Ult. Claims ($000)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	132	24,839	1.000	24,839	637	15,822
1999	120	23,980	0.999	23,956	1,047	25,082
2000	108	26,453	0.990	26,189	1,416	37,083
2001	96	26,665	0.992	26,452	1,466	38,778
2002	84	30,997	1.003	31,090	1,565	48,655
2003	72	27,239	1.016	27,675	1,666	46,107
2004	60	31,129	1.066	33,183	2,309	76,620
2005	48	29,563	1.100	32,519	2,483	80,745
2006	36	29,453	1.212	35,697	1,807	64,505
2007	24	25,104	1.498	37,606	1,556	58,516
2008	12	17,985	2.310	41,544	1,426	59,242
Total					17,378	551,155

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) Based on data from XYZ Insurer.
(4) Based on CDF from Exhibit II, Sheet 5.
(5) = [(3) x (4)].
(6) Developed in Exhibit II, Sheet 3.
(7) = [(5) x (6) / 1000].

Frequency-Severity Approach 1 - XYZ Insurer - Auto BI
Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate at 12/31/08 IBNR	Unpaid Claim Estimate at 12/31/08 Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	15,822	15,822	15,822	0	0	0
1999	25,107	24,817	25,082	290	- 25	265
2000	37,246	36,782	37,083	465	- 163	302
2001	38,798	38,519	38,778	278	- 19	259
2002	48,169	44,437	48,655	3,731	486	4,218
2003	44,373	39,320	46,107	5,052	1,734	6,786
2004	70,288	52,811	76,620	17,477	6,331	23,809
2005	70,655	40,026	80,745	30,629	10,090	40,718
2006	48,804	22,819	64,505	25,985	15,701	41,686
2007	31,732	11,865	58,516	19,867	26,784	46,651
2008	18,632	3,409	59,242	15,223	40,610	55,833
Total	449,626	330,629	551,155	118,997	101,529	220,526

Column Notes:
(2) and (3) Based on data from insurer.
(4) Developed in Exhibit II, Sheet 6.
(5) Based on data from insurer.
(6) = [(4) - (2)].
(7) = [(5) + (6)].

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 2 - WC Self-Insurer
Closed Claim Counts

PART 1 - Data Triangle

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
2001	789	1,196	1,255	1,310	1,324	1,327	1,332	1,343
2002	978	1,506	1,609	1,629	1,669	1,676	1,683	
2003	1,070	1,557	1,665	1,721	1,738	1,748		
2004	1,029	1,525	1,618	1,688	1,717			
2005	974	1,459	1,532	1,597				
2006	1,746	2,632	2,761					
2007	1,683	2,572						
2008	1,560							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
2001	1.515	1.050	1.044	1.011	1.002	1.004	1.008	
2002	1.539	1.069	1.012	1.025	1.004	1.004		
2003	1.456	1.069	1.034	1.009	1.006			
2004	1.483	1.061	1.043	1.017				
2005	1.498	1.050	1.042					
2006	1.507	1.049						
2007	1.528							
2008								

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
Latest 5	1.494	1.060	1.035	1.016	1.004	1.004	1.008	
Latest 3	1.511	1.053	1.040	1.017	1.004	1.004	1.008	
Medial Average								
Latest 5x1	1.496	1.060	1.040	1.014	1.004	1.004	1.008	
Volume-weighted Average								
Latest 5	1.499	1.058	1.035	1.016	1.004	1.004	1.008	
Latest 3	1.513	1.053	1.040	1.017	1.004	1.004	1.008	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	1.499	1.058	1.035	1.016	1.004	1.004	1.003	1.007
CDF to Ultimate	1.698	1.133	1.071	1.034	1.018	1.014	1.010	1.007
Percent Closed	58.9%	88.3%	93.4%	96.7%	98.2%	98.6%	99.0%	99.3%

PART 1 - Data Triangle

Accident Year	Reported Claim Counts as of (months) 12	24	36	48	60	72	84	96
2001	1,235	1,321	1,342	1,349	1,350	1,350	1,350	1,350
2002	1,555	1,660	1,685	1,695	1,700	1,700	1,700	
2003	1,628	1,740	1,762	1,771	1,775	1,775		
2004	1,600	1,714	1,740	1,747	1,750			
2005	1,510	1,612	1,639	1,647				
2006	2,750	2,941	2,985					
2007	2,650	2,842						
2008	2,438							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
2001	1.070	1.016	1.005	1.001	1.000	1.000	1.000	
2002	1.068	1.015	1.006	1.003	1.000	1.000		
2003	1.069	1.013	1.005	1.002	1.000			
2004	1.071	1.015	1.004	1.002				
2005	1.068	1.017	1.005					
2006	1.069	1.015						
2007	1.072							
2008								

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
Latest 5	1.070	1.015	1.005	1.002	1.000	1.000	1.000	
Latest 3	1.070	1.016	1.005	1.002	1.000	1.000	1.000	
Medial Average								
Latest 5x1	1.070	1.015	1.005	1.002	1.000	1.000	1.000	
Volume-weighted Average								
Latest 5	1.070	1.015	1.005	1.002	1.000	1.000	1.000	
Latest 3	1.070	1.015	1.005	1.002	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	1.070	1.015	1.005	1.002	1.000	1.000	1.000	1.000
CDF to Ultimate	1.094	1.022	1.007	1.002	1.000	1.000	1.000	1.000
Percent Reported	91.4%	97.8%	99.3%	99.8%	100.0%	100.0%	100.0%	100.0%

Projection of Ultimate Claim Counts

Accident Year	Age of Accident Year at 12/31/08	Claim Counts at 12/31/08 Closed	Claim Counts at 12/31/08 Reported	CDF to Ultimate Closed	CDF to Ultimate Reported	Proj. Ult. Claim Counts Using Dev Method with Closed	Proj. Ult. Claim Counts Using Dev Method with Reported	Selected Ult. Claim Counts
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2001	96	1,343	1,350	1.007	1.000	1,353	1,350	1,351
2002	84	1,683	1,700	1.010	1.000	1,700	1,700	1,700
2003	72	1,748	1,775	1.014	1.000	1,773	1,775	1,774
2004	60	1,717	1,750	1.018	1.000	1,748	1,750	1,749
2005	48	1,597	1,647	1.034	1.002	1,652	1,650	1,651
2006	36	2,761	2,985	1.071	1.007	2,957	3,006	2,982
2007	24	2,572	2,842	1.133	1.022	2,914	2,905	2,909
2008	12	1,560	2,438	1.698	1.094	2,649	2,667	2,658
Total		14,982	16,487			16,745	16,803	16,774

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on U.S. workers compensation self-insurance experience.
(5) and (6) Based on CDF from Exhibit III, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Projection of Ultimate Frequency

	Claim Counts						
Accident Year	Selected Ultimate	Trend to 2008 at -1.00%	Trended Ultimate	Payroll ($00)	Trend to 2008 at 2.50%	Trended Payroll ($00)	Trended Ultimate Frequency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2001	1,351	0.932	1,260	195,000	1.189	231,794	0.54%
2002	1,700	0.941	1,600	260,000	1.160	301,520	0.53%
2003	1,774	0.951	1,687	280,000	1.131	316,794	0.53%
2004	1,749	0.961	1,680	280,000	1.104	309,068	0.54%
2005	1,651	0.970	1,602	350,000	1.077	376,912	0.43%
2006	2,982	0.980	2,922	790,000	1.051	829,994	0.35%
2007	2,909	0.990	2,880	780,000	1.025	799,500	0.36%
2008	2,658	1.000	2,658	740,000	1.000	740,000	0.36%
Total	16,774		16,289	3,675,000		3,905,581	0.42%

(9) Selected frequency at 2008 level	0.36%
(10) Selected frequency at 2007 level	0.37%

Column and Line Notes:
(2) Developed in (9) in Exhibit III, Sheet 3.
(3) Assume -1.00% annual claim count trend.
(4) = [(2) x (3)].
(5) Based on U.S. workers compensation self-insurance experience.
(6) Assume 2.50% annual payroll trend.
(7) = [(5) x (6)].
(8) = [(4) / (7)].
(9) Judgmentally selected.
(10) = {(9) x [1 + (annual payroll trend of 2.50%)] / [1 + (annual claim count trend of -1.00%)]}.

Accident Year	Paid Claims as of (months)							
	12	24	36	48	60	72	84	96
2001	1,318,000	2,842,000	3,750,000	4,300,000	4,650,000	4,850,000	5,050,000	5,200,000
2002	1,780,000	3,817,000	5,016,000	5,750,000	6,100,000	6,300,000	6,555,000	
2003	1,890,000	4,184,000	5,500,000	6,300,000	6,800,000	7,100,000		
2004	1,900,000	4,100,000	5,560,000	6,430,000	6,950,000			
2005	1,960,000	4,290,000	5,688,000	6,570,000				
2006	4,030,000	8,650,000	11,400,000					
2007	4,200,000	9,043,000						
2008	4,170,000							

Accident Year	Paid Severities = Paid Claims / Closed Claim Counts							
	12	24	36	48	60	72	84	96
2001	1,670	2,377	2,989	3,283	3,511	3,655	3,790	3,871
2002	1,820	2,535	3,117	3,530	3,654	3,759	3,895	
2003	1,767	2,687	3,303	3,660	3,913	4,061		
2004	1,847	2,688	3,436	3,810	4,048			
2005	2,012	2,941	3,712	4,113				
2006	2,308	3,286	4,129					
2007	2,496	3,516						
2008	2,673							

Accident Year	Reported Claims as of (months)							
	12	24	36	48	60	72	84	96
2001	3,200,000	4,300,000	4,900,000	5,200,000	5,300,000	5,400,000	5,550,000	5,650,000
2002	4,300,000	5,900,000	6,600,000	6,950,000	7,200,000	7,400,000	7,500,000	
2003	4,800,000	6,600,000	7,400,000	7,800,000	8,100,000	8,300,000		
2004	4,900,000	6,700,000	7,700,000	8,150,000	8,600,000			
2005	5,200,000	7,100,000	7,900,000	8,350,000				
2006	10,100,000	13,800,000	15,500,000					
2007	10,500,000	14,400,000						
2008	10,300,000							

Accident Year	Reported Severities = Reported Claims / Reported Claim Counts							
	12	24	36	48	60	72	84	96
2001	2,591	3,255	3,651	3,855	3,926	4,000	4,111	4,185
2002	2,765	3,554	3,917	4,100	4,235	4,353	4,412	
2003	2,948	3,793	4,200	4,404	4,563	4,676		
2004	3,063	3,909	4,425	4,665	4,914			
2005	3,444	4,404	4,821	5,071				
2006	3,673	4,692	5,193					
2007	3,962	5,067						
2008	4,225							

Paid Severities

PART 1 - Data Triangle

Accident Year	Paid Severities as of (months) 12	24	36	48	60	72	84	96
2001	1,670	2,377	2,989	3,283	3,511	3,655	3,790	3,871
2002	1,820	2,535	3,117	3,530	3,654	3,759	3,895	
2003	1,767	2,687	3,303	3,660	3,913	4,061		
2004	1,847	2,688	3,436	3,810	4,048			
2005	2,012	2,941	3,712	4,113				
2006	2,308	3,286	4,129					
2007	2,496	3,516						
2008	2,673							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
2001	1.423	1.257	1.098	1.070	1.041	1.037	1.021	
2002	1.393	1.230	1.132	1.035	1.029	1.036		
2003	1.520	1.229	1.108	1.069	1.038			
2004	1.455	1.278	1.109	1.063				
2005	1.461	1.262	1.108					
2006	1.424	1.256						
2007	1.409							
2008								

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
Latest 5	1.454	1.251	1.111	1.059	1.036	1.037	1.021	
Latest 3	1.431	1.266	1.108	1.056	1.036	1.037	1.021	
Medial Average								
Latest 5x1	1.447	1.249	1.108	1.066	1.038	1.037	1.021	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	1.447	1.249	1.108	1.066	1.038	1.037	1.021	1.150
CDF to Ultimate	2.698	1.864	1.493	1.347	1.264	1.218	1.174	1.150

PART 1 - Data Triangle

Accident Year	Reported Severities as of (months) 12	24	36	48	60	72	84	96
2001	2,591	3,255	3,651	3,855	3,926	4,000	4,111	4,185
2002	2,765	3,554	3,917	4,100	4,235	4,353	4,412	
2003	2,948	3,793	4,200	4,404	4,563	4,676		
2004	3,063	3,909	4,425	4,665	4,914			
2005	3,444	4,404	4,821	5,071				
2006	3,673	4,692	5,193					
2007	3,962	5,067						
2008	4,225							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
2001	1.256	1.122	1.056	1.018	1.019	1.028	1.018	
2002	1.285	1.102	1.047	1.033	1.028	1.014		
2003	1.286	1.107	1.049	1.036	1.025			
2004	1.276	1.132	1.054	1.053				
2005	1.279	1.094	1.052					
2006	1.278	1.107						
2007	1.279							
2008								

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
Latest 5	1.280	1.108	1.051	1.035	1.024	1.021	1.018	
Latest 3	1.278	1.111	1.052	1.041	1.024	1.021	1.018	
Medial Average								
Latest 5x1	1.278	1.105	1.052	1.035	1.025	1.021	1.018	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	1.278	1.105	1.052	1.035	1.025	1.021	1.018	1.025
CDF to Ultimate	1.679	1.314	1.189	1.130	1.092	1.065	1.043	1.025

Accident Year	Age of Accident Year at 12/31/08	Severities at 12/31/08		CDF to Ultimate		Projected Ultimate Severities Using Dev. Method with		Selected Severity
		Paid	Reported	Paid	Reported	Paid	Reported	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2001	96	3,871	4,185	1.150	1.025	4,452	4,290	4,371
2002	84	3,895	4,412	1.174	1.043	4,573	4,601	4,587
2003	72	4,061	4,676	1.218	1.065	4,946	4,980	4,963
2004	60	4,048	4,914	1.264	1.092	5,117	5,366	5,242
2005	48	4,113	5,071	1.347	1.130	5,540	5,730	5,635
2006	36	4,129	5,193	1.493	1.189	6,164	6,174	6,169

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on U.S. workers compensation self-insurance experience.
(5) and (6) Based on CDF from Exhibit III, Sheets 6 and 7.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 2 - WC Self-Insurer
Selection of 2008 and 2007 Severities

Accident Year	Selected Ultimate Severity	Trend to 2008 at 7.50%	Trended Ultimate Severity
(1)	(2)	(3)	(4)
2001	4,371	1.659	7,251
2002	4,587	1.543	7,079
2003	4,963	1.436	7,125
2004	5,242	1.335	7,000
2005	5,635	1.242	7,001
2006	6,169	1.156	7,129

(5) Average Trended Severity at 2008 Cost Level	
(a) All Years	7,098
(b) All Years Excl. High and Low	7,084
(c) Latest 3 Years	7,043
(6) Selected 2008 Severity	7,100
(7) Estimated 2007 Severity	6,605

Column Notes:
(2) Developed in (9) in Exhibit III, Sheet 8.
(3) Trend factors with annual severity trend of 7.50%.
(4) = [(2) x (3)].
(5) Based on (4).
(6) Judgmentally selected.
(7) = {(6) / [1 + (annual severity trend of 7.50%)]}.

Frequency-Severity Approach 2 - WC Self-Insurer

Projection of Ultimate Claims and Development of Unpaid Claim Estimate

		Accident Year	
		2007	2008
(1)	Payroll ($00)	780,000	740,000
(2)	Selected Frequency	0.37%	0.36%
(3)	Projected Ultimate Claim Counts	2,907	2,664
(4)	Selected Severity	6,605	7,100
(5)	Projected Ultimate Claims	19,200,735	18,914,400
(6)	Reported Claims at 12/31/08	14,400,000	10,300,000
(7)	Case Outstanding at 12/31/08	5,357,000	6,130,000
(8)	Estimated IBNR at 12/31/08	4,800,735	8,614,400
(9)	Unpaid Claim Estimate at 12/31/08	10,157,735	14,744,400

Line Notes:
(1) Based on U.S. workers compensation self-insurance experience.
(2) Developed in Exhibit III, Sheet 4.
(3) = [(1) x (2)].
(4) Developed in Exhibit III, Sheet 9.
(5) = [(3) x (4)].
(6) and (7) Based on U.S. workers compensation self-insurance experience.
(8) = [(5) - (6)].
(9) = [(7) + (8)].

Chapter 11 - Frequency-Severity Technique Exhibit IV
Frequency-Severity Approach 2 - XYZ Insurer - Auto BI Sheet 1
Projection of Ultimate Frequency

	Claim Counts						
Accident Year	Selected Ultimate	Trend to 2008 at -1.50%	Trended Ultimate	Earned Premium ($000)	On-Level Adjustment	On-Level Premium ($000)	Trended Ultimate Frequency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2002	1,554	0.913	1,419	61,183	0.914	55,911	2.54%
2003	1,631	0.927	1,512	69,175	0.870	60,204	2.51%
2004	2,263	0.941	2,130	99,322	0.810	80,411	2.65%
2005	2,402	0.956	2,295	138,151	0.704	97,258	2.36%
2006	1,679	0.970	1,629	107,578	0.640	68,850	2.37%

(9) Average Trended Ultimate Frequency at 2008 Level
(a) All Years 2.48%
(b) All Years Excluding High and Low 2.47%
(c) Latest 2 Years 2.36%

(10) Selected 2008 Frequency 2.36%

(11) Estimated 2007 Frequency 1.92%

Column and Line Notes:
(2) Developed in (8) in Exhibit II, Sheet 3.
(3) Assume -1.50% annual claim count trend.
(4) = [(2) x (3)].
(5) Based on data from XYZ Insurer.
(6) Based on rate level history provided by XYZ Insurer.
(7) = [(5) x (6)].
(8) = [(4) / (7)].
(9) Based on (8).
(10) Judgmentally selected.
(11) = {(10) x (on level factor of 0.800) / [1 + (annual claim count trend of -1.50%)]}.

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 2 - XYZ Insurer - Auto BI
Projection of Ultimate Severity

Accident Year	Selected Ultimate Severity	Trend to 2008 at 5.00%	Tort Reform Factors	Trended Ultimate Severity
(1)	(2)	(3)	(4)	(5)
1998	24,839	1.629	0.670	27,108
1999	23,956	1.551	0.670	24,899
2000	26,189	1.477	0.670	25,924
2001	26,452	1.407	0.670	24,938
2002	31,090	1.340	0.670	27,914
2003	27,675	1.276	0.670	23,665
2004	33,183	1.216	0.670	27,024
2005	32,519	1.158	0.670	25,222
2006	35,697	1.103	0.750	29,517

(6) Average Trended Severity at 2008 Cost Level	
(a) Latest 5 Years	26,669
(b) Latest 5 Years Excl. High and Low	26,720
(c) Latest 3 Years	27,254
(7) Selected 2008 Severity	26,720
(8) Estimated 2007 Severity	25,448

Column Notes:
(2) Developed in (5) in Exhibit II, Sheet 6.
(3) Trend factors with annual severity trend of 5.00%.
(4) From Chapter 8, Exhibit III, Sheet 2.
(5) = [(2) x (3) x (4)].
(6) Based on (5).
(7) Judgmentally selected.
(8) = {(7) / [1 + (annual severity trend of 5.00%)] / (reform impact factor of 1.000)}.

Chapter 11 - Frequency-Severity Technique Exhibit IV
Frequency-Severity Approach 2 - XYZ Insurer - Auto BI Sheet 3
Projection of Ultimate Claims and Development of Unpaid Claim Estimate

		Accident Year	
		2007	2008
(1)	Earned Premium ($000)	62,438	47,797
(2)	Selected Frequency	1.92%	2.36%
(3)	Projected Ultimate Claim Counts	1,199	1,128
(4)	Selected Severity	25,448	26,720
(5)	Projected Ultimate Claims	30,512,152	30,140,260
(6)	Reported Claims at 12/31/08	31,732,000	18,632,000
(7)	Case Outstanding at 12/31/08	19,867,000	15,223,000
(8)	Estimated IBNR at 12/31/08	-1,219,848	11,508,260
(9)	Unpaid Claim Estimate at 12/31/08	18,647,152	26,731,260

Line Notes:
(1) Based on data from XYZ Insurer.
(2) Developed in Exhibit IV, Sheet 1.
(3) = [(1) x (2)].
(4) Developed in Exhibit IV, Sheet 2.
(5) = [(3) x (4)].
(6) and (7) Based on data from XYZ Insurer.
(8) = [(5) - (6)].
(9) = [(7) + (8)].

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 3 - GL Insurer
Closed Claim Counts

Exhibit V
Sheet 1

PART 1 - Data Triangle

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
2001	195	375	510	625	702	752	780	796
2002	199	349	445	508	563	594	626	
2003	106	294	383	453	499	542		
2004	126	281	377	445	494			
2005	114	249	315	403				
2006	114	229	300					
2007	79	188						
2008	127							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
2001	1.923	1.360	1.225	1.123	1.071	1.037	1.021	
2002	1.754	1.275	1.142	1.108	1.055	1.054		
2003	2.774	1.303	1.183	1.102	1.086			
2004	2.230	1.342	1.180	1.110				
2005	2.184	1.265	1.279					
2006	2.009	1.310						
2007	2.380							
2008								

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
Latest 5	2.315	1.299	1.202	1.111	1.071	1.046	1.021	
Latest 3	2.191	1.306	1.214	1.107	1.071	1.046	1.021	
Medial Average								
Latest 5x1	2.265	1.296	1.196	1.109	1.071	1.046	1.021	
Volume-weighted Average								
Latest 5	2.302	1.298	1.199	1.112	1.070	1.045	1.021	
Latest 3	2.169	1.307	1.210	1.107	1.070	1.045	1.021	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	2.169	1.307	1.210	1.107	1.070	1.045	1.021	1.100
CDF to Ultimate	4.769	2.199	1.682	1.390	1.256	1.174	1.123	1.100
Percent Closed	21.0%	45.5%	59.5%	71.9%	79.6%	85.2%	89.0%	90.9%

PART 1 - Data Triangle

Accident	Reported Claim Counts as of (months)							
Year	12	24	36	48	60	72	84	96
2001	1,299	1,077	1,057	965	930	917	864	870
2002	847	945	864	787	784	743	731	
2003	800	831	762	704	669	636		
2004	823	862	797	728	684			
2005	828	850	765	687				
2006	824	809	734					
2007	604	620						
2008	812							

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors							
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
2001	0.829	0.981	0.913	0.964	0.986	0.942	1.007	
2002	1.116	0.914	0.911	0.996	0.948	0.984		
2003	1.039	0.917	0.924	0.950	0.951			
2004	1.047	0.925	0.913	0.940				
2005	1.027	0.900	0.898					
2006	0.982	0.907						
2007	1.026							
2008								

PART 3 - Average Age-to-Age Factors

	Averages							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
Latest 5	1.024	0.913	0.912	0.962	0.961	0.963	1.007	
Latest 3	1.012	0.911	0.912	0.962	0.961	0.963	1.007	
Medial Average								
Latest 5x1	1.031	0.913	0.912	0.957	0.951	0.963	1.007	
Volume-weighted Average								
Latest 5	1.024	0.913	0.912	0.963	0.963	0.961	1.007	
Latest 3	1.010	0.911	0.912	0.963	0.963	0.961	1.007	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Selected	1.010	0.911	0.912	0.963	0.963	0.961	1.007	1.000
CDF to Ultimate	0.753	0.746	0.818	0.897	0.932	0.968	1.007	1.000
Percent Reported	132.8%	134.0%	122.2%	111.5%	107.3%	103.3%	99.3%	100.0%

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 3 - GL Insurer
Projection of Ultimate Claim Counts

Exhibit V
Sheet 3

Accident Year	Age of Accident Year at 12/31/08	Claim Counts at 12/31/08		CDF to Ultimate		Proj. Ult. Claim Counts Using Dev. Method with		Selected Ult. Claim Counts
		Closed	Reported	Closed	Reported	Closed	Reported	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2001	96	796	870	1.100	1.000	876	870	873
2002	84	626	731	1.123	1.007	703	736	720
2003	72	542	636	1.174	0.968	636	616	626
2004	60	494	684	1.256	0.932	620	637	629
2005	48	403	687	1.390	0.897	560	616	588
2006	36	300	734	1.682	0.818	505	600	553
2007	24	188	620	2.199	0.746	413	463	438
2008	12	127	812	4.769	0.753	606	611	609
Total		3,476	5,774			4,919	5,150	5,035

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from GL Insurer.
(5) and (6) Based on CDF from Exhibit V, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Chapter 11 - Frequency-Severity Technique Exhibit V
Frequency-Severity Approach 3 - GL Insurer Sheet 4
Development of Disposal Rate

PART 1 - Disposal Rate Triangle

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	72	84	96
2001	0.223	0.430	0.584	0.716	0.804	0.862	0.894	0.912
2002	0.277	0.485	0.618	0.706	0.782	0.826	0.870	
2003	0.169	0.470	0.612	0.724	0.797	0.866		
2004	0.200	0.447	0.599	0.707	0.785			
2005	0.194	0.423	0.536	0.685				
2006	0.206	0.414	0.543					
2007	0.180	0.429						
2008	0.209							

PART 2 - Average Disposal Rate Factors

	Average Disposal Rate by Maturity Age 12	24	36	48	60	72	84	96	To Ult
Simple Average									
Latest 5	0.198	0.437	0.582	0.708	0.792	0.851	0.882	0.912	
Latest 3	0.198	0.422	0.559	0.705	0.788	0.851	0.882	0.912	
Medial Average									
Latest 5x1	0.200	0.433	0.585	0.710	0.791	0.862	0.882	0.912	

PART 3 - Selected Disposal Rate Factors

	Selected Disposal Rate by Maturity Age 12	24	36	48	60	72	84	96	To Ult
Selected	0.200	0.433	0.585	0.710	0.791	0.862	0.882	0.912	1.000

Exhibit V
Sheet 5

Development of Closed Claim Counts

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
2001	195	375	510	625	702	752	780	796
2002	199	349	445	508	563	594	626	
2003	106	294	383	453	499	542		
2004	126	281	377	445	494			
2005	114	249	315	403				
2006	114	229	300					
2007	79	188						
2008	127							

Accident Year	Projected Incremental Closed Claim Counts (months) 12	24	36	48	60	72	84	96	To Ult
2001	195	180	135	115	77	50	28	16	77
2002	199	150	96	63	55	31	32	24	70
2003	106	188	89	70	46	43	12	18	54
2004	126	155	96	68	49	46	13	19	57
2005	114	135	66	88	52	45	13	19	56
2006	114	115	71	76	49	43	12	18	54
2007	79	109	67	55	36	31	9	13	39
2008	127	140	91	75	49	43	12	18	53

Calculation of Severities

Accident Year	Paid Claims as of (months)							
	12	24	36	48	60	72	84	96
2001	1,119,962	4,373,268	8,398,345	13,490,793	17,372,233	22,052,662	27,359,691	29,901,361
2002	1,411,957	6,287,005	11,443,820	15,520,552	21,295,572	28,410,418	32,468,911	
2003	984,748	6,128,957	10,470,758	14,604,684	21,936,647	23,942,499		
2004	1,158,659	5,811,172	10,497,504	15,087,416	18,242,570			
2005	1,198,767	5,103,837	9,042,134	15,443,929				
2006	1,220,778	4,594,746	8,983,864					
2007	796,774	4,233,641						
2008	1,445,365							

Accident Year	Incremental Paid Claims as of (months)							
	12	24	36	48	60	72	84	96
2001	1,119,962	3,253,306	4,025,077	5,092,448	3,881,440	4,680,429	5,307,029	2,541,670
2002	1,411,957	4,875,048	5,156,815	4,076,732	5,775,020	7,114,846	4,058,493	
2003	984,748	5,144,209	4,341,801	4,133,926	7,331,963	2,005,852		
2004	1,158,659	4,652,513	4,686,332	4,589,912	3,155,154			
2005	1,198,767	3,905,070	3,938,297	6,401,795				
2006	1,220,778	3,373,968	4,389,118					
2007	796,774	3,436,867						
2008	1,445,365							

Accident Year	Incremental Closed Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
2001	195	180	135	115	77	50	28	16
2002	199	150	96	63	55	31	32	
2003	106	188	89	70	46	43		
2004	126	155	96	68	49			
2005	114	135	66	88				
2006	114	115	71					
2007	79	109						
2008	127							

Accident Year	Incremental Paid Severities as of (months)							
	12	24	36	48	60	72	84	96
2001	5,743	18,074	29,815	44,282	50,408	93,609	189,537	158,854
2002	7,095	32,500	53,717	64,710	105,000	229,511	126,828	
2003	9,290	27,363	48,784	59,056	159,391	46,648		
2004	9,196	30,016	48,816	67,499	64,391			
2005	10,516	28,926	59,671	72,748				
2006	10,709	29,339	61,819					
2007	10,086	31,531						
2008	11,381							

Accident Year	Incremental Paid Severities as of (months) 12	24	36	48	60	72	84	96
2001	5,743	18,074	29,815	44,282	50,408	93,609	189,537	158,854
2002	7,095	32,500	53,717	64,710	105,000	229,511	126,828	
2003	9,290	27,363	48,784	59,056	159,391	46,648		
2004	9,196	30,016	48,816	67,499	64,391			
2005	10,516	28,926	59,671	72,748				
2006	10,709	29,339	61,819					
2007	10,086	31,531						
2008	11,381							

Annual Change based on Exponential Regression Analysis of Severities and Accident Year

	12	24	36	48	60	72	84
All Years	8.8%	5.6%	12.0%	10.9%	12.2%	-29.4%	-33.1%
Latest 6	3.8%	0.1%	12.0%	10.9%	12.2%	-29.4%	-33.1%
Latest 4	1.8%	1.6%	9.5%	5.0%	12.2%	-29.4%	-33.1%
All Years x/ 2001	6.4%	0.1%	4.9%	5.0%	-21.7%	-79.7%	0.0%

Goodness of Fit Test of Exponential Regression Analysis (R-Squared)

	12	24	36	48	60	72	84
All Years	78.7%	34.9%	64.4%	72.2%	8.4%	19.0%	100.0%
Latest 6	70.4%	0.0%	64.4%	72.2%	8.4%	19.0%	100.0%
Latest 4	20.8%	30.6%	85.6%	51.8%	8.4%	19.0%	100.0%
All Years x/ 2001	73.7%	0.0%	47.8%	51.8%	29.0%	100.0%	100.0%

Accident Year	Incremental Paid Severities as of (months) 12	24	36	48	60	72	84	96
2001	5,743	18,074	29,815	44,282	50,408	93,609	189,537	158,854
2002	7,095	32,500	53,717	64,710	105,000	229,511	126,828	
2003	9,290	27,363	48,784	59,056	159,391	46,648		
2004	9,196	30,016	48,816	67,499	64,391			
2005	10,516	28,926	59,671	72,748				
2006	10,709	29,339	61,819					
2007	10,086	31,531						
2008	11,381							

Accident Year	Trended Average Incremental Paid Claims Assuming 5% Annual Severity Trend Rate 12	24	36	48	60	72	84	96
2001	8,082	25,432	41,953	62,309	70,930	131,717	266,697	223,524
2002	9,508	43,554	71,986	86,718	140,711	307,567	169,962	
2003	11,857	34,923	62,262	75,372	203,427	59,536		
2004	11,177	36,485	59,336	82,045	78,268			
2005	12,173	33,486	69,077	84,215				
2006	11,806	32,346	68,155					
2007	10,590	33,107						
2008	11,381							

	Averages of the Trended Incremental Paid Severities as of (months) 12	24	36	48	60	72	84	96
Simple Average								
Latest 5	11,426	34,069	66,163	78,132	123,334	166,273	218,329	223,524
Latest 3	11,259	32,980	65,523	80,544	140,802	166,273	218,329	223,524
Medial Average								
Latest 5x1	11,455	33,839	66,498	80,544	109,489	131,717	218,329	223,524

	Selected Incremental Paid Severities as of (months) 12	24	36	48	60	72	84	96
Selected	11,259	32,980	65,523	80,544	140,802	(To be determined in Exhibit V, Sheet 9)		

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 3 - GL Insurer
Development of Trended Tail Severity

Exhibit V
Sheet 9

Accident Year	Incremental Closed Claim Counts as of (months)			
	60	72	84	96
2001	77	50	28	16
2002	55	31	32	
2003	46	43		
2004	49			
Total	227	124	60	16

Accident Year	Incremental Paid Claims as of (months)			
	60	72	84	96
2001	3,881,440	4,680,429	5,307,029	2,541,670
2002	5,775,020	7,114,846	4,058,493	
2003	7,331,963	2,005,852		
2004	3,155,154			

Accident Year	Trended Incremental Paid Claims as of (months)			
	60	72	84	96
2001	5,461,576	6,585,834	7,467,523	3,576,385
2002	7,739,079	9,534,574	5,438,769	
2003	9,357,649	2,560,032		
2004	3,835,109			
Total	26,393,414	18,680,440	12,906,292	3,576,385

	Age 60 & Older	Age 72 & Older
(1) Total Closed Claim Counts	427	200
(2) Total Trended Paid Claims	61,556,530	35,163,116
(3) Estimated Trended Tail Severity	144,160	175,816
(4) Estimated Incremental Trended Paid Severity	140,802	166,273
(5) Selected Incremental Paid Severity	140,802	175,816

Accident Year	Incremental Paid Severities as of (months)							
	12	24	36	48	60	72	84	96
2001	5,743	18,074	29,815	44,282	50,408	93,609	189,537	158,854
2002	7,095	32,500	53,717	64,710	105,000	229,511	126,828	
2003	9,290	27,363	48,784	59,056	159,391	46,648		
2004	9,196	30,016	48,816	67,499	64,391			
2005	10,516	28,926	59,671	72,748				
2006	10,709	29,339	61,819					
2007	10,086	31,531						
2008	11,381							

	Selected Incremental Paid Severity at 2008 Cost Level								
	12	24	36	48	60	72	84	96	108+
Selected	11,259	32,980	65,523	80,544	140,802	175,816	175,816	175,816	175,816

Accident Year	Incremental Paid Severities Adjusted to Cost Level of Accident Year Assuming 5% Annual Trend Rate								
	12	24	36	48	60	72	84	96	108+
2001	5,743	18,074	29,815	44,282	50,408	93,609	189,537	158,854	124,949
2002	7,095	32,500	53,717	64,710	105,000	229,511	126,828	131,196	131,196
2003	9,290	27,363	48,784	59,056	159,391	46,648	137,756	137,756	137,756
2004	9,196	30,016	48,816	67,499	64,391	144,644	144,644	144,644	144,644
2005	10,516	28,926	59,671	72,748	121,630	151,876	151,876	151,876	151,876
2006	10,709	29,339	61,819	73,056	127,711	159,470	159,470	159,470	159,470
2007	10,086	31,531	62,403	76,709	134,097	167,443	167,443	167,443	167,443
2008	11,381	32,980	65,523	80,544	140,802	175,816	175,816	175,816	175,816

Accident Year	Projected Incremental Closed Claim Counts								
	12	24	36	48	60	72	84	96	108+
2001	195	180	135	115	77	50	28	16	77
2002	199	150	96	63	55	31	32	24	70
2003	106	188	89	70	46	43	12	18	54
2004	126	155	96	68	49	46	13	19	57
2005	114	135	66	88	52	45	13	19	56
2006	114	115	71	76	49	43	12	18	54
2007	79	109	67	55	36	31	9	13	39
2008	127	140	91	75	49	43	12	18	53

Accident Year	Incremental Paid Severities Adjusted to Cost Level of Accident Year Assuming 5% Annual Trend Rate								
	12	24	36	48	60	72	84	96	108+
2001	5,743	18,074	29,815	44,282	50,408	93,609	189,537	158,854	124,949
2002	7,095	32,500	53,717	64,710	105,000	229,511	126,828	131,196	131,196
2003	9,290	27,363	48,784	59,056	159,391	46,648	137,756	137,756	137,756
2004	9,196	30,016	48,816	67,499	64,391	144,644	144,644	144,644	144,644
2005	10,516	28,926	59,671	72,748	121,630	151,876	151,876	151,876	151,876
2006	10,709	29,339	61,819	73,056	127,711	159,470	159,470	159,470	159,470
2007	10,086	31,531	62,403	76,709	134,097	167,443	167,443	167,443	167,443
2008	11,381	32,980	65,523	80,544	140,802	175,816	175,816	175,816	175,816

Accident Year	Projected Incremental Paid Claims = Projected Closed Claim Counts x Projected Incremental Paid Severities								
	12	24	36	48	60	72	84	96	108+
2001	1,119,962	3,253,306	4,025,077	5,092,448	3,881,440	4,680,429	5,307,029	2,541,670	9,596,072
2002	1,411,957	4,875,048	5,156,815	4,076,732	5,775,020	7,114,846	4,058,493	3,120,609	9,153,788
2003	984,748	5,144,209	4,341,801	4,133,926	7,331,963	2,005,852	1,676,592	2,514,887	7,377,003
2004	1,158,659	4,652,513	4,686,332	4,589,912	3,155,154	6,632,371	1,868,273	2,802,410	8,220,403
2005	1,198,767	3,905,070	3,938,297	6,401,795	6,291,855	6,886,544	1,939,872	2,909,807	8,535,435
2006	1,220,778	3,373,968	4,389,118	5,556,332	6,294,164	6,889,072	1,940,584	2,910,875	8,538,568
2007	796,774	3,436,867	4,181,633	4,227,190	4,788,524	5,241,122	1,476,372	2,214,559	6,496,039
2008	1,445,365	4,625,488	5,994,988	6,060,300	6,865,055	7,513,922	2,116,598	3,174,896	9,313,030

Accident Year	Projected Cumulative Paid Claims								
	12	24	36	48	60	72	84	96	108+
2001	1,119,962	4,373,268	8,398,345	13,490,793	17,372,233	22,052,662	27,359,691	29,901,361	39,497,433
2002	1,411,957	6,287,005	11,443,820	15,520,552	21,295,572	28,410,418	32,468,911	35,589,520	44,743,308
2003	984,748	6,128,957	10,470,758	14,604,684	21,936,647	23,942,499	25,619,091	28,133,978	35,510,981
2004	1,158,659	5,811,172	10,497,504	15,087,416	18,242,570	24,874,941	26,743,214	29,545,624	37,766,027
2005	1,198,767	5,103,837	9,042,134	15,443,929	21,735,784	28,622,328	30,562,200	33,472,007	42,007,442
2006	1,220,778	4,594,746	8,983,864	14,540,196	20,834,360	27,723,432	29,664,016	32,574,891	41,113,459
2007	796,774	4,233,641	8,415,274	12,642,464	17,430,988	22,672,110	24,148,483	26,363,041	32,859,080
2008	1,445,365	6,070,853	12,065,841	18,126,141	24,991,196	32,505,117	34,621,715	37,796,611	47,109,641

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 3 - GL Insurer
Development of Unpaid Claim Estimate ($000)

Accident	Claims at 12/31/08		Projected Ultimate	Case Outstanding	Unpaid Claim Estimate at 12/31/08	
Year	Reported	Paid	Claims	at 12/31/08	IBNR	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2001	35,592	29,901	39,497	5,691	3,905	9,596
2002	36,330	32,469	44,743	3,861	8,414	12,274
2003	31,900	23,942	35,511	7,958	3,611	11,568
2004	39,716	18,243	37,766	21,473	- 1,950	19,523
2005	32,667	15,444	42,007	17,223	9,340	26,564
2006	27,774	8,984	41,113	18,790	13,339	32,130
2007	16,246	4,234	32,859	12,013	16,613	28,625
2008	8,216	1,445	47,110	6,771	38,894	45,664
Total	228,441	134,662	320,607	93,779	92,166	185,945

Column Notes:
(2) and (3) Based on data from GL Insurer.
(4) Developed in in Exhibit V, Sheet 11.
(5) Based on data from GL Insurer.
(6) = [(4) - (2)].
(7) = [(5) + (6)].

PART 1 - Disposal Rate Triangle

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	72	84	96
2001	0.209	0.468	0.643	0.751	0.842	0.933	0.984	0.994
2002	0.131	0.391	0.541	0.701	0.854	0.942	0.980	
2003	0.111	0.377	0.577	0.775	0.924	0.962		
2004	0.104	0.375	0.637	0.819	0.897			
2005	0.123	0.466	0.693	0.810				
2006	0.183	0.540	0.716					
2007	0.251	0.605						
2008	0.236							

PART 2 - Average Disposal Rate Factors

	Average Disposal Rate by Maturity Age 12	24	36	48	60	72	84	96	To Ult
Simple Average									
Latest 3	0.223	0.537	0.682	0.801	0.892	0.945	0.982	0.994	
Latest 2	0.244	0.572	0.704	0.814	0.910	0.952	0.982	0.994	
Medial Average									
Latest 5x1	0.180	0.461	0.636	0.778	0.875	0.942	0.982	0.994	

PART 3 - Selected Disposal Rate Factors

	Disposal Rate Selection 12	24	36	48	60	72	84	96	To Ult
Selected	0.244	0.572	0.704	0.814	0.910	0.952	0.982	0.994	1.000

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 3 - XYZ Insurer - Auto BI
Development of Closed Claim Counts

Exhibit VI
Sheet 2

Accident Year	Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
2001	304	681	936	1,092	1,225	1,357	1,432	1,446
2002	203	607	841	1,089	1,327	1,464	1,523	
2003	181	614	941	1,263	1,507	1,568		
2004	235	848	1,442	1,852	2,029			
2005	295	1,119	1,664	1,946				
2006	307	906	1,201					
2007	329	791						
2008	276							

Accident Year	Projected Incremental Closed Claim Counts 12	24	36	48	60	72	84	96	To Ult
2001	304	377	255	156	133	132	75	14	9
2002	203	404	234	248	238	137	59	21	10
2003	181	433	327	322	244	61	39	16	8
2004	235	613	594	410	177	109	78	31	16
2005	295	824	545	282	235	103	74	29	15
2006	307	599	295	177	155	68	48	19	10
2007	329	462	160	133	116	51	36	15	7
2008	276	389	156	130	114	50	36	14	7

Calculation of Severities

Accident Year	Paid Claims ($000) as of (months)							
	12	24	36	48	60	72	84	96
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437	
2003	1,743	6,240	12,683	22,892	34,505	39,320		
2004	2,221	9,898	25,950	43,439	52,811			
2005	3,043	12,219	27,073	40,026				
2006	3,531	11,778	22,819					
2007	3,529	11,865						
2008	3,409							

Accident Year	Incremental Paid Claims ($000) as of (months)							
	12	24	36	48	60	72	84	96
2001	1,539	4,413	6,367	6,289	5,778	6,703	5,980	1,450
2002	2,318	5,614	5,891	8,273	9,850	8,683	3,809	
2003	1,743	4,497	6,443	10,209	11,613	4,815		
2004	2,221	7,677	16,052	17,489	9,372			
2005	3,043	9,176	14,854	12,953				
2006	3,531	8,247	11,041					
2007	3,529	8,336						
2008	3,409							

Accident Year	Incremental Closed Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
2001	304	377	255	156	133	132	75	14
2002	203	404	234	248	238	137	59	
2003	181	433	327	322	244	61		
2004	235	613	594	410	177			
2005	295	824	545	282				
2006	307	599	295					
2007	329	462						
2008	276							

Accident Year	Incremental Paid Severities as of (months)							
	12	24	36	48	60	72	84	96
2001	5,064	11,705	24,969	40,317	43,445	50,781	79,730	103,551
2002	11,417	13,896	25,175	33,359	41,386	63,382	64,556	
2003	9,631	10,386	19,703	31,706	47,592	78,942		
2004	9,452	12,524	27,023	42,657	52,947			
2005	10,315	11,136	27,255	45,934				
2006	11,502	13,768	37,427					
2007	10,726	18,043						
2008	12,351							

Exhibit VI
Sheet 4

Development of Trended Severities

Accident Year	Incremental Paid Severities as of (months)							
	12	24	36	48	60	72	84	96
2001	5,064	11,705	24,969	40,317	43,445	50,781	79,730	103,551
2002	11,417	13,896	25,175	33,359	41,386	63,382	64,556	
2003	9,631	10,386	19,703	31,706	47,592	78,942		
2004	9,452	12,524	27,023	42,657	52,947			
2005	10,315	11,136	27,255	45,934				
2006	11,502	13,768	37,427					
2007	10,726	18,043						
2008	12,351							

Accident Year	Incremental Paid Severities Trended at 5% Annual Severity Trend Rate and Adjusted for Tort Reform							
	12	24	36	48	60	72	84	96
2001	4,774	11,035	23,540	38,009	40,958	47,874	75,166	97,624
2002	10,251	12,476	22,604	29,952	37,159	56,908	57,963	
2003	8,236	8,881	16,848	27,112	40,697	67,504		
2004	7,697	10,199	22,008	34,739	43,119			
2005	8,001	8,637	21,139	35,627				
2006	9,510	11,384	30,948					
2007	11,263	18,945						
2008	12,351							

	Averages of the Trended Incremental Paid Severities							
	12	24	36	48	60	72	84	96
Simple Average								
Latest 3	11,042	12,989	24,698	32,493	40,325	57,429	66,565	97,624
Latest 2	11,807	15,165	26,043	35,183	41,908	62,206	66,565	97,624
Medial Average								
Latest 5x1	9,591	10,155	21,917	33,439	40,827	56,908	66,565	97,624

	Selected Incremental Paid Severities							
	12	24	36	48	60	72	84	96
Selected	11,807	15,165	26,043	35,183	41,908	62,206	(TBD in Exhibit VI, Sheet 5)	

Development of Trended Tail Severity

Accident Year	Incremental Closed Claim Counts as of (months) 72	84	96
2001	132	75	14
2002	137	59	
2003	61		
Total	330	134	14

Accident Year	Incremental Paid Claims as of (months) 72	84	96
2001	6,703,111	5,979,775	1,449,720
2002	8,683,309	3,808,813	
2003	4,815,457		

Accident Year	Trended and Adj. Incremental Paid Claims as of (months) 72	84	96
2001	6,319,407	5,637,477	1,366,734
2002	7,796,431	3,419,796	
2003	4,117,739		
Total	18,233,577	9,057,273	1,366,734

	Age 72 & Older	Age 84 & Older
(1) Total Closed Claim Counts	478	148
(2) Total Trended Paid Claims	28,657,584	10,424,007
(3) Estimated Trended Tail Severity	59,953	70,432
(4) Estimated Incremental Trended Paid Severity	62,206	66,565
(5) Selected Incremental Paid Severity	62,206	70,432

Accident Year	Incremental Paid Severities as of (months)							
	12	24	36	48	60	72	84	96
2001	5,064	11,705	24,969	40,317	43,445	50,781	79,730	103,551
2002	11,417	13,896	25,175	33,359	41,386	63,382	64,556	
2003	9,631	10,386	19,703	31,706	47,592	78,942		
2004	9,452	12,524	27,023	42,657	52,947			
2005	10,315	11,136	27,255	45,934				
2006	11,502	13,768	37,427					
2007	10,726	18,043						
2008	12,351							

	Selected Incremental Paid Severities at 2008 Cost Level								
	12	24	36	48	60	72	84	96	108
Selected	11,807	15,165	26,043	35,183	41,908	62,206	70,432	70,432	70,432

Accident Year	Incremental Paid Severities Adjusted to Cost Level of Accident Year Assuming 5% Annual Trend Rate and Tort Reform Adjustment								
	12	24	36	48	60	72	84	96	108
2001	5,064	11,705	24,969	40,317	43,445	50,781	79,730	103,551	74,709
2002	11,417	13,896	25,175	33,359	41,386	63,382	64,556	78,444	78,444
2003	9,631	10,386	19,703	31,706	47,592	78,942	82,367	82,367	82,367
2004	9,452	12,524	27,023	42,657	52,947	76,384	86,485	86,485	86,485
2005	10,315	11,136	27,255	45,934	54,032	80,203	90,809	90,809	90,809
2006	11,502	13,768	37,427	42,549	50,682	75,230	85,179	85,179	85,179
2007	10,726	18,043	24,803	33,508	39,912	59,244	67,079	67,079	67,079
2008	12,351	15,165	26,043	35,183	41,908	62,206	70,432	70,432	70,432

Projection of Ultimate Claims

Accident Year	Projected Incremental Closed Claim Counts								
	12	24	36	48	60	72	84	96	108+
2001	304	377	255	156	133	132	75	14	9
2002	203	404	234	248	238	137	59	21	10
2003	181	433	327	322	244	61	39	16	8
2004	235	613	594	410	177	109	78	31	16
2005	295	824	545	282	235	103	74	29	15
2006	307	599	295	177	155	68	48	19	10
2007	329	462	160	133	116	51	36	15	7
2008	276	389	156	130	114	50	36	14	7

Accident Year	Incremental Paid Severities Adjusted to Cost Level of Accident Year Assuming 5% Annual Trend Rate and Tort Reform Adjustment								
	12	24	36	48	60	72	84	96	108+
2001	5,064	11,705	24,969	40,317	43,445	50,781	79,730	103,551	74,709
2002	11,417	13,896	25,175	33,359	41,386	63,382	64,556	78,444	78,444
2003	9,631	10,386	19,703	31,706	47,592	78,942	82,367	82,367	82,367
2004	9,452	12,524	27,023	42,657	52,947	76,384	86,485	86,485	86,485
2005	10,315	11,136	27,255	45,934	54,032	80,203	90,809	90,809	90,809
2006	11,502	13,768	37,427	42,549	50,682	75,230	85,179	85,179	85,179
2007	10,726	18,043	24,803	33,508	39,912	59,244	67,079	67,079	67,079
2008	12,351	15,165	26,043	35,183	41,908	62,206	70,432	70,432	70,432

Accident Year	Projected Incremental Paid Claims = Projected Closed Claim Counts x Projected Paid Severities								
	12	24	36	48	60	72	84	96	108+
2001	1,539	4,413	6,367	6,289	5,778	6,703	5,980	1,450	672
2002	2,318	5,614	5,891	8,273	9,850	8,683	3,809	1,621	811
2003	1,743	4,497	6,443	10,209	11,613	4,815	3,224	1,290	645
2004	2,221	7,677	16,052	17,489	9,372	8,324	6,732	2,693	1,346
2005	3,043	9,176	14,854	12,953	12,715	8,257	6,678	2,671	1,336
2006	3,531	8,247	11,041	7,551	7,850	5,098	4,123	1,649	825
2007	3,529	8,336	3,957	4,454	4,630	3,007	2,432	973	486
2008	3,409	5,893	4,073	4,585	4,767	3,095	2,503	1,001	501

Accident Year	Projected Cumulative Paid Claims								
	12	24	36	48	60	72	84	96	108+
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519	39,192
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437	46,059	46,869
2003	1,743	6,240	12,683	22,892	34,505	39,320	42,544	43,834	44,479
2004	2,221	9,898	25,950	43,439	52,811	61,135	67,867	70,560	71,906
2005	3,043	12,219	27,073	40,026	52,742	60,999	67,677	70,349	71,684
2006	3,531	11,778	22,819	30,370	38,220	43,317	47,440	49,089	49,913
2007	3,529	11,865	15,822	20,276	24,906	27,914	30,345	31,318	31,805
2008	3,409	9,302	13,375	17,961	22,727	25,823	28,326	29,328	29,828

Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate at 12/31/08 IBNR	Unpaid Claim Estimate at 12/31/08 Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2001	38,798	38,519	39,192	278	394	672
2002	48,169	44,437	46,869	3,731	- 1,300	2,432
2003	44,373	39,320	44,479	5,052	106	5,159
2004	70,288	52,811	71,906	17,477	1,618	19,095
2005	70,655	40,026	71,684	30,629	1,029	31,658
2006	48,804	22,819	49,913	25,985	1,109	27,094
2007	31,732	11,865	31,805	19,867	73	19,940
2008	18,632	3,409	29,828	15,223	11,196	26,419
Total	371,451	253,208	385,676	118,243	14,226	132,469

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) Developed in Exhibit VI, Sheet 7.
(5) Based on data from insurer.
(6) = [(4) - (2)].
(7) = [(5) + (6)].

Accident	Claims at 12/31/08		Projected Ultimate Claims: Development Method		Expected	B-F Method		Cape	Frequency-Severity		
Year	Reported	Paid	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977	15,822	15,822		
1999	25,107	24,817	25,082	25,164	24,665	25,107	25,158	25,107	25,082		
2000	37,246	36,782	36,948	37,922	35,235	37,246	37,841	37,246	37,083		
2001	38,798	38,519	38,487	40,600	39,150	38,798	40,525	38,798	38,778		39,192
2002	48,169	44,437	48,313	49,592	47,906	48,312	49,417	48,313	48,655		46,869
2003	44,373	39,320	44,950	49,858	54,164	45,068	50,768	45,062	46,107		44,479
2004	70,288	52,811	74,787	80,537	86,509	75,492	82,593	74,754	76,620		71,906
2005	70,655	40,026	76,661	80,333	108,172	79,129	94,301	77,931	80,745		71,684
2006	48,804	22,819	58,370	72,108	70,786	60,404	71,205	58,759	64,505		49,913
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636	43,307	58,516	30,512	31,805
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049	39,201	59,242	30,140	29,828
Total	449,626	330,629	514,929	605,030	561,516	513,207	554,471	504,300	551,155		

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Chapter 9, Exhibit II, Sheet 1.
(9) Developed in Chapter 10, Exhibit II, Sheet 2.
(10) Developed in Exhibit II, Sheet 6.
(11) Developed in Exhibit IV, Sheet 3.
(12) Developed in Exhibit VI, Sheet 7.

Chapter 11 - Frequency-Severity Technique
Frequency-Severity Approach 3 - XYZ Insurer - Auto BI
Summary of IBNR ($000)

	Case	Estimated IBNR								
Accident	Outstanding	Development Method		Expected	B-F Method		Cape	Frequency-Severity		
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	0	0	158	- 162	0	155	0	0		
1999	290	- 25	58	- 442	0	51	0	- 25		
2000	465	- 298	676	- 2,011	0	595	0	- 163		
2001	278	- 310	1,802	352	0	1,728	0	- 19		394
2002	3,731	145	1,423	- 262	143	1,248	144	486		- 1,300
2003	5,052	577	5,485	9,791	695	6,396	690	1,734		106
2004	17,477	4,498	10,249	16,221	5,204	12,305	4,466	6,331		1,618
2005	30,629	6,006	9,678	37,517	8,474	23,646	7,276	10,090		1,029
2006	25,985	9,566	23,304	21,982	11,600	22,401	9,955	15,701		1,109
2007	19,867	16,247	46,209	8,103	13,489	13,904	11,575	26,784	- 1,220	73
2008	15,223	28,898	56,363	20,801	23,975	22,417	20,569	40,610	11,508	11,196
Total	118,997	65,303	155,405	111,890	63,581	104,845	54,674	101,529		

<u>Column Notes:</u>
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Chapter 9, Exhibit II, Sheet 2.
(8) Estimated in Chapter 10, Exhibit II, Sheet 3.
(9) Estimated in Exhibit II, Sheet 7.
(10) Estimated in Exhibit IV, Sheet 3.
(11) Estimated in Exhibit VI, Sheet 8.

CHAPTER 12 – CASE OUTSTANDING DEVELOPMENT TECHNIQUE

In "Loss Reserving,"[69] Ronald Wiser describes a development approach that incorporates the historical relationships between paid claims and case outstanding. Mr. Wiser states: "The reserve development method attempts to analyze the adequacy of case reserves based on the history of payments against those case reserves." In this chapter, we present two accident year examples of Mr. Wiser's case outstanding development technique.[70] In this chapter, we refer to this technique as Approach #1. We also present an example for a self-insurer of the standard development technique applied to case outstanding in which the case outstanding development factors to ultimate are derived from industry-based benchmark reported and paid claim development factors; we refer to this example as Approach #2.

Case Outstanding Development Technique – Approach #1

Key Assumptions

Assumptions for the case outstanding development technique are similar to those for other development techniques described in this book. An additional important assumption is that claims activity related to IBNR is related consistently to claims already reported.

Common Uses

The case outstanding development technique is not used extensively by actuaries. The assumption that IBNR claim activity is related to claims already reported (i.e., development on known claims versus pure IBNR) limits its use. In other words, this method is appropriate when applied to lines of insurance for which most of the claims are reported in the first accident period. It is this requirement that makes the case outstanding development method so strong for claims-made coverages and report year analysis because the claims for a given accident year are known at the end of the accident year.

Mechanics of the Method

We use both U.S. Industry Auto and XYZ Insurer as examples of the case outstanding development technique. We begin with an explanation of the projection for U.S. Industry Auto.

In Exhibit I, Sheet 1, we summarize the development triangles for case outstanding and incremental paid claims. These are derived from the reported and paid claim triangles presented in Chapter 7. The next step is to calculate the ratio of the incremental paid claims at age *x* to the

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[69] *Foundations of Casualty Actuarial Science*, 2001.

[70] The case outstanding development method can also be used with report year data; such analysis can be valuable for testing the accuracy of case outstanding on known claims over time. We refer the reader to both Wiser's "Loss Reserving" and "Loss Reserve Testing: A Report Year Approach," by W.H. Fisher and J.T. Lange (*PCAS*, 1973).

case outstanding at age *x-12*. (See Exhibit I, Sheet 2.) This ratio tells us the proportion of claims that were paid during the development interval (i.e., age *x-12* to age *x*) on the claims outstanding at the beginning of the age (i.e., age *x-12*). For example, the incremental paid claims for accident year 1998 were $14,691,785 between the 12- and 24-month age interval (labeled 24 months in our development triangle). At the end of 12 months, the case outstanding for accident year 1998 was $18,478,233. Thus, the incremental payment in the 12-to-24 month interval represents 79.5% of the case outstanding at 12 months (i.e., $14,691,785/$18,478,233). Similarly, the incremental paid claims for accident year 2004 between 24 and 36 months were $7,746,815. At the end of 24 months, the case outstanding for accident year 2004 was $11,150,459. Thus, the payment in the this interval represents 69.5% of the case outstanding at 24 months (i.e. $7,746,815/$11,150,459) In Exhibit I, Sheet 2, we present the triangle of ratios of incremental paid claims to previous case outstanding and calculate various averages of these ratios at each maturity. In our example, we select ratios based on the simple average of the latest three years. For the ratio to ultimate, we judgmentally select a ratio of 1.10. In other words, we assume that 10% more than the case outstanding at 120 months will ultimately be paid out.

In Exhibit I, Sheet 3, we calculate the ratios of the case outstanding to the previous case outstanding; these ratios are equal to the case outstanding at age *x* divided by the case outstanding at age *x-12*. For example, the case outstanding for accident year 1998 is $9,937,970 at 24 months and $18,478,233 at 12 months. Thus, the ratio of the case outstanding to the previous case outstanding at 24 months is equal to $9,937,970/$18,478,233, or 0.538. For accident year 2004, the case outstanding at 36 months is $6,316,995, and the case outstanding at 24 months is $11,150,459. Thus, the ratio of case outstanding to previous case outstanding for accident year 2004 at 36 months is 0.567 ($6,316,995/$11,150,459). At the bottom of Exhibit I, Sheet 3, we calculate various averages and select ratios based on the simple average for the latest three years. For the ratio to ultimate, we judgmentally select 0.00. In other words, we make a simplifying assumption in this example for U.S. Industry Auto that there will be no case outstanding remaining for 132 months and later.[71]

A challenge of this technique is the selection of the “to ultimate” ratios for both the ratio of incremental paid claims to previous case outstanding and the ratio of case outstanding to previous case outstanding. These concepts are not frequently used nor are there readily available benchmarks for comparison purposes.

The goal of the case outstanding development method is to project ultimate claims based on completing the square of incremental paid claims. In this method, the incremental paid claims in each interval are related to the case outstanding at the beginning of the interval. Thus, the next step is to complete the square of the case outstanding triangle. We will then be able to project the incremental paid claims using the completed square of case outstanding.

We use the selected ratios of case outstanding to previous case outstanding in Exhibit I, Sheet 3, to project the case outstanding for each accident year and age combination in Exhibit I, Sheet 4. Examples will assist in understanding the mechanics of this projection. For accident year 1999, the projected case outstanding at 120 months of $107,435 is equal to the 0.580 selected ratio at 120 months multiplied by the case outstanding at 108 months of $185,233. Similarly, for accident year 2007, the projected case outstanding at 24 months of $11,374,010 is equal to the 0.526 selected ratio at 24 months multiplied by the case outstanding at 12 months of $21,623,594. (See top section of Exhibit I, Sheet 4.)

[71] If the actuary were to choose a ratio of case outstanding to previous case outstanding greater than 0.0 beyond 120 months, the size of the projection matrices in Exhibit I, Sheet 4 would require expansion.

Now that we have the completed square of case outstanding, we can use the selected ratios of incremental paid claims to case outstanding to project incremental paid claims for all accident years and maturities. (See middle section of Exhibit I, Sheet 4.) Again, we use examples to demonstrate the calculations. To project the 2000 accident year incremental payments for 120 months (i.e., the interval 108 to 120 months is labeled 120 months in the exhibit), we multiply the 0.524 selected ratio at 120 months by the case outstanding at 108 months ($205,370 x 0.524 = $107,614). Similarly, accident year 2006 incremental paid claims at 48 months of $4,459,444 are equal to the selected ratio at 48 months of 0.714 multiplied by the case outstanding at 36 months of $6,245,721.

The highlighted cells represent the projected values; the others values are from the original data triangles for U.S. Industry Auto.

At the bottom of Exhibit I, Sheet 4, we calculate cumulative paid claims. The projected ultimate claims are equal to the last column of the cumulative paid claims. (Ultimate claims are also summarized in Column (4) of Exhibit I, Sheet 5.) We calculate estimated IBNR and the total unpaid claim estimate in Exhibit I, Sheet 5 in the same manner as that presented in the preceding chapters. Estimated IBNR is equal to projected ultimate claims minus reported claims, and the total unpaid claim estimate is equal to projected ultimate claims less paid claims. We suggest that you compare the results of the case outstanding development method with the reported and paid claim development projections from Chapter 7.

XYZ Insurer

We present the example for XYZ Insurer in Exhibit II, Sheets 1 through 5; these exhibits follow the exact same format as Exhibit I. We first present the case outstanding and incremental paid claim triangles. The next step is to calculate the ratios of incremental paid claims to previous case outstanding (Exhibit II, Sheet 2) and the ratios of case outstanding to previous case outstanding (Exhibit II, Sheet 3). As a result of the various operational and environmental changes noted in our discussions with management and our previous diagnostic review, we select ratios based on the latest two years of experience in an attempt to reflect the most current operating environment for XYZ Insurer.

In Exhibit II, Sheet 4, we complete the square for both case outstanding and incremental paid claims. Projected ultimate claims using the case outstanding development technique are based on the cumulative paid claims through all maturities. We summarize projected ultimate claims in Column (4) of Exhibit II, Sheet 5 and calculate estimated IBNR and the total unpaid claim estimate in Columns (6) and (7), respectively. We compare the results of the case outstanding development technique method with the frequency-severity method, the Cape Cod method, the Bornhuetter-Ferguson method, the expected claims method, and the development method in Exhibit II, Sheet 6 (projected ultimate claims) and in Exhibit II, Sheet 7 (estimated IBNR).

When the Case Outstanding Development Technique Works and When it Does Not

There are several limitations with the use of the case outstanding development technique. First, as noted earlier in this chapter, an important assumption underlying this method is that future IBNR is related to claims already reported. This assumption does not hold true for many P&C lines of insurance. Other limitations, also referred to earlier, are the infrequent use and the absence of benchmark data (for accident year applications of this method). Related to the infrequent use and absence of benchmarks is a lack of intuitive sense and experiential knowledge as to what ratios are appropriate at each maturity for both the incremental paid claims to previous case outstanding and the case outstanding to previous case outstanding across P&C lines of insurance.

Case Outstanding Development Technique – Approach #2

In our final example of this chapter, we assume that the only data available for our self-insurer is case outstanding. While this situation is not particularly common, it can occur, particularly for older years. The absence of historical cumulative paid claims can arise following times of transition such as mergers and acquisitions of corporations with self-insurance programs or consolidation or amalgamation of self-insured public entities. Some organizations create self-insurance programs to address insurance coverage needs that are not readily met in the commercial market. Such organizations may have complete data for the years following the start of the formal self-insurance program; however, the only information that may be available for years prior to the commencement of the self-insurance program may be current case outstanding for claims in the process of investigation and settlement.

Key Assumptions

In this example (called Self-Insurer Case Only), we use the standard development technique with case outstanding to project an estimate of total unpaid claims for a self-insured entity of general liability coverage. In Chapter 7, we described the development technique and demonstrated its use with reported and paid claims. The key assumptions presented in Chapter 7 are equally applicable in our Self-Insurer Case Only example. We use industry-based reporting and payment development patterns to derive case outstanding development patterns. Thus, we implicitly assume that claims recorded to date for the self-insurer will develop in a similar manner in the future as our industry benchmark (i.e., the historical industry experience is indicative of the future experience for the self-insurer).

Common Uses

Similar to the case outstanding development technique Approach #1, Approach #2 is also not used extensively by actuaries. When used, it is most often due to the absence of other reliable claims data for the purpose of developing an unpaid claim estimate.

Mechanics of the Method

In our Self-Insurer Case Only example, there is no available data for historical paid claims. Therefore, we are not able to create paid or reported claim development triangles based on the self-insurer's own experience. Instead we rely on insurance industry benchmark development patterns to project the general liability case outstanding values that are available. One important difference between the development technique applied to case outstanding and the development technique applied to reported claims and paid claims is that the projected values are estimates of unpaid claims and not ultimate claims.

The projection of the unpaid claim estimates for GL Self-Insurer Case Only is presented in Exhibit III. We use the benchmark reported and paid claim development factors to ultimate to derive the development factor for case outstanding. The following presents the formula for the case outstanding development factor:

$$\frac{(\text{Reported CDF to Ultimate} - 1.00) \times (\text{Paid CDF to Ultimate})}{(\text{Paid CDF to Ultimate} - \text{Reported CDF to Ultimate})} + 1.00$$

The resulting case development factor includes provisions for case outstanding and IBNR (the broad definition of IBNR, which includes development on known claims). The estimated unpaid claims for GL self-insurer are shown in Column (6) of Exhibit III and are equal to the current estimate of case outstanding multiplied by the derived case outstanding CDF to ultimate.

Potential Limitations

There are a few potential drawbacks of this case outstanding development approach. First, by its nature, this technique is used when historical claims experience specific to the insurer (or self-insurer) is not available, and thus industry benchmarks development patterns are required. Such benchmarks may prove to be inaccurate in projecting future claims experience for the particular insurer. Furthermore, this technique is generally inappropriate for the more recent, less mature years due to the increased variability of results related to the highly leveraged nature of the derived development factors. Finally, individual large claims present in the case outstanding data can distort the results of projections based on this approach.

Accident Year	Case Outstanding as of (months)									
	12	24	36	48	60	72	84	96	108	120
1998	18,478,233	9,937,970	5,506,911	2,892,519	1,440,783	767,842	413,097	242,778	169,222	98,117
1999	18,544,291	9,955,034	5,623,522	3,060,431	1,520,760	764,736	443,528	284,732	185,233	
2000	19,034,933	10,395,464	5,969,194	3,217,937	1,567,806	842,849	457,854	304,704		
2001	19,401,810	10,487,914	5,936,461	3,056,202	1,532,147	777,926	421,141			
2002	20,662,461	11,176,330	6,198,509	3,350,967	1,609,188	785,497				
2003	21,078,651	11,098,119	6,398,219	3,431,210	1,634,690					
2004	21,047,539	11,150,459	6,316,995	3,201,985						
2005	21,260,172	11,087,832	6,141,416							
2006	20,973,908	11,034,842								
2007	21,623,594									

Accident Year	Incremental Paid Claims as of (months)									
	12	24	36	48	60	72	84	96	108	120
1998	18,539,254	14,691,785	6,830,969	3,830,031	2,004,496	868,887	455,900	225,555	108,579	88,731
1999	20,410,193	15,680,491	7,168,718	3,899,839	2,049,291	953,511	463,714	253,051	121,726	
2000	22,120,843	16,855,171	7,413,268	4,173,103	2,172,895	1,004,821	544,233	248,891		
2001	22,992,259	17,103,939	7,671,637	4,326,081	2,269,520	1,015,365	499,620			
2002	24,092,782	17,702,531	8,108,490	4,449,081	2,401,492	1,052,839				
2003	24,084,451	17,315,161	7,670,720	4,513,869	2,346,453					
2004	24,369,770	17,120,093	7,746,815	4,537,994						
2005	25,100,697	17,601,532	7,942,765							
2006	25,608,776	17,997,721								
2007	27,229,969									

Chapter 12 - Case Outstanding Development Technique
U.S. Industry Auto
Ratio of Incremental Paid Claims to Previous Case Outstanding

Exhibit I
Sheet 2

Accident Year	Ratio of Incremental Paid Claims to Previous Case Outstanding as of (months) 12	24	36	48	60	72	84	96	108	120	To Ult
1998		0.795	0.687	0.695	0.693	0.603	0.594	0.546	0.447	0.524	
1999		0.846	0.720	0.693	0.670	0.627	0.606	0.571	0.428		
2000		0.885	0.713	0.699	0.675	0.641	0.646	0.544			
2001		0.882	0.731	0.729	0.743	0.663	0.642				
2002		0.857	0.726	0.718	0.717	0.654					
2003		0.821	0.691	0.705	0.684						
2004		0.813	0.695	0.718							
2005		0.828	0.716								
2006		0.858									
2007											

Averages of the Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Simple Average											
Latest 5		0.836	0.712	0.714	0.698	0.638	0.622	0.553	0.437	0.524	
Latest 3		0.833	0.701	0.714	0.714	0.653	0.631	0.553	0.437	0.524	
Medial Average											
Latest 5x1		0.835	0.712	0.714	0.692	0.641	0.624	0.546	0.437	0.524	

Selected Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Selected		0.833	0.701	0.714	0.714	0.653	0.631	0.553	0.437	0.524	1.100

Accident Year	Ratio of Case Outstanding to Previous Case Outstanding as of (months)										
	12	24	36	48	60	72	84	96	108	120	To Ult
1998		0.538	0.554	0.525	0.498	0.533	0.538	0.588	0.697	0.580	
1999		0.537	0.565	0.544	0.497	0.503	0.580	0.642	0.651		
2000		0.546	0.574	0.539	0.487	0.538	0.543	0.666			
2001		0.541	0.566	0.515	0.501	0.508	0.541				
2002		0.541	0.555	0.541	0.480	0.488					
2003		0.527	0.577	0.536	0.476						
2004		0.530	0.567	0.507							
2005		0.522	0.554								
2006		0.526									
2007											

Averages of the Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Simple Average											
Latest 5		0.529	0.564	0.528	0.488	0.514	0.551	0.632	0.674	0.580	
Latest 3		0.526	0.566	0.528	0.486	0.511	0.555	0.632	0.674	0.580	
Medial Average											
Latest 5x1		0.527	0.562	0.530	0.488	0.515	0.542	0.642	0.674	0.580	

Selected Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	To Ult
Selected		0.526	0.566	0.528	0.486	0.511	0.555	0.632	0.674	0.580	0.000

Accident Year	Case Outstanding as of (months)										
	12	24	36	48	60	72	84	96	108	120	To Ult
1998	18,478,233	9,937,970	5,506,911	2,892,519	1,440,783	767,842	413,097	242,778	169,222	98,117	0
1999	18,544,291	9,955,034	5,623,522	3,060,431	1,520,760	764,736	443,528	284,732	185,233	107,435	0
2000	19,034,933	10,395,464	5,969,194	3,217,937	1,567,806	842,849	457,854	304,704	205,370	119,115	0
2001	19,401,810	10,487,914	5,936,461	3,056,202	1,532,147	777,926	421,141	266,161	179,393	104,048	0
2002	20,662,461	11,176,330	6,198,509	3,350,967	1,609,188	785,497	435,951	275,521	185,701	107,707	0
2003	21,078,651	11,098,119	6,398,219	3,431,210	1,634,690	835,327	463,606	292,999	197,481	114,539	0
2004	21,047,539	11,150,459	6,316,995	3,201,985	1,556,165	795,200	441,336	278,924	187,995	109,037	0
2005	21,260,172	11,087,832	6,141,416	3,242,668	1,575,936	805,304	446,943	282,468	190,384	110,422	0
2006	20,973,908	11,034,842	6,245,721	3,297,740	1,602,702	818,981	454,534	287,266	193,617	112,298	0
2007	21,623,594	11,374,010	6,437,690	3,399,100	1,651,963	844,153	468,505	296,095	199,568	115,749	0

Accident Year	Incremental Paid Claims as of (months)										
	12	24	36	48	60	72	84	96	108	120	To Ult
1998	18,539,254	14,691,785	6,830,969	3,830,031	2,004,496	868,887	455,900	225,555	108,579	88,731	107,929
1999	20,410,193	15,680,491	7,168,718	3,899,839	2,049,291	953,511	463,714	253,051	121,726	97,062	118,179
2000	22,120,843	16,855,171	7,413,268	4,173,103	2,172,895	1,004,821	544,233	248,891	133,156	107,614	131,026
2001	22,992,259	17,103,939	7,671,637	4,326,081	2,269,520	1,015,365	499,620	232,891	116,312	94,002	114,452
2002	24,092,782	17,702,531	8,108,490	4,449,081	2,401,492	1,052,839	495,649	241,081	120,403	97,307	118,477
2003	24,084,451	17,315,161	7,670,720	4,513,869	2,346,453	1,067,453	527,091	256,374	128,041	103,480	125,993
2004	24,369,770	17,120,093	7,746,815	4,537,994	2,286,217	1,016,176	501,771	244,059	121,890	98,509	119,941
2005	25,100,697	17,601,532	7,942,765	4,384,971	2,315,265	1,029,087	508,147	247,160	123,439	99,761	121,465
2006	25,608,776	17,997,721	7,735,424	4,459,444	2,354,587	1,046,564	516,777	251,357	125,535	101,455	123,528
2007	27,229,969	18,012,454	7,973,181	4,596,511	2,426,958	1,078,732	532,661	259,083	129,394	104,574	127,324

Accident Year	Cumulative Paid Claims as of (months)										
	12	24	36	48	60	72	84	96	108	120	To Ult
1998	18,539,254	33,231,039	40,062,008	43,892,039	45,896,535	46,765,422	47,221,322	47,446,877	47,555,456	47,644,187	47,752,116
1999	20,410,193	36,090,684	43,259,402	47,159,241	49,208,532	50,162,043	50,625,757	50,878,808	51,000,534	51,097,596	51,215,775
2000	22,120,843	38,976,014	46,389,282	50,562,385	52,735,280	53,740,101	54,284,334	54,533,225	54,666,381	54,773,995	54,905,021
2001	22,992,259	40,096,198	47,767,835	52,093,916	54,363,436	55,378,801	55,878,421	56,111,312	56,227,624	56,321,626	56,436,079
2002	24,092,782	41,795,313	49,903,803	54,352,884	56,754,376	57,807,215	58,302,864	58,543,944	58,664,347	58,761,654	58,880,132
2003	24,084,451	41,399,612	49,070,332	53,584,201	55,930,654	56,998,107	57,525,198	57,781,572	57,909,613	58,013,093	58,139,086
2004	24,369,770	41,489,863	49,236,678	53,774,672	56,060,889	57,077,065	57,578,836	57,822,895	57,944,785	58,043,294	58,163,235
2005	25,100,697	42,702,229	50,644,994	55,029,965	57,345,230	58,374,316	58,882,463	59,129,623	59,253,061	59,352,822	59,474,287
2006	25,608,776	43,606,497	51,341,921	55,801,366	58,155,952	59,202,517	59,719,294	59,970,651	60,096,186	60,197,641	60,321,169
2007	27,229,969	45,242,423	53,215,604	57,812,115	60,239,072	61,317,804	61,850,464	62,109,548	62,238,941	62,343,515	62,470,839

Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/07 Reported	Claims at 12/31/07 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/07	Unpaid Claim Estimate Based on Case Outstanding Development Method IBNR	Unpaid Claim Estimate Based on Case Outstanding Development Method Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	47,742,304	47,644,187	47,752,116	98,117	9,812	107,929
1999	51,185,767	51,000,534	51,215,775	185,233	30,008	215,241
2000	54,837,929	54,533,225	54,905,021	304,704	67,092	371,796
2001	56,299,562	55,878,421	56,436,079	421,141	136,517	557,658
2002	58,592,712	57,807,215	58,880,132	785,497	287,420	1,072,917
2003	57,565,344	55,930,654	58,139,086	1,634,690	573,742	2,208,432
2004	56,976,657	53,774,672	58,163,235	3,201,985	1,186,578	4,388,563
2005	56,786,410	50,644,994	59,474,287	6,141,416	2,687,877	8,829,293
2006	54,641,339	43,606,497	60,321,169	11,034,842	5,679,830	16,714,672
2007	48,853,563	27,229,969	62,470,839	21,623,594	13,617,276	35,240,870
Total	543,481,587	498,050,368	567,757,738	45,431,219	24,276,151	69,707,370

Column Notes:
(2) and (3) Based on Best's Aggregates & Averages U.S. private passenger automobile experience.
(4) Developed in Exhibit I, Sheet 4.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(4) - (3)].

Chapter 12 - Case Outstanding Development Technique
XYZ Insurer - Auto BI
Case Outstanding and Incremental Paid Claims ($000)

Accident Year	Case Outstanding as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998			4,861	3,859	3,134	2,447	1,446	1,947	853	71	0
1999		8,589	6,544	5,668	4,347	1,732	1,583	649	479	290	
2000	14,374	12,237	9,760	9,316	5,458	5,605	3,727	1,603	465		
2001	10,288	10,052	8,703	7,969	9,818	6,046	1,471	278			
2002	10,494	12,439	12,833	15,572	12,469	8,072	3,731				
2003	7,908	10,755	17,671	17,702	9,726	5,052					
2004	14,774	30,281	32,916	28,268	17,477						
2005	25,631	35,213	43,268	30,629							
2006	23,535	35,005	25,985								
2007	15,948	19,867									
2008	15,223										

Accident Year	Incremental Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998			6,309	2,212	1,561	1,537	1,622	1,177	892	453	58
1999		4,666	5,195	4,110	4,156	3,906	1,478	635	446	225	
2000	1,302	5,210	5,627	5,689	6,202	4,823	4,369	2,680	880		
2001	1,539	4,413	6,367	6,289	5,778	6,703	5,980	1,450			
2002	2,318	5,614	5,891	8,273	9,850	8,683	3,809				
2003	1,743	4,497	6,443	10,209	11,613	4,815					
2004	2,221	7,677	16,052	17,489	9,372						
2005	3,043	9,176	14,854	12,953							
2006	3,531	8,247	11,041								
2007	3,529	8,336									
2008	3,409										

Accident Year	Ratio of Incremental Paid Claims to Previous Case Outstanding as of (months)											
	12	24	36	48	60	72	84	96	108	120	132	To Ult
1998				0.455	0.405	0.491	0.663	0.814	0.458	0.532	0.816	
1999			0.605	0.628	0.733	0.899	0.854	0.401	0.688	0.469		
2000		0.362	0.460	0.583	0.666	0.884	0.780	0.719	0.549			
2001		0.429	0.633	0.723	0.725	0.683	0.989	0.985				
2002		0.535	0.474	0.645	0.633	0.696	0.472					
2003		0.569	0.599	0.578	0.656	0.495						
2004		0.520	0.530	0.531	0.332							
2005		0.358	0.422	0.299								
2006		0.350	0.315									
2007		0.523										
2008												

Averages of the Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	132	To Ult
Simple Average												
Latest 5		0.464	0.468	0.555	0.602	0.731	0.751	0.730	0.565	0.501	0.816	
Latest 2		0.437	0.369	0.415	0.494	0.596	0.730	0.852	0.618	0.501	0.816	
Medial Average												
Latest 5x1		0.467	0.475	0.585	0.651	0.754	0.765	0.766	0.549	0.501	0.816	

Selected Ratio of Incremental Paid Claims to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	132	To Ult
Selected		0.437	0.369	0.415	0.494	0.596	0.730	0.852	0.618	0.501	0.816	1.100

Accident Year	Ratio of Case Outstanding to Previous Case Outstanding as of (months)											
	12	24	36	48	60	72	84	96	108	120	132	To Ult
1998				0.794	0.812	0.781	0.591	1.346	0.438	0.084	0.000	
1999			0.762	0.866	0.767	0.398	0.914	0.410	0.739	0.605		
2000		0.851	0.798	0.954	0.586	1.027	0.665	0.430	0.290			
2001		0.977	0.866	0.916	1.232	0.616	0.243	0.189				
2002		1.185	1.032	1.213	0.801	0.647	0.462					
2003		1.360	1.643	1.002	0.549	0.519						
2004		2.050	1.087	0.859	0.618							
2005		1.374	1.229	0.708								
2006		1.487	0.742									
2007		1.246										
2008												

Averages of the Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	132	To Ult
Simple Average												
Latest 5		1.503	1.147	0.940	0.757	0.642	0.575	0.594	0.489	0.344	0.000	
Latest 2		1.367	0.986	0.783	0.584	0.583	0.353	0.310	0.514	0.344	0.000	
Medial Average												
Latest 5x1		1.407	1.116	0.925	0.668	0.594	0.573	0.420	0.438	0.344	0.000	

Selected Ratio of Case Outstanding to Previous Case Outstanding

	12	24	36	48	60	72	84	96	108	120	132	To Ult
Selected		1.367	0.986	0.783	0.584	0.583	0.353	0.310	0.514	0.344	0.000	0.000

Chapter 12 - Case Outstanding Development Technique
XYZ Insurer - Auto BI
Projection of Paid Claims ($000)

Exhibit II
Sheet 4

Accident Year	Case Outstanding as of (months) 12	24	36	48	60	72	84	96	108	120	132	To Ult
1998			4,861	3,859	3,134	2,447	1,446	1,947	853	71	0	0
1999		8,589	6,544	5,668	4,347	1,732	1,583	649	479	290	0	0
2000	14,374	12,237	9,760	9,316	5,458	5,605	3,727	1,603	465	160	0	0
2001	10,288	10,052	8,703	7,969	9,818	6,046	1,471	278	143	49	0	0
2002	10,494	12,439	12,833	15,572	12,469	8,072	3,731	1,155	594	204	0	0
2003	7,908	10,755	17,671	17,702	9,726	5,052	1,782	552	284	98	0	0
2004	14,774	30,281	32,916	28,268	17,477	10,197	3,597	1,114	573	197	0	0
2005	25,631	35,213	43,268	30,629	17,882	10,433	3,681	1,140	586	202	0	0
2006	23,535	35,005	25,985	20,355	11,884	6,934	2,446	757	390	134	0	0
2007	15,948	19,867	19,579	15,337	8,955	5,224	1,843	571	294	101	0	0
2008	15,223	20,803	20,502	16,060	9,376	5,471	1,930	598	307	106	0	0

Accident Year	Incremental Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132	To Ult
1998			6,309	2,212	1,561	1,537	1,622	1,177	892	453	58	0
1999		4,666	5,195	4,110	4,156	3,906	1,478	635	446	225	237	0
2000	1,302	5,210	5,627	5,689	6,202	4,823	4,369	2,680	880	0	130	0
2001	1,539	4,413	6,367	6,289	5,778	6,703	5,980	1,450	172	72	40	0
2002	2,318	5,614	5,891	8,273	9,850	8,683	3,809	3,180	714	297	167	0
2003	1,743	4,497	6,443	10,209	11,613	4,815	3,690	1,519	341	142	80	0
2004	2,221	7,677	16,052	17,489	9,372	10,412	7,448	3,066	689	287	161	0
2005	3,043	9,176	14,854	12,953	15,123	10,654	7,621	3,137	704	293	165	0
2006	3,531	8,247	11,041	10,793	10,051	7,080	5,064	2,085	468	195	109	0
2007	3,529	8,336	7,323	8,132	7,573	5,335	3,816	1,571	353	147	82	0
2008	3,409	6,646	7,668	8,516	7,930	5,586	3,996	1,645	369	154	86	0

Accident Year	Cumulative Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132	To Ult
1998			6,309	8,521	10,082	11,620	13,242	14,419	15,311	15,764	15,822	15,822
1999		4,666	9,861	13,971	18,127	22,032	23,511	24,146	24,592	24,817	25,054	25,054
2000	1,302	6,513	12,139	17,828	24,030	28,853	33,222	35,902	36,782	36,782	36,912	36,912
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519	38,691	38,763	38,803	38,803
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437	47,618	48,332	48,629	48,796	48,796
2003	1,743	6,240	12,683	22,892	34,505	39,320	43,011	44,530	44,871	45,013	45,093	45,093
2004	2,221	9,898	25,950	43,439	52,811	63,223	70,671	73,737	74,426	74,712	74,873	74,873
2005	3,043	12,219	27,073	40,026	55,150	65,803	73,424	76,561	77,265	77,559	77,723	77,723
2006	3,531	11,778	22,819	33,612	43,663	50,743	55,807	57,892	58,360	58,555	58,665	58,665
2007	3,529	11,865	19,188	27,321	34,894	40,229	44,045	45,616	45,968	46,115	46,198	46,198
2008	3,409	10,055	17,723	26,239	34,169	39,755	43,751	45,395	45,765	45,919	46,005	46,005

Development of Unpaid Claim Estimate ($000)

Accident Year	Claims at 12/31/08 Reported	Claims at 12/31/08 Paid	Projected Ultimate Claims	Case Outstanding at 12/31/08	Unpaid Claim Estimate Based on Case Outstanding Development Method IBNR	Unpaid Claim Estimate Based on Case Outstanding Development Method Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	15,822	15,822	15,822	0	0	0
1999	25,107	24,817	25,054	290	- 53	237
2000	37,246	36,782	36,912	465	- 334	130
2001	38,798	38,519	38,803	278	6	284
2002	48,169	44,437	48,796	3,731	627	4,359
2003	44,373	39,320	45,093	5,052	720	5,772
2004	70,288	52,811	74,873	17,477	4,585	22,062
2005	70,655	40,026	77,723	30,629	7,068	37,697
2006	48,804	22,819	58,665	25,985	9,861	35,846
2007	31,732	11,865	46,198	19,867	14,466	34,333
2008	18,632	3,409	46,005	15,223	27,373	42,596
Total	449,626	330,629	513,944	118,997	64,318	183,315

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) Developed in Exhibit II, Sheet 4.
(5) = [(2) - (3)].
(6) = [(4) - (2)].
(7) = [(4) - (3)].

Chapter 12 - Case Outstanding Development Technique
XYZ Insurer - Auto BI
Summary of Ultimate Claims ($000)

Exhibit II
Sheet 6

			Projected Ultimate Claims									
Accident	Claims at 12/31/08		Development Method		Expected	B-F Method		Cape	Frequency-Severity			Case O/S
Year	Reported	Paid	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3	Dev.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977	15,822	15,822			15,822
1999	25,107	24,817	25,082	25,164	24,665	25,107	25,158	25,107	25,082			25,054
2000	37,246	36,782	36,948	37,922	35,235	37,246	37,841	37,246	37,083			36,912
2001	38,798	38,519	38,487	40,600	39,150	38,798	40,525	38,798	38,778		39,192	38,803
2002	48,169	44,437	48,313	49,592	47,906	48,312	49,417	48,313	48,655		46,869	48,796
2003	44,373	39,320	44,950	49,858	54,164	45,068	50,768	45,062	46,107		44,479	45,093
2004	70,288	52,811	74,787	80,537	86,509	75,492	82,593	74,754	76,620		71,906	74,873
2005	70,655	40,026	76,661	80,333	108,172	79,129	94,301	77,931	80,745		71,684	77,723
2006	48,804	22,819	58,370	72,108	70,786	60,404	71,205	58,759	64,505		49,913	58,665
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636	43,307	58,516	30,512	31,805	46,198
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049	39,201	59,242	30,140	29,828	46,005
Total	449,626	330,629	514,929	605,030	561,516	513,207	554,471	504,300	551,155			513,944

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Chapter 9, Exhibit II, Sheet 1.
(9) Developed in Chapter 10, Exhibit II, Sheet 2.
(10) Developed in Chapter 11, Exhibit II, Sheet 6.
(11) Developed in Chapter 11, Exhibit IV, Sheet 3.
(12) Developed in Chapter 11, Exhibit VI, Sheet 7.
(13) Developed in Exhibit II, Sheet 4.

Chapter 12 - Case Outstanding Development Technique
XYZ Insurer - Auto BI
Summary of IBNR ($000)

Exhibit II
Sheet 7

	Case	Estimated IBNR									
Accident	Outstanding	Development Method		Expected	B-F Method		Cape	Frequency-Severity			Case O/S
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3	Dev.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1998	0	0	158	- 162	0	155	0	0			0
1999	290	- 25	58	- 442	0	51	0	- 25			- 53
2000	465	- 298	676	- 2,011	0	595	0	- 163			- 334
2001	278	- 310	1,802	352	0	1,728	0	- 19		394	6
2002	3,731	145	1,423	- 262	143	1,248	144	486		- 1,300	627
2003	5,052	577	5,485	9,791	695	6,396	690	1,734		106	720
2004	17,477	4,498	10,249	16,221	5,204	12,305	4,466	6,331		1,618	4,585
2005	30,629	6,006	9,678	37,517	8,474	23,646	7,276	10,090		1,029	7,068
2006	25,985	9,566	23,304	21,982	11,600	22,401	9,955	15,701		1,109	9,861
2007	19,867	16,247	46,209	8,103	13,489	13,904	11,575	26,784	- 1,220	73	14,466
2008	15,223	28,898	56,363	20,801	23,975	22,417	20,569	40,610	11,508	11,196	27,373
Total	118,997	65,303	155,405	111,890	63,581	104,845	54,674	101,529			64,318

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Chapter 9, Exhibit II, Sheet 2.
(8) Estimated in Chapter 10, Exhibit II, Sheet 3.
(9) Estimated in Chapter 11, Exhibit II, Sheet 7.
(10) Estimated in Chapter 11, Exhibit IV, Sheet 3.
(11) Estimated in Chapter 11, Exhibit VI, Sheet 8.
(12) Estimated in Exhibit II, Sheet 5.

Chapter 12 - Case Outstanding Development Technique Exhibit III
Self-Insurer Case Outstanding Only - General Liability
Development of Unpaid Claim Estimate

Accident Year	Case Outstanding at 12/31/08	CDF to Ultimate Reported	CDF to Ultimate Paid	CDF to Ultimate Case Outstanding	Unpaid Claim Estimate
(1)	(2)	(3)	(4)	(5)	(6)
1998	500,000	1.015	1.046	1.506	753,000
1999	650,000	1.020	1.067	1.454	945,100
2000	800,000	1.030	1.109	1.421	1,136,800
2001	850,000	1.051	1.187	1.445	1,228,250
2002	975,000	1.077	1.306	1.439	1,403,025
2003	1,000,000	1.131	1.489	1.545	1,545,000
Total	4,775,000				7,011,175

Column Notes:
(2) Based on data from Self-Insurer Case Outstanding Only.
(3) and (4) From Exhibit I, Sheet 2 in Chapter 8.
(5) = {[((3) - 1) x (4)] / ((4) - (3))} + 1.
(6) = [(2) x (5)].

CHAPTER 13 – BERQUIST-SHERMAN TECHNIQUES

We have already referred frequently to the pivotal paper by Berquist and Sherman "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach."[72] This paper, which continues to be invaluable to actuaries more than 30 years after its publication, addresses many important issues for actuaries conducting analyses of unpaid claims.

One of the many valuable contributions that arose from this paper was a methodical actuarial approach for analyzing unpaid claims for insurers who had undergone changes in operations and procedures. Berquist and Sherman present two alternatives for the actuary in addressing such situations:

- Treat problem areas through data selection and rearrangement
- Treat problem areas through data adjustment

Reacting to a Changing Environment through Data Selection and Rearrangement

Berquist and Sherman recommend that, wherever possible, the actuary should use data that is relatively unaffected by changes in the insurer's claims and underwriting procedures and operations. For example, if the insurer has experienced a change in its approach to the establishment of opening case outstanding, then the actuary may place greater reliance on methods using paid claims that will be unaffected by the changes in case outstanding. Berquist and Sherman cite the following examples for selecting alternative data to respond to potential problems related to a changing environment:

- Using earned exposures instead of the number of claims when claim count data is of questionable accuracy or if there has been a major change in the definition of a claim count.

- Substituting policy year data for accident year data when there has been a significant change in policy limits or deductibles between successive policy years.

- Substituting report year data for accident year data when there has been a dramatic shift in the social or legal climate that causes claim severity to more closely correlate with the report year than with the accident date.

- Substituting accident quarter for accident year when the rate of growth of earned exposures changes markedly, causing distortions in development factors due to significant shifts in the average accident date within each exposure period.

Another way to adjust the data for changes in operations is to divide the data into more homogeneous groups. This approach may be particularly valuable when there have been changes in the composition of business by jurisdiction, coverage, class, territory, or size of risk. We recall from Chapter 6, the discussion of homogeneity and credibility of data. While dividing the data into more homogeneous groups, the actuary must seek to retain sufficient volume of experience within each grouping to ensure the credibility of the data.

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[72] *PCAS*, 1977.

Berquist and Sherman also discuss the value of grouping claims data according to the size of the claim. A shift in emphasis by the claims department affecting its propensity to settle large claims versus small claims is an example of an operational change that could affect many types of data that actuaries typically use for estimating unpaid claims. For example, greater attention to large claims could result in an overall slowdown in the rate of total claim settlements. If claims adjusters focus on the larger claims, which are typically fewer in number, more complex, and require a longer period of time to settle than small claims, the small claims may not be settled at the same rate as in the past. Furthermore, with greater attention directed at the handling of large claims, there may be a speed-up in the settlement of these particular claims that could affect both the paid claims and case outstanding triangles; if the large claims are settled earlier then the case outstanding will no longer be present in the triangle at the later maturities and the payments will appear in the triangles at earlier maturities than in the past. Also, without appropriate attention, the smaller claims may become larger claims more quickly than past experience would suggest.

Treat Problem Areas through Data Adjustment

In some circumstances, the actuary is not able to sufficiently address the effect of changes in operations through data selection and rearrangement. In these situations, Berquist and Sherman introduce two techniques for quantitative adjustments to the data prior to application of traditional development techniques. The first technique adjusts the case outstanding triangle when there have been changes in the adequacy of case outstanding. The second technique adjusts the paid claim triangle where there have been changes in the rate of claims settlement.

In the discussion below we use the same examples that were presented in the 1977 paper by Berquist and Sherman. The first example is for a portfolio of U.S. medical malpractice insurance for an experience period of 1969 to 1976 (Berq-Sher Med Mal Insurer); and the second example is a portfolio of automobile bodily injury liability also for an experience period of 1969 to 1976 (Berq-Sher Auto BI Insurer). Notwithstanding the dated nature of these examples, the concepts are equally applicable to insurers operating today. Later in this chapter, we use the Berquist-Sherman adjustments to project ultimate claims for XYZ Insurer.

Detecting Changes in the Adequacy Level of Case Outstanding and Reducing the Effect of Such Changes on Reported Claims Projections

We present the analysis for Berq-Sher Med Mal Insurer in Exhibit I, Sheets 1 through 10. In Exhibit I, Sheet 1, we present the unadjusted reported claim development triangle. Berquist and Sherman use the simple average for all years to project ultimate claims. In Exhibit I, Sheet 2, we show the unadjusted paid claim triangle; for paid claims, Berquist and Sherman use the volume-weighted average for all years to project ultimate claims. In Exhibit I, Sheet 3, we project the unadjusted reported and unadjusted paid claims to an ultimate basis. There are significant differences in these projections by accident year and in total. It is worth noting that while Berquist and Sherman show the paid claim development method in this example for demonstration purposes, it is not a reliable projection method due to the highly leveraged nature of the cumulative development factors for almost every accident year in the experience period. (The format of Exhibit I, Sheet 3 is similar to that presented in the preceding chapters.)

Testing the Assumptions of the Reported Claim Development Technique

We recall that the underlying assumption of the reported claim development technique is that claims reported to date will continue to develop in a similar manner in the future. Thus, we assume that the adequacy of the case outstanding is not changing over time or at least is relatively stable other than inflationary pressures. If there has been a change in the adequacy of case outstanding over the experience period, then the fundamental assumption of the development method does not hold and the method will most likely not produce reliable results of ultimate claims or unpaid claims.

It is very important that the actuary test the appropriateness of underlying assumptions prior to relying on the results of any particular method. There are several approaches that an actuary can use to determine if an insurer has sustained changes in case outstanding adequacy. As we discuss in Chapter 6, one of the most important sources of information for the actuary is the claims department management of the insurer. A meeting with claims department management to discuss the claims process should be a prerequisite to any analysis of unpaid claims. The actuary can also calculate various claim development diagnostic tests, including: the ratio of paid-to-reported claims, average case outstanding, average reported claim, and average paid claims. In their medical malpractice example, Berquist and Sherman compare the annual change in the average case outstanding to the annual change in the average paid claims to confirm a shift in case outstanding adequacy.

We begin our testing of the underlying assumptions in Exhibit I, Sheet 4 with a review of the average case outstanding triangle. (Note that the average case outstanding triangle is the unadjusted case outstanding divided by the open claim counts in Exhibit I, Sheet 4.) When we look down each column, we observe that the two latest points are significantly higher than the preceding values at each maturity age (i.e., the latest two diagonals are higher than prior diagonals). For example, at 24 months, the average case outstanding values for the last two accident years are \$22,477 and \$32,160 compared to \$13,785 and \$11,433 for the preceding two accident years.

We use an exponential regression analysis to determine the annual trend rate in the average case outstanding at each maturity age. We fit the average case outstanding at each maturity age with the accident year. At the bottom of Exhibit I, Sheet 4, we present the fitted trend rate and the *R-squared* test for each maturity age. The *R-squared* test provides an indication of the goodness of the exponential fit for each maturity age. We observe annual trend rates of roughly 30% for maturity ages 24 months through 72 months with *R-squared* values of 85% or greater for all of these ages.[73]

In Exhibit I, Sheet 5, we continue our testing by calculating the ratios of paid-to-reported claims and reviewing the trend rates inherent in the average paid claim triangle. If there had been an increase in the case outstanding adequacy level, which seems apparent based on a review of the average case outstanding triangle, we would expect the ratios of paid-to-reported claims to be decreasing along the latest two diagonals of the triangle. While we see some decreases in this ratio triangle, there is substantial variability and it is hard to draw definitive conclusions based on this diagnostic alone.

[73] We again remind the reader that the results of regression analyses with limited data points must be used with caution.

The test that Berquist and Sherman used to determine that there had been an increase in case outstanding adequacy is a comparison of the annual trend rates, based on regression analysis, of the average case outstanding and the average paid claims on closed counts. Since medical malpractice tends to be a line of business where partial payments are not common, the paid claim triangle can be used with the closed claim counts triangle to approximate the average paid claims on closed counts. At the bottom of Exhibit I, Sheet 5, we reproduce the average paid claims on closed count triangle from the Berquist-Sherman paper.

When we compare the annual rates of change between average case outstanding and average paid claims, we observe very different trend indications. The annual trend rate appears to be approximately 30% based on a review of the average case outstanding triangle; however, using the average paid claim triangle, the annual trend rate indications range from approximately 7% to 14%. Berquist and Sherman note that the observed trends for average paid claims are similar to industry benchmarks (at the time), and thus they conclude that the higher trends for average case outstanding are indicative of changes in case outstanding adequacy.

Mechanics of the Berquist-Sherman Case Outstanding Adjustment

The mechanics of the Berquist-Sherman adjustment for changes in case outstanding adequacy are fairly straightforward. There are, however, two decisions requiring judgment by the actuary. First, the actuary must choose a diagonal from which he or she will calculate all other values of the adjusted average case outstanding triangle. For this purpose, the most prevalent choice tends to be the latest diagonal of the average case outstanding triangle. An advantage of selecting these average case outstanding values is that the latest diagonal of the adjusted reported claim triangle will not change from the unadjusted data triangle. Second, the actuary must select an annual severity trend to adjust the average case outstanding values from the selected diagonal to all other accident year-maturity age cells in the triangle.

In the medical malpractice example, Berquist and Sherman selected the latest diagonal as the starting point and a 15% annual severity trend. (The annual trend rate was based on a review of the historical experience for the specific insurer as well as overall insurance industry experience at the time.) In Exhibit I, Sheet 6, we present the adjusted average case outstanding triangle. The last diagonal does not change from the unadjusted average case outstanding triangle which we present in Exhibit I, Sheet 4. However, we now derive all other values by formula; these shaded values differ from the original triangle. The calculations proceed within each column starting with the latest point and the selected severity trend rate. For example, the 1975 adjusted average case outstanding at 12 months of $11,329 is equal to the 1976 average case outstanding at 12 months of $13,028 divided by 1.15^1, which represents one year of trend. Similarly, we calculate the 1970 adjusted average case outstanding at 48 months of $21,873 based on the 1973 average case outstanding of $33,266 divided by 1.15^3, which represents three years of trend.

The intent of these calculations is to restate the average case outstanding triangle so that each diagonal in the triangle is at the same case outstanding adequacy level as the latest diagonal (i.e., latest valuation). To determine the adjusted reported claims, we multiply the adjusted average case outstanding by the number of open claims and then add the unadjusted paid claims. In Exhibit I, Sheet 7, we analyze the adjusted reported claim triangle and select development factors for each age-to-age maturity. At the bottom of this exhibit, we compare the selected development factors from the unadjusted reported claim triangle to those selected for the adjusted reported claim triangle. We note that the selected development factor is lower based on adjusted data than on unadjusted data for all age-to-age maturities except 12-to-24 months. This is consistent with our belief that the case outstanding adequacy had increased in recent years and an unadjusted reported claim development projection would overstate future claim development.

In Exhibit I, Sheet 8, we repeat the claim development projections based on unadjusted reported and paid claims data. We also add the projection based on the adjusted reported claims. As expected, the projected ultimate claims based on the adjusted reported claim triangle are significantly less than the ultimate claims produced by the unadjusted data. To demonstrate the significant effect on the estimate of unpaid claims of this type of data adjustment, we calculate estimated IBNR and the total unpaid claim estimate in Exhibit I, Sheet 9 using all three projection methods (i.e., unadjusted reported claims, unadjusted paid claims, and adjusted reported claims). We summarize the totals in the following table.

Claims Data Type	Estimated IBNR Total All Years ($ millions)	Total Unpaid Claim Estimate Total All Years ($ millions)
Unadjusted Reported	470	747
Unadjusted Paid	284	560
Adjusted Reported	154	431

Because these three methods produce such dramatically different results, the actuary would likely seek alternative methods and additional information to determine which is, in fact, the most appropriate estimate of unpaid claims or whether another estimation method may be more appropriate. In many situations, actuaries summarize the results of numerous methodologies and select a final estimate of unpaid claims that they believe is most appropriate based on the insurer's particular circumstances. (See Chapter 15 – Evaluation of Techniques for further discussion.)

Potential Difficulty with the Adjustment

In his review of the Berquist and Sherman paper, Joseph Thorne comments on the importance of the estimation of the underlying trend in severity. He states: "The estimation of the underlying trend in severity requires much care due to the sensitivity of the reserve estimates to the selected rate, and due to the substantial judgment often necessary."[74] In his review, he presents a graph depicting the sensitivity of the unpaid claim estimate to the assumed rate of growth in the average outstanding claim cost. We reproduce this graph in Exhibit I, Sheet 10. He notes that estimating severity trends for medical malpractice is complicated by the following factors:

- The slow payment of claims substantially reduces the data available by accident year (less than 3% of ultimate claims are paid during the first 24 months and less than 30% during the first 60 months)

- Severity trends can be distorted by irregular settlements and variation in the rate of claims closed without payment

He concludes: "The degree of judgment necessary in the estimation of the severity trend makes this substantial effect on the loss reserve estimate particularly critical." While the CAS published Thorne's review in 1978, his comments are equally applicable today.

[74] *PCAS*, 1978

Detecting Changes in the Rate of Settlement of Claims and Adjusting Paid Claims for Such Changes

Berquist and Sherman also present a technique to adjust the paid claim development method for changes in settlement rates. We reproduce the Berq-Sher Auto BI Insurer example in Exhibit II, Sheets 1 through 12. In Exhibit II, Sheet 1, we present the unadjusted paid claim development triangle analysis; we include this analysis for comparison purposes with the Berquist-Sherman adjusted paid claim triangle. Berquist and Sherman use the volume-weighted average for all years to project ultimate claims.

Similar to the previous example, we test the data to determine if the rate of claims settlement is consistent for the reviewed line over the experience period (i.e., the underlying assumption of the paid claim development technique). In Exhibit II, Sheet 2, we summarize closed and reported claim counts and the ratio of closed-to-reported claim counts. When we look down each column of the ratio triangle, we readily see evidence of a steady decrease in the rate of claim settlement over the experience period. Thus, the primary assumption of the paid claim development method does not appear to hold true for Berq-Sher Auto BI Insurer, and the method would likely understate the true value required for unpaid claims.

Mechanics of the Berquist-Sherman Paid Claim Development Adjustment

The first step of the Berquist-Sherman paid claims adjustment is to determine the disposal rates by accident year and maturity. Berquist and Sherman use the same definition of disposal rates as that presented in the final frequency-severity approach of Chapter 11. (It is worthwhile to note that the definition of disposal rate differs among different authors in published actuarial papers.) To determine the disposal rates, we first project the number of ultimate claims based on reported claim counts (Exhibit II, Sheets 3 and 4). The disposal rate is equal to the cumulative closed claim counts for each accident year-maturity age cell divided by the ultimate claim counts for the particular accident year. Upon review of the disposal rates (top part of Exhibit II, Sheet 5), we see evidence of a decrease in the rate of claims settlement for Berq-Sher Auto BI Insurer.

Berquist and Sherman select the claims disposal rate along the latest diagonal as the basis for adjusting the closed claim count triangle. An advantage of selecting the latest diagonal as the starting point is that the latest diagonal of the adjusted paid claim triangle will not change from the unadjusted paid claim triangle.

We multiply the selected disposal rate for each maturity by the ultimate number of claims to determine the adjusted triangle of closed claim counts. For example, the adjusted closed claim counts for accident year 1974 at 12 months of 3,379[75] is equal to the selected disposal rate at 12 months of 0.433 multiplied by the projected ultimate claim counts for accident year 1974 of 7,803. Similarly, the adjusted closed claim counts for accident year 1971 at 60 months of 9,716[76] is equal to the selected disposal rate at 60 months of 0.977 multiplied by the projected ultimate claim counts for accident year 1971 of 9,945. The last diagonal in the adjusted closed claim count triangle in Exhibit II, Sheet 5 is the same as the unadjusted closed claim count triangle presented

[75] Note, slight differences which exist between values in the text and values in the exhibits are due to the fact that the exhibits carry a greater number of decimals than shown.

[76] Note, slight differences which exist between values in the text and values in the exhibits are due to the fact that the exhibits carry a greater number of decimals than shown.

in Exhibit II, Sheet 2. We highlight all other values in the triangle to indicate that they are adjusted, not actual values.

Berquist and Sherman then use regression analysis to identify a mathematical formula that approximates the relationship between the cumulative number of closed claims (X) and cumulative paid claims (Y). Using the automobile BI data, Berquist and Sherman find that a curve of the form $Y = ae^{(bX)}$ fits exceptionally well. We conduct the regression analysis for the oldest three accident years. In Exhibit II, Sheet 6, we present the results of this analysis for accident years 1969, 1970, and 1971, including the *R-squared* value and the estimated *a* and *b* values.

Since exponential curves closely approximate the relationship between cumulative closed claim counts and cumulative paid claims, Berquist and Sherman suggest that fitting exponential curves for every pair of two successive points is appropriate as the basis for adjusting paid claims. For ease of illustration, we reproduce triangles for unadjusted closed claim counts, unadjusted paid claims, and adjusted closed claim counts on the left side of Exhibit II, Sheet 7. We show the estimated parameters *a* and *b* for all two-point exponential regressions on the right side. For example, the exponential regression for accident year 1969 between ages 12 and 24, such that X = (4,079; 6,616) and Y = (1,904; 5,398), would result in a = 356 and b = 0.000411, which we place in the age 24 cell.

After estimating all parameter values, we can then proceed with adjusting the paid claims. We adjust paid claims based on the modifications that we have made to the closed claim count triangle earlier. In general, there are three kinds of treatments: no adjustment, interpolation, and extrapolation. Since adjusted closed claim counts are the same as unadjusted closed claim counts along the latest diagonal, the latest diagonal of the paid claim triangle does not require any adjustment. If the number of adjusted closed claims is within the range of any regression in its specific accident year, we use interpolation. For example, accident year 1970 at age 48 has 8,231 adjusted closed claims, which is within the range of unadjusted closed claims between ages 36 and 48 (7,899; 8,291), then the paid claims for accident year 1970 at age 48 would be adjusted based on such regression with a = 215 and b = 0.000468. Therefore, the adjusted paid claims for accident year 1970 at age 48 are equal to $\{215 \text{ x } [e^{(0.000468 \text{ x } 8{,}231)}]\}$ = 10,156. On the other hand, if the number of adjusted closed claims is not within the range of all regression in its specific accident year, then extrapolation would be used to the regression that has the closest range. For example, accident year 1969 at age 12 has 3,383 adjusted closed claim counts, in which the regression between ages 12 and 24 has the closest unadjusted closed claim count range (4,079; 6,616) among all regressions in year 1969. Therefore, the adjusted paid claims for year 1969 at age 12 is calculated as $\{356 \text{ x } [e^{(0.000411 \text{ x } 3{,}383)}]\}$ = 1,431.

In Exhibit II, Sheet 8, we analyze the adjusted paid claim development triangle and select development factors for each age-to-age maturity. At the bottom of this exhibit, we compare the selected development factors from the unadjusted paid claim triangle to those selected for the adjusted paid claim triangle. For both the adjusted and unadjusted paid claim development triangles, we select factors based on the volume-weighted average for all years. We note that at all age-to-age maturities except 72-to-84 and 84-to-96 months, the selected development factors are higher based on the adjusted data than on the unadjusted data. This is consistent with our belief that the rate of claims settlement has decreased in recent years and an unadjusted paid claim development projection would understate future claim development and the estimate of unpaid claims.

In their 1977 paper, Berquist and Sherman present numerous alternatives for the derivation of claim development factors. We continue the example for Berq-Sher Auto BI Insurer with two additional approaches for determining claim development factors for the adjusted paid claim triangle. The first approach, presented in Exhibit II, Sheet 9, is based on a linear regression of the claim development factors at each maturity age with the accident year. We show the *Y* intercepts, slope, and *R-squared* values for each maturity age. The second approach, shown in Exhibit II, Sheet 10, is similar to the first except that the development factors are derived using an exponential regression analysis rather than a linear regression analysis. As we see in the middle section of both Sheets, the *R-squared* values are never greater than 75% for any maturity age. We use the extrapolated claim development factors to complete the age-to-age triangles in order to derive the ultimate claim development factor for each accident year.[77]

In Exhibit II, Sheet 11, we project ultimate claims based on the unadjusted and adjusted paid claim development triangles. The projections based on the unadjusted paid claim triangle rely on the all-year volume-weighted average age-to-age factors. For the adjusted paid claims, we project claims using the all-year volume-weighted average as well as the development factors derived from the linear and exponential regression analyses. In Exhibit II, Sheet 12, we calculate the unpaid claim estimates based on the results of the four claims projections. The estimated IBNR based on the adjusted paid claims projections are relatively close to one another; these estimates are all roughly $10 million greater than the estimates from the unadjusted development technique.

Potential Difficulty with the Adjustment

A key assumption in the Berquist-Sherman paid claims adjustment is that a higher percentage of closed claim counts relative to ultimate claim counts is associated with a higher percentage of ultimate claims paid. Joseph O. Thorne, in his review of the Berquist-Sherman paper, notes: “Lack of recognition of the settlement patterns *by size of loss* can be an important source of error … it may be necessary to modify the technique to apply to size of loss categories adjusted for ‘inflation’.” Thorne presents a detailed example in which the number of small claims (limited to $3,000) is steadily decreasing and the number of larger claims (limited to $20,000) is steadily increasing. He shows that the percentage of closed claim counts decreases and yet the percentage of paid claims increases due to the shift to settling larger claims. Thus, he notes that the Berquist-Sherman technique actually adjusts paid claims to be less comparable among accident years and increases the error in the estimate of unpaid claims. He concludes: “Although the example is hypothetical, it was selected recognizing the recent trend toward an increasing proportion of severe, late closing claims in many lines of business and demonstrates the hazards of not recognizing settlement patterns by size of loss.”[78]

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[77] We note that actuaries must take care when extrapolating development patterns particularly for high maturity ages where data is thin. For volatile age-to-age factors, extrapolation can lead to unreasonable estimates of age-to-age factors.

[78] *PCAS*, 1978.

XYZ Insurer

In previous chapters, we discuss the numerous operational and environmental changes that XYZ Insurer has been subject to in recent years. Therefore, we conclude that both Berquist-Sherman adjustments are appropriate for XYZ Insurer. For this example, we prepare three separate projections:

- Adjustment due to changes in case outstanding adequacy only
- Adjustment for changes in settlement rate only
- Adjustments for both the change in case outstanding adequacy and settlement rates

The first step of the adjustment for changes in case outstanding adequacy is the determination of the severity trend rate. In Exhibit III, Sheet 1, we analyze the average paid claims (using unadjusted data). We perform exponential regression analyses at each maturity age. Based on this analysis and our knowledge of the insurance industry's experience for this line of business, we select a 5% severity trend rate for XYZ Insurer. We do not observe any significant differences in the trend rate by maturity age for ages 24 through 72 months; thus, we use the 5% severity trend rate for all maturities.

In the top part of Exhibit III, Sheet 2, we present the adjusted average case outstanding triangle. We use the latest diagonal as the starting point and the selected 5% severity trend rate to develop this triangle. In the bottom part of Exhibit III, Sheet 2, we summarize the adjusted reported claim development triangle. Adjusted reported claims are equal to the adjusted average case outstanding triangle multiplied by the number of open claims and then added to the paid claims for each accident year-maturity age cell. We follow this approach for ages 12 months through 84 months.

For the most mature ages (i.e., ages 96 months through 132 months), we judgmentally assume that the unadjusted reported claim triangle is appropriate without any adjustment, although the method can be applied to all claim maturities. For claims at these older maturities, we expect that the claims department has complete information and thus the case outstanding amounts for these claims are adequate. This is an example of how actuarial judgment influences the application of a mechanical projection methodology for a specific insurer.

We analyze the adjusted reported claim development triangle (case adjustment only) in Exhibit III, Sheet 3. At the 12-to-24 month interval, we observe a persistent downward trend in the age-to-age factors. A similar pattern, though not quite as pronounced, also exists at 24 months. This leads us to question whether or not the trend rate is appropriate, particularly for these two maturity ages. We also return to an issue raised earlier about a potential shift in the type of claim that is now closed at 12 and 24 months. This could have a distorting effect on this projection methodology.

We select claim development factors based on the volume-weighted three-year average to recognize the decreasing age-to-age factors in the most recent diagonals. We compare the estimated average age-to-age factors with our selected factors based on the unadjusted reported claim triangle (from Chapter 7). As expected, the estimated average age-to-age factors for most maturities are less than those based on the unadjusted claims. This is consistent with our expectation since we believe that case outstanding strengthening has occurred at XYZ Insurer; thus, an unadjusted reported claim development method would likely result in an overstated estimate of unpaid claims. When selecting claim development factors, we rely on the latest three-year volume-weighted average for ages 12-to-24, 24-to-36, and 36-to-48. We judgmentally select a factor of 1.000 for all remaining intervals to smooth out the variability seen in the average age-to-age factors. In practice, actuarial judgment plays a vital role in the selection of claim development factors.

In Exhibit III, Sheet 4, we begin the adjustment process for changes in claims settlement rates. We select disposal rates based on the last diagonal of closed claim counts divided by the projected ultimate reported claim counts. (We developed the projected ultimate reported claim counts in Chapter 11.) We follow the same approach that is described for Berq-Sher Auto BI Insurer. Exhibits III, Sheets 5 and 6, which provide for the derivation of adjusted paid claims, follow the same format as the previous example.

We analyze the adjusted paid claim development triangle in Exhibit III, Sheet 7. We select claim development factors based on the five-year volume-weighted average and compare these selected factors to those selected in Chapter 7 based on the unadjusted paid claim triangle. For most maturity ages, the selected development factors based on the adjusted paid claims are less than those based on the unadjusted claims. This is consistent with our expectations since we believe that the rate of settlement has increased, and thus, an unadjusted paid claim development method would likely result in an overstated unpaid claim estimate.

Our last projection for XYZ Insurer adjusts the data for changes in both case outstanding adequacy and the rate of claims settlement. Since we know that there have been changes in the rate of claims settlement for XYZ Insurer, we question the first projection, which is a case outstanding only adjustment. In our final projection, we use both an adjusted average paid claim triangle and the adjusted average case outstanding triangle. There is one new adjusted triangle we need to create for this projection: the adjusted number of open claims. We derive the adjusted open claim count triangle by subtracting the adjusted closed claim count triangle from reported claim counts. The adjusted reported claim triangle is then equal to:

{[(adjusted average case outstanding) x (adjusted open claim counts)] + (adjusted paid claims)}

We analyze this adjusted reported claim triangle in Exhibit III, Sheet 9. We present the unadjusted selected claim development factors as well as the selected claim development factors from the case outstanding only adjustment. We note that the average age-to-age factors tend to be between these two sets of selected claim development factors. In Exhibit III, Sheet 9, we select claim development factors based on the three-year volume-weighted average through 72 months; to smooth the indications for the older maturities, we select a claim development factor of 1.00 for all remaining age intervals.

In Exhibit III, Sheets 10 and 11, we project ultimate claims and derive estimates of unpaid claims, respectively, based on the three Berquist-Sherman adjustments to reported and paid claims. We quickly see that all three projections are relatively close to one another for all accident years. In Exhibit III, Sheets 12 and 13, we compare the results of the Berquist-Sherman projections with all the other techniques presented for XYZ Insurer. In Exhibit III, Sheet 12, we compare projected ultimate claims and in Exhibit III, Sheet 13, we compare estimated IBNR.

We observe significant differences when we compare the estimates of total unpaid claims based on the unadjusted development technique to the unpaid claim estimates based on the development technique applied to adjusted claims data. In the following table, we summarize these estimates of unpaid claims.

($ Millions)	**Estimated IBNR**	**Total Unpaid Claim Estimate**
Unadjusted Reported Claims	65	184
Unadjusted Paid Claims	155	274
Adjusted (Case Only) Reported Claims	27	146
Adjusted (Case and Settlement) Reported Claims	40	159
Adjusted Paid Claims	36	155

In Chapter 15, we address the evaluation and selection of ultimate claims for many of our examples, including XYZ Insurer.

The actuary may also want to consider whether or not the results of the Berquist-Sherman analyses should be reflected in a revised Bornhuetter-Ferguson projection for XYZ Insurer. Specifically, the adjusted reporting and payment patterns could be used in place of the unadjusted reporting and payment patterns, and any changes in the expected claim ratios due to Berquist-Sherman indications could also be considered in the initial expected claims.

Unadjusted Reported Claims

PART 1 - Data Triangle

Accident Year	Unadjusted Reported Claims as of (months) 12	24	36	48	60	72	84	96
1969	2,897,000	5,160,000	10,714,000	15,228,000	16,611,000	20,899,000	22,892,000	23,506,000
1970	4,828,000	10,707,000	16,907,000	22,840,000	26,211,000	31,970,000	32,216,000	
1971	5,455,000	11,941,000	20,733,000	30,928,000	42,395,000	48,377,000		
1972	8,732,000	18,633,000	32,143,000	57,196,000	61,163,000			
1973	11,228,000	19,967,000	50,143,000	73,733,000				
1974	8,706,000	33,459,000	63,477,000					
1975	12,928,000	48,904,000						
1976	15,791,000							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	1.781	2.076	1.421	1.091	1.258	1.095	1.027	
1970	2.218	1.579	1.351	1.148	1.220	1.008		
1971	2.189	1.736	1.492	1.371	1.141			
1972	2.134	1.725	1.779	1.069				
1973	1.778	2.511	1.470					
1974	3.843	1.897						
1975	3.783							

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	2.532	1.921	1.503	1.170	1.206	1.052	1.027	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108
Selected	2.532	1.921	1.503	1.170	1.206	1.052	1.027	1.000
CDF to Ultimate	11.145	4.402	2.291	1.524	1.303	1.080	1.027	1.000
Percent Reported	9.0%	22.7%	43.6%	65.6%	76.7%	92.6%	97.4%	100.0%

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 2
Unadjusted Paid Claims

PART 1 - Data Triangle

Accident	Unadjusted Paid Claims as of (months)							
Year	12	24	36	48	60	72	84	96
1969	125,000	406,000	1,443,000	2,986,000	4,467,000	8,179,000	12,638,000	15,815,000
1970	43,000	529,000	2,016,000	3,641,000	7,523,000	14,295,000	18,983,000	
1971	295,000	1,147,000	2,479,000	5,071,000	11,399,000	17,707,000		
1972	50,000	786,000	3,810,000	9,771,000	18,518,000			
1973	213,000	833,000	3,599,000	11,292,000				
1974	172,000	1,587,000	6,267,000					
1975	210,000	1,565,000						
1976	209,000							

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors							
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	3.248	3.554	2.069	1.496	1.831	1.545	1.251	
1970	12.302	3.811	1.806	2.066	1.900	1.328		
1971	3.888	2.161	2.046	2.248	1.553			
1972	15.720	4.847	2.565	1.895				
1973	3.911	4.321	3.138					
1974	9.227	3.949						
1975	7.452							

PART 3 - Average Age-to-Age Factors

	Averages							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Volume-weighted Average								
All Years	6.185	3.709	2.455	1.952	1.718	1.407	1.251	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection							
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108
Selected	6.185	3.709	2.455	1.952	1.718	1.407	1.251	1.486
CDF to Ultimate	494.097	79.886	21.538	8.773	4.495	2.616	1.859	1.486
Percent Paid	0.2%	1.3%	4.6%	11.4%	22.2%	38.2%	53.8%	67.3%

Projection of Ultimate Claims Using Development Technique and Unadjusted Data

Accident Year	Age of Accident Year at 12/31/76	Claims at 12/31/76 Reported	Claims at 12/31/76 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate Claims Using Dev. Method with Reported	Projected Ultimate Claims Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1969	96	23,506,000	15,815,000	1.000	1.486	23,506,000	23,501,090
1970	84	32,216,000	18,983,000	1.027	1.859	33,085,832	35,289,397
1971	72	48,377,000	17,707,000	1.080	2.616	52,247,160	46,321,512
1972	60	61,163,000	18,518,000	1.303	4.495	79,695,389	83,238,410
1973	48	73,733,000	11,292,000	1.524	8.773	112,369,092	99,064,716
1974	36	63,477,000	6,267,000	2.291	21.538	145,425,807	134,978,646
1975	24	48,904,000	1,565,000	4.402	79.886	215,275,408	125,021,590
1976	12	15,791,000	209,000	11.145	494.097	175,990,695	103,266,273
Total		367,167,000	90,356,000			837,595,383	650,681,634

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) and (4) Based on data from Berq-Sher Med Mal Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 4
Development Triangles - Unadjusted Data

Accident Year	Unadjusted Case Outstanding as of (months)							
	12	24	36	48	60	72	84	96
1969	2,772,000	4,754,000	9,271,000	12,242,000	12,144,000	12,720,000	10,254,000	7,691,000
1970	4,785,000	10,178,000	14,891,000	19,199,000	18,688,000	17,675,000	13,233,000	
1971	5,160,000	10,794,000	18,254,000	25,857,000	30,996,000	30,670,000		
1972	8,682,000	17,847,000	28,333,000	47,425,000	42,645,000			
1973	11,015,000	19,134,000	46,544,000	62,441,000				
1974	8,534,000	31,872,000	57,210,000					
1975	12,718,000	47,339,000						
1976	15,582,000							

Accident Year	Open Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
1969	749	840	1,001	1,206	1,034	765	533	359
1970	660	957	1,149	1,350	1,095	755	539	
1971	878	1,329	1,720	1,799	1,428	1,056		
1972	1,043	1,561	1,828	1,894	1,522			
1973	1,088	1,388	1,540	1,877				
1974	1,033	1,418	1,663					
1975	1,138	1,472						
1976	1,196							

Accident Year	Unadjusted Average Case Outstanding as of (months)							
	12	24	36	48	60	72	84	96
1969	3,701	5,660	9,262	10,151	11,745	16,627	19,238	21,423
1970	7,250	10,635	12,960	14,221	17,067	23,411	24,551	
1971	5,877	8,122	10,613	14,373	21,706	29,044		
1972	8,324	11,433	15,499	25,040	28,019			
1973	10,124	13,785	30,223	33,266				
1974	8,261	22,477	34,402					
1975	11,176	32,160						
1976	13,028							

Annual Change based on Exponential Regression Analysis of Severities and Accident Year							
	15.6%	29.5%	31.1%	34.2%	33.0%	32.2%	27.6%
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)							
	80.0%	89.5%	85.8%	94.1%	98.9%	98.3%	100.0%

Development Triangles - Unadjusted Data

Accident Year	Unadjusted Paid Claims as of (months)							
	12	24	36	48	60	72	84	96
1969	125,000	406,000	1,443,000	2,986,000	4,467,000	8,179,000	12,638,000	15,815,000
1970	43,000	529,000	2,016,000	3,641,000	7,523,000	14,295,000	18,983,000	
1971	295,000	1,147,000	2,479,000	5,071,000	11,399,000	17,707,000		
1972	50,000	786,000	3,810,000	9,771,000	18,518,000			
1973	213,000	833,000	3,599,000	11,292,000				
1974	172,000	1,587,000	6,267,000					
1975	210,000	1,565,000						
1976	209,000							

Accident Year	Ratio of Unadjusted Paid Claims to Reported Claims as of (months)							
	12	24	36	48	60	72	84	96
1969	0.043	0.079	0.135	0.196	0.269	0.391	0.552	0.673
1970	0.009	0.049	0.119	0.159	0.287	0.447	0.589	
1971	0.054	0.096	0.120	0.164	0.269	0.366		
1972	0.006	0.042	0.119	0.171	0.303			
1973	0.019	0.042	0.072	0.153				
1974	0.020	0.047	0.099					
1975	0.016	0.032						
1976	0.013							

Accident Year	Unadjusted Average Paid Claims as of (months)							
	12	24	36	48	60	72	84	96
1969	402	539	2,971	8,620	9,199	12,669	17,084	16,634
1970	110	919	5,487	9,129	12,403	18,452	19,533	
1971	706	1,115	5,644	4,928	12,994	14,948		
1972	161	862	5,782	9,477	14,085			
1973	724	541	4,003	11,709				
1974	518	1,394	7,635					
1975	517	1,494						
1976	525							

	12	24	36	48	60	72	84
Annual Change based on Exponential Regression Analysis of Severities and Accident Year	12.9%	12.0%	11.5%	6.7%	14.2%	8.6%	14.3%
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)	18.3%	35.3%	37.9%	10.1%	84.6%	19.3%	100.0%

Derivation of Adjusted Reported Claim Development Triangle

Accident Year	Adjusted Average Case Outstanding as of (months)							
	12	24	36	48	60	72	84	96
1969	4,898	13,904	17,104	19,020	18,423	21,961	21,349	21,423
1970	5,633	15,989	19,669	21,873	21,186	25,255	24,551	
1971	6,477	18,387	22,620	25,154	24,364	29,044		
1972	7,449	21,145	26,013	28,927	28,019			
1973	8,566	24,317	29,915	33,266				
1974	9,851	27,965	34,402					
1975	11,329	32,160						
1976	13,028							

Selected Annual Severity Trend Rate 15%

Accident Year	Adjusted Reported Claims as of (months)							
	12	24	36	48	60	72	84	96
1969	3,793,504	12,084,942	18,563,821	25,924,316	23,516,364	24,979,245	24,016,864	23,506,000
1970	3,760,482	15,830,500	24,615,996	33,169,802	30,722,141	33,362,729	32,216,000	
1971	5,982,185	25,583,831	41,384,825	50,323,342	46,191,356	48,377,000		
1972	7,819,355	33,794,110	51,361,061	64,559,286	61,163,000			
1973	9,533,246	34,585,431	49,667,342	73,733,000				
1974	10,348,458	41,241,243	63,477,000					
1975	13,102,479	48,904,000						
1976	15,791,000							

Chapter 13 - Berquist-Sherman Techniques Exhibit I
Berq-Sher Med Mal Insurer Sheet 7
Adjusted Reported Claims

PART 1 - Data Triangle

Accident Year	Adjusted Reported Claims as of (months) 12	24	36	48	60	72	84	96
1969	3,793,504	12,084,942	18,563,821	25,924,316	23,516,364	24,979,245	24,016,864	23,506,000
1970	3,760,482	15,830,500	24,615,996	33,169,802	30,722,141	33,362,729	32,216,000	
1971	5,982,185	25,583,831	41,384,825	50,323,342	46,191,356	48,377,000		
1972	7,819,355	33,794,110	51,361,061	64,559,286	61,163,000			
1973	9,533,246	34,585,431	49,667,342	73,733,000				
1974	10,348,458	41,241,243	63,477,000					
1975	13,102,479	48,904,000						
1976	15,791,000							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	3.186	1.536	1.396	0.907	1.062	0.961	0.979	
1970	4.210	1.555	1.347	0.926	1.086	0.966		
1971	4.277	1.618	1.216	0.918	1.047			
1972	4.322	1.520	1.257	0.947				
1973	3.628	1.436	1.485					
1974	3.985	1.539						
1975	3.732							

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	3.906	1.534	1.340	0.925	1.065	0.964	0.979	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108
Unadj Selected	2.532	1.921	1.503	1.170	1.206	1.052	1.027	1.000
Adj Selected	3.906	1.534	1.340	0.925	1.065	0.964	0.979	1.000
CDF to Ultimate	7.465	1.911	1.246	0.930	1.005	0.944	0.979	1.000
Percent Reported	13.4%	52.3%	80.3%	107.5%	99.5%	105.9%	102.1%	100.0%

Exhibit I
Sheet 8

Projection of Ultimate Claims Using Development Technique and Adjusted Data

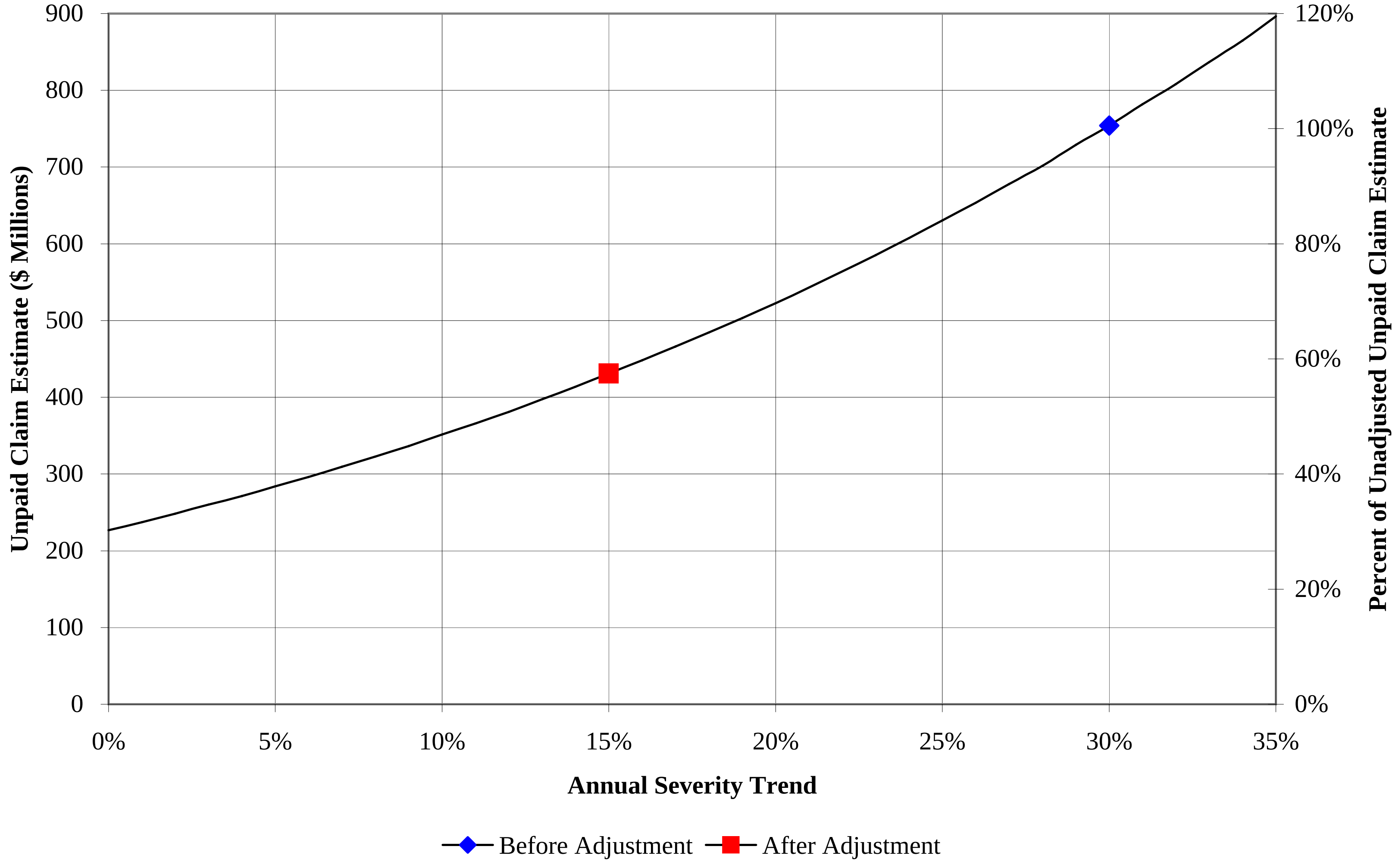
	Age of	Claims at 12/31/76			CDF to Ultimate			Projected Ultimate Claims Using Dev. Method with		
Accident Year	Accident Year at 12/31/76	Reported	Paid	Adjusted Reported	Reported	Paid	Adjusted Reported	Reported	Paid	Adjusted Reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1969	96	23,506,000	15,815,000	23,506,000	1.000	1.486	1.000	23,506,000	23,501,090	23,506,000
1970	84	32,216,000	18,983,000	32,216,000	1.027	1.859	0.979	33,085,832	35,289,397	31,539,464
1971	72	48,377,000	17,707,000	48,377,000	1.080	2.616	0.944	52,247,160	46,321,512	45,667,888
1972	60	61,163,000	18,518,000	61,163,000	1.303	4.495	1.005	79,695,389	83,238,410	61,468,815
1973	48	73,733,000	11,292,000	73,733,000	1.524	8.773	0.930	112,369,092	99,064,716	68,571,690
1974	36	63,477,000	6,267,000	63,477,000	2.291	21.538	1.246	145,425,807	134,978,646	79,092,342
1975	24	48,904,000	1,565,000	48,904,000	4.402	79.886	1.911	215,275,408	125,021,590	93,455,544
1976	12	15,791,000	209,000	15,791,000	11.145	494.097	7.465	175,990,695	103,266,273	117,879,815
Total		367,167,000	90,356,000	367,167,000				837,595,383	650,681,634	521,181,558

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) and (4) Based on data from Berq-Sher Med Mal Insurer.
(5) Developed in Exhibit I, Sheet 6.
(6) and (7) Based on CDF from Exhibit I, Sheets 1 and 2.
(8) Based on CDF from Exhibit I, Sheet 7.
(9) = [(3) x (6)].
(10) = [(4) x (7)].
(11) = [(5) x (8)].

			Projected Ultimate Claims Using Dev. Method with			Case	Unpaid Claim Estimate at 12/31/76 — IBNR - Based on Dev. Method with			Unpaid Claim Estimate at 12/31/76 — Total - Based on Dev. Method with		
Accident	Claims at 12/31/76				Adjusted	Outstanding			Adjusted			Adjusted
Year	Reported	Paid	Reported	Paid	Reported	at 12/31/76	Reported	Paid	Reported	Reported	Paid	Reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1969	23,506,000	15,815,000	23,506,000	23,501,090	23,506,000	7,691,000	0	- 4,910	0	7,691,000	7,686,090	7,691,000
1970	32,216,000	18,983,000	33,085,832	35,289,397	31,539,464	13,233,000	869,832	3,073,397	- 676,536	14,102,832	16,306,397	12,556,464
1971	48,377,000	17,707,000	52,247,160	46,321,512	45,667,888	30,670,000	3,870,160	- 2,055,488	- 2,709,112	34,540,160	28,614,512	27,960,888
1972	61,163,000	18,518,000	79,695,389	83,238,410	61,468,815	42,645,000	18,532,389	22,075,410	305,815	61,177,389	64,720,410	42,950,815
1973	73,733,000	11,292,000	112,369,092	99,064,716	68,571,690	62,441,000	38,636,092	25,331,716	- 5,161,310	101,077,092	87,772,716	57,279,690
1974	63,477,000	6,267,000	145,425,807	134,978,646	79,092,342	57,210,000	81,948,807	71,501,646	15,615,342	139,158,807	128,711,646	72,825,342
1975	48,904,000	1,565,000	215,275,408	125,021,590	93,455,544	47,339,000	166,371,408	76,117,590	44,551,544	213,710,408	123,456,590	91,890,544
1976	15,791,000	209,000	175,990,695	103,266,273	117,879,815	15,582,000	160,199,695	87,475,273	102,088,815	175,781,695	103,057,273	117,670,815
Total	367,167,000	90,356,000	837,595,383	650,681,634	521,181,558	276,811,000	470,428,383	283,514,634	154,014,558	747,239,383	560,325,634	430,825,558

Column Notes:
(2) and (3) Based on data from Berq-Sher Med Mal Insurer.
(4) through (6) Developed in Exhibit I, Sheet 8.
(7) = [(2) - (3)].
(8) = [(4) - (2)].
(9) = [(5) - (2)].
(10) = [(6) - (2)].
(11) = [(7) + (8)].
(12) = [(7) + (9)].
(13) = [(7) + (10)].

Chapter 13 - Berquist-Sherman Techniques
Berq-Sher Med Mal Insurer
Sensitivity of Unpaid Claim Estimate to Assumed Annual Severity Trend



PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96
1969	1,904	5,398	7,496	8,882	9,712	10,071	10,199	10,256
1970	2,235	6,261	8,691	10,443	11,346	11,754	12,031	
1971	2,441	7,348	10,662	12,655	13,748	14,235		
1972	2,503	8,173	11,810	14,176	15,383			
1973	2,838	8,712	12,728	15,278				
1974	2,405	7,858	11,771					
1975	2,759	9,182						
1976	2,801							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.835	1.389	1.185	1.093	1.037	1.013	1.006	
1970	2.801	1.388	1.202	1.086	1.036	1.024		
1971	3.010	1.451	1.187	1.086	1.035			
1972	3.265	1.445	1.200	1.085				
1973	3.070	1.461	1.200					
1974	3.267	1.498						
1975	3.328							

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	3.082	1.439	1.195	1.088	1.036	1.018	1.006	
Latest 4	3.233	1.464	1.197	1.088	1.036	1.018	1.006	
Volume-weighted Average								
All Years	3.098	1.444	1.196	1.087	1.036	1.019	1.006	
Latest 4	3.229	1.464	1.197	1.087	1.036	1.019	1.006	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108
Selected	3.098	1.444	1.196	1.087	1.036	1.019	1.006	1.000
CDF to Ultimate	6.170	1.991	1.379	1.154	1.061	1.024	1.006	1.000
Percent Reported	16.2%	50.2%	72.5%	86.7%	94.3%	97.7%	99.4%	100.0%

Development Triangles - Unadjusted Data

Accident Year	Closed Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
1969	4,079	6,616	7,192	7,494	7,670	7,749	7,792	7,806
1970	4,429	7,230	7,899	8,291	8,494	8,606	8,647	
1971	4,914	8,174	9,068	9,518	9,761	9,855		
1972	4,497	7,842	8,747	9,254	9,469			
1973	4,419	7,665	8,659	9,093				
1974	3,486	6,214	6,916					
1975	3,516	6,226						
1976	3,230							

Accident Year	Reported Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
1969	6,553	7,696	7,770	7,799	7,814	7,819	7,820	7,821
1970	7,277	8,537	8,615	8,661	8,675	8,679	8,682	
1971	8,259	9,765	9,884	9,926	9,940	9,945		
1972	7,858	9,474	9,615	9,664	9,680			
1973	7,808	9,376	9,513	9,562				
1974	6,278	7,614	7,741					
1975	6,446	7,884						
1976	6,115							

Accident Year	Ratio of Closed to Reported Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
1969	0.622	0.860	0.926	0.961	0.982	0.991	0.996	0.998
1970	0.609	0.847	0.917	0.957	0.979	0.992	0.996	
1971	0.595	0.837	0.917	0.959	0.982	0.991		
1972	0.572	0.828	0.910	0.958	0.978			
1973	0.566	0.818	0.910	0.951				
1974	0.555	0.816	0.893					
1975	0.545	0.790						
1976	0.528							

Reported Claim Counts

PART 1 - Data Triangle

Accident Year	Reported Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	6,553	7,696	7,770	7,799	7,814	7,819	7,820	7,821
1970	7,277	8,537	8,615	8,661	8,675	8,679	8,682	
1971	8,259	9,765	9,884	9,926	9,940	9,945		
1972	7,858	9,474	9,615	9,664	9,680			
1973	7,808	9,376	9,513	9,562				
1974	6,278	7,614	7,741					
1975	6,446	7,884						
1976	6,115							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	1.174	1.010	1.004	1.002	1.001	1.000	1.000	
1970	1.173	1.009	1.005	1.002	1.000	1.000		
1971	1.182	1.012	1.004	1.001	1.001			
1972	1.206	1.015	1.005	1.002				
1973	1.201	1.015	1.005					
1974	1.213	1.017						
1975	1.223							

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	1.196	1.013	1.005	1.002	1.001	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108
Selected	1.196	1.013	1.005	1.002	1.001	1.000	1.000	1.000
CDF to Ultimate	1.221	1.021	1.008	1.003	1.001	1.000	1.000	1.000
Percent Reported	81.9%	97.9%	99.2%	99.7%	99.9%	100.0%	100.0%	100.0%

Projection of Ultimate Claim Counts

Accident Year	Age of Accident Year at 12/31/76	Reported Claim Counts at 12/31/76	CDF to Ultimate	Projected Ultimate Claim Counts
(1)	(2)	(3)	(4)	(5)
1969	96	7,821	1.000	7,821
1970	84	8,682	1.000	8,682
1971	72	9,945	1.000	9,945
1972	60	9,680	1.001	9,690
1973	48	9,562	1.003	9,591
1974	36	7,741	1.008	7,803
1975	24	7,884	1.021	8,050
1976	12	6,115	1.221	7,466
Total		67,430		69,047

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) Based on data from Berq-Sher Auto BI Insurer.
(4) Based on CDF from Exhibit II, Sheet 3.
(5) = [(3) x (4)].

Disposal Rate and Development of Adjusted Closed Claim Counts

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	72	84	96	Projected Ultimate Claim Counts
1969	0.522	0.846	0.920	0.958	0.981	0.991	0.996	0.998	7,821
1970	0.510	0.833	0.910	0.955	0.978	0.991	0.996		8,682
1971	0.494	0.822	0.912	0.957	0.981	0.991			9,945
1972	0.464	0.809	0.903	0.955	0.977				9,690
1973	0.461	0.799	0.903	0.948					9,591
1974	0.447	0.796	0.886						7,803
1975	0.437	0.773							8,050
1976	0.433								7,466

Selected Disposal Rate by Maturity Age

	12	24	36	48	60	72	84	96
	0.433	0.773	0.886	0.948	0.977	0.991	0.996	0.998

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96
1969	3,383	6,049	6,932	7,415	7,643	7,750	7,789	7,806
1970	3,756	6,715	7,695	8,231	8,484	8,603	8,647	
1971	4,302	7,692	8,815	9,429	9,719	9,855		
1972	4,192	7,495	8,588	9,187	9,469			
1973	4,149	7,418	8,501	9,093				
1974	3,376	6,035	6,916					
1975	3,482	6,226						
1976	3,230							

Summary of Regression Analyses

	Accident Year 1969			Accident Year 1970			Accident Year 1971		
	Cumulative			Cumulative			Cumulative		
Months of Development	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)	Closed Claim Counts X	Paid Claims Y	Predicted Y Value Y=ae^(bX)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(5)	(6)	(7)
12	4,079	1,904	1,850	4,429	2,235	2,184	4,914	2,441	2,404
24	6,616	5,398	5,885	7,230	6,261	6,715	8,174	7,348	7,722
36	7,192	7,496	7,653	7,899	8,691	8,781	9,068	10,662	10,634
48	7,494	8,882	8,783	8,291	10,443	10,275	9,518	12,655	12,493
60	7,670	9,712	9,518	8,494	11,346	11,147	9,761	13,748	13,628
72	7,749	10,071	9,867	8,606	11,754	11,659	9,855	14,235	14,095
84	7,792	10,199	10,062	8,647	12,031	11,852			
96	7,806	10,256	10,127						
R Squared			0.99573			0.99709			0.99866
a			287.742			369.685			413.901
b			0.000456			0.000401			0.000358

Derivation of Adjusted Paid Claims

Accident Year	Closed Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
1969	4,079	6,616	7,192	7,494	7,670	7,749	7,792	7,806
1970	4,429	7,230	7,899	8,291	8,494	8,606	8,647	
1971	4,914	8,174	9,068	9,518	9,761	9,855		
1972	4,497	7,842	8,747	9,254	9,469			
1973	4,419	7,665	8,659	9,093				
1974	3,486	6,214	6,916					
1975	3,516	6,226						
1976	3,230							

Accident Year	Parameter a for Two-Point Exponential Fit							
	12	24	36	48	60	72	84	96
1969		356	124	132	198	286	1,034	459
1970		438	181	215	353	778	88	
1971		464	244	337	493	370		
1972		510	337	506	421			
1973		616	468	333				
1974		530	220					
1975		580						
1976								

Accident Year	Paid Claims ($000) as of (months)							
	12	24	36	48	60	72	84	96
1969	1,904	5,398	7,496	8,882	9,712	10,071	10,199	10,256
1970	2,235	6,261	8,691	10,443	11,346	11,754	12,031	
1971	2,441	7,348	10,662	12,655	13,748	14,235		
1972	2,503	8,173	11,810	14,176	15,383			
1973	2,838	8,712	12,728	15,278				
1974	2,405	7,858	11,771					
1975	2,759	9,182						
1976	2,801							

Accident Year	Parameter b for Two-Point Exponential Fit							
	12	24	36	48	60	72	84	96
1969		0.000411	0.000570	0.000562	0.000508	0.000459	0.000294	0.000398
1970		0.000368	0.000490	0.000468	0.000409	0.000315	0.000568	
1971		0.000338	0.000416	0.000381	0.000341	0.000370		
1972		0.000354	0.000407	0.000360	0.000380			
1973		0.000346	0.000381	0.000421				
1974		0.000434	0.000576					
1975		0.000444						
1976								

Accident Year	Adjusted Closed Claim Counts as of (months)							
	12	24	36	48	60	72	84	96
1969	3,383	6,049	6,932	7,415	7,643	7,750	7,789	7,806
1970	3,756	6,715	7,695	8,231	8,484	8,603	8,647	
1971	4,302	7,692	8,815	9,429	9,719	9,855		
1972	4,192	7,495	8,588	9,187	9,469			
1973	4,149	7,418	8,501	9,093				
1974	3,376	6,035	6,916					
1975	3,482	6,226						
1976	3,230							

Accident Year	Adjusted Paid Claims ($000) as of (months)							
	12	24	36	48	60	72	84	96
1969	1,431	4,277	6,463	8,497	9,579	10,075	10,191	10,256
1970	1,745	5,181	7,865	10,156	11,301	11,744	12,031	
1971	1,985	6,243	9,594	12,233	13,550	14,235		
1972	2,247	7,228	11,072	13,837	15,383			
1973	2,585	7,999	11,982	15,278				
1974	2,292	7,271	11,771					
1975	2,718	9,182						
1976	2,801							

Adjusted Paid Claims ($000)

PART 1 - Data Triangle

Accident Year	Adjusted Paid Claims as of (months) 12	24	36	48	60	72	84	96
1969	1,431	4,277	6,463	8,497	9,579	10,075	10,191	10,256
1970	1,745	5,181	7,865	10,156	11,301	11,744	12,031	
1971	1,985	6,243	9,594	12,233	13,550	14,235		
1972	2,247	7,228	11,072	13,837	15,383			
1973	2,585	7,999	11,982	15,278				
1974	2,292	7,271	11,771					
1975	2,718	9,182						
1976	2,801							

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	
1970	2.969	1.518	1.291	1.113	1.039	1.024		
1971	3.145	1.537	1.275	1.108	1.051			
1972	3.217	1.532	1.250	1.112				
1973	3.094	1.498	1.275					
1974	3.172	1.619						
1975	3.378							

PART 3 - Average Age-to-Age Factors

Averages	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
Simple Average								
All Years	3.138	1.536	1.281	1.115	1.047	1.018	1.006	
Latest 4	3.215	1.546	1.273	1.115	1.047	1.018	1.006	
Volume-weighted Average								
All Years	3.158	1.538	1.277	1.114	1.047	1.018	1.006	
Latest 4	3.219	1.545	1.271	1.114	1.047	1.018	1.006	

PART 4 - Selected Age-to-Age Factors

Development Factor Selection	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108
Unadj Selected	3.098	1.444	1.196	1.087	1.036	1.019	1.006	1.000
Adj Selected	3.158	1.538	1.277	1.114	1.047	1.018	1.006	1.000
CDF to Ultimate	7.416	2.348	1.527	1.195	1.073	1.025	1.006	1.000
Percent Reported	13.5%	42.6%	65.5%	83.7%	93.2%	97.6%	99.4%	100.0%

Chapter 13 - Berquist-Sherman Techniques
Berq-Sher Auto BI Insurer
Linear Regression of Development Factors Using Adjusted Paid Claims

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	
1970	2.969	1.518	1.291	1.113	1.039	1.024		
1971	3.145	1.537	1.275	1.108	1.051			
1972	3.217	1.532	1.250	1.112				
1973	3.094	1.498	1.275					
1974	3.172	1.619						
1975	3.378							

	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72
Estimated Intercept from Linear Regression Analysis of Age-to-Age Factors and Accident Year	-104.01	-25.08	25.05	11.36	2.21
Estimated Slope from Linear Regression Analysis of Age-to-Age Factors and Accident Year	0.0543	0.0135	-0.0121	-0.0052	-0.0006
Goodness of Fit Test of Linear Regression Analysis (R-Squared)	70.3%	34.4%	63.7%	61.0%	0.7%

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult	CDF to Ultimate
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	1.000	1.000
1970	2.969	1.518	1.291	1.113	1.039	1.024	1.006	1.000	1.006
1971	3.145	1.537	1.275	1.108	1.051	1.018	1.006	1.000	1.024
1972	3.217	1.532	1.250	1.112	1.047	1.018	1.006	1.000	1.073
1973	3.094	1.498	1.275	1.102	1.047	1.018	1.006	1.000	1.182
1974	3.172	1.619	1.245	1.097	1.047	1.018	1.006	1.000	1.465
1975	3.378	1.583	1.233	1.091	1.047	1.018	1.006	1.000	2.285
1976	3.355	1.596	1.221	1.086	1.047	1.018	1.006	1.000	7.621

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	
1970	2.969	1.518	1.291	1.113	1.039	1.024		
1971	3.145	1.537	1.275	1.108	1.051			
1972	3.217	1.532	1.250	1.112				
1973	3.094	1.498	1.275					
1974	3.172	1.619						
1975	3.378							
Estimated Constant from Exponential Regression Analysis of Age-to-Age Factors and Accident Year								
	0	0	135,483,653	10,606	3			
Estimated Growth from Exponential Regression Analysis of Age-to-Age Factors and Accident Year								
	1.0174	1.0086	0.9907	0.9954	0.9994			
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)								
	70.6%	34.0%	63.3%	61.0%	0.7%			

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	To Ult	CDF to Ultimate
1969	2.989	1.511	1.315	1.127	1.052	1.012	1.006	1.000	1.000
1970	2.969	1.518	1.291	1.113	1.039	1.024	1.006	1.000	1.006
1971	3.145	1.537	1.275	1.108	1.051	1.018	1.006	1.000	1.024
1972	3.217	1.532	1.250	1.112	1.047	1.018	1.006	1.000	1.073
1973	3.094	1.498	1.275	1.102	1.047	1.018	1.006	1.000	1.182
1974	3.172	1.619	1.245	1.097	1.047	1.018	1.006	1.000	1.466
1975	3.378	1.582	1.234	1.092	1.047	1.018	1.006	1.000	2.286
1976	3.359	1.596	1.222	1.087	1.047	1.018	1.006	1.000	7.638

Projection of Ultimate Claims Using Development Technique and Adjusted Data ($000)

			CDF to Ultimate				Projected Ultimate Claims Using Dev Method with			
	Age of			Adjusted Paid				Adjusted Paid		
Accident	Accident Year	Paid Claims	Unadjusted	Volume	Regression		Unadjusted	Volume	Regression	
Year	at 12/31/76	at 12/31/76	Paid	Weighted	Linear	Exponential	Paid	Weighted	Linear	Exponential
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1969	96	10,256	1.000	1.000	1.000	1.000	10,256	10,256	10,256	10,256
1970	84	12,031	1.006	1.006	1.006	1.006	12,103	12,103	12,107	12,107
1971	72	14,235	1.024	1.025	1.024	1.024	14,577	14,591	14,583	14,583
1972	60	15,383	1.061	1.073	1.073	1.073	16,321	16,506	16,502	16,502
1973	48	15,278	1.154	1.195	1.182	1.182	17,631	18,257	18,059	18,061
1974	36	11,771	1.379	1.527	1.465	1.466	16,232	17,974	17,241	17,251
1975	24	9,182	1.991	2.348	2.285	2.286	18,281	21,559	20,984	20,993
1976	12	2,801	6.170	7.416	7.621	7.638	17,282	20,772	21,346	21,394
Total		90,937					122,684	132,019	131,079	131,147

Column Notes:
(2) Age of accident year in (1) at December 31, 1976.
(3) Developed in Exhibit II, Sheet 7.
(4) Based on CDF from Exhibit II, Sheet 1.
(5) through (7) Based on CDF from Exhibit II, Sheets 8 through 10, respectively.
(8) = [(3) x (4)].
(9) = [(3) x (5)].
(10) = [(3) x (6)].
(11) = [(3) x (7)].

Development of Unpaid Claim Estimate ($000)

		Projected Ultimate Claims Using Dev Method with				Unpaid Claim Estimate at 12/31/76			
			Adjusted Paid				Adjusted Paid		
Accident	Paid Claims	Unadjusted	Volume	Regression		Unadjusted	Volume	Regression	
Year	at 12/31/76	Paid	Weighted	Linear	Exponential	Paid	Weighted	Linear	Exponential
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1969	10,256	10,256	10,256	10,256	10,256	0	0	0	0
1970	12,031	12,103	12,103	12,107	12,107	72	72	76	76
1971	14,235	14,577	14,591	14,583	14,583	342	356	348	348
1972	15,383	16,321	16,506	16,502	16,502	938	1,123	1,119	1,119
1973	15,278	17,631	18,257	18,059	18,061	2,353	2,979	2,781	2,783
1974	11,771	16,232	17,974	17,241	17,251	4,461	6,203	5,470	5,480
1975	9,182	18,281	21,559	20,984	20,993	9,099	12,377	11,802	11,811
1976	2,801	17,282	20,772	21,346	21,394	14,481	17,971	18,545	18,593
Total	90,937	122,684	132,019	131,079	131,147	31,747	41,082	40,142	40,210

Column Notes:
(2) Based on data from Berq-Sher Auto BI Insurer.
(3) through (6) Developed in Exhibit II, Sheet 11.
(7) = [(3) - (2)].
(8) = [(4) - (2)].
(9) = [(5) - (2)].
(10) = [(6) - (2)].

Exhibit III
Sheet 1

Average Paid Claims - Unadjusted Data

Accident Year	Average Paid Claims as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998				16,708	18,432	20,208	22,143	23,560	24,695	24,825	24,839
1999			14,375	17,059	19,919	22,482	23,347	23,307	23,669	23,771	
2000		10,020	13,025	16,281	19,762	22,332	24,303	25,810	26,235		
2001	5,064	8,740	13,162	17,041	19,908	22,911	25,887	26,639			
2002	11,417	13,067	16,436	20,290	24,073	27,752	29,178				
2003	9,631	10,163	13,478	18,125	22,896	25,077					
2004	9,452	11,673	17,996	23,455	26,028						
2005	10,315	10,920	16,270	20,569							
2006	11,502	13,000	19,000								
2007	10,726	15,000									
2008	12,351										

	12	24	36	48	60	72	84	96	108	120
Annual Change based on Exponential Regression Analysis of Severities and Accident Year	8.1%	5.4%	4.6%	4.3%	5.5%	5.1%	6.8%	4.8%	3.1%	-4.2%
Goodness of Fit Test of Exponential Regression Analysis (R-Squared)	46.4%	54.1%	57.2%	64.2%	85.2%	72.3%	95.1%	83.9%	34.2%	100.0%

Exhibit III
Sheet 2

Derivation of Case Adjusted Reported Claim Development Triangle

Accident Year	Adjusted Average Case Outstanding as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998	12,297	27,075	38,569	49,025	56,951	64,896	99,025	77,898	50,157	35,608	-
1999	12,912	28,429	40,498	51,477	59,799	68,141	103,977	58,961	59,918	96,618	
2000	13,557	29,850	42,523	54,050	62,789	71,548	109,176	94,306	77,421		
2001	14,235	31,343	44,649	56,753	65,928	75,125	114,634	30,907			
2002	14,947	32,910	46,881	59,591	69,225	78,882	120,366				
2003	15,694	34,555	49,225	62,570	72,686	82,826					
2004	16,479	36,283	51,687	65,699	76,320						
2005	17,303	38,097	54,271	68,983							
2006	18,168	40,002	56,985								
2007	19,076	42,002									
2008	20,030										

Selected Annual Severity Trend Rate 5%

Accident Year	Case Adjusted Reported Claims ($000) as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998				14,600	15,094	15,513	17,104	16,366	16,163	15,835	15,822
1999			23,630	25,296	26,319	26,802	28,294	24,795	25,071	25,107	
2000		27,527	31,913	34,908	36,211	37,153	37,698	37,505	37,246		
2001	15,789	29,146	35,224	39,380	39,748	38,452	39,706	38,798			
2002	19,342	37,781	46,968	49,984	47,313	47,570	48,169				
2003	20,451	40,865	46,599	45,605	43,373	44,373					
2004	30,186	57,792	66,886	69,522	70,288						
2005	33,704	56,945	65,226	70,655							
2006	24,715	41,339	48,804								
2007	19,992	31,732									
2008	18,632										

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 3
Case Adjusted Reported Claims ($000)

PART 1 - Data Triangle

Accident Year	Case Adjusted Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998				14,600	15,094	15,513	17,104	16,366	16,163	15,835	15,822
1999			23,630	25,296	26,319	26,802	28,294	24,795	25,071	25,107	
2000		27,527	31,913	34,908	36,211	37,153	37,698	37,505	37,246		
2001	15,789	29,146	35,224	39,380	39,748	38,452	39,706	38,798			
2002	19,342	37,781	46,968	49,984	47,313	47,570	48,169				
2003	20,451	40,865	46,599	45,605	43,373	44,373					
2004	30,186	57,792	66,886	69,522	70,288						
2005	33,704	56,945	65,226	70,655							
2006	24,715	41,339	48,804								
2007	19,992	31,732									
2008	18,632										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.034	1.028	1.103	0.957	0.988	0.980	0.999	
1999			1.070	1.040	1.018	1.056	0.876	1.011	1.001		
2000		1.159	1.094	1.037	1.026	1.015	0.995	0.993			
2001	1.846	1.209	1.118	1.009	0.967	1.033	0.977				
2002	1.953	1.243	1.064	0.947	1.005	1.013					
2003	1.998	1.140	0.979	0.951	1.023						
2004	1.915	1.157	1.039	1.011							
2005	1.690	1.145	1.083								
2006	1.673	1.181									
2007	1.587										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.772	1.173	1.057	0.991	1.008	1.044	0.951	0.997	0.991	0.999	
Latest 3	1.650	1.161	1.034	0.970	0.999	1.020	0.949	0.997	0.991	0.999	
Medial Average											
Latest 5x1	1.759	1.161	1.062	0.990	1.016	1.034	0.967	0.993	0.991	0.999	
Volume-weighted Average											
Latest 5	1.772	1.169	1.055	0.990	1.007	1.033	0.957	0.998	0.993	0.999	
Latest 3	1.658	1.159	1.040	0.975	1.000	1.019	0.956	0.998	0.993	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Unadj Selected	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	1.000
Case Adj Selected	1.658	1.159	1.040	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.998	1.205	1.040	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Percent Reported	50.1%	83.0%	96.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chapter 13 - Berquist-Sherman Techniques
XYZ Insurer - Auto BI
Disposal Rate and Development of Adjusted Closed Claim Counts

Exhibit III
Sheet 4

Accident Year	Disposal Rate as of (months) 12	24	36	48	60	72	84	96	108	120	132	Proj. Ultimate Reported Claim Counts
1998				0.801	0.859	0.903	0.939	0.961	0.973	0.997	1.000	637
1999			0.655	0.782	0.869	0.936	0.962	0.989	0.992	0.997		1,047
2000		0.462	0.662	0.778	0.864	0.918	0.971	0.988	0.996			1,408
2001	0.209	0.468	0.643	0.751	0.842	0.933	0.984	0.994				1,455
2002	0.131	0.391	0.541	0.701	0.854	0.942	0.980					1,554
2003	0.111	0.377	0.577	0.775	0.924	0.962						1,631
2004	0.104	0.375	0.637	0.819	0.897							2,263
2005	0.123	0.466	0.693	0.810								2,402
2006	0.183	0.540	0.716									1,679
2007	0.251	0.605										1,308
2008	0.236											1,172
Selected Disposal Rate by Maturity Age												
	0.236	0.605	0.716	0.810	0.897	0.962	0.980	0.994	0.996	0.997	1.000	

Accident Year	Adjusted Closed Claim Counts as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	150	385	456	516	571	613	624	633	634	635	637
1999	247	633	749	848	939	1,007	1,026	1,041	1,043	1,044	
2000	332	851	1,007	1,141	1,263	1,354	1,380	1,399	1,402		
2001	343	880	1,041	1,179	1,305	1,399	1,426	1,446			
2002	366	940	1,112	1,259	1,394	1,494	1,523				
2003	384	986	1,167	1,321	1,462	1,568					
2004	533	1,368	1,619	1,833	2,029						
2005	566	1,452	1,719	1,946							
2006	395	1,015	1,201								
2007	308	791									
2008	276										

Summary of Regression Analyses

	Accident Year 1998			Accident Year 1999			Accident Year 2000		
	Cumulative			Cumulative			Cumulative		
	Closed	Paid	Predicted	Closed	Paid	Predicted	Closed	Paid	Predicted
Months of	Claim Counts	Claims	Y Value	Claim Counts	Claims	Y Value	Claim Counts	Claims	Y Value
Development	X	Y	Y=ae^(bX)	X	Y	Y=ae^(bX)	X	Y	Y=ae^(bX)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(5)	(6)	(7)
12									
24							650	6,513	6,437
36				686	9,861	9,952	932	12,139	12,357
48	510	8,521	8,458	819	13,971	14,066	1,095	17,828	18,013
60	547	10,082	10,208	910	18,127	17,823	1,216	24,030	23,829
72	575	11,620	11,770	980	22,032	21,383	1,292	28,853	28,407
84	598	13,242	13,230	1,007	23,511	22,939	1,367	33,222	33,786
96	612	14,419	14,206	1,036	24,146	24,737	1,391	35,902	35,714
108	620	15,311	14,796	1,039	24,592	24,930	1,402	36,782	36,635
120	635	15,764	15,968	1,044	24,817	25,257			
132	637	15,822	16,131						
R Squared			0.99373			0.99620			0.99954
a			632.591			1,670.748			1,432.021
b			0.005084			0.002601			0.002312

Chapter 13 - Berquist-Sherman Techniques
XYZ Insurer - Auto BI
Derivation of Adjusted Paid Claims

Exhibit III
Sheet 6

Accident Year	Closed Claim Counts as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998				510	547	575	598	612	620	635	637
1999			686	819	910	980	1,007	1,036	1,039	1,044	
2000		650	932	1,095	1,216	1,292	1,367	1,391	1,402		
2001	304	681	936	1,092	1,225	1,357	1,432	1,446			
2002	203	607	841	1,089	1,327	1,464	1,523				
2003	181	614	941	1,263	1,507	1,568					
2004	235	848	1,442	1,852	2,029						
2005	295	1,119	1,664	1,946							
2006	307	906	1,201								
2007	329	791									
2008	276										

Accident Year	Parameter a for Two-Point Exponential Fit										
	12	24	36	48	60	72	84	96	108	120	132
1998					838	631	443	349	146	4,582	4,898
1999				1,635	1,341	1,434	2,086	9,315	43	3,708	
2000			1,550	1,349	1,196	1,288	2,543	400	1,682		
2001		517	853	1,037	2,021	2,561	1,289	733			
2002		1,249	1,878	2,817	4,090	3,111	4,397				
2003		1,023	1,647	2,258	2,737	1,368					
2004		1,253	2,500	4,239	5,626						
2005		1,850	2,386	2,695							
2006		1,904	1,545								
2007		1,488									
2008											

Accident Year	Paid Claims ($000) as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998			6,309	8,521	10,082	11,620	13,242	14,419	15,311	15,764	15,822
1999		4,666	9,861	13,971	18,127	22,032	23,511	24,146	24,592	24,817	
2000	1,302	6,513	12,139	17,828	24,030	28,853	33,222	35,902	36,782		
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519			
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437				
2003	1,743	6,240	12,683	22,892	34,505	39,320					
2004	2,221	9,898	25,950	43,439	52,811						
2005	3,043	12,219	27,073	40,026							
2006	3,531	11,778	22,819								
2007	3,529	11,865									
2008	3,409										

Accident Year	Parameter b for Two-Point Exponential Fit										
	12	24	36	48	60	72	84	96	108	120	132
1998					0.004548	0.005068	0.005682	0.006082	0.007504	0.001946	0.001841
1999				0.002619	0.002861	0.002788	0.002405	0.000919	0.006102	0.001821	
2000			0.002208	0.002358	0.002467	0.002407	0.001880	0.003233	0.002200		
2001		0.003587	0.002853	0.002644	0.002033	0.001840	0.002346	0.002740			
2002		0.003045	0.002374	0.001891	0.001549	0.001755	0.001519				
2003		0.002945	0.002169	0.001834	0.001682	0.002142					
2004		0.002438	0.001623	0.001257	0.001104						
2005		0.001687	0.001460	0.001387							
2006		0.002011	0.002242								
2007		0.002625									
2008											

Accident Year	Adjusted Closed Claim Counts as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998	150	385	456	516	571	613	624	633	634	635	637
1999	247	633	749	848	939	1,007	1,026	1,041	1,043	1,044	
2000	332	851	1,007	1,141	1,263	1,354	1,380	1,399	1,402		
2001	343	880	1,041	1,179	1,305	1,399	1,426	1,446			
2002	366	940	1,112	1,259	1,394	1,494	1,523				
2003	384	986	1,167	1,321	1,462	1,568					
2004	533	1,368	1,619	1,833	2,029						
2005	566	1,452	1,719	1,946							
2006	395	1,015	1,201								
2007	308	791									
2008	276										

Accident Year	Adjusted Paid Claims ($000) as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998	1,658	4,830	6,659	8,760	11,401	14,476	15,439	15,705	15,742	15,769	15,822
1999	3,120	8,584	11,634	15,191	19,649	23,499	23,928	24,660	24,751	24,817	
2000	3,225	10,158	14,502	19,957	26,887	32,415	34,638	36,563	36,782		
2001	1,769	10,493	16,264	22,201	28,245	34,318	36,550	38,519			
2002	3,808	16,656	22,893	28,752	35,907	42,543	44,437				
2003	3,171	13,772	19,187	25,242	32,008	39,320					
2004	4,592	23,014	32,407	42,416	52,811						
2005	4,805	19,876	29,202	40,026							
2006	4,218	15,035	22,819								
2007	3,341	11,865									
2008	3,409										

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 7
Adjusted Paid Claims ($000)

PART 1 - Data Triangle

Accident Year	Adjusted Paid Claims as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998	1,658	4,830	6,659	8,760	11,401	14,476	15,439	15,705	15,742	15,769	15,822
1999	3,120	8,584	11,634	15,191	19,649	23,499	23,928	24,660	24,751	24,817	
2000	3,225	10,158	14,502	19,957	26,887	32,415	34,638	36,563	36,782		
2001	1,769	10,493	16,264	22,201	28,245	34,318	36,550	38,519			
2002	3,808	16,656	22,893	28,752	35,907	42,543	44,437				
2003	3,171	13,772	19,187	25,242	32,008	39,320					
2004	4,592	23,014	32,407	42,416	52,811						
2005	4,805	19,876	29,202	40,026							
2006	4,218	15,035	22,819								
2007	3,341	11,865									
2008	3,409										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998			1.316	1.302	1.270	1.066	1.017	1.002	1.002	1.003	
1999		1.355	1.306	1.294	1.196	1.018	1.031	1.004	1.003		
2000	3.150	1.428	1.376	1.347	1.206	1.069	1.056	1.006			
2001	5.932	1.550	1.365	1.272	1.215	1.065	1.054				
2002	4.374	1.374	1.256	1.249	1.185	1.045					
2003	4.344	1.393	1.316	1.268	1.228						
2004	5.012	1.408	1.309	1.245							
2005	4.136	1.469	1.371								
2006	3.565	1.518									
2007	3.551										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	4.122	1.433	1.323	1.276	1.206	1.053	1.039	1.004	1.002	1.003	
Latest 3	3.751	1.465	1.332	1.254	1.209	1.059	1.047	1.004	1.002	1.003	
Medial Average											
Latest 5x1	4.015	1.424	1.330	1.263	1.206	1.059	1.042	1.004	1.002	1.003	
Volume-weighted Average											
Latest 5	4.152	1.432	1.322	1.269	1.206	1.053	1.044	1.005	1.002	1.003	
Latest 3	3.783	1.458	1.333	1.252	1.208	1.058	1.049	1.005	1.002	1.003	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Unadj Selected	3.349	2.079	1.574	1.316	1.203	1.136	1.059	1.022	1.017	1.004	1.010
Adj Selected	4.152	1.432	1.322	1.269	1.206	1.053	1.044	1.005	1.002	1.003	1.010
CDF to Ultimate	13.490	3.249	2.269	1.716	1.352	1.121	1.065	1.020	1.015	1.013	1.010
Percent Reported	7.4%	30.8%	44.1%	58.3%	74.0%	89.2%	93.9%	98.0%	98.5%	98.7%	99.0%

Derivation of Both Adjusted Reported Claims

Accident Year	Adjusted Open Claim Counts as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998				118	64	22	13	4	3	2	-
1999			277	191	108	43	27	6	4	3	
2000		503	390	270	147	54	28	9	6		
2001	962	541	408	279	153	56	29	9			
2002	976	574	436	298	155	58	31				
2003	989	630	463	305	167	61					
2004	1,399	800	615	416	229						
2005	1,501	841	648	444							
2006	1,078	630	456								
2007	884	473									
2008	760										

Accident Year	Both Adjusted Reported Claims ($000) as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998				14,541	15,031	15,934	16,697	16,012	15,878	15,834	15,822
1999			22,847	25,010	26,111	26,443	26,723	25,042	25,018	25,107	
2000		25,164	31,068	34,566	36,137	36,285	37,705	37,385	37,246		
2001	15,467	27,457	34,478	38,046	38,343	38,516	39,877	38,798			
2002	18,395	35,560	43,338	46,509	46,664	47,093	48,169				
2003	18,691	35,545	41,992	44,319	44,123	44,373					
2004	27,647	52,041	64,203	69,745	70,288						
2005	30,780	51,904	64,391	70,655							
2006	23,796	40,240	48,804								
2007	20,202	31,732									
2008	18,632										

Chapter 13 - Berquist-Sherman Techniques Exhibit III
XYZ Insurer - Auto BI Sheet 9
Both Adjusted Reported Claims ($000)

PART 1 - Data Triangle

Accident Year	Both Adjusted Reported Claims as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998				14,541	15,031	15,934	16,697	16,012	15,878	15,834	15,822
1999			22,847	25,010	26,111	26,443	26,723	25,042	25,018	25,107	
2000		25,164	31,068	34,566	36,137	36,285	37,705	37,385	37,246		
2001	15,467	27,457	34,478	38,046	38,343	38,516	39,877	38,798			
2002	18,395	35,560	43,338	46,509	46,664	47,093	48,169				
2003	18,691	35,545	41,992	44,319	44,123	44,373					
2004	27,647	52,041	64,203	69,745	70,288						
2005	30,780	51,904	64,391	70,655							
2006	23,796	40,240	48,804								
2007	20,202	31,732									
2008	18,632										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998				1.034	1.060	1.048	0.959	0.992	0.996	0.999	
1999			1.095	1.044	1.013	1.011	0.937	0.999	1.004		
2000		1.235	1.113	1.045	1.004	1.039	0.992	0.996			
2001	1.775	1.256	1.103	1.008	1.005	1.035	0.973				
2002	1.933	1.219	1.073	1.003	1.009	1.023					
2003	1.902	1.181	1.055	0.996	1.006						
2004	1.882	1.234	1.086	1.008							
2005	1.686	1.241	1.097								
2006	1.691	1.213									
2007	1.571										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.746	1.217	1.083	1.012	1.007	1.031	0.965	0.996	1.000	0.999	
Latest 3	1.649	1.229	1.080	1.002	1.006	1.032	0.967	0.996	1.000	0.999	
Medial Average											
Latest 5x1	1.753	1.222	1.086	1.006	1.006	1.032	0.966	0.996	1.000	0.999	
Volume-weighted Average											
Latest 5	1.746	1.220	1.084	1.010	1.007	1.030	0.969	0.996	1.001	0.999	
Latest 3	1.657	1.230	1.083	1.003	1.007	1.032	0.970	0.996	1.001	0.999	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Unadj Selected	1.687	1.265	1.102	1.020	1.050	1.010	1.011	1.000	0.993	0.999	1.000
Case Adj Selected	1.658	1.159	1.040	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Both Adj Selected	1.657	1.230	1.083	1.003	1.007	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	2.229	1.345	1.094	1.010	1.007	1.000	1.000	1.000	1.000	1.000	1.000
Percent Reported	44.9%	74.3%	91.4%	99.0%	99.3%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Projection of Ultimate Claims Using Development Technique and Adjusted Data ($000)

				CDF to Ultimate			Projected Ultimate Claims Using Dev. Method with		
Accident	Age of Accident Year	Claims at 12/31/08		Adjusted Reported		Adjusted	Adjusted Reported		Adjusted
Year	at 12/31/08	Reported	Paid	Case	Both	Paid	Case	Both	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	132	15,822	15,822	1.000	1.000	1.010	15,822	15,822	15,980
1999	120	25,107	24,817	1.000	1.000	1.013	25,107	25,107	25,140
2000	108	37,246	36,782	1.000	1.000	1.015	37,246	37,246	37,334
2001	96	38,798	38,519	1.000	1.000	1.020	38,798	38,798	39,290
2002	84	48,169	44,437	1.000	1.000	1.065	48,169	48,169	47,326
2003	72	44,373	39,320	1.000	1.000	1.121	44,373	44,373	44,078
2004	60	70,288	52,811	1.000	1.007	1.352	70,288	70,780	71,401
2005	48	70,655	40,026	1.000	1.010	1.716	70,655	71,362	68,685
2006	36	48,804	22,819	1.040	1.094	2.269	50,756	53,392	51,776
2007	24	31,732	11,865	1.205	1.345	3.249	38,237	42,680	38,549
2008	12	18,632	3,409	1.998	2.229	13.490	37,227	41,531	45,987
Total		449,626	330,629				476,678	489,258	485,546

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from XYZ Insurer.
(5) through (7) Based on CDF from Exhibit III, Sheets 3, 9 and 7, respectively.
(8) = [(3) x (5)].
(9) = [(3) x (6)].
(10) = [(4) x (7)].

Development of Unpaid Claim Estimate ($000)

			Projected Ultimate Claims Using Dev. Method with				Unpaid Claim Estimate at 12/31/08					
						Case	IBNR - Based on Dev. Method with			Total - Based on Dev. Method with		
Accident	Claims at 12/31/08		Adjusted Reported		Adjusted	Outstanding	Adjusted Reported		Adjusted	Adjusted Reported		Adjusted
Year	Reported	Paid	Case	Both	Paid	at 12/31/08	Case	Both	Paid	Case	Both	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1998	15,822	15,822	15,822	15,822	15,980	0	0	0	158	0	0	158
1999	25,107	24,817	25,107	25,107	25,140	290	0	0	33	290	290	323
2000	37,246	36,782	37,246	37,246	37,334	465	0	0	87	465	465	552
2001	38,798	38,519	38,798	38,798	39,290	278	0	0	492	278	278	770
2002	48,169	44,437	48,169	48,169	47,326	3,731	0	0	- 843	3,731	3,731	2,888
2003	44,373	39,320	44,373	44,373	44,078	5,052	0	0	- 295	5,052	5,052	4,758
2004	70,288	52,811	70,288	70,780	71,401	17,477	0	492	1,112	17,477	17,969	18,589
2005	70,655	40,026	70,655	71,362	68,685	30,629	0	707	- 1,970	30,629	31,335	28,659
2006	48,804	22,819	50,756	53,392	51,776	25,985	1,952	4,588	2,972	27,937	30,573	28,957
2007	31,732	11,865	38,237	42,680	38,549	19,867	6,505	10,948	6,817	26,372	30,815	26,684
2008	18,632	3,409	37,227	41,531	45,987	15,223	18,595	22,899	27,355	33,818	38,122	42,578
Total	449,626	330,629	476,678	489,258	485,546	118,997	27,052	39,632	35,920	146,049	158,630	154,918

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) through (6) Developed in Exhibit III, Sheet 10.
(7) = [(2) - (3)].
(8) = [(4) - (2)].
(9) = [(5) - (2)].
(10) = [(6) - (2)].
(11) = [(7) + (8)].
(12) = [(7) + (9)].
(13) = [(7) + (10)].

			Projected Ultimate Claims												
Accident	Claims at 12/31/08		Development Method		Expected	B-F Method		Cape	Frequency-Severity			Case O/S	B-S Adjusted Reported		B-S Adj
Year	Reported	Paid	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3	Dev.	Case	Both	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1998	15,822	15,822	15,822	15,980	15,660	15,822	15,977	15,822	15,822			15,822	15,822	15,822	15,980
1999	25,107	24,817	25,082	25,164	24,665	25,107	25,158	25,107	25,082			25,054	25,107	25,107	25,140
2000	37,246	36,782	36,948	37,922	35,235	37,246	37,841	37,246	37,083			36,912	37,246	37,246	37,334
2001	38,798	38,519	38,487	40,600	39,150	38,798	40,525	38,798	38,778		39,192	38,803	38,798	38,798	39,290
2002	48,169	44,437	48,313	49,592	47,906	48,312	49,417	48,313	48,655		46,869	48,796	48,169	48,169	47,326
2003	44,373	39,320	44,950	49,858	54,164	45,068	50,768	45,062	46,107		44,479	45,093	44,373	44,373	44,078
2004	70,288	52,811	74,787	80,537	86,509	75,492	82,593	74,754	76,620		71,906	74,873	70,288	70,780	71,401
2005	70,655	40,026	76,661	80,333	108,172	79,129	94,301	77,931	80,745		71,684	77,723	70,655	71,362	68,685
2006	48,804	22,819	58,370	72,108	70,786	60,404	71,205	58,759	64,505		49,913	58,665	50,756	53,392	51,776
2007	31,732	11,865	47,979	77,941	39,835	45,221	45,636	43,307	58,516	30,512	31,805	46,198	38,237	42,680	38,549
2008	18,632	3,409	47,530	74,995	39,433	42,607	41,049	39,201	59,242	30,140	29,828	46,005	37,227	41,531	45,987
Total	449,626	330,629	514,929	605,030	561,516	513,207	554,471	504,300	551,155			513,944	476,678	489,258	485,546

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 7, Exhibit II, Sheet 3.
(6) Developed in Chapter 8, Exhibit III, Sheet 1.
(7) and (8) Developed in Chapter 9, Exhibit II, Sheet 1.
(9) Developed in Chapter 10, Exhibit II, Sheet 2.
(10) Developed in Chapter 11, Exhibit II, Sheet 6.
(11) Developed in Chapter 11, Exhibit IV, Sheet 3.
(12) Developed in Chapter 11, Exhibit VI, Sheet 7.
(13) Developed in Chapter 12, Exhibit II, Sheet 4.
(14)-(16) Developed in Exhibit III, Sheet 10.

Chapter 13 - Berquist-Sherman Techniques
XYZ Insurer - Auto BI
Summary of IBNR ($000)

	Case	Estimated IBNR												
Accident	Outstanding	Development Method		Expected	B-F Method		Cape	Frequency-Severity			Case O/S	B-S Adjusted Reported		B-S Adj
Year	at 12/31/08	Reported	Paid	Claims	Reported	Paid	Cod	Method 1	Method 2	Method 3	Dev.	Case	Both	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1998	0	0	158	- 162	0	155	0	0			0	0	0	158
1999	290	- 25	58	- 442	0	51	0	- 25			- 53	0	0	33
2000	465	- 298	676	- 2,011	0	595	0	- 163			- 334	0	0	87
2001	278	- 310	1,802	352	0	1,728	0	- 19		394	6	0	0	492
2002	3,731	145	1,423	- 262	143	1,248	144	486		- 1,300	627	0	0	- 843
2003	5,052	577	5,485	9,791	695	6,396	690	1,734		106	720	0	0	- 295
2004	17,477	4,498	10,249	16,221	5,204	12,305	4,466	6,331		1,618	4,585	0	492	1,112
2005	30,629	6,006	9,678	37,517	8,474	23,646	7,276	10,090		1,029	7,068	0	707	- 1,970
2006	25,985	9,566	23,304	21,982	11,600	22,401	9,955	15,701		1,109	9,861	1,952	4,588	2,972
2007	19,867	16,247	46,209	8,103	13,489	13,904	11,575	26,784	- 1,220	73	14,466	6,505	10,948	6,817
2008	15,223	28,898	56,363	20,801	23,975	22,417	20,569	40,610	11,508	11,196	27,373	18,595	22,899	27,355
Total	118,997	65,303	155,405	111,890	63,581	104,845	54,674	101,529			64,318	27,052	39,632	35,920

Column Notes:
(2) Based on data from XYZ Insurer.
(3) and (4) Estimated in Chapter 7, Exhibit II, Sheet 4.
(5) Estimated in Chapter 8, Exhibit III, Sheet 3.
(6) and (7) Estimated in Chapter 9, Exhibit II, Sheet 2.
(8) Estimated in Chapter 10, Exhibit II, Sheet 3.
(9) Estimated in Chapter 11, Exhibit II, Sheet 7.
(10) Estimated in Chapter 11, Exhibit IV, Sheet 3.
(11) Estimated in Chapter 11, Exhibit VI, Sheet 8.
(12) Estimated in Chapter 12, Exhibit II, Sheet 5.
(13)-(15) Estimated in Exhibit III, Sheet 11.

CHAPTER 14 – RECOVERIES: SALVAGE AND SUBROGATION AND REINSURANCE

Salvage and subrogation (S&S) are two of the most common types of recoveries for insurers. When an insurer pays an insured for a claim considered to be a total loss, the insurer acquires the rights to the damaged property. Salvage represents any amount that the insurer is able to collect from the sale of such damaged property. Subrogation refers to an insurer's right to recover the amount of claim payment to a covered insured from a third-party responsible for the injury or damage.

In Chapter 3 – Information Gathering, we discuss the importance of the actuary understanding the insurer's practices with respect to S&S. The actuary needs to know whether paid claims are recorded net or gross of these recoveries.

Salvage, Subrogation, and Collateral Sources

Some insurers maintain detailed information regarding case outstanding estimates and payments for the different types of recoveries (e.g., salvage, subrogation, deductibles, and collateral sources). Other insurers may combine claims data for all types of recoveries; many insurers record only payments and do not estimate case outstanding for recoveries. Finally, some insurers treat recoveries as a negative claim payment and do not maintain separate data for recoveries. In order for the actuary to determine how to quantify the potential effect of S&S, he or she must understand how the insurer processes such recoveries and what data is available for analysis.

When S&S data is available, actuaries frequently use the development technique to quantify the effect of S&S recoveries on estimates of total unpaid claims. The salvage portion of such recoveries is most commonly associated with property coverages and tends to be fast reporting and fast settling. Recoveries due to subrogation, typically associated with liability types of coverage, can take years to realize, well after the underlying claims are paid, resulting in age-to-age factors less than one for older maturities for some lines of business.

Estimating S&S Recoveries – Auto Physical Damage Insurer

We use an example of an insurer writing automobile physical damage insurance (Auto Physical Damage Insurer) to demonstrate two methods commonly used to quantify S&S recoveries. This particular insurer maintains, separately, payment activity and case outstanding estimates for S&S. In Exhibit I, Sheets 1 and 2, we use the development technique on reported and received S&S. (Some insurers use the term paid S&S instead of received S&S. It is important to recognize that paid S&S represents a payment made by a third-party to the insurer.) Since automobile physical damage is typically a quick reporting line of business, it is not surprising that the S&S associated with this coverage is also exhibiting a quick reporting pattern.

The reported salvage and subrogation development factors in Exhibit I, Sheet 1, are very stable and indicate an age-to-age factor of approximately 1.068 at 12-to-24 months and slightly less than 1.00 at 24-to-36 months. The development factors are also fairly stable for received S&S (Exhibit I, Sheet 2). We select factors based on the latest five-year volume-weighted average factors. In Exhibit I, Sheet 3, we project ultimate S&S based on the development technique described in previous chapters of this book. The format of Exhibit I, Sheet 3 is identical to the development projection exhibits of many other chapters.

Many actuaries also use a ratio approach when analyzing S&S. The first step in such an approach is to estimate the ultimate claims gross of S&S. In Exhibit I, Sheets 4 through 6, we project ultimate claims for Auto Physical Damage Insurer based on reported and paid claims. We rely on the five-year volume-weighted averages and select ultimate claims based on the average of the reported and paid claims projections (Exhibit I, Sheet 6). It is not surprising that the projections are very similar for this fast reporting and settling line of insurance. In Exhibit I, Sheet 7, we use the development technique to analyze the ratio of received S&S to paid claims.[79]

One advantage of the ratio approach is that the development factors tend not to be as highly leveraged as the development factors based on received S&S dollars. Another advantage is related to the selection of the ultimate S&S ratio(s) for the most recent year(s) in the experience period. In Exhibit I, Sheet 8, we use the development technique to project an initial estimate of the S&S ratio to claim amount of 0.315 for accident year 2008. However, based on comparison to the immediate preceding years, 0.315 seems low. This may be due to a change in procedures for recording S&S or an unusually large claim. The average of the ultimate S&S ratios for the last five years excluding 2008 is 0.347 and for the last three years excluding 2008 is 0.344. Thus, we select an ultimate S&S ratio for 2008 of 0.345. We determine ultimate S&S based on the multiplication of selected ultimate claims (from Exhibit I, Sheet 6) and the selected ultimate S&S ratio (from Column (6)).

The results of all three projections are summarized in Exhibit I, Sheet 9. In this exhibit, we also present the estimated S&S recoverable, which are equal to projected ultimate S&S less received S&S. The estimated S&S recoverable represent a reduction to total estimate of unpaid claims for the insurer.

Reinsurance and Aggregate Limits

All of the different types of techniques for estimating unpaid claims presented in Chapters 7 through 13 can be applied to gross, ceded, or net of reinsurance claims experience. When required to estimate unpaid claims on a net of reinsurance basis, actuaries vary in their approach. Some actuaries analyze gross (i.e., direct and assumed) and ceded experience separately; others analyze gross and net experience separately. The choice of a gross versus net versus ceded analysis may depend on data availability, characteristics of the gross versus ceded program, and also personal preferences of the actuary. Some insurers code ceded claims in the same information system as the gross data; thus, the net data is readily available. For such insurers, the actuary is more likely to conduct both gross and net analyses. On the other hand, some insurers code the ceded claims data to a different system; thus matching the gross and ceded data to derive net claim triangles may be more difficult. For these insurers, the actuary will likely prepare separate gross and ceded analyses. Furthermore, the choice of gross versus net versus ceded analysis may be a function of data volume and quality.

[79] To present a complete example for the reader of this text, we use the development method with paid and reported claims to project ultimate claims for Auto Physical Damage. However, we could use many other projection methods to derive ultimate claims. The ratio method for determining ultimate S&S is independent of any specific methodology for estimating ultimate claims.

It is particularly important for a net (of reinsurance) or ceded analysis that the actuary be aware of the implied relationships between gross, ceded, and net claims. This is critical at all stages of the analysis:

- At the beginning of the analysis when the actuary is reviewing and reconciling the data
- During the analysis especially when the actuary uses judgment in the process of developing an unpaid claim estimate
- At the end of the analysis when the actuary evaluates the various projection methods and selects ultimate claims and unpaid claim estimates

One of the first checks that an actuary can conduct with the data provided for the analysis of unpaid claims is that net claim and net premium data are equal to or less than the gross data. Reinsurance arrangements are typically categorized as quota share or excess of loss. If the reinsurance program consists of quota share arrangements, the actuary can create a development triangle with the ratio of net-to-gross claims and thus test the quota share percentage(s) by year. The actuary will want to confirm that the ratios in such a triangle are consistent with information available for the insurer and consistent with relationships between net and gross premium. In Exhibit II, Sheet 1, we present three triangles for an insurer who has maintained a quota share reinsurance program for the past four years. For 2005, the insurer had a 70% quota share arrangement; the insurer increased the percentage to 85% in 2007 and to 90% in 2008. We present the gross reported claims, the net reported claims, and the ratio of net to gross reported claims.

If the reinsurance program consists of excess of loss arrangements, the actuary may want to examine large claims to confirm that retentions and limits for ceded claims by year are consistent with the corresponding excess of loss reinsurance contracts or with information provided. Such verification of the treatment of large claims is an important part of ensuring that the ceded and/or net claim triangles are correct. In Exhibit II, Sheet 2, we present three triangles for an insurer who maintains $1 million excess of loss reinsurance. In accident year 2005, the insurer sustained two large claims in excess of $1 million, and in accident year 2007, one large claim in excess of $1 million. We present the gross, net, and ceded reported claim triangles in Exhibit II, Sheet 2.

During the analysis, the actuary should ensure that key assumptions, particularly those involving actuarial judgment, are consistent between the gross and net or gross and ceded analyses. For example, it is generally not reasonable for the tail factor to be larger for net claims than for gross claims. Since net claims are often capped due to excess or aggregate coverage, we frequently observe net claim development patterns that are less than or equal to gross claim development patterns.[80]

Actuaries differ in their practice with respect to the order in which they choose gross or net claim development factors. Some actuaries first select gross claim development factors since these triangles contain a greater volume of claims experience, and thus may be considered to have greater credibility. The gross claim development factors may then be used as input for the selection of ceded or net claim development factors. On the other hand, it may be that gross

[80] This relationship does not hold in some circumstances, such as for an insurance company fronting for a captive insurer (where the captive assumes the working layer and the fronting company retains the excess layer). There are also situations in which the effect of limiting large claims due to excess coverage may result in net factors that are greater than gross factors.

claims are subject to more random variation due to large claims, and thus the actuary first selects claim development factors for the net claims. In such situations, the actuary may then use the selected net claim development factors as input for the selection of gross claim development factors. The important point to remember is that there should generally be a reasonable relationship between the selected development factors for net and gross claims. It should be recognized, however, that this is not always the case.

Similarly, the actuary must consider the reasonableness of trend assumptions between the net and gross or ceded and gross analyses as well as expected claim ratios, frequency, and severity assumptions. At the final stages of the analysis, when the actuary is selecting ultimate claims, the actuary must review the implied relationship between the net and gross claims and resulting estimates of unpaid claims to ensure that the ceded claims are reasonable, or alternatively the relationship between gross and ceded ultimate claims to ensure that net ultimate claims and unpaid claim estimates are appropriate. A critical point is that net IBNR in each accident year is generally not greater than gross IBNR.[81]

Many insurers also use aggregate or stop-loss coverage to protect their financial results across multiple lines of coverage. This coverage can apply on an accident year, policy year, or calendar year basis. In addition to fully understanding how the coverage operates, it is important that the actuary understands how the insurer treats prior recoveries from aggregate coverage in the source data used in the actuarial analysis of unpaid claims. The actuary will need to determine whether or not he or she should take stop-loss or aggregate programs into account within the claim development triangles or at a later stage of the analysis. The specific circumstances of the stop-loss program could influence the actuary's decision. Typically, the actuary would want data prior to the application of stop-loss or aggregate coverage since the actuary will often adjust for such coverage as a final step in the development of the unpaid claim estimate.

In Exhibit II, Sheet 3, we present a simple example with one approach for adjusting for the effect of excess of loss and stop-loss reinsurance. In this example, we assume that Self-Insurance Pool is an association of self-insured municipalities that has maintained a $500,000 per occurrence excess of loss coverage since the inception of the pool. The stop-loss coverage, however, has varied over time depending on the availability and price of such coverage. For the first three years of Self-Insurance Pool, there was a $4 million combined stop-loss (i.e., the stop-loss limit of $4 million applied to the sum of ultimate claims for policy years 2002-03 through 2004-05). The stop-loss limit was $1.5 million for policy years 2005-06 and 2006-07. There was no stop-loss coverage purchased for 2007-08. For Self-Insurance Pool, the actuary first estimates ultimate claims using reported and paid claims limited to the per occurrence retention (i.e., $500,000 per occurrence). In Exhibit II, Sheet 3, we summarize the selected ultimate claims at $500,000 per occurrence in Column (2) and the stop-loss limits in Column (3). In Column (4), we apply the stop-loss limits to derive the estimates of ultimate claims for Self-Insurance Pool that take into account both the excess of loss and stop-loss coverages. In the final columns of this exhibit, we calculate the unpaid claim estimate net of both excess of loss and stop-loss coverage.

[81] There are times when the net IBNR will be greater than the gross IBNR. This occurs when an estimate of uncollectible reinsurance is included in the net IBNR but not in the gross IBNR and there are significant billed reinsurance amounts for which significant collectibility issues exist. Another example in which net IBNR may be greater than gross IBNR is for a runoff book with reinsurance disputes for items such as asbestos.

Reported Salvage and Subrogation ($000)

PART 1 - Data Triangle

Accident Year	Reported Salvage and Subrogation as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	713	781	771	770	770	785	793	793	793	793	793
1999	1,328	1,369	1,361	1,360	1,360	1,360	1,360	1,360	1,360	1,360	
2000	2,180	2,432	2,423	2,424	2,421	2,421	2,421	2,421	2,421		
2001	3,314	3,674	3,656	3,637	3,635	3,637	3,637	3,637			
2002	3,807	4,092	4,085	4,088	4,084	4,085	4,091				
2003	4,171	4,323	4,317	4,341	4,360	4,366					
2004	4,805	5,166	5,162	5,163	5,160						
2005	5,387	5,735	5,731	5,731							
2006	5,337	5,752	5,715								
2007	5,590	6,031									
2008	5,414										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.095	0.987	0.998	1.000	1.019	1.011	1.000	1.000	1.000	1.000	
1999	1.031	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000		
2000	1.115	0.996	1.000	0.999	1.000	1.000	1.000	1.000			
2001	1.109	0.995	0.995	0.999	1.001	1.000	1.000				
2002	1.075	0.998	1.001	0.999	1.000	1.001					
2003	1.036	0.999	1.006	1.004	1.001						
2004	1.075	0.999	1.000	0.999							
2005	1.065	0.999	1.000								
2006	1.078	0.994									
2007	1.079										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.067	0.998	1.000	1.000	1.000	1.002	1.000	1.000	1.000	1.000	
Latest 3	1.074	0.997	1.002	1.001	1.001	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.072	0.999	1.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.068	0.998	1.000	1.000	1.000	1.001	1.000	1.000	1.000	1.000	
Latest 3	1.074	0.997	1.002	1.001	1.001	1.001	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.068	0.998	1.000	1.000	1.000	1.001	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.067	0.999	1.001	1.001	1.001	1.001	1.000	1.000	1.000	1.000	1.000
Percent Reported	93.7%	100.1%	99.9%	99.9%	99.9%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%

Received Salvage and Subrogation ($000)

PART 1 - Data Triangle

Accident Year	Received Salvage and Subrogation as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	312	735	766	770	770	770	793	793	793	793	793
1999	704	1,324	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	
2000	951	2,356	2,407	2,421	2,421	2,421	2,421	2,421	2,421		
2001	2,101	3,591	3,619	3,635	3,635	3,637	3,637	3,637			
2002	2,251	4,023	4,082	4,084	4,084	4,084	4,090				
2003	2,122	4,264	4,317	4,321	4,360	4,365					
2004	2,602	5,100	5,156	5,157	5,160						
2005	3,279	5,666	5,731	5,731							
2006	3,104	5,493	5,655								
2007	2,863	5,957									
2008	2,710										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	2.357	1.043	1.004	1.000	1.001	1.030	1.000	1.000	1.000	1.000	
1999	1.880	1.027	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
2000	2.478	1.022	1.006	1.000	1.000	1.000	1.000	1.000			
2001	1.709	1.008	1.004	1.000	1.001	1.000	1.000				
2002	1.787	1.015	1.000	1.000	1.000	1.001					
2003	2.010	1.012	1.001	1.009	1.001						
2004	1.960	1.011	1.000	1.001							
2005	1.728	1.011	1.000								
2006	1.769	1.029									
2007	2.081										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.910	1.016	1.001	1.002	1.000	1.006	1.000	1.000	1.000	1.000	
Latest 3	1.860	1.017	1.000	1.003	1.001	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.913	1.013	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.896	1.016	1.001	1.002	1.001	1.002	1.000	1.000	1.000	1.000	
Latest 3	1.851	1.017	1.000	1.003	1.001	1.001	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.896	1.016	1.001	1.002	1.001	1.002	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.938	1.022	1.006	1.005	1.003	1.002	1.000	1.000	1.000	1.000	1.000
Percent Received	51.6%	97.8%	99.4%	99.5%	99.7%	99.8%	100.0%	100.0%	100.0%	100.0%	100.0%

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance
Auto Physical Damage Insurer
Projection of Ultimate Salvage and Subrogation ($000)

Exhibit I
Sheet 3

Accident Year	Age of Accident Year at 12/31/08	S&S at 12/31/08 Reported	S&S at 12/31/08 Received	CDF to Ultimate Reported	CDF to Ultimate Received	Projected Ultimate S&S Using Dev. Method with Reported	Projected Ultimate S&S Using Dev. Method with Received
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	793	793	1.000	1.000	793	793
1999	120	1,360	1,360	1.000	1.000	1,360	1,360
2000	108	2,421	2,421	1.000	1.000	2,421	2,421
2001	96	3,637	3,637	1.000	1.000	3,637	3,637
2002	84	4,091	4,090	1.000	1.000	4,091	4,090
2003	72	4,366	4,365	1.001	1.002	4,370	4,374
2004	60	5,160	5,160	1.001	1.003	5,165	5,175
2005	48	5,731	5,731	1.001	1.005	5,737	5,760
2006	36	5,715	5,655	1.001	1.006	5,720	5,688
2007	24	6,031	5,957	0.999	1.022	6,025	6,088
2008	12	5,414	2,710	1.067	1.938	5,776	5,252
Total		44,718	41,879			45,096	44,639

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Physical Damage Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Reported Claims Gross of S&S ($000)

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	2,412	2,862	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864
1999	4,225	4,677	4,695	4,696	4,697	4,697	4,697	4,697	4,697	4,697	
2000	6,968	7,879	7,896	7,900	7,901	7,902	7,902	7,902	7,902		
2001	9,063	10,277	10,314	10,318	10,318	10,318	10,319	10,319			
2002	9,982	11,115	11,136	11,138	11,139	11,139	11,137				
2003	11,396	12,493	12,508	12,527	12,526	12,527					
2004	12,878	14,505	14,540	14,544	14,552						
2005	15,181	16,815	16,834	16,837							
2006	15,117	16,953	16,945								
2007	15,092	16,862									
2008	14,727										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.187	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
1999	1.107	1.004	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
2000	1.131	1.002	1.001	1.000	1.000	1.000	1.000	1.000			
2001	1.134	1.004	1.000	1.000	1.000	1.000	1.000				
2002	1.113	1.002	1.000	1.000	1.000	1.000					
2003	1.096	1.001	1.002	1.000	1.000						
2004	1.126	1.002	1.000	1.001							
2005	1.108	1.001	1.000								
2006	1.121	1.000									
2007	1.117										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.114	1.001	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.115	1.001	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.115	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.114	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.115	1.001	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.114	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.115	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Percent Reported	89.7%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Auto Physical Damage Insurer
Paid Claims Gross of S&S ($000)

PART 1 - Data Triangle

Accident Year	Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	1,991	2,858	2,861	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864
1999	3,558	4,666	4,694	4,696	4,697	4,697	4,697	4,697	4,697	4,697	
2000	5,718	7,869	7,893	7,900	7,901	7,902	7,902	7,902	7,902		
2001	7,967	10,253	10,307	10,317	10,317	10,318	10,319	10,319			
2002	8,745	11,076	11,126	11,134	11,136	11,136	11,137				
2003	9,658	12,459	12,500	12,526	12,526	12,526					
2004	11,088	14,466	14,503	14,505	14,521						
2005	13,518	16,775	16,827	16,837							
2006	13,322	16,872	16,942								
2007	13,191	16,822									
2008	12,889										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.436	1.001	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
1999	1.311	1.006	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
2000	1.376	1.003	1.001	1.000	1.000	1.000	1.000	1.000			
2001	1.287	1.005	1.001	1.000	1.000	1.000	1.000				
2002	1.267	1.005	1.001	1.000	1.000	1.000					
2003	1.290	1.003	1.002	1.000	1.000						
2004	1.305	1.003	1.000	1.001							
2005	1.241	1.003	1.001								
2006	1.266	1.004									
2007	1.275										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.275	1.004	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.261	1.003	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.277	1.004	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.273	1.004	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.261	1.003	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.273	1.004	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.279	1.005	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Percent Paid	78.2%	99.5%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Projection of Ultimate Claims Gross of S&S Using Reported and Paid Claims ($000)

Accident Year	Age of Accident Year at 12/31/08	Claims at 12/31/08		CDF to Ultimate		Projected Ultimate Claims Using Dev. Method with		Selected Ult. Claims Gross of S&S
		Reported	Paid	Reported	Paid	Reported	Paid	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	132	2,864	2,864	1.000	1.000	2,864	2,864	2,864
1999	120	4,697	4,697	1.000	1.000	4,697	4,697	4,697
2000	108	7,902	7,902	1.000	1.000	7,902	7,902	7,902
2001	96	10,319	10,319	1.000	1.000	10,319	10,319	10,319
2002	84	11,137	11,137	1.000	1.000	11,137	11,137	11,137
2003	72	12,527	12,526	1.000	1.000	12,527	12,526	12,527
2004	60	14,552	14,521	1.000	1.000	14,552	14,521	14,536
2005	48	16,837	16,837	1.000	1.000	16,837	16,837	16,837
2006	36	16,945	16,942	1.000	1.001	16,945	16,959	16,952
2007	24	16,862	16,822	1.001	1.005	16,879	16,906	16,893
2008	12	14,727	12,889	1.115	1.279	16,421	16,485	16,453
Total		129,370	127,456			131,081	131,153	131,117

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Physical Damage Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 4 and 5.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Ratio of Received Salvage and Subrogation to Paid Claims

PART 1 - Ratio Triangle

Accident Year	Ratio of Received Salvage and Subrogation to Paid Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	0.157	0.257	0.268	0.269	0.269	0.269	0.277	0.277	0.277	0.277	0.277
1999	0.198	0.284	0.290	0.290	0.290	0.290	0.290	0.290	0.290	0.290	
2000	0.166	0.299	0.305	0.306	0.306	0.306	0.306	0.306	0.306		
2001	0.264	0.350	0.351	0.352	0.352	0.353	0.352	0.352			
2002	0.257	0.363	0.367	0.367	0.367	0.367	0.367				
2003	0.220	0.342	0.345	0.345	0.348	0.348					
2004	0.235	0.353	0.355	0.355	0.355						
2005	0.243	0.338	0.341	0.340							
2006	0.233	0.326	0.334								
2007	0.217	0.354									
2008	0.210										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.642	1.041	1.003	1.000	1.001	1.030	1.000	1.000	1.000	1.000	
1999	1.434	1.021	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
2000	1.801	1.019	1.005	1.000	1.000	1.000	1.000	1.000			
2001	1.328	1.003	1.003	1.000	1.001	1.000	1.000				
2002	1.411	1.010	1.000	1.000	1.000	1.001					
2003	1.558	1.009	0.999	1.009	1.001						
2004	1.502	1.008	1.000	1.000							
2005	1.393	1.008	0.999								
2006	1.397	1.025									
2007	1.632										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.496	1.012	1.000	1.002	1.000	1.006	1.000	1.000	1.000	1.000	
Latest 3	1.474	1.014	0.999	1.003	1.001	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.486	1.009	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.486	1.009	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.499	1.009	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Projection of Ultimate Salvage and Subrogation ($000)

Accident Year	Age of Accident Year at 12/31/08	Ratio of Received S&S to Paid Claims at 12/31/08	CDF to Ultimate	Projected Ultimate Ratio	Selected Ultimate S&S Ratio	Selected Ultimate Claims Gross of S&S	Projected Ultimate S&S
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	0.277	1.000	0.277	0.277	2,864	793
1999	120	0.290	1.000	0.290	0.290	4,697	1,360
2000	108	0.306	1.000	0.306	0.306	7,902	2,421
2001	96	0.352	1.000	0.352	0.352	10,319	3,637
2002	84	0.367	1.000	0.367	0.367	11,137	4,090
2003	72	0.348	1.000	0.348	0.348	12,527	4,365
2004	60	0.355	1.000	0.355	0.355	14,536	5,165
2005	48	0.340	1.000	0.340	0.340	16,837	5,731
2006	36	0.334	1.000	0.334	0.334	16,952	5,658
2007	24	0.354	1.009	0.357	0.357	16,893	6,036
2008	12	0.210	1.499	0.315	0.345	16,453	5,676
Total						131,117	44,934

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) From latest diagonal of triangle in Exhibit I, Sheet 7.
(4) Based on CDF from Exhibit I, Sheet 7.
(5) = [(3) x (4)].
(6) = (5) for all years except accident year 2008. Judgmentally selected 0.345 for 2008 based on review of prior years.
(7) Developed in Exhibit I, Sheet 6.
(8) = [(6) x (7)].

Development of Unpaid Claim Estimate ($000)

Accident Year	Age of Accident Year at 12/31/08	Received S&S at 12/31/08	Projected Ultimate S&S Using Dev Method with Reported	Projected Ultimate S&S Using Dev Method with Received	Projected Ultimate S&S Ratio	Estimated S&S Recoverables Using Dev Method with Reported	Estimated S&S Recoverables Using Dev Method with Received	Estimated S&S Recoverables Ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	132	793	793	793	793	0	0	0
1999	120	1,360	1,360	1,360	1,360	0	0	0
2000	108	2,421	2,421	2,421	2,421	0	0	0
2001	96	3,637	3,637	3,637	3,637	0	0	0
2002	84	4,090	4,091	4,090	4,090	0	0	0
2003	72	4,365	4,370	4,374	4,365	5	9	0
2004	60	5,160	5,165	5,175	5,165	5	15	6
2005	48	5,731	5,737	5,760	5,731	6	29	0
2006	36	5,655	5,720	5,688	5,658	66	34	3
2007	24	5,957	6,025	6,088	6,036	68	131	79
2008	12	2,710	5,776	5,252	5,676	3,066	2,542	2,966
Total		41,879	45,096	44,639	44,934	3,216	2,760	3,054

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) Based on data from Auto Physical Damage Insurer.
(4) and (5) Developed in Exhibit I, Sheet 3.
(6) Developed in Exhibit I, Sheet 8.
(7) = [(4) - (3)].
(8) = [(5) - (3)].
(9) = [(6) - (3)].

Accident Year	Gross Reported Claims ($000) as of (months) 12	24	36	48
2005	35,839	42,290	47,365	49,733
2006	37,452	44,568	49,024	
2007	39,324	46,009		
2008	41,212			

Accident Year	Net Reported Claims ($000) as of (months) 12	24	36	48
2005	25,087	29,603	33,155	34,813
2006	26,216	31,197	34,317	
2007	33,426	39,108		
2008	37,091			

Accident Year	Ratio of Net to Gross Reported Claims as of (months) 12	24	36	48
2005	0.700	0.700	0.700	0.700
2006	0.700	0.700	0.700	
2007	0.850	0.850		
2008	0.900			

Accident Year	Gross Reported Claims ($000) as of (months)			
	12	24	36	48
2005	12,199	15,615	18,425	20,268
2006	12,992	16,890	20,267	
2007	13,901	17,655		
2008	14,735			

Accident Year	Net Reported Claims ($000) as of (months)			
	12	24	36	48
2005	11,752	14,076	16,502	18,056
2006	12,992	16,890	20,267	
2007	13,644	17,303		
2008	14,735			

Accident Year	Ceded Reported Claims ($000) as of (months)			
	12	24	36	48
2005	447	1,539	1,924	2,212
2006	-	-	-	
2007	257	352		
2008	-			

Chapter 14 - Recoveries: Salvage and Subrogation and Reinsurance
Impact of Reinsurance Programs
Self-Insurance Pool with Excess of Loss and Stop Loss Reinsurance

Exhibit II
Sheet 3

	Ultimate Claims		Net of Excess of Loss, Net of Stop Loss				
Policy	Net of Excess of Loss	Stop Loss	Ultimate	Claims at 12/31/08		Estimated	Unpaid Claim
Year	Gross of Stop Loss	Limit	Claims	Reported	Paid	IBNR	Estimate
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2002 - 03	1,184,999						
2003 - 04	1,770,725	4,000,000	4,000,000	3,753,248	3,253,624	246,752	746,376
2004 - 05	1,306,107						
2005 - 06	2,168,077	1,500,000	1,500,000	1,500,000	1,016,783	-	483,217
2006 - 07	1,137,216	1,500,000	1,137,216	914,262	629,296	222,954	507,920
2007 - 08	1,364,048	N/A	1,364,048	432,679	257,877	931,369	1,106,171
Total	8,931,172		8,001,264	6,600,189	5,157,579	1,401,075	2,843,685

Column Notes:
(2) Selected based on review of various projection techniques.
(3) Based on Self-Insurance Pool stop-loss reinsurance program.
(4) = [minimum of (2) and (3)].
(5) and (6) Based on Self-Insurance Pool experience.
(7) = [(4) - (5)].
(8) = [(4) - (6)].

CHAPTER 15 – EVALUATION OF TECHNIQUES

In this final chapter in Part 3, we bring together the various methods for estimating unpaid claims used for the examples presented in Chapters 7 through 14. We use numerous methodologies for the same examples, not simply for the purpose of demonstration, but because actuaries should use more than one method when analyzing unpaid claims. No single method can produce the best estimate in all situations. In their 1977 paper, Berquist and Sherman recommend that where possible, the actuary conducting an analysis of unpaid claims should use methods that incorporate the following:

- Projections of reported claims
- Projections of paid claims
- Projections of ultimate reported claim counts and severities
- Estimates of the number and average amount of outstanding claims
- Claim ratio estimates[82]

Berquist and Sherman further recommend that wherever possible the actuary should incorporate the concepts of credibility, regression analysis, and data smoothing into the actuarial methods used. They state: “The methods applied should range from those which are highly stable (i.e., representative of the average of experience over several years) to those which are highly responsive to trends and to more recent experience.” It is then the responsibility of the actuary to select the most appropriate estimate of unpaid claims. In some situations, actuaries may incorporate the concept of credibility into the selection process; at other times actuarial judgment will prevail. When incorporating regression analysis into a method, Berquist and Sherman recommend using some measure of the goodness-of-fit to evaluate the appropriateness of that method’s projections.

In “Reinsurance,” Patrik comments on the selection process of techniques for the analysis of unpaid claims:

> You can see there are many possibilities, and no single right method. Any good actuary will want to use as many legitimate methods for which reasonably good information and time is available, and compare and contrast the estimates from these methods. As with pricing, it is often informative to see the spread of estimates derived from different approaches. This helps us understand better the range and distribution of possibilities, and may give us some idea of the sensitivity of our answers to varying assumptions and varying estimation methodologies.[83]

If there is sufficient claim history available, testing the method retroactively is one method for evaluating the appropriateness of a particular technique for estimating unpaid claims. The actuary can then determine the historical accuracy of the method and whether or not the particular method is free from bias in projecting future results.

[82] *PCAS*, 1977.

[83] *Foundations of Casualty Actuarial Science*, 2001.

The actuary should explain significant differences between the projections of various methods. Often such differences are due to changes in company operations and procedures or to changes in the external environment. Ronald Wiser notes in "Loss Reserving"[84] that the attempt to reconcile a number of different estimates is extremely difficult, but often yields important new insights for the actuary.

An important final check of the selected ultimate claims, particularly for the most recent years, should include calculation of claim ratios, severities, pure premiums, and claim frequencies. Such a review is consistent with Mr. Wiser's recommendations that proposed ultimate amounts be evaluated in contexts outside their original frame of analysis. If exposures are not available, the actuary can compare ultimate claim counts with premiums as a proxy for frequency. Another valuable test for the actuary is the implied average case outstanding and unreported claim on open and unreported claims. The actuary should review these statistics for reasonableness from the perspective of year-to-year changes, knowledge gained from meetings with management, and knowledge of the industry in general. Such review should either result in the actuary having greater confidence in the unpaid claim estimate or lead the actuary to seek additional information before reaching a conclusion.

In Chapters 7 through 14, we present numerous examples for insurers and self-insurers providing coverage for many different lines of insurance. In the following sections of this chapter, we review the results for many of these examples. We conclude this chapter with a brief discussion of monitoring and interim testing of unpaid claim estimates.

U.S. Industry Auto

For U.S. Industry Auto, the results of the various projection techniques are all quite consistent. This is not surprising given the volume of business. This example is based on the consolidated results for all U.S. private passenger automobile insurance. The following table summarizes the estimated IBNR and the total unpaid claim estimate (in billions of dollars) for each of the projection techniques.

	Estimated Unpaid Claims as of 12/31/07	
$ Billions	**IBNR**	**Total**
Development – Reported	26	71
Development – Paid	29	74
Expected Claims	26	71
Bornhuetter-Ferguson – Reported	26	71
Bornhuetter-Ferguson – Paid	27	73
Cape Cod	27	73
Case Outstanding Development	24	70

In total and by accident year, the methods produce unpaid claims that are similar to one another.

[84] *Foundations of Casualty Actuarial Science*, 2001.

XYZ Insurer

While we do not expect to see material differences in the various estimates of unpaid claims for U.S. Industry Auto, we do expect significant differences in results for XYZ Insurer. We know that the underlying assumptions of some of the methods do not hold true for XYZ Insurer as a result of recent changes in both its internal operations as well as the external environment. To demonstrate the influence of the Berquist-Sherman adjustments on the projected ultimate claims, we summarize in Exhibit I, Sheet 1, the projected ultimate claims from the following methods:

- Reported and paid claim development techniques based on unadjusted reported and paid claims

- Bornhuetter-Ferguson technique based on unadjusted reported and paid claim development patterns

- Cape Cod method based on unadjusted reported claim development pattern

- Reported and paid claim development techniques incorporating Berquist-Sherman adjustments to case outstanding only, paid claims only, as well as to both case outstanding and paid claims

- Bornhuetter-Ferguson based on adjusted reported and paid claim development patterns as well as revised expected claim ratios

The calculations for the revised Bornhuetter-Ferguson incorporating the Berquist-Sherman adjustments on development patterns and the expected claim ratio are not included in this book. We suggest that the user of this book reproduce these calculations to ensure a greater understanding of the mechanics of each method.

Since we know that using unadjusted data does not satisfy the underlying assumptions for the first three projection techniques above, we do not consider these projections when selecting ultimate claims for XYZ Insurer. We also do not consider the Berquist-Sherman adjustment for case outstanding only since this projection does not reflect the changes observed in settlement rates.

In Exhibit I, Sheets 2 through 6, we present exhibits that will assist us in selecting ultimate claims by accident year. We present the following:

- Exhibit I, Sheet 2 – Summary of Ultimate Claims
- Exhibit I, Sheet 3 – Comparison of Estimated Ultimate Claim Ratios
- Exhibit I, Sheet 4 – Comparison of Estimated Ultimate Severities
- Exhibit I, Sheet 5 – Comparison of Estimated Average Case Outstanding and Unreported Claims
- Exhibit I, Sheet 6 – Comparison of Estimated IBNR

Each of these exhibits contains details by accident year. For some techniques, such as the frequency-severity approaches (#2 and #3), we only estimate ultimate claims for the recent accident years. For other techniques, we project ultimate claims for all accident years in the experience period (i.e., 1998 through 2008). In Exhibit I, Sheets 2 through 6, we summarize the results for the following methods:

— Reported and paid claim development techniques incorporating Berquist-Sherman adjustments to paid claims only as well as to both case outstanding and paid claims

— Bornhuetter-Ferguson based on adjusted reported and paid claim development patterns as well as revised expected claim ratios

— All three frequency-severity projections (from Chapter 11)

We recall from Chapter 11, that there are concerns about the first frequency-severity approach for XYZ Insurer. We believe that the incorporation of closed claim counts into the selection of ultimate claim counts may overstate the true value of projected ultimate claims. We observe that this projection method results in significantly higher ultimate claims than all other methods summarized in Exhibit I, Sheet 2. The estimate of total ultimate claims for all accident years combined from frequency-severity approach method 1 is $551,155; the total ultimate claims for all other methods are less than $490,000. Thus, we exclude the frequency-severity method 1 from further consideration.

For the oldest seven years, 1998 through 2004, we observe fairly consistent results from the various projection methods. However, beginning in 2005, the differences become more substantial. A review of the estimated ultimate claim ratios and ultimate severities as well as the estimated IBNR can assist the actuary in the selection of ultimate claims. Another valuable statistic is the estimated average case outstanding and unreported claim on open and IBNR claims.

There are many acceptable ways to select ultimate claims in such an example. Some actuaries may select one method and use it for all years. The Berquist-Sherman adjusted reported claim (both case and paid adjustments) method may be a reasonable selection for all years for XYZ Insurer. Alternatively, an actuary may select different methods for different accident years. For example, select the Berquist-Sherman adjusted reported claim method for accident years 1998 through 2006 and the Bornhuetter-Ferguson method for 2007 and 2008. Another alternative is for the actuary to use a weighted average based on assigned weights to the various methods; these weights may be consistent for all years or may vary by accident year. The important point is that there is no single “right” way for the actuary to select ultimate claims (and thus the unpaid claim estimate). The actuary must take into consideration the results of the various techniques, diagnostic tests including implied claim ratios and severities, and all the information gained during the process of estimating unpaid claims. As stated earlier in this chapter, to the extent sufficient data is available, retroactive tests may also prove valuable to the actuary when selecting which methods to rely on for selecting ultimate claims.

For our example, we select ultimate claims based on: the Berquist-Sherman adjusted reported claim for accident years 1998 through 2004; the average of the adjusted reported and paid Bornhuetter-Ferguson techniques for accident years 2005 and 2006; the adjusted reported Bornhuetter-Ferguson technique for accident year 2007; and the average of the adjusted reported Bornhuetter-Ferguson technique and frequency-severity approach #2 for accident year 2008. The key drivers in our selections by accident year are the estimated IBNR, the estimated ultimate severities, and the estimated claim ratios. Later in this chapter, we will return to these selected ultimate claims when we present an example for monitoring the unpaid claim estimate on a quarterly basis.

Changing Conditions – Changes in Claim Ratios and Case Outstanding Adequacy and Changes in Product Mix

In Chapters 7 through 10, we present various scenarios related to changes in claim ratios and case outstanding adequacy based on a U.S. private passenger automobile example. For the first scenario, U.S. PP Auto Steady-State, all of the techniques produced an accurate estimate of unpaid claims. In this scenario, we assume that there are no changes in the underlying claim ratio or the strength of case outstanding. In the next three scenarios (U.S. PP Auto Increasing Claim Ratios, U.S. PP Auto Increasing Case Outstanding Strength, and U.S. PP Auto Increasing Claim Ratios and Case Outstanding Strength) the estimation techniques vary in their ability to accurately respond to the changing conditions.

We also create an example based on a combined portfolio of private passenger and commercial automobile insurance. Similar to the U.S. PP Auto Steady-State, all of the techniques used for the example with a steady-state product mix (U.S. Auto Steady-State) produce the actual IBNR value. When the product mix changes, however, the methods respond differently to the changing conditions.

The following table summarizes the estimated IBNR for each of the projection techniques for all of the scenarios other than steady-state examples. The first line of the table shows the actual IBNR needed for each scenario.

Estimated IBNR ($000)

Estimation Technique	Increasing Claim Ratios	Increasing Case Outstanding Strength	Increasing Claim Ratios and Case Outstanding Strength	Changing Product Mix
True IBNR	602	253	348	2,391
Development – Reported	602	501	694	2,153
Development – Paid	602	253	348	1,723
Expected Claims	-843	253	-1,097	2,167
Bornhuetter-Ferguson – Reported	439	458	460	2,168
Bornhuetter-Ferguson – Paid	159	253	-96	1,991
Benktander – Reported	573	492	648	2,159
Benktander – Paid	406	253	151	1,893
Cape Cod	506	470	546	2,168

For each of these scenarios, there is considerable variability between the methods in total and by accident year. In such a situation, it is very important that the actuary seek to understand what the drivers are for the differences between methods. The actuary might require more information from management as well as further quantitative analysis to determine which method is most appropriate for the particular circumstances. In these types of situations, the availability of claim counts and the ability to test the estimated ultimate severities could prove very valuable to the actuary.

Berq-Sher Insurers

The Berq-Sher Med Mal Insurer and Berq-Sher Auto BI Insurer are copies of examples presented in the Berquist and Sherman paper "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach."[85] In Exhibit II, we summarize the results of the various projection methods for Berq-Sher Med Mal Insurer; and in Exhibit III, we summarize the results for Berq-Sher Auto BI Insurer.

For Berq-Sher Med Mal Insurer, we develop ultimate claims using the development technique applied to unadjusted reported and paid claims. We also use the development technique with adjusted reported claims, whereby claims are adjusted to reflect changes in case outstanding adequacy. In Exhibit II, we compare ultimate claims and estimated IBNR. We are limited in the diagnostics we can perform for both the Berquist-Sherman examples since we do not have complete claim count data.

In our analysis, it is clear from the diagnostics that an increase in case outstanding strength occurred during the experience period. Thus, the development method based on unadjusted reported claims is not appropriate since an underlying assumption of this technique is not valid (i.e., case outstanding adequacy did not remain constant over the experience period). Since the two remaining methods (i.e., unadjusted paid claim development and adjusted reported claim development) produce such significant differences, the actuary should seek additional information, including the potential use of other methodologies, before making a final determination as to ultimate claims and thus the unpaid claim estimate.

For Berq-Sher Auto BI Insurer, we develop four estimates of ultimate claims using the development technique. First, we project ultimate claims based on unadjusted paid claims data. We then adjust the paid claims data for changes in the rate of claims settlement and develop three alternative sets of claim development factors. In Exhibit III, we summarize ultimate claims and estimated ultimate severities for each of the four projections. All three of the projections based on the adjusted paid claim triangle are similar to one another, in total and by accident year. The results of the Berquist-Sherman adjustment are consistent with our expectations due to our conclusion of a decrease in the rate of claims settlement.

While the three projections based on adjusted paid claims are similar to one another, we do not consider these methods to necessarily be independent since they are based on the same source data. Ideally, the actuary would incorporate other techniques to verify the results of the Berquist-Sherman adjusted paid claims methodology.

Monitoring and Interim Techniques for Unpaid Claim Estimates

We begin Part 2 of this book by presenting Ronald Wiser's four-phase approach to estimating unpaid claims. His final phase is monitoring projections of the development of unpaid claims over subsequent calendar periods. He notes that deviations of actual development from projected development of claims or claim counts are one of the most useful diagnostic tools for evaluating the accuracy of the unpaid claim estimate.

Monitoring performance between detailed analyses of unpaid claims is important both for commercial insurers and self-insurers. Many actuaries build models to capture the difference

[85] *PCAS*, 1977.

between actual and expected claims reported (or paid) in the month or quarter. While some actuaries at very large companies may perform detailed analyses of unpaid claims on a quarterly basis, many use "roll-forward" types of analyses to capture and compare actual claims with expected claims between complete, detailed analyses. In addition to measuring changes in claims for historical periods, the actuary must incorporate the effect of changes in the exposure for the current period to any changes in the unpaid claim estimate used for financial reporting purposes.

Comparisons of actual-to-expected claims are valuable so that the actuary can understand the appropriateness of prior selections and make revisions as necessary if actual claims do not emerge as expected. Monitoring unpaid claims can be important for insurers from a financial reporting perspective, for budgeting and planning purposes, for pricing and other strategic decision-making, and for planning for the next complete analysis of unpaid claims.

It is typically a simple exercise to develop a model that allows comparisons of actual and expected claims by accident year between successive annual valuations. We present an example of such a model in Exhibit IV. For DC Insurer, we derive ultimate claims at December 31, 2007 based on the reported claim development technique. In Exhibit IV, Sheet 3, we use the selected ultimate claims and the selected reporting pattern to compare actual reported claims one year later (i.e., December 31, 2008) with our expected claims for the year.

For each accident year, expected reported claims in the calendar year are equal to:

[(ultimate claims selected at December 31, 2007 – actual reported claims at December 31, 2007) / (% unreported at December 31, 2007)] x (% reported at December 31, 2008 - % reported at December 31, 2007)

We derive the percentage unreported from the selected claim development pattern as [1.00 – (1.00 / cumulative claim development factor)]. For example, the expected reported claims for accident year 2007 during calendar year 2008 are equal to:

$$AY_{07} \text{ Expected Claim}_{CY08} = \{[(\$2{,}798 - \$2{,}463) / (1 - 0.880)] \times (0.999 - 0.880)\} = \$332$$

The expected reported claims for accident year 2006 during calendar year 2008 are equal to:

$$AY_{06} \text{ Expected Claim}_{CY08} = \{[(\$2{,}952 - \$2{,}949) / (1 - 0.999)] \times (1.000 - 0.999)\} = \$3$$

In the example for DC Insurer, we derive the reporting pattern based on the development factors to ultimate. This is a reasonable approach when selected ultimate claims for all accident years are based on the reported claim development technique. However, actuaries often rely on techniques other than the development technique to select ultimate claims. In such situations, it is often valuable to look at an alternative method for deriving reporting and payment patterns (other than the inverse of the cumulative development factor). A method often used to derive payment patterns is to compare the historical paid claim development triangle to the final value of selected ultimate claims. We present such a comparison for XYZ Insurer in Exhibit V, Sheet 1. Various averages of the percentage paid at each maturity are calculated and a payment pattern is selected. We present similar calculations for the reporting pattern in Exhibit V, Sheet 2.

In the table below, we compare the implied payment and reporting patterns based on the unadjusted development patterns, the development patterns after Berquist-Sherman adjustments, and the final selections from Exhibit V, Sheets 1 and 2.

Comparison of Reporting and Payment Patterns						
	Reporting Patterns			Payment Patterns		
Maturity Age	Unadjusted CDF	Adjusted CDF	Selected	Unadjusted CDF	Adjusted CDF	Selected
12	39.2%	44.9%	51.1%	4.5%	7.4%	8.5%
24	66.1%	74.3%	75.8%	15.2%	30.8%	22.4%
36	83.6%	91.4%	88.7%	31.6%	44.1%	38.1%
48	92.2%	99.0%	95.8%	49.8%	58.3%	55.5%
60	94.0%	99.3%	97.1%	65.6%	74.0%	72.9%
72	98.7%	100.0%	98.9%	78.9%	89.2%	84.4%

It can be a challenging task to develop a system for quarterly or monthly monitoring given an estimation process that focuses only on annual claim development patterns. Some insurers maintain claim development data on a quarterly basis. For these organizations, development factors are readily available for quarterly analyses, and linear interpolation between quarters is likely sufficient for monthly monitoring purposes. However, for insurers who only have annual claim development data, linear interpolation of annual development patterns is usually not appropriate, particularly for the most immature accident years.

In the paper "The Actuary and IBNR," Bornhuetter and Ferguson suggest:

> In the absence of data, it might be reasonable to assume that the cumulative distribution of development by quarter for the most recent accident year is skewed say 40% at three months, 70% at six months, 85% at nine months, 100% at 12 months, and that the distribution for prior accident years is uniform: 25%, 50%, 75%, 100%. Upon further study the authors were somewhat surprised to find that their data revealed prior year's development were also skewed; approximate distribution: 33%, 60%, 80%, 100%. The data reviewed were excess of loss and it is recognized that distributions observed may not be typical of ordinary business.[86]

For our example, we assume that DC Insurer has the systems capability to capture claim development data on a quarterly basis. Thus, we are able to build a model for monthly claims monitoring based on linear interpolation of the quarterly claim development factors. In Exhibit IV, Sheet 4, we present the template for January and February 2008.

In his 1973 review of the Bornhuetter and Ferguson's paper "The Actuary and IBNR," Hugh White offered a problem that is still relevant for actuaries monitoring unpaid claims today. Mr. White stated:

> You are trying to establish the reserve for commercial automobile bodily injury and the reported proportion of expected losses as of statement date for the current accident year period is 8% higher than it should be. Do you:

[86] *PCAS*, 1972.

> 1. Reduce the bulk (i.e., IBNR) reserve a corresponding amount (because you sense an acceleration in the rate of report);
>
> 2. Leave the bulk reserve at the same percentage level of expected losses (because you sense a random fluctuation such as a large loss); or
>
> 3. Increase the bulk reserve in proportion to the increase of actual reported over expected reported (because you don't have 100% confidence in your "expected losses")?
>
> Obviously, none of the three suggested "answers" is satisfactory without further extensive investigation, and yet, all are reasonable.[87]

While his comments are directed at limitations in the expected claims component of the Bornhuetter-Ferguson technique, in our opinion they are more applicable to an actuary monitoring unpaid claims and trying to determine the consequences that differences in expected and actual claims will have on the unpaid claim estimate. As Mr. White notes, there is no single "satisfactory" answer as to how an increase in reported claims should be addressed in establishing the unpaid claim estimate. In an effort to best understand the drivers underlying the greater-than-expected claims, the actuary must seek a comprehensive understanding of the specific situation. Such understanding can be achieved through meetings with management and other parties who understand the situation at-hand and through detailed analyses of the claims and claims experience.

[87] *PCAS*, 1973.

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Summary of Ultimate Claims ($000)

	Unadjusted Projections for Ultimate Claims					Adjusted Projections for Ultimate Claims				
Accident	Development Method		B-F Method		Cape Cod	Development Method			B-F Method	
Year	Reported	Paid	Reported	Paid	Method	Case Rptd	Both Rptd	Paid	Reported	Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	15,822	15,980	15,822	15,977	15,822	15,822	15,822	15,980	15,822	15,975
1999	25,082	25,164	25,107	25,158	25,107	25,107	25,107	25,140	25,107	25,128
2000	36,948	37,922	37,246	37,841	37,246	37,246	37,246	37,334	37,246	37,294
2001	38,487	40,600	38,798	40,525	38,798	38,798	38,798	39,290	38,798	39,274
2002	48,313	49,592	48,312	49,417	48,313	48,169	48,169	47,326	48,169	47,313
2003	44,950	49,858	45,068	50,768	45,062	44,373	44,373	44,078	44,373	45,070
2004	74,787	80,537	75,492	82,593	74,754	70,288	70,780	71,401	70,792	71,688
2005	76,661	80,333	79,129	94,301	77,931	70,655	71,362	68,685	71,554	77,898
2006	58,370	72,108	60,404	71,205	58,759	50,756	53,392	51,776	53,906	56,031
2007	47,979	77,941	45,221	45,636	43,307	38,237	42,680	38,549	40,300	34,988
2008	47,530	74,995	42,607	41,049	39,201	37,227	41,531	45,987	36,842	33,988
Total	514,929	605,030	513,207	554,471	504,300	476,678	489,258	485,546	482,910	484,648

Column Notes:
(2) and (3) Developed in Chapter 7, Exhibit II, Sheet 3.
(4) and (5) Developed in Chapter 9, Exhibit II, Sheet 1.
(6) Developed in Chapter 10, Exhibit II, Sheet 2.
(7) through (9) Developed in Chapter 13, Exhibit III, Sheet 10.
(10) and (11) Developed using projected ultimate claims in (8) as the new intial expected claims estimates.

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Summary of Ultimate Claims ($000)

			Adjusted Projections for Ultimate Claims				Projections for Ultimate Claims			Selected
Accident	Claims as of 12/31/08		Development Method		B-F Method		Frequency-Severity			Ultimate
Year	Reported	Paid	Both Rptd	Paid	Reported	Paid	Method 1	Method 2	Method 3	Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	15,822	15,822	15,822	15,980	15,822	15,975	15,822			15,822
1999	25,107	24,817	25,107	25,140	25,107	25,128	25,082			25,107
2000	37,246	36,782	37,246	37,334	37,246	37,294	37,083			37,246
2001	38,798	38,519	38,798	39,290	38,798	39,274	38,778		39,192	38,798
2002	48,169	44,437	48,169	47,326	48,169	47,313	48,655		46,869	48,169
2003	44,373	39,320	44,373	44,078	44,373	45,070	46,107		44,479	44,373
2004	70,288	52,811	70,780	71,401	70,792	71,688	76,620		71,906	70,780
2005	70,655	40,026	71,362	68,685	71,554	77,898	80,745		71,684	74,726
2006	48,804	22,819	53,392	51,776	53,906	56,031	64,505		49,913	54,968
2007	31,732	11,865	42,680	38,549	40,300	34,988	58,516	30,512	31,805	40,300
2008	18,632	3,409	41,531	45,987	36,842	33,988	59,242	30,140	29,828	33,491
Total	449,626	330,629	489,258	485,546	482,910	484,648	551,155			483,781

Column Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) and (5) Developed in Chapter 13, Exhibit III, Sheet 10.
(6) and (7) Developed using projected ultimate claims in (4) as the new intial expected claims estimates.
(8) Developed in Chapter 11, Exhibit II, Sheet 6.
(9) Developed in Chapter 11, Exhibit IV, Sheet 3.
(10) Developed in Chapter 11, Exhibit VI, Sheet 8.
(11) = (4) for AYs 2004 and prior; (11) = [Average of (6) and (7) for 2005 and 2006]; (11) = (6) for 2007; (11) = [Average of (6) and (9)] for 2008.

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Comparison of Estimated Ultimate Claim Ratios

		Estimated Ultimate Claim Ratios Based on							Selected
Accident	Earned	Development Method		B-F Method		Frequency-Severity			Ult. Claims
Year	Premium	Both Rptd	Paid	Reported	Paid	Method 1	Method 2	Method 3	Ratios
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	20,000	79.1%	79.9%	79.1%	79.9%	79.1%			79.1%
1999	31,500	79.7%	79.8%	79.7%	79.8%	79.6%			79.7%
2000	45,000	82.8%	83.0%	82.8%	82.9%	82.4%			82.8%
2001	50,000	77.6%	78.6%	77.6%	78.5%	77.6%		78.4%	77.6%
2002	61,183	78.7%	77.4%	78.7%	77.3%	79.5%		76.6%	78.7%
2003	69,175	64.1%	63.7%	64.1%	65.2%	66.7%		64.3%	64.1%
2004	99,322	71.3%	71.9%	71.3%	72.2%	77.1%		72.4%	71.3%
2005	138,151	51.7%	49.7%	51.8%	56.4%	58.4%		51.9%	54.1%
2006	107,578	49.6%	48.1%	50.1%	52.1%	60.0%		46.4%	51.1%
2007	62,438	68.4%	61.7%	64.5%	56.0%	93.7%	48.9%	50.9%	64.5%
2008	47,797	86.9%	96.2%	77.1%	71.1%	123.9%	63.1%	62.4%	70.1%
Total	732,144	66.8%	66.3%	66.0%	66.2%	75.3%			66.1%

Column Notes:
(2) Based on data from XYZ Insurer.
(3) through (10) = [(projected ultimate claims in Exhibit I, Sheet 2) / (2)].

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Comparison of Estimated Ultimate Severities

Exhibit I
Sheet 4

		Estimated Ultimate Severities Based on							Selected
Accident	Ultimate	Development Method		B-F Method		Frequency-Severity			Ultimate
Year	Claim Counts	Both Rptd	Paid	Reported	Paid	Method 1	Method 2	Method 3	Severities
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	637	24,839	25,087	24,839	25,078	24,839			24,839
1999	1,047	23,980	24,011	23,980	24,000	23,956			23,980
2000	1,416	26,304	26,365	26,304	26,338	26,189			26,304
2001	1,466	26,465	26,801	26,465	26,790	26,452		26,734	26,465
2002	1,565	30,779	30,240	30,779	30,232	31,090		29,948	30,779
2003	1,666	26,634	26,457	26,634	27,053	27,675		26,698	26,634
2004	2,309	30,654	30,923	30,659	31,047	33,183		31,142	30,654
2005	2,483	28,740	27,662	28,817	31,373	32,519		28,870	30,095
2006	1,807	29,547	28,653	29,832	31,008	35,697		27,622	30,420
2007	1,556	27,429	24,775	25,900	22,486	37,606	19,609	20,440	25,900
2008	1,426	29,124	32,249	25,836	23,835	41,544	21,136	20,918	23,486
Total	17,378	28,154	27,940	27,789	27,889	31,716			27,839

Column Notes:
(2) Developed in Chapter 11, Exhibit II, Sheet 3.
(3) through (10) = [(projected ultimate claims in Exhibit I, Sheet 2) x 1000 / (2)].

Exhibit I
Sheet 5

Comparison of Estimated Average Case Outstanding and Unreported Claims

Accident Year	Open and IBNR Counts at 12/31/08	Estimated Average Case Outstanding and Unreported Claims Based on: Development Method: Both Rptd	Development Method: Paid	B-F Method: Reported	B-F Method: Paid	Frequency-Severity: Method 1	Frequency-Severity: Method 2	Frequency-Severity: Method 3	Selected Ultimate Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	0	-	-	-	-	-			-
1999	3	96,618	107,540	96,618	103,768	88,249			96,618
2000	14	33,181	39,409	33,181	36,581	21,541			33,181
2001	20	13,908	38,519	13,908	37,750	12,938		33,619	13,908
2002	42	88,842	68,772	88,842	68,468	100,425		57,899	88,842
2003	98	51,555	48,549	51,555	58,674	69,248		52,638	51,555
2004	280	64,176	66,391	64,219	67,418	85,031		68,196	64,176
2005	537	58,352	53,369	58,710	70,525	75,826		58,953	64,617
2006	606	50,450	47,784	51,299	54,805	68,789		44,710	53,052
2007	765	40,280	34,882	37,170	30,226	60,981	24,375	26,065	37,170
2008	1,150	33,149	37,025	29,073	26,591	48,551	23,245	22,973	26,159
Total	3,515	530,511	542,240	524,574	554,805	631,578			529,277

Column Notes:
(2) Based on data from XYZ Insurer.
(3) through (10) = {[(estimated IBNR in Exhibit I, Sheet 6) + ((2) in Exhibit I, Sheet 6)] x 1000 / (2)}.

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Comparison of Estimated IBNR ($000)

Exhibit I
Sheet 6

	Case	Estimated IBNR Based on							
Accident	Outstanding	Development Method		B-F Method		Frequency-Severity			Selected
Year	at 12/31/08	Both Rptd	Paid	Reported	Paid	Method 1	Method 2	Method 3	IBNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	0	0	158	0	152	0			0
1999	290	0	33	0	21	- 25			0
2000	465	0	87	0	48	- 163			0
2001	278	0	492	0	477	- 19		394	0
2002	3,731	0	- 843	0	- 856	486		- 1,300	0
2003	5,052	0	- 295	0	698	1,734		106	0
2004	17,477	492	1,112	504	1,400	6,331		1,618	492
2005	30,629	707	- 1,970	899	7,243	10,090		1,029	4,071
2006	25,985	4,588	2,972	5,102	7,227	15,701		1,109	6,164
2007	19,867	10,948	6,817	8,568	3,256	26,784	- 1,220	73	8,568
2008	15,223	22,899	27,355	18,210	15,356	40,610	11,508	11,196	14,859
Total	118,997	39,632	35,920	33,284	35,022	101,529			34,155

Column Notes:
(2) Based on data from XYZ Insurer.
(3) through (10) = [(projected ultimate claims in Exhibit I, Sheet 2) - ((2) in Exhibit I, Sheet 2)].

Chapter 15 - Evaluation of Techniques
Berq-Sher Med Mal Insurer
Summary of Ultimate Claims and Estimated IBNR

Exhibit II

Accident Year	Claims as of 12/31/76 Reported	Claims as of 12/31/76 Paid	Projected Ultimate Claims: Development Method Reported	Projected Ultimate Claims: Development Method Paid	Projected Ultimate Claims: Berq-Sher Adj Rptd	Estimated IBNR Based on: Development Method Reported	Estimated IBNR Based on: Development Method Paid	Estimated IBNR Based on: Berq-Sher Adj Rptd
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1969	23,506,000	15,815,000	23,506,000	23,501,090	23,506,000	0	- 4,910	0
1970	32,216,000	18,983,000	33,085,832	35,289,397	31,539,464	869,832	3,073,397	- 676,536
1971	48,377,000	17,707,000	52,247,160	46,321,512	45,667,888	3,870,160	- 2,055,488	- 2,709,112
1972	61,163,000	18,518,000	79,695,389	83,238,410	61,468,815	18,532,389	22,075,410	305,815
1973	73,733,000	11,292,000	112,369,092	99,064,716	68,571,690	38,636,092	25,331,716	- 5,161,310
1974	63,477,000	6,267,000	145,425,807	134,978,646	79,092,342	81,948,807	71,501,646	15,615,342
1975	48,904,000	1,565,000	215,275,408	125,021,590	93,455,544	166,371,408	76,117,590	44,551,544
1976	15,791,000	209,000	175,990,695	103,266,273	117,879,815	160,199,695	87,475,273	102,088,815
Total	367,167,000	90,356,000	837,595,383	650,681,634	521,181,558	470,428,383	283,514,634	154,014,558

Column Notes:
(2) and (3) Based on medical malpractice insurance experience.
(4) through (6) Developed in Chapter 13, Exhibit I, Sheet 8.
(7) = [(4) - (2)].
(8) = [(5) - (2)].
(9) = [(6) - (2)].

Chapter 15 - Evaluation of Techniques
Berq-Sher Auto BI Insurer
Summary of Ultimate Claims and Estimated Ultimate Severities

Accident Year	Paid Claims at 12/31/76	Projected Ultimate Claims: Paid Claims Dev Method	Projected Ultimate Claims: Berquist-Sherman Adjusted Paid Dev Method	Projected Ultimate Claims: Berquist-Sherman Adjusted Paid Lin Reg	Projected Ultimate Claims: Berquist-Sherman Adjusted Paid Exp Reg	Ultimate Claim Counts	Estimated Ultimate Severities Based on: Paid Claims Dev Method	Estimated Ultimate Severities Based on: Berquist-Sherman Adjusted Paid Dev Method	Estimated Ultimate Severities Based on: Berquist-Sherman Adjusted Paid Lin Reg	Estimated Ultimate Severities Based on: Berquist-Sherman Adjusted Paid Exp Reg
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1969	10,256	10,256	10,256	10,256	10,256	7,821	1,311	1,311	1,311	1,311
1970	12,031	12,103	12,103	12,107	12,107	8,682	1,394	1,394	1,395	1,395
1971	14,235	14,577	14,591	14,583	14,583	9,945	1,466	1,467	1,466	1,466
1972	15,383	16,321	16,506	16,502	16,502	9,690	1,684	1,703	1,703	1,703
1973	15,278	17,631	18,257	18,059	18,061	9,591	1,838	1,904	1,883	1,883
1974	11,771	16,232	17,974	17,241	17,251	7,803	2,080	2,304	2,210	2,211
1975	9,182	18,281	21,559	20,984	20,993	8,050	2,271	2,678	2,607	2,608
1976	2,801	17,282	20,772	21,346	21,394	7,466	2,315	2,782	2,859	2,865
Total	90,937	122,684	132,019	131,079	131,147	69,047	1,777	1,912	1,898	1,899

Column Notes:
(2) Based on automobile bodily injurty experience.
(3) through (6) Developed in Chapter 13, Exhibit II, Sheet 11.
(7) Developed in Chapter 13, Exhibit II, Sheet 4.
(8) = [(3) x 1000 / (7)].
(9) = [(4) x 1000 / (7)].
(10) = [(5) x 1000 / (7)].
(11) = [(6) x 1000 / (7)].

Chapter 15 - Evaluation of Techniques Exhibit IV
DC Insurer Sheet 1
Reported Claims ($000)

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 3	6	9	12	15	18	21	24	27	30	33	36
1997	861	1,668	2,459	3,255	3,366	3,385	3,385	3,374	3,372	3,374	3,376	3,376
1998	878	1,493	2,248	2,756	2,826	2,812	2,805	2,804	2,785	2,787	2,787	2,788
1999	463	786	1,166	1,605	1,673	1,642	1,646	1,645	1,649	1,649	1,649	1,649
2000	511	806	1,112	1,530	1,684	1,689	1,686	1,688	1,686	1,687	1,687	1,687
2001	414	750	1,264	1,836	2,088	2,078	2,081	2,086	2,086	2,087	2,087	2,088
2002	502	961	1,424	2,016	2,307	2,330	2,342	2,348	2,352	2,354	2,355	2,355
2003	614	1,231	1,940	2,576	2,878	2,936	2,977	2,988	2,992	2,992	2,994	2,994
2004	833	1,576	2,181	3,048	3,407	3,406	3,397	3,403	3,407	3,410	3,412	3,412
2005	675	1,248	1,833	2,601	2,792	2,791	2,803	2,810	2,813	2,814	2,814	2,814
2006	764	1,374	2,157	2,531	2,897	2,930	2,945	2,949				
2007	754	1,468	1,987	2,463								

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 3 - 6	6 - 9	9 - 12	12 - 15	15 - 18	18 - 21	21 - 24	24 - 27	27 - 30	30 - 33	33 - 36	To Ult
1997	1.936	1.475	1.324	1.034	1.006	1.000	0.997	1.000	1.001	1.000	1.000	
1998	1.700	1.506	1.226	1.025	0.995	0.997	1.000	0.993	1.001	1.000	1.000	
1999	1.697	1.483	1.377	1.043	0.981	1.002	1.000	1.002	1.000	1.000	1.000	
2000	1.575	1.380	1.376	1.101	1.003	0.998	1.001	0.999	1.000	1.000	1.000	
2001	1.813	1.685	1.452	1.137	0.995	1.001	1.002	1.000	1.000	1.000	1.000	
2002	1.913	1.482	1.416	1.144	1.010	1.005	1.002	1.002	1.001	1.000	1.000	
2003	2.005	1.576	1.328	1.117	1.020	1.014	1.004	1.001	1.000	1.000	1.000	
2004	1.892	1.384	1.397	1.118	0.999	0.998	1.002	1.001	1.001	1.001	1.000	
2005	1.848	1.468	1.420	1.073	1.000	1.004	1.003	1.001	1.000	1.000	1.000	
2006	1.798	1.569	1.174	1.145	1.011	1.005	1.001					
2007	1.947	1.354	1.240									

PART 3 - Average Age-to-Age Factors

	Averages 3 - 6	6 - 9	9 - 12	12 - 15	15 - 18	18 - 21	21 - 24	24 - 27	27 - 30	30 - 33	33 - 36	To Ult
Simple Average												
All Years	1.830	1.487	1.339	1.094	1.002	1.003	1.001	1.000	1.000	1.000	1.000	
Latest 7	1.888	1.503	1.347	1.119	1.006	1.004	1.002	1.001	1.000	1.000	1.000	
Latest 5	1.898	1.470	1.312	1.119	1.008	1.005	1.002	1.001	1.000	1.000	1.000	
Medial Average												
Latest 5x1	1.883	1.496	1.360	1.124	1.005	1.003	1.002	1.001	1.000	1.000	1.000	
Volume-weighted Average												
All Years	1.838	1.480	1.326	1.091	1.003	1.003	1.001	1.000	1.001	1.000	1.000	
Latest 7	1.889	1.485	1.335	1.119	1.006	1.004	1.002	1.001	1.000	1.000	1.000	
Latest 5	1.895	1.464	1.309	1.118	1.008	1.005	1.002	1.001	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 3 - 6	6 - 9	9 - 12	12 - 15	15 - 18	18 - 21	21 - 24	24 - 27	27 - 30	30 - 33	33 - 36	To Ult
Selected	1.895	1.464	1.309	1.118	1.008	1.005	1.002	1.001	1.000	1.000	1.000	1.000
CDF to Ultimate	4.125	2.177	1.487	1.136	1.016	1.008	1.003	1.001	1.000	1.000	1.000	1.000
Percent Reported	24.2%	45.9%	67.2%	88.0%	98.4%	99.2%	99.7%	99.9%	100.0%	100.0%	100.0%	100.0%

Projection of Ultimate Claims Using Reported Claims ($000)

Accident Year	Age of Accident Year at 12/31/07	Reported Claims at 12/31/07	CDF to Ultimate	Projected Ultimate Claims
(1)	(2)	(3)	(4)	(5)
1997	132	3,376	1.000	3,376
1998	120	2,788	1.000	2,788
1999	108	1,649	1.000	1,649
2000	96	1,687	1.000	1,687
2001	84	2,088	1.000	2,088
2002	72	2,355	1.000	2,355
2003	60	2,994	1.000	2,994
2004	48	3,412	1.000	3,412
2005	36	2,814	1.000	2,814
2006	24	2,949	1.001	2,952
2007	12	2,463	1.136	2,798
Total		28,577		28,915

Column Notes:
(2) Age of accident year in (1) at December 31, 2007.
(3) Based on data from DC Insurer.
(4) Based on selected CDF in Exhibit IV, Sheet 1.
(5) = [(3) x (4)].

Chapter 15 - Evaluation of Techniques
DC Insurer
Annual Monitoring Test ($000)

Exhibit IV
Sheet 3

Accident Year	Selected Ultimate Claims	Expected % Reported at 12/31/07	Expected % Reported at 12/31/08	Reported Claims at 12/31/07	Reported Claims at 12/31/08	Claims Reported Between 12/31/07 and 12/31/08 Actual	Expected	Difference
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1997	3,376	100.0%	100.0%	3,376	3,376	0	0	0
1998	2,788	100.0%	100.0%	2,788	2,788	0	0	0
1999	1,649	100.0%	100.0%	1,649	1,649	0	0	0
2000	1,687	100.0%	100.0%	1,687	1,687	0	0	0
2001	2,088	100.0%	100.0%	2,088	2,096	8	0	8
2002	2,355	100.0%	100.0%	2,355	2,340	- 15	0	- 15
2003	2,994	100.0%	100.0%	2,994	3,007	13	0	13
2004	3,412	100.0%	100.0%	3,412	3,392	- 20	0	- 20
2005	2,814	100.0%	100.0%	2,814	2,885	71	0	71
2006	2,952	99.9%	100.0%	2,949	3,030	81	3	78
2007	2,798	88.0%	99.9%	2,463	2,733	270	332	- 62
Total	28,915			28,577	28,984	407	335	72

Column Notes:
(2) Developed in Exhibit IV, Sheet 2.
(3) and (4) Based on selected CDF in Exhibit IV, Sheet 1.
(5) and (6) Based on data from DC Insurer.
(7) = [(6) - (5)].
(8) = {[(2) - (5)] / [1.0 - (3)] x [(4) - (3)]}.
(9) = [(7) - (8)].

Accident Year	Selected Ultimate Claims	Expected % Reported at			Actual Reported Claims at			Claims Reported Between 12/31/07 and 01/31/08			Claims Reported Between 01/31/08 and 02/29/08		
		12/31/07	01/31/08	02/29/08	12/31/07	01/31/08	02/29/08	Actual	Expected	Difference	Actual	Expected	Difference
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1997	3,376	100.0%	100.0%	100.0%	3,376	3,376	3,376	0	0	0	0	0	0
1998	2,788	100.0%	100.0%	100.0%	2,788	2,788	2,788	0	0	0	0	0	0
1999	1,649	100.0%	100.0%	100.0%	1,649	1,649	1,649	0	0	0	0	0	0
2000	1,687	100.0%	100.0%	100.0%	1,687	1,687	1,687	0	0	0	0	0	0
2001	2,088	100.0%	100.0%	100.0%	2,088	2,096	2,096	8	0	8	0	0	0
2002	2,355	100.0%	100.0%	100.0%	2,355	2,355	2,355	0	0	0	0	0	0
2003	2,994	100.0%	100.0%	100.0%	2,994	2,994	2,998	0	0	0	4	0	4
2004	3,412	100.0%	100.0%	100.0%	3,412	3,422	3,422	10	0	10	0	0	0
2005	2,814	100.0%	100.0%	100.0%	2,814	2,825	2,832	10	0	10	7	0	7
2006	2,952	99.9%	99.9%	100.0%	2,949	2,951	2,986	2	1	1	35	1	34
2007	2,798	88.0%	91.5%	95.0%	2,463	2,473	2,538	10	97	- 87	64	97	- 32
Total	28,915				28,577	28,618	28,728	41	98	- 57	110	98	12

<u>Column Notes:</u>
(2) Developed in Exhibit IV, Sheet 2.
(3) Based on selected CDF in Exhibit IV, Sheet 1.
(4) and (5) Based on linear interpolation of selected CDF in Exhibit IV, Sheet 1.
(6) through (8) Based on data from DC Insurer.
(9) = [(7) - (6)].
(10) = {[(2) - (6)] / [1.0 - (3)] x [(4) - (3)]}.
(11) = [(9) - (10)].
(12) = [(8) - (7)].
(13) = {[(2) - (6)] / [1.0 - (3)] x [(5) - (4)]}.
(14) = [(12) - (13)].

Chapter 15 - Evaluation of Techniques Exhibit V
XYZ Insurer - Auto BI Sheet 1
Ratio of Paid Claims to Selected Ultimate Claims ($000)

PART 1 - Data Triangle

Accident	Paid Claims as of (months)											Selected
Year	12	24	36	48	60	72	84	96	108	120	132	Ultimate
1998			6,309	8,521	10,082	11,620	13,242	14,419	15,311	15,764	15,822	15,822
1999		4,666	9,861	13,971	18,127	22,032	23,511	24,146	24,592	24,817		25,107
2000	1,302	6,513	12,139	17,828	24,030	28,853	33,222	35,902	36,782			37,246
2001	1,539	5,952	12,319	18,609	24,387	31,090	37,070	38,519				38,798
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437					48,169
2003	1,743	6,240	12,683	22,892	34,505	39,320						44,373
2004	2,221	9,898	25,950	43,439	52,811							70,780
2005	3,043	12,219	27,073	40,026								74,726
2006	3,531	11,778	22,819									54,968
2007	3,529	11,865										40,300
2008	3,409											33,491

PART 2 - Ratios

Accident	Ratio of Paid Claims to Selected Ultimate Claims as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998			0.399	0.539	0.637	0.734	0.837	0.911	0.968	0.996	1.000
1999		0.186	0.393	0.556	0.722	0.878	0.936	0.962	0.979	0.988	
2000	0.035	0.175	0.326	0.479	0.645	0.775	0.892	0.964	0.988		
2001	0.040	0.153	0.318	0.480	0.629	0.801	0.955	0.993			
2002	0.048	0.165	0.287	0.459	0.663	0.843	0.923				
2003	0.039	0.141	0.286	0.516	0.778	0.886					
2004	0.031	0.140	0.367	0.614	0.746						
2005	0.041	0.164	0.362	0.536							
2006	0.064	0.214	0.415								
2007	0.088	0.294									
2008	0.102										

PART 3 - Average Ratios

	Averages										
	12	24	36	48	60	72	84	96	108	120	132
Simple Average											
Latest 5	0.065	0.191	0.343	0.521	0.692	0.837	0.909	0.957	0.978	0.992	1.000
Latest 3	0.085	0.224	0.381	0.555	0.729	0.844	0.923	0.973	0.978	0.992	1.000
Latest 2	0.095	0.254	0.389	0.575	0.762	0.865	0.939	0.978	0.984	0.992	1.000
Medial Average											
Latest 5x1	0.064	0.173	0.339	0.510	0.685	0.824	0.917	0.963	0.979	0.992	1.000

PART 4 - Selected Ratios

	Ratios Selection										
	12	24	36	48	60	72	84	96	108	120	132
Selected	0.085	0.224	0.381	0.555	0.729	0.844	0.923	0.973	0.978	0.992	1.000

Chapter 15 - Evaluation of Techniques
XYZ Insurer - Auto BI
Ratio of Reported Claims to Selected Ultimate Claims ($000)

Exhibit V
Sheet 2

PART 1 - Data Triangle

Accident Year	Reported Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132	Selected Ultimate
1998			11,171	12,380	13,216	14,067	14,688	16,366	16,163	15,835	15,822	15,822
1999		13,255	16,405	19,639	22,473	23,764	25,094	24,795	25,071	25,107		25,107
2000	15,676	18,749	21,900	27,144	29,488	34,458	36,949	37,505	37,246			37,246
2001	11,827	16,004	21,022	26,578	34,205	37,136	38,541	38,798				38,798
2002	12,811	20,370	26,656	37,667	44,414	48,701	48,169					48,169
2003	9,651	16,995	30,354	40,594	44,231	44,373						44,373
2004	16,995	40,180	58,866	71,707	70,288							70,780
2005	28,674	47,432	70,340	70,655								74,726
2006	27,066	46,783	48,804									54,968
2007	19,477	31,732										40,300
2008	18,632											33,491

PART 2 - Ratios

Accident Year	Ratio of Reported Claims to Selected Ultimate Claims as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998			0.706	0.782	0.835	0.889	0.928	1.034	1.022	1.001	1.000
1999		0.528	0.653	0.782	0.895	0.947	0.999	0.988	0.999	1.000	
2000	0.421	0.503	0.588	0.729	0.792	0.925	0.992	1.007	1.000		
2001	0.305	0.412	0.542	0.685	0.882	0.957	0.993	1.000			
2002	0.266	0.423	0.553	0.782	0.922	1.011	1.000				
2003	0.217	0.383	0.684	0.915	0.997	1.000					
2004	0.240	0.568	0.832	1.013	0.993						
2005	0.384	0.635	0.941	0.946							
2006	0.492	0.851	0.888								
2007	0.483	0.787									
2008	0.556										

PART 3 - Average Ratios

	Averages 12	24	36	48	60	72	84	96	108	120	132
Simple Average											
Latest 5	0.431	0.645	0.780	0.868	0.917	0.968	0.983	1.007	1.007	1.000	1.000
Latest 3	0.511	0.758	0.887	0.958	0.971	0.989	0.995	0.998	1.007	1.000	1.000
Latest 2	0.520	0.819	0.915	0.979	0.995	1.006	0.997	1.003	0.999	1.000	1.000
Medial Average											
Latest 5x1	0.453	0.663	0.801	0.881	0.932	0.957	0.995	1.003	1.000	1.000	1.000

PART 4 - Selected Ratios

	Ratios Selection 12	24	36	48	60	72	84	96	108	120	132
Selected	0.511	0.758	0.887	0.958	0.971	0.989	0.995	0.998	1.000	1.000	1.000

PART 4 – ESTIMATING UNPAID CLAIM ADJUSTMENT EXPENSES

INTRODUCTION TO PART 4 – ESTIMATING UNPAID CLAIM ADJUSTMENT EXPENSES

In prior chapters of this book, we discuss the categorization of claim adjustment expenses into allocated loss adjustment expenses (ALAE) and unallocated loss adjustment expenses (ULAE). ALAE correspond to those costs the insurer can assign to a particular claim, such as legal and expert witness expenses – thus, the name allocated loss adjustment expense. ULAE, on the other hand, cannot be allocated to a specific claim. Examples of ULAE include salaries, rent, and computer expenses for the claims department of an insurer.

Actuaries in Canada still separate LAE into ALAE and ULAE (also known as internal loss adjusting expense, or ILAE, in Canada). However, the NAIC promulgated two new categorizations of claim adjustment expenses (effective January 1, 1998) for U.S. insurers reporting on Schedule P of the P&C statutory Annual Statement: defense and cost containment (DCC) and adjusting and other (A&O). Generally, DCC expenses include all defense litigation and medical cost containment expenses regardless of whether internal or external to the insurer; A&O expenses include all claims adjusting expenses, whether internal or external to the insurer.

Some insurers in the U.S. now separately analyze DCC and A&O. Other U.S. insurers continue to use the ALAE and ULAE categorization for the purpose of determining unpaid claims adjustment expenses; these insurers use other allocation methods to distinguish between DCC and A&O for statutory financial statement reporting purposes. In Chapter 16, we address common techniques for estimating unpaid ALAE. While we choose to use the term ALAE in this chapter, we point out that the development methods presented in Chapter 16 can also be used for DCC. Key determining factors include:

- Whether or not sufficient detail is available regarding the expenses such that the data can be organized by accident year (policy, underwriting, or report year)

- Whether the expenses tend to track accident year (policy, underwriting, or report year) or are more dependent on calendar year

Unlike ALAE, which often demonstrate a close relationship with claims experience, ULAE or A&O are often related to the size of the insurer's claims department and are less closely related to claims. In Chapter 17, we present techniques for estimating unpaid ULAE (and A&O).

CHAPTER 16 – ESTIMATING UNPAID ALLOCATED CLAIM ADJUSTMENT EXPENSES

After describing the 1998 changes to the categorization of expenses from ALAE and ULAE to DCC and A&O, Mr. Wiser states:

> The key in grouping expenses for reserving purposes is still whether or not the expenses are assigned to an individual claim. Significantly more analysis can be completed for those expenses that are assigned to an individual claim (allocated expenses) because more data exists. For instance, the accident date of the claim that generated the expense is known for an allocated expense, but unknown for an unallocated expense.[88]

All of the development techniques described in Part 3 can be used with ALAE. The greatest challenge for the actuary is often obtaining data for ALAE separate from claim only data. In order for the actuary to determine how to estimate unpaid ALAE, he or she must understand how the insurer processes such expenses and what data is available for analysis.

Many insurers record only ALAE payments and do not separately estimate case outstanding for ALAE. Other insurers may combine data for all types of ALAE. Some insurers maintain detailed information regarding case outstanding estimates and payments for the different types of ALAE (e.g., defense costs, expert witness fees, claims adjusting, and investigation). Mr. Wiser comments on the value of splitting the analysis of ALAE by subcategory:

> The most important subcategory is attorneys' fees and court costs. It will often be conducive to obtaining better estimates of loss adjustment expense to develop legal expense separate from all other allocated expense items.

Due to data limitations, actuaries often combine ALAE with claims data for the purpose of determining estimates of unpaid ALAE. However, it is important that the actuary recognizes that for some lines of business the development patterns for ALAE differ significantly from the patterns inherent in the claim only experience. For example, for some third-party liability lines of insurance, defense and expert witness costs may occur on an ongoing basis during the period of investigation and well before any claim payment to the claimant. Furthermore, some defense and settlement costs may lag the payment to the injured party. Thus, combining claim amount with ALAE for such lines of business can present challenges similar to combining two lines of business with non-homogeneous experience.

In Chapter 3 – Understanding the Types of Data Used in the Estimation of Unpaid Claims, we state: "We cannot emphasize strongly enough how critical it is for the actuary to fully understand the types of data generated by the insurer's information systems." This comment is equally applicable for the actuary gathering data for an analysis of unpaid ALAE. The actuary must understand the definition of ALAE used by the insurer and ensure that such definition has not changed over the experience period. The actuary must also understand how changes in the insurer's operations and/or policies may have affected the historical ALAE experience.

[88] *Foundations of Casualty Actuarial Science*, 2001.

Example – Auto Property Damage Insurer

The development technique is frequently used by actuaries with paid ALAE. When separate case outstanding for ALAE exists, actuaries will also use a reported ALAE development technique. Another frequently used approach is the development of the ratio of paid ALAE-to-paid claims only. We use a sample insurer writing automobile property damage insurance (Auto Property Damage Insurer) to demonstrate four projection techniques for ALAE. We understand based on our discussions with the claims department management that Auto Property Damage Insurer maintains separate case outstanding for ALAE.

In Exhibit I, Sheets 1 through 3, we present the ALAE development method for reported and paid ALAE; in Exhibit I, Sheets 4 through 8, we use the development method applied to the ratio of paid ALAE-to-paid claims. We present our final projection of ultimate ALAE in Exhibit I, Sheets 9 and 10. In this approach, we also review the ratio of paid ALAE-to-paid claims. However, we use additive development factors instead of multiplicative factors to project ultimate ALAE. In "Loss Reserving," Mr. Wiser notes: "If the ratios are very small at early maturities, the additive approach seems to be more stable."[89] It is important to remember that all of the assumptions underlying the development technique described in Chapter 7 are equally applicable to the following example for ALAE.

We begin our example with the projection of reported and paid ALAE in Exhibit I, Sheets 1 and 2, respectively. We immediately notice an increasing volume of reported and paid ALAE for accident years 2006 through 2008. After a quick review of the age-to-age factors (looking down the columns) for the reported ALAE, we also observe a changing pattern of development particularly at 12-to-24 months and 24-to-36 months. The age-to-age factors are smaller for the more recent accident year when compared to the earliest accident years in the experience period. Both of these observations should lead us to seek further information. Is ALAE increasing because the size of the portfolio is increasing (i.e., are there more insureds for recent years than prior years)? Were there operational or policy changes over the experience period that have led to earlier recognition of ALAE case outstanding? The same magnitude of change is not evident when looking down the columns of the age-to-age factors for paid ALAE.

To reflect the most recent experience, we select age-to-age factors based on the volume-weighted average for the latest three years for both reported ALAE and paid ALAE. We select a tail factor of 1.00 for reported ALAE since there is no further development beyond 96 months evident in the triangle. For paid ALAE, we select a tail factor of 1.005 based on a review of the ratios of reported ALAE-to-paid ALAE from 96 months to 132 months and consideration of the observed paid development during this period. In Exhibit I, Sheet 3, we project ultimate ALAE using the development technique described previously in this book. The format of Exhibit I, Sheet 3 is identical to the development projection exhibits of many other chapters. The reported and paid ALAE projections are very similar; we do see a significant increase in the ultimate ALAE for accident years 2006 through 2008.

Our second approach for the projection of ultimate ALAE is in Exhibit I, Sheets 4 through 8. This approach uses the development technique applied to the ratio of paid ALAE-to-paid claims only. When using a ratio approach for ALAE, the first step is to determine an estimate of the ultimate claims. In Exhibit I, Sheets 4 and 5, we project ultimate claims for Auto Property Damage Insurer based on reported claims only and paid claims only, respectively. While there is some evidence of an increasing volume of claims, it does not appear as significant as the increase in ALAE

[89] *Foundations of Casualty Actuarial Science*, 2001.

mentioned earlier. We notice age-to-age factors of less than 1.00 (also known as downward or negative development) for reported claims only. This is not surprising to us since we know, based on meetings with claims department management, that Auto Property Damage Insurer does not consider salvage and subrogation (S&S) when setting case outstanding even though substantial recoveries due to S&S are quite common for this line of business.

It is interesting at this time to compare the development patterns for ALAE and claims only. In the following two tables we summarize the selected development patterns and the implied reporting and payment patterns for Auto Property Damage Insurer.

	Reported ALAE		Reported Claims Only	
Age (Months)	**CDF**	**Implied % Reported**	**CDF**	**Implied % Reported**
12	1.367	73.2%	1.101	90.8%
24	1.169	85.5%	0.990	101.0%
36	1.106	90.4%	0.989	101.1%
48	1.066	93.8%	0.991	100.9%
60	1.045	95.7%	0.993	100.7%
72	1.008	99.2%	0.998	100.2%
84	1.002	99.8%	0.999	100.1%
96	1.000	100.0%	0.999	100.1%
108			1.000	100.0%

	Paid ALAE		Paid Claims Only	
Age (Months)	**CDF**	**Implied % Paid**	**CDF**	**Implied % Paid**
12	2.138	46.8%	1.584	63.1%
24	1.241	80.6%	1.029	97.2%
36	1.155	86.6%	1.007	99.3%
48	1.096	91.2%	1.004	99.6%
60	1.058	94.5%	1.002	99.8%
72	1.028	97.3%	1.001	99.9%
84	1.013	98.7%	1.001	99.9%
96	1.009	99.1%	1.001	99.9%
108	1.007	99.3%	1.000	100.0%
120	1.005	99.5%		
132	1.005	99.5%		

We see that the ALAE reported and paid patterns lag the claims only patterns. One potential explanation for this could be related to the S&S and the expenses incurred in achieving these recoveries.

We continue to rely on the three-year volume-weighted averages to reflect the most recent experience for Auto Property Damage Insurer. In Exhibit I, Sheet 6, we select ultimate claims only based on the average of the reported and paid claims only projections. It is not surprising that the reported and paid claims only projections are very similar for this relatively stable, short-tail line of insurance.

In Exhibit I, Sheet 7, we use the development technique to analyze the ratio of paid ALAE-to-paid claims only. An important assumption underlying the ratio analysis is that the relationship between ALAE and claims only is relatively stable over the experience period. The actuary should confirm this assumption during his or her data gathering process and specifically during discussions with management. A change in defense strategy or a new policy with respect to the use of external versus internal defense counsel are two examples of changes that could result in difficulties in using historical relationships to project future ALAE experience.

While an advantage of the ratio method is that it recognizes the relationship between ALAE and claims only, a disadvantage is that any error in the estimate of ultimate claims only could affect the estimate of ultimate ALAE. Another potential challenge with a ratio method exists for some lines of business where large amounts of ALAE may be spent on claims that ultimately settle with no claim payment. In previous chapters, we discuss the importance of reviewing large claims and possibly projecting estimates of unpaid large claims separately. Similar comments apply to the analysis of unpaid ALAE with respect to large expenses as for large claims.

An advantage of the ratio approach (noted previously in our discussion of salvage and subrogation) is that the ratio development factors tend not to be as highly leveraged as the development factors based on paid ALAE dollars. We select age-to-age factors based on the simple average of the latest three years. Initially, we select a tail factor of 1.00 for the ratio of paid ALAE-to-paid claims based on the absence of development seen at 108-to-120 months. We will see that this method produces projected ultimate ALAE that are less than the reported and paid ALAE projections; a key reason for this difference is the absence of a tail factor. If we review the previous tables, we will note that paid ALAE lagged paid claims only. If these implied patterns are, in fact, correct, then there should be a tail factor for the ratio of paid ALAE-to-paid claims only.

Another advantage of using a ratio approach is the ability to easily interject actuarial judgment in the projection analysis, particularly for the selection of the ultimate ALAE ratio for the most recent year(s) in the experience period. In Exhibit I, Sheet 8, we use the development technique to project an initial estimate of the ALAE ratio to claim amount of 0.0102 for accident years 2007 and 2008. However, based on comparison to the immediate preceding years, 0.0102 seems high. The higher ratio may be due to a change in procedures for recording ALAE or unusually large expenses. The average of the ultimate ALAE ratios for all the years up to 2006 in the experience period is .0077, and the average for the latest three years excluding 2007 and 2008 is 0.0071. We select an ultimate ALAE ratio for 2007 and 2008 of 0.0077, based on the average for all years. We determine ultimate ALAE based on the multiplication of the selected ultimate claims (from Exhibit I, Sheet 6) and the ultimate ALAE ratio (from Column (6)).

In Exhibit I, Sheets 9 and 10, we present an alternative to the standard multiplicative development method. In our third approach, we use additive rather than multiplicative development factors to ultimate. The mechanics of this approach are quite similar to the standard method. We first display the ratio of paid ALAE-to-paid claims only. (See Part 1 in the top section of Exhibit I, Sheet 9.) In the middle section of this exhibit (Part 2), we develop age-to-age factors based on the difference between the ratios at successive ages. For example, the 12-to-24 month factor for accident year 1998 is equal to the paid ratio of 0.0081 at 24 months minus the paid ratio of 0.0066 at 12 months, or .0015. Similarly, the 36-to-48 month factor for accident year 2002 is equal to the paid ratio at 48 months of 0.0068 less the paid ratio at 36 months of 0.0063, or 0.0005. In Part 3 of this exhibit, we calculate average age-to-age factors in the same manner as for the standard development technique. To be consistent with the other projections used for Auto Property Damage Insurer, we select additive age-to-age factors based on the simple average for the latest three years. The age-to-ultimate factor is then based on cumulative addition (not multiplication) beginning with the selected factor for the oldest age.

We present the projection of ultimate ALAE using the additive approach in Exhibit I, Sheet 10. The only difference between this projection and the projection in Exhibit I, Sheet 8, which is based on the standard (i.e., multiplicative) approach, is that we add the paid ALAE ratio from the latest diagonal of the triangle to the cumulative development factor instead of multiplying by the cumulative development factor. In Exhibit I, Sheet 9, we do not modify the ALAE ratio for the latest years, instead we allow the initial projected ratio values for 2007 and 2008 to be used to project ultimate ALAE.

The results of the four projections are summarized in Exhibit I, Sheet 11. In this exhibit, we also present the estimated unpaid ALAE, which is equal to projected ultimate ALAE less paid ALAE. The estimated unpaid ALAE in this exhibit represent total unpaid ALAE, including both case outstanding for ALAE and ALAE IBNR. We observe that without a tail factor, the projected ALAE based on the standard development technique applied to the ratio of paid ALAE-to-paid claims only appears low. Even if we change the tail factor to 1.005, this method still does not appear sufficient. The challenge is in selecting the ultimate ALAE ratio for the most recent two accident years. With a selected ratio of 0.0077, the estimate of unpaid ALAE is negative for accident year 2007. This intuitively does not seem correct based on our knowledge of the property damage line of insurance and the operations of XYZ Insurer. In selecting which method is appropriate for each accident year, the actuary will need to conduct similar evaluation analyses as described in Chapter 15 for claims.

Choosing a Technique for Estimating Unpaid ALAE

Similar comments apply for ALAE as for claims with respect to when the various estimation techniques work and when they do not. For many actuaries, the choice of a technique to estimate unpaid ALAE depends primarily on the types of data available, the credibility of the data, and an understanding as to how the insurer's environment affects the various projection techniques.

Reported ALAE ($000)

PART 1 - Data Triangle

Accident Year	Reported ALAE as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	684	953	1,031	1,062	1,080	1,084	1,089	1,092	1,092	1,092	1,092
1999	625	929	1,006	1,033	1,041	1,046	1,049	1,051	1,051	1,051	
2000	571	771	821	844	858	861	862	862	862		
2001	629	894	943	982	997	1,002	1,003	1,007			
2002	618	872	952	1,005	1,033	1,093	1,110				
2003	757	948	1,035	1,092	1,095	1,143					
2004	743	915	976	1,001	1,032						
2005	789	948	1,001	1,032							
2006	988	1,140	1,198								
2007	1,373	1,596									
2008	1,556										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.393	1.082	1.030	1.017	1.004	1.005	1.003	1.000	1.000	1.000	
1999	1.486	1.083	1.027	1.008	1.005	1.003	1.002	1.000	1.000		
2000	1.350	1.065	1.028	1.017	1.003	1.001	1.000	1.000			
2001	1.421	1.055	1.041	1.015	1.005	1.001	1.004				
2002	1.411	1.092	1.056	1.028	1.058	1.016					
2003	1.252	1.092	1.055	1.003	1.044						
2004	1.231	1.067	1.026	1.031							
2005	1.202	1.056	1.031								
2006	1.154	1.051									
2007	1.162										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.200	1.071	1.042	1.019	1.023	1.005	1.002	1.000	1.000	1.000	
Latest 3	1.173	1.058	1.037	1.021	1.036	1.006	1.002	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.198	1.071	1.042	1.020	1.018	1.003	1.002	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.193	1.070	1.042	1.018	1.024	1.005	1.002	1.000	1.000	1.000	
Latest 3	1.170	1.057	1.038	1.020	1.036	1.006	1.002	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.170	1.057	1.038	1.020	1.036	1.006	1.002	1.000	1.000	1.000	1.000
CDF to Ultimate	1.367	1.169	1.106	1.066	1.045	1.008	1.002	1.000	1.000	1.000	1.000
Percent Reported	73.2%	85.5%	90.4%	93.8%	95.7%	99.2%	99.8%	100.0%	100.0%	100.0%	100.0%

Chapter 16 - Estimating Unpaid Allocated Claim Adjustment Expenses Exhibit I
Auto Property Damage Insurer Sheet 2
Paid ALAE ($000)

PART 1 - Data Triangle

Accident Year	Paid ALAE as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998	512	856	949	1,003	1,049	1,065	1,075	1,080	1,082	1,084	1,084
1999	529	874	952	988	1,016	1,024	1,034	1,040	1,042	1,045	
2000	471	720	787	821	846	855	857	860	861		
2001	480	802	882	936	975	987	995	998			
2002	451	793	887	956	1,004	1,067	1,098				
2003	572	874	974	1,041	1,069	1,085					
2004	557	840	921	960	989						
2005	563	882	941	987							
2006	636	1,064	1,132								
2007	774	1,454									
2008	952										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.672	1.109	1.057	1.046	1.015	1.009	1.005	1.002	1.002	1.000	
1999	1.652	1.089	1.038	1.028	1.008	1.010	1.006	1.002	1.003		
2000	1.529	1.093	1.043	1.030	1.011	1.002	1.004	1.001			
2001	1.671	1.100	1.061	1.042	1.012	1.008	1.003				
2002	1.758	1.119	1.078	1.050	1.063	1.029					
2003	1.528	1.114	1.069	1.027	1.015						
2004	1.508	1.096	1.042	1.030							
2005	1.567	1.067	1.049								
2006	1.673	1.064									
2007	1.879										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.631	1.092	1.060	1.036	1.022	1.012	1.004	1.002	1.002	1.000	
Latest 3	1.706	1.076	1.053	1.036	1.030	1.013	1.004	1.002	1.002	1.000	
Medial Average											
Latest 5x1	1.589	1.093	1.060	1.034	1.013	1.009	1.004	1.002	1.002	1.000	
Volume-weighted Average											
Latest 5	1.649	1.090	1.060	1.036	1.022	1.012	1.004	1.002	1.002	1.000	
Latest 3	1.723	1.075	1.054	1.036	1.030	1.014	1.004	1.002	1.002	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.723	1.075	1.054	1.036	1.030	1.014	1.004	1.002	1.002	1.000	1.005
CDF to Ultimate	2.138	1.241	1.155	1.096	1.058	1.028	1.013	1.009	1.007	1.005	1.005
Percent Received	46.8%	80.6%	86.6%	91.2%	94.5%	97.3%	98.7%	99.1%	99.3%	99.5%	99.5%

Projection of Ultimate ALAE ($000)

Accident Year	Age of Accident Year at 12/31/08	ALAE at 12/31/08 Reported	ALAE at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Projected Ultimate ALAE Using Dev. Method with Reported	Projected Ultimate ALAE Using Dev. Method with Paid
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	1,092	1,084	1.000	1.005	1,092	1,089
1999	120	1,051	1,045	1.000	1.005	1,051	1,050
2000	108	862	861	1.000	1.007	862	867
2001	96	1,007	998	1.000	1.009	1,007	1,007
2002	84	1,110	1,098	1.002	1.013	1,112	1,112
2003	72	1,143	1,085	1.008	1.028	1,152	1,115
2004	60	1,032	989	1.045	1.058	1,078	1,046
2005	48	1,032	987	1.066	1.096	1,100	1,082
2006	36	1,198	1,132	1.106	1.155	1,325	1,307
2007	24	1,596	1,454	1.169	1.241	1,866	1,804
2008	12	1,556	952	1.367	2.138	2,127	2,035
Total		12,679	11,685			13,773	13,517

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Property Damage Insurer.
(5) and (6) Based on CDF from Exhibit I, Sheets 1 and 2.
(7) = [(3) x (5)].
(8) = [(4) x (6)].

Reported Claims Only ($000)

PART 1 - Data Triangle

Accident Year	Reported Claims Only as of (months) 12	24	36	48	60	72	84	96	108	120	132
1998	109,286	111,832	110,648	109,174	108,849	108,779	108,786	108,646	108,736	108,735	108,732
1999	120,639	119,607	116,924	116,482	116,332	116,230	116,236	116,161	116,160	116,125	
2000	115,422	119,143	118,641	117,008	116,782	116,919	116,860	116,825	116,472		
2001	129,430	139,925	138,161	137,395	137,269	137,033	136,998	137,056			
2002	134,190	143,852	143,093	142,360	142,004	141,715	141,627				
2003	152,678	166,131	166,015	165,579	165,229	163,508					
2004	144,595	154,830	154,295	154,228	153,750						
2005	137,791	154,230	154,307	153,981							
2006	159,818	178,399	179,384								
2007	162,205	178,425									
2008	176,030										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.023	0.989	0.987	0.997	0.999	1.000	0.999	1.001	1.000	1.000	
1999	0.991	0.978	0.996	0.999	0.999	1.000	0.999	1.000	1.000		
2000	1.032	0.996	0.986	0.998	1.001	0.999	1.000	0.997			
2001	1.081	0.987	0.994	0.999	0.998	1.000	1.000				
2002	1.072	0.995	0.995	0.997	0.998	0.999					
2003	1.088	0.999	0.997	0.998	0.990						
2004	1.071	0.997	1.000	0.997							
2005	1.119	1.001	0.998								
2006	1.116	1.006									
2007	1.100										
2008											

PART 3 - Average Age-to-Age Factors

	Averages 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.099	0.999	0.997	0.998	0.997	1.000	1.000	0.999	1.000	1.000	
Latest 3	1.112	1.001	0.998	0.997	0.995	1.000	1.000	0.999	1.000	1.000	
Medial Average											
Latest 5x1	1.101	0.999	0.997	0.998	0.998	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.099	1.000	0.997	0.998	0.997	1.000	1.000	0.999	1.000	1.000	
Latest 3	1.111	1.001	0.998	0.997	0.995	1.000	1.000	0.999	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection 12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.111	1.001	0.998	0.997	0.995	1.000	1.000	0.999	1.000	1.000	1.000
CDF to Ultimate	1.101	0.990	0.989	0.991	0.993	0.998	0.999	0.999	1.000	1.000	1.000
Percent Reported	90.8%	101.0%	101.1%	100.9%	100.7%	100.2%	100.1%	100.1%	100.0%	100.0%	100.0%

Paid Claims Only ($000)

PART 1 - Data Triangle

Accident	Paid Claims Only as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	78,144	105,902	107,306	108,135	108,307	108,494	108,523	108,628	108,731	108,730	108,730
1999	81,290	114,037	115,347	115,696	115,843	115,930	115,962	115,969	115,969	116,033	
2000	83,563	114,175	116,044	116,458	116,620	116,857	116,810	116,807	116,807		
2001	91,475	133,761	136,143	136,552	136,818	136,838	136,960	136,995			
2002	92,349	138,461	140,904	141,323	141,380	141,452	141,461				
2003	111,655	158,092	161,823	162,556	162,802	163,257					
2004	106,032	149,157	151,729	152,229	152,613						
2005	98,270	149,504	152,895	153,154							
2006	107,137	171,332	175,602								
2007	114,337	171,505									
2008	124,470										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.355	1.013	1.008	1.002	1.002	1.000	1.001	1.001	1.000	1.000	
1999	1.403	1.011	1.003	1.001	1.001	1.000	1.000	1.000	1.001		
2000	1.366	1.016	1.004	1.001	1.002	1.000	1.000	1.000			
2001	1.462	1.018	1.003	1.002	1.000	1.001	1.000				
2002	1.499	1.018	1.003	1.000	1.001	1.000					
2003	1.416	1.024	1.005	1.002	1.003						
2004	1.407	1.017	1.003	1.003							
2005	1.521	1.023	1.002								
2006	1.599	1.025									
2007	1.500										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.489	1.021	1.003	1.002	1.001	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.540	1.022	1.003	1.001	1.001	1.000	1.000	1.000	1.000	1.000	
Medial Average											
Latest 5x1	1.479	1.021	1.003	1.002	1.001	1.000	1.000	1.000	1.000	1.000	
Volume-weighted Average											
Latest 5	1.488	1.021	1.003	1.002	1.001	1.000	1.000	1.000	1.000	1.000	
Latest 3	1.540	1.022	1.003	1.002	1.001	1.000	1.000	1.000	1.000	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.540	1.022	1.003	1.002	1.001	1.000	1.000	1.000	1.000	1.000	1.000
CDF to Ultimate	1.584	1.029	1.007	1.004	1.002	1.001	1.001	1.001	1.000	1.000	1.000
Percent Paid	63.1%	97.2%	99.3%	99.6%	99.8%	99.9%	99.9%	99.9%	100.0%	100.0%	100.0%

Chapter 16 - Estimating Unpaid Allocated Claim Adjustment Expenses
Auto Property Damage Insurer
Projection of Ultimate Claims Using Reported and Paid Claims Only ($000)

Accident Year	Age of Accident Year at 12/31/08	Claims Only at 12/31/08 Reported	Claims Only at 12/31/08 Paid	CDF to Ultimate Reported	CDF to Ultimate Paid	Proj. Ultimate Claims Only Using Dev. Method with Reported	Proj. Ultimate Claims Only Using Dev. Method with Paid	Selected Ultimate Claims Only
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1998	132	108,732	108,730	1.000	1.000	108,732	108,730	108,731
1999	120	116,125	116,033	1.000	1.000	116,125	116,033	116,079
2000	108	116,472	116,807	1.000	1.000	116,472	116,807	116,639
2001	96	137,056	136,995	0.999	1.001	136,919	137,132	137,026
2002	84	141,627	141,461	0.999	1.001	141,485	141,602	141,544
2003	72	163,508	163,257	0.998	1.001	163,181	163,420	163,301
2004	60	153,750	152,613	0.993	1.002	152,674	152,918	152,796
2005	48	153,981	153,154	0.991	1.004	152,596	153,766	153,181
2006	36	179,384	175,602	0.989	1.007	177,410	176,831	177,121
2007	24	178,425	171,505	0.990	1.029	176,641	176,479	176,560
2008	12	176,030	124,470	1.101	1.584	193,809	197,161	195,485
Total		1,625,091	1,560,626			1,636,045	1,640,879	1,638,462

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) and (4) Based on data from Auto Property Damage Insurer
(5) and (6) Based on CDF from Exhibit I, Sheets 4 and 5.
(7) = [(3) x (5)].
(8) = [(4) x (6)].
(9) = [Average of (7) and (8)].

Ratio of Paid ALAE to Paid Claims Only

PART 1 - Ratio Triangle

Accident	Ratio of Paid ALAE to Paid Claims Only as of (months)										
Year	12	24	36	48	60	72	84	96	108	120	132
1998	0.0066	0.0081	0.0088	0.0093	0.0097	0.0098	0.0099	0.0099	0.0100	0.0100	0.0100
1999	0.0065	0.0077	0.0083	0.0085	0.0088	0.0088	0.0089	0.0090	0.0090	0.0090	
2000	0.0056	0.0063	0.0068	0.0070	0.0073	0.0073	0.0073	0.0074	0.0074		
2001	0.0052	0.0060	0.0065	0.0069	0.0071	0.0072	0.0073	0.0073			
2002	0.0049	0.0057	0.0063	0.0068	0.0071	0.0075	0.0078				
2003	0.0051	0.0055	0.0060	0.0064	0.0066	0.0066					
2004	0.0053	0.0056	0.0061	0.0063	0.0065						
2005	0.0057	0.0059	0.0062	0.0064							
2006	0.0059	0.0062	0.0064								
2007	0.0068	0.0085									
2008	0.0076										

PART 2 - Age-to-Age Factors

Accident	Age-to-Age Factors										
Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	1.234	1.094	1.049	1.044	1.014	1.009	1.004	1.001	1.002	1.000	
1999	1.178	1.077	1.035	1.027	1.007	1.009	1.006	1.002	1.002		
2000	1.119	1.075	1.039	1.029	1.009	1.003	1.004	1.001			
2001	1.143	1.081	1.058	1.040	1.012	1.007	1.003				
2002	1.173	1.099	1.075	1.050	1.062	1.029					
2003	1.079	1.089	1.064	1.025	1.012						
2004	1.072	1.078	1.039	1.028							
2005	1.030	1.043	1.047								
2006	1.046	1.038									
2007	1.252										
2008											

PART 3 - Average Age-to-Age Factors

	Averages										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	1.096	1.069	1.057	1.034	1.020	1.012	1.004	1.001	1.002	1.000	
Latest 3	1.109	1.053	1.050	1.034	1.029	1.013	1.004	1.001	1.002	1.000	
Medial Average											
Latest 5x1	1.066	1.070	1.056	1.032	1.011	1.009	1.004	1.001	1.002	1.000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	1.109	1.053	1.050	1.034	1.029	1.013	1.004	1.001	1.002	1.000	1.000
CDF to Ultimate	1.332	1.201	1.140	1.086	1.050	1.021	1.007	1.003	1.002	1.000	1.000

Auto Property Damage Insurer
Projection of Ultimate ALAE ($000)

Accident Year	Age of Accident Year at 12/31/08	Ratio of Paid ALAE to Paid Claims Only at 12/31/08	CDF to Ultimate	Projected Ultimate Ratio	Selected Ultimate Paid-to-Paid Ratio	Selected Ultimate Claims Only	Projected Ultimate Paid ALAE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	0.0100	1.000	0.0100	0.0100	108,731	1,084
1999	120	0.0090	1.000	0.0090	0.0090	116,079	1,045
2000	108	0.0074	1.002	0.0074	0.0074	116,639	861
2001	96	0.0073	1.003	0.0073	0.0073	137,026	1,001
2002	84	0.0078	1.007	0.0078	0.0078	141,544	1,106
2003	72	0.0066	1.021	0.0068	0.0068	163,301	1,108
2004	60	0.0065	1.050	0.0068	0.0068	152,796	1,040
2005	48	0.0064	1.086	0.0070	0.0070	153,181	1,072
2006	36	0.0064	1.140	0.0073	0.0073	177,121	1,302
2007	24	0.0085	1.201	0.0102	0.0077	176,560	1,360
2008	12	0.0076	1.332	0.0102	0.0077	195,485	1,505
Total						1,638,462	12,485

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) From latest diagonal of triangle in Exhibit I, Sheet 7.
(4) Based on CDF from Exhibit I, Sheet 7.
(5) = [(3) x (4)].
(6) = (5), except for 2007 and 2008 which are judgementally selected based on review of prior years.
(7) Developed in Exhibit I, Sheet 6.
(8) = [(6) x (7)].

Ratio of Paid ALAE to Paid Claims Only - Additive Method

PART 1 - Ratio Triangle

Accident Year	Ratio of Paid ALAE to Paid Claims Only as of (months)										
	12	24	36	48	60	72	84	96	108	120	132
1998	0.0066	0.0081	0.0088	0.0093	0.0097	0.0098	0.0099	0.0099	0.0100	0.0100	0.0100
1999	0.0065	0.0077	0.0083	0.0085	0.0088	0.0088	0.0089	0.0090	0.0090	0.0090	
2000	0.0056	0.0063	0.0068	0.0070	0.0073	0.0073	0.0073	0.0074	0.0074		
2001	0.0052	0.0060	0.0065	0.0069	0.0071	0.0072	0.0073	0.0073			
2002	0.0049	0.0057	0.0063	0.0068	0.0071	0.0075	0.0078				
2003	0.0051	0.0055	0.0060	0.0064	0.0066	0.0066					
2004	0.0053	0.0056	0.0061	0.0063	0.0065						
2005	0.0057	0.0059	0.0062	0.0064							
2006	0.0059	0.0062	0.0064								
2007	0.0068	0.0085									
2008	0.0076										

PART 2 - Age-to-Age Factors

Accident Year	Age-to-Age Factors - Additive										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	109 - 120	To Ult
1998	0.0015	0.0008	0.0004	0.0004	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	
1999	0.0012	0.0006	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000		
2000	0.0007	0.0005	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000			
2001	0.0007	0.0005	0.0004	0.0003	0.0001	0.0001	0.0000				
2002	0.0008	0.0006	0.0005	0.0003	0.0004	0.0002					
2003	0.0004	0.0005	0.0004	0.0002	0.0001						
2004	0.0004	0.0004	0.0002	0.0002							
2005	0.0002	0.0003	0.0003								
2006	0.0003	0.0002									
2007	0.0017										
2008											

PART 3 - Average Age-to-Age Factors

	Averages - Additive										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Simple Average											
Latest 5	0.0006	0.0004	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	
Latest 3	0.0007	0.0003	0.0003	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	
Medial Average											
Latest 5x1	0.0004	0.0004	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	

PART 4 - Selected Age-to-Age Factors

	Development Factor Selection - Additive										
	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	To Ult
Selected	0.0007	0.0003	0.0003	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
CDF to Ultimate	0.0019	0.0012	0.0009	0.0006	0.0004	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000

Chapter 16 - Estimating Unpaid Allocated Claim Adjustment Expenses
Auto Property Damage Insurer
Projection of Ultimate ALAE ($000) - Additive Method

Accident Year	Age of Accident Year at 12/31/08	Ratio of Paid ALAE to Paid Claims Only at 12/31/08	Additive CDF to Ultimate	Projected Ultimate Ratio	Selected Ultimate Paid-to-Paid Ratio	Selected Ultimate Claims Only	Projected Ultimate Paid ALAE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	132	0.0100	0.0000	0.0100	0.0100	108,731	1,084
1999	120	0.0090	0.0000	0.0090	0.0090	116,079	1,045
2000	108	0.0074	0.0000	0.0074	0.0074	116,639	862
2001	96	0.0073	0.0000	0.0073	0.0073	137,026	1,003
2002	84	0.0078	0.0001	0.0078	0.0078	141,544	1,108
2003	72	0.0066	0.0002	0.0068	0.0068	163,301	1,112
2004	60	0.0065	0.0004	0.0068	0.0068	152,796	1,046
2005	48	0.0064	0.0006	0.0070	0.0070	153,181	1,077
2006	36	0.0064	0.0009	0.0073	0.0073	177,121	1,300
2007	24	0.0085	0.0012	0.0097	0.0097	176,560	1,709
2008	12	0.0076	0.0019	0.0096	0.0096	195,485	1,870
Total						1,638,462	13,215

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) From latest diagonal of triangle in Exhibit I, Sheet 9.
(4) Based on additive CDF from Exhibit I, Sheet 9.
(5) = [(3) + (4)].
(6) = (5).
(7) Developed in Exhibit I, Sheet 6.
(8) = [(6) x (7)].

Development of Estimated Unpaid ALAE ($000)

Accident Year	Age of Accident Year at 12/31/08	Paid ALAE at 12/31/08	Projected Ultimate ALAE: Using Dev Method with Reported	Projected Ultimate ALAE: Using Dev Method with Paid	Projected Ultimate ALAE: Using Ratio Method with Mult.	Projected Ultimate ALAE: Using Ratio Method with Additive	Estimated Unpaid ALAE: Using Dev Method with Reported	Estimated Unpaid ALAE: Using Dev Method with Paid	Estimated Unpaid ALAE: Using Ratio Method with Mult.	Estimated Unpaid ALAE: Using Ratio Method with Additive
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1998	132	1,084	1,092	1,089	1,084	1,084	8	5	0	0
1999	120	1,045	1,051	1,050	1,045	1,045	6	5	0	0
2000	108	861	862	867	861	862	1	6	0	1
2001	96	998	1,007	1,007	1,001	1,003	9	9	3	5
2002	84	1,098	1,112	1,112	1,106	1,108	14	14	8	10
2003	72	1,085	1,152	1,115	1,108	1,112	67	30	23	27
2004	60	989	1,078	1,046	1,040	1,046	89	57	51	57
2005	48	987	1,100	1,082	1,072	1,077	113	95	85	90
2006	36	1,132	1,325	1,307	1,302	1,300	193	175	170	168
2007	24	1,454	1,866	1,804	1,360	1,709	412	350	- 94	255
2008	12	952	2,127	2,035	1,505	1,870	1,175	1,083	553	918
Total		11,685	13,773	13,517	12,485	13,215	2,088	1,832	800	1,530

Column Notes:
(2) Age of accident year in (1) at December 31, 2008.
(3) Based on data from Auto Property Damage Insurer.
(4) and (5) Developed in Exhibit I, Sheet 3.
(6) Developed in Exhibit I, Sheet 8.
(7) Developed in Exhibit I, Sheet 10.
(8) = [(4) - (3)].
(9) = [(5) - (3)].
(10) = [(6) - (3)].
(11) = [(7) - (3)].

CHAPTER 17 – ESTIMATING UNPAID UNALLOCATED CLAIM ADJUSTMENT EXPENSES

In this chapter, we present several techniques for estimating unpaid unallocated claim adjustment expenses (ULAE). We rely extensively on the 2003 paper by Robert F. Conger, FCAS, FCIA, MAAA and Alejandra Nolibos, FCAS, MAAA "Estimating ULAE Liabilities: Rediscovering and Expanding Kittel's Approach." [90]

ULAE (known as ILAE in Canada) refer to general overhead expenses associated with the claims-handling process, and particularly the costs of investigating, handling, paying, and resolving claims. We can differentiate between ALAE and ULAE. As described in Chapter 16, ALAE are those costs that can be assigned to a specific claim. Examples of ALAE include legal fees, the cost of expert witnesses, police reports, engineering reports, and independent adjusters if assigned to a particular claim. In contrast, ULAE are the costs that cannot be assigned to a unique claim; ULAE are those costs associated with operating the claims department, including rent, technology, salaries, as well as management and administrative expenses.

There are two broad classifications of techniques for estimating unpaid ULAE: dollar-based and count based. These techniques, which rely on fundamentally different assumptions, vary significantly in the amount of data and calculations required. In practice, the seemingly divergent assumptions of the various methods may not affect the resulting unpaid ULAE estimates quite as severely as it might seem at first glance. Since the methods are used for an entire population of claims, they need to be correct only for the "average" claim being reported, handled, paid, or closed during a time period – not for each individual claim. In other cases, the gulf can be bridged by stratifying the claims data and types of transactions and making assumptions about the relative ULAE resources required in the various strata.

This chapter is organized as follows:

- Dollar-based techniques
- Count-based techniques
- Triangle-based techniques
- Comparison example

Ideally, an actuary estimating unpaid ULAE would have access to sufficient data to employ both dollar-based and count-based methods. Given the specific characteristics of the company, the actuary would then select the methodology that is likely to produce the best estimate of future ULAE.

ULAE liabilities also have a "market value" in the fees that a third-party claims administrator (TPA) would require to take over the management of the book of claims. Many self-insurers use such market values to determine the unpaid ULAE for financial reporting purposes.

[90] Mr. Conger and Ms. Nolibos granted permission for the use of direct quotes from their paper without the standard punctuation for quotation to facilitate the ease of reading of this text.

Dollar-Based Techniques

A fundamental assumption of dollar-based techniques is that ULAE expenditures track with claim[91] dollars with regards to both timing and relative amount. Most importantly, this assumption means that the general timing of ULAE expenditures (or of specified portions of ULAE expenditures) follows the timing of the reporting or payment of claim dollars. In addition, this assumption implies that a $1,000 claim requires ten times as much ULAE as a $100 claim. In the following sections, we describe four commonly used dollar-based techniques:

- Classical (also known as traditional)
- Kittel refinement
- Conger and Nolibos method – generalized Kittel approach
- Mango-Allen refinement

Classical (or Traditional) Technique

In the classical technique, the unpaid ULAE is estimated using a paid ULAE-to-paid claims ratio determined by comparing the calendar year paid ULAE to the calendar year paid claims.

Key Assumptions of Classical Technique

Key assumptions of the classical technique include:

- The insurer's ULAE-to-claim relationship has achieved a steady-state so that the ratio of paid ULAE-to-paid claims provides a reasonable approximation of the relationship of ultimate ULAE-to-ultimate claims.

- The relative volume and cost of future claims management activity on not-yet-reported claims and reported-but-not-yet-closed claims will be proportional to the dollars of IBNR and case outstanding, respectively.

The classical technique assumes that one-half of ULAE are sustained when opening a claim and one-half is sustained when closing the claim. Thus, we apply 50% of the ULAE ratio to case outstanding, since, for known claims, one-half of the unallocated work was already completed at the time of opening; and we apply 100% of the ULAE ratio to IBNR, since all unallocated work remains to be completed (that is, the work associated with opening and closing the claims).

Mechanics of Classical Technique

There are four steps in the classical technique for estimating unpaid ULAE:

- Calculate ratios of historical calendar year paid ULAE-to-calendar year paid claims

- Review historical paid ULAE-to-paid claims ratios for trends or patterns

[91] The terms *claim dollars* or *claims* include ALAE but exclude ULAE.

- Select a ratio of ULAE-to-claims applicable to future claims payments

- Apply 50% of the selected ULAE ratio to case outstanding and 100% of the selected ULAE ratio to IBNR

In Exhibit I, we calculate the ratios of paid ULAE-to-paid claims (including ALAE) for XYZ Insurer. In the examples presented for XYZ Insurer in previous chapters, we refer to the experience of one particular line of insurance. In estimating unpaid ULAE, we use the experience for the insurer as a whole (i.e., all lines of coverage combined). For this example, we are fortunate to have five years of complete and accurate data. We are somewhat surprised to observe relatively stable ULAE ratios given all the changes we know transpired at XYZ Insurer during the experience period. We select a ULAE ratio of 0.045 based on a review of the historical experience as well as discussions with company management regarding their expectations for the future. These discussions included expectations regarding claims department caseload, the relationship between claim and salary inflation, as well as management's expectations of the future use of independent adjusters and TPAs.

For XYZ Insurer, case outstanding at December 31, 2008 is $603 million and selected IBNR is $316 million. Using the classical technique, we estimate unpaid ULAE at December 31, 2008 to be $27.8 million. As calculated in Exhibit I, Line (9):

$$\$27.8 \text{ million} = [(0.045 \text{ x } 50\% \text{ x } \$603 \text{ million}) + (0.045 \text{ x } 100\% \text{ x } \$316 \text{ million})]$$

Challenges of the Classical Technique

Recall that the key assumption underlying the application of 50% of the ULAE ratio to case outstanding and 100% of the ULAE ratio to IBNR is that 50% of the expenses are sustained when opening the claim and the remaining 50% when closing the claim. One challenge with the classical technique is that "closing" a claim and "paying" a claim do not necessarily mean the same thing. For some lines of business, a single payment may be the norm, and thus, such payment may in fact represent settlement (i.e., closure) of the claim, and therefore the end of the claims handling activity. An example is glass coverage to replace a shattered windshield under automobile physical damage insurance. (Note, not all automobile physical damage insurance can necessarily be categorized as single payment where payment equates to closure of the claim.) An example of insurance where a claim payment and closing of the claim often differ is U.S. workers compensation; for this coverage, regular payments can replace lost wages for an extended period of time.

Some actuaries address this challenge by adjusting the percentages applied to the case outstanding and the IBNR to reflect their expectations for the particular company. For example, an actuary of an insurer with a portfolio of long-tail professional liability coverage, which is characterized by very long-tailed liabilities and substantial claims-handling work during the life of the claim, estimates unpaid ULAE assuming ratios of 25% applied to case outstanding and 75% to IBNR, which includes development on case outstanding. Thus, they assume a greater proportion of the expenses are related to closing the claims rather than opening claims.

The definition of IBNR poses another challenge for actuaries using the classical technique. Actuaries typically use the broad definition of IBNR, and thus IBNR reserves represent the liability for both claims that are not yet reported as well as future case development on known claims. As described in Chapter 1, claims that are incurred but not yet reported (IBNYR) are also referred to as pure IBNR or the narrow definition of IBNR; future case development on known claims is referred to as incurred but not enough reported (IBNER). Theoretically, in using the classical technique, the actuary would apply 100% of the ULAE ratio to IBNYR (pure IBNR) and 50% of the ULAE ratio to the sum of case reserves and IBNER.

Some actuaries refine the classical technique by estimating pure IBNR as a percentage of total IBNR or a percentage of the selected ultimate claims for the latest accident year(s).[92] For example, assume that pure IBNR for XYZ Insurer is equal to 5% of the latest accident year's (2008) ultimate claims. Given ultimate claims for accident year 2008 of $380 million, we can calculate the unpaid ULAE for XYZ Insurer as follows:

Unpd ULAE = [(ULAE ratio x 50% x unpd known claims) + (ULAE ratio x 100% x Pure IBNR)]
= [(0.045 x 50% x (case outstanding + IBNER)) + (0.045 x 100% x IBNYR)]

We calculate IBNYR claims of $19 million based on 5% of accident year 2008 ultimate claims (0.05 x $380 million) and derive the IBNER claims as total IBNR less IBNYR or $297 million ($316 million - $19 million). Following the formula for the classical technique, we calculate that the estimated unpaid ULAE for XYZ Insurer is $21.1 million.

Unpd ULAE = [(0.045 x 50% x ($603 million + $297 million)) + (0.045 x 100% x $19 million)]

This estimate of unpaid ULAE is significantly less than the initial estimate of $27.8 million for XYZ insurer. (See Exhibit I, Lines (9) and (10).)

The selected pure IBNR percentage relative to the ultimate losses of the latest accident year is clearly an important assumption in the above calculation. The indicated unpaid ULAE differ by more than $6 million, or 24%, when the pure IBNR refinement is included in the classical technique. While actuaries frequently assume 5% of the most recent accident year ultimate claims as an approximation to estimate pure IBNR, the actuary should be able to support such an approximation based on the experience of the organization. To the extent possible, the actuary would test this assumption by calculating the pure IBNR claims and determine the ratio to total unpaid claims. One method for testing this assumption is to first estimate the number of IBNR claim counts (projected ultimate claim counts minus reported claim counts). The actuary can then multiply the number of IBNR counts for each accident year by an ultimate severity value for each accident year to determine an estimate of ultimate claims associated with pure IBNR. Such an analysis can be performed for each line of business, and the total ultimate claims associated with pure IBNR can be compared to total ultimate claims for both IBNR and reported claim counts for the latest accident year.

[92] We do not address particular methods for allocating total IBNR between IBNYR and IBNER. However, actuaries may rely on report year analysis, frequency-severity techniques, or other approaches to estimate the proportion of total IBNR that is pure IBNR. Actuaries often rely on judgment for this allocation when estimating unpaid ULAE.

When the Classical Technique Works and When it Does Not

In the 1989 paper "Determination of Outstanding Liabilities for Unallocated Loss Adjustment Expenses,"[93] Wendy Johnson states that upon analysis it is apparent that the classical technique "will only give good results for very short-tailed, stable lines of business."
She continues:

> This method came into use at a time when most lines developed in well under five years, cost inflation was low and level if it existed at all, most calculations were made using only pencil and paper, and claim reporting and payment patterns were stable. We no longer live in this kind of environment. Our estimation methods should be adapted to fit the current environment and grounded firmly in our understanding of the claims process, even for estimation of peripheral liabilities like ULAE.

Similar observations are expressed by Kay Kellogg Rahardjo in the 1996 paper "A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation."[94] She states:

> It is no longer acceptable for companies to estimate unallocated loss adjustment expenses (ULAE) and, in particular, claim expense reserves by using paid to paid ratios. The paid to paid methodology assumes that claims incur expenses only when initially opened and when closed. While this may not be an unreasonable assumption for claims from short-tailed lines, this is definitely not true for liability claims. Moreover, the paid to paid ratio itself is subject to distortion when a company is growing or shrinking or when a line of business is in "transition", as was the case for workers compensation throughout the early 1990s as many large customers moved to deductible policies or towards self-insurance.

As noted previously, there are challenges associated with the use of the classical technique due to the differences between paying and closing claims as well as the use of total IBNR as opposed to pure IBNR in the formula. Furthermore, the assumption that 50% of ULAE payments are sustained when a claim is opened and the remaining 50% when a claim is closed may not accurately describe an insurer's application of resources to the various stages in the life cycle of its claims.

It is also important to recognize that the classical technique can lead to inaccurate results whenever the volume of claims is growing. Donald Mango and Craig Allen expand on this point in their paper "Two Alternative Methods for Calculating the Unallocated Loss Adjustment Expense Reserve."[95] They note that the numerator in the ratio (i.e., calendar year paid ULAE) tends to react relatively quickly to an increase in exposure or an increase in the number of claims being reported. However, the denominator (i.e., paid claims) reflects claim payments made on claims that were reported at the former, lower, exposure base and will not be as responsive to the growth in volume. Thus, the resulting paid ULAE-to-paid claims ratio may misrepresent the true situation. A similar mismatch between paid ULAE and paid claims can occur if the volume is decreasing.

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[93] *CAS Discussion Paper Program*, May 1988.
[94] *CAS Forum*, Summer 1996.
[95] *CAS Forum*, Fall 1999.

Finally, we point out that inflation can also create distortions in the classical technique. In his 1973 paper "Unallocated Loss Adjustment Expense Reserves in an Inflationary Economic Environment,"[96] John Kittel notes that the classical technique does include an inflation adjustment to the degree that total unpaid claims take inflation into account. If the costs underlying ULAE inflate at the same rate as claim costs, then inflation is accounted for. However, if different rates of inflation underlie the claims experience and ULAE, the estimated unpaid ULAE may not be predictive of future experience.

Mango and Allen expand on this point:

> … the paid-to-paid ratio is distorted in an upward direction under inflationary conditions. This distortion arises because the impact of inflation on the denominator of the ratio lags its impact on the numerator. This lag is due to the fact that most of the losses paid in a calendar year were incurred in a prior year, and thus are largely unaffected by the most recent inflation.[97]

In summary, the classical technique may not be appropriate for every situation. In particular, the classical technique may not be appropriate for:

- Long-tail lines of business
- Times of changing inflationary forces, either in the past or expected in the future
- When an insurer is experiencing a rapid change in volume (either expansion or decrease in the size of its portfolio)
- Where the 50/50 assumption is not an appropriate representation of the claims handling workflow

Kittel Refinement

In his 1973 paper, John Kittel describes a weakness in the classical technique:

> The concept upon which this method is based is to relate the paid unallocated loss adjustment expense cost to the work completed by the Loss Department measured in dollars of claim. Calendar year paid losses are used to represent the dollars of losses worked on by the Loss Department. There is an inconsistency here. The Loss Department, unfortunately, doesn't just close claims. It also opens them. Paid losses don't accurately represent the work done by the Loss Department since they do not take into account claims opened during the year which remain open at year end. This can be significant when loss reserves vary from year to year. A growing line with rapidly inflating loss costs could easily have loss reserves increasing at thirty to forty percent a year.[98]

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[96] *CAS Discussion Paper Program*, 1981.

[97] *CAS Forum*, Fall 1999.
[98] *CAS Discussion Paper Program*, 1981.

Kittel refines the classical technique to explicitly recognize that ULAE is sustained as claims are reported even if no claim payments are made. The refinement recognizes that ULAE payments for a specific calendar year would not be expected to track perfectly with claim payments since actual ULAE is related to both the reporting and payment of claims. In contrast, the classical technique, by assuming a steady state, makes the implicit simplifying assumption that paid claims are approximately equal to reported claims, and thus the two quantities can be used interchangeably.

Key Assumptions of Kittel Refinement

Key assumptions of the Kittel refinement to the classical technique include:

- ULAE is sustained as claims are reported even if no claim payments are made.
- ULAE payments for a specific calendar year are related to both the reporting and payment of claims.

Thus, in the Kittel refinement to the classical technique, an insurer's ULAE-to-claim relationship is derived based on a review of the ratio of paid ULAE-to-the average of paid claims and incurred[99] claims to determine a reasonable approximation of the relationship of ultimate ULAE-to-ultimate claims. In the Kittel refinement, calendar year incurred claims are defined to be calendar year paid claims plus the change in total claim liabilities, including both case outstanding and IBNR.

Kittel derives his formula as follows:

> If we use the 50/50 assumption and ignore partial payments, the loss dollars processed with the calendar year paid unallocated loss adjustment expenses are:
>
> ½ unit of work x payments on prior outstanding reserves
> 1 complete unit x losses opened and paid during the year
> ½ unit of work x losses opened remaining open
>
> The ratio of calendar year paid unallocated loss adjustment expense to the dollars of loss as represented above should be used as a more accurate starting point.
>
> If reserves are accurate, calendar year incurred = accident year incurred = losses opened and paid + opened remaining open.
>
> So,
>
> Calendar paid = opened and paid + paid on prior outstanding reserves
> Calendar incurred = opened and paid + opened remaining opened
>
> ½ (calendar paid + incurred) = Losses opened and paid
> \+ ½ payments on prior outstanding
> \+ ½ losses opened remaining open

[99] It is important to note the use of the term *incurred claims*, which includes reported claims as well as IBNR.

the desired quantity.[100]

The second key assumption of the classical technique remains valid for the Kittel refinement. The relative volume and cost of future claims management activity on not-yet-reported claims and reported-but-not-yet-closed claims is expected to be proportional to the dollars of IBNR and case outstanding, respectively. Specifically, we assume that one-half of expenses are sustained when opening a claim and one-half of expenses when closing a claim.

Mechanics of the Kittel Refinement

We present the Kittel refinement to the classical technique in Exhibit II. There are four steps in this technique:

- Develop ratio of historical calendar year paid ULAE-to-average of calendar year paid and calendar year incurred claims
- Review historical ratios for trends or patterns
- Select a ratio of ULAE-to-claims applicable to future claims payments
- Apply 50% of the selected ULAE ratio to case outstanding and 100% of the selected ULAE ratio to IBNR

Using Kittel's refinement, we observe lower ULAE ratios than with the classical technique (traditional paid-to-paid approach). This is expected when incurred claims are greater than paid claims on a calendar year basis. For both techniques, we note that the ULAE ratios are lower for the two earliest years in the experience period (i.e., 2004 and 2005). Based on Kittel's refinement, we select a ULAE ratio of 0.040.

The final step of Kittel's refined technique is identical to the classical technique. Assuming that one-half of a claim's ULAE is sustained when the claim is reported and one-half when it is paid (i.e., closed), we estimate unpaid ULAE for XYZ Insurer to be \$24.7 million using the formula with total IBNR and \$18.8 million using the formula with an adjustment to determine pure IBNR.

\$24.7 million = [(0.04 x 50% x \$603 million) + (0.04 x 100% x \$316 million)]

\$18.8 million = [(0.04 x 50% x (\$603 million + \$297 million)) + (0.04 x 100% x \$19 million)]

The Kittel refinement does address the challenge identified in the classical technique related to sustaining ULAE for activities beyond simply paying a claim. However, the refinement does not explicitly address the issue associated with the definition of IBNR. Without specific modification of the formula to differentiate between IBNYR and IBNER, the Kittel technique could overstate the unpaid ULAE.

[100] *CAS Discussion Paper Program*, 1981.

When the Kittel Refinement Works and When it Does Not

Although the Kittel refinement addresses the distortion created when using the classical technique for a growing insurer, it maintains the traditional 50/50 assumption regarding ULAE expenditures. Therefore it does not allow for the particular allocation of ULAE costs between opening, maintaining, and closing claims which may vary from insurer to insurer. Finally, the issue related to the potential for different rates of inflation between ULAE and claims remains in the Kittel refinement.

Conger and Nolibos Method – Generalized Kittel Approach

In developing their generalized approach as part of a specific client assignment, Conger and Nolibos sought to define a procedure to estimate unpaid ULAE that would:

- Recognize an insurer's rapid growth
- Be consistent with patterns of the insurer's ULAE expenditures over the life of a claim
- Reproduce key concepts underlying the Johnson technique
- Use commonly available and reliable aggregate payment and unpaid claims data
- Include an extension to the Kittel refinement which would allow for alternatives to the traditional 50/50 rule

The generalized approach employs the concept of weighted claims, which recognizes that claims use up different amounts of ULAE at different stages of their life cycle, from opening to closing. Newly opened, open, and newly closed claims are each given different weights when determining the claims basis to which ULAE payments during a past or future calendar period are related. Since Conger and Nolibos believe that handling costlier claims warrants and requires relatively more resources than handling smaller claims, they use claim dollars instead of claim counts in their generalized approach.

The claim basis for a particular time period is defined to be the weighted average of the:

- Ultimate cost of claims reported during the period (ultimate includes reported amounts and future development on known claims)
- Ultimate cost of claims closed during the period (includes any future payment made after the closing of the claim)[101]
- Claims paid during the period

Conger and Nolibos compare the claims basis of the generalized approach to Kittel's introduction of a weighted average claims basis including incurred and paid claims. Kittel's weights are fixed

[101] Conger and Nolibos note that their approach assumes that there is no additional costs associated with reopening or reclosing a reopened claim. The formulas do provide, however, for the cost of maintaining reopened claims.

at 50% for incurred claims and 50% for paid claims. By comparison, the generalized method introduces a third claim measure that allows distinguishing the cost of maintenance from the cost of closing. This is an important distinction for lines of business where a claim can remain open for an extended period of time with regular claim activity, such as workers compensation. The generalized approach also allows for flexibility in selecting the weights appropriate to the insurer and to the particular segment of business.

Key Assumptions of Generalized Approach

Key assumptions of the generalized approach include:

- Expenditure of ULAE resources is proportional to the dollars of claims being handled. (This is in contrast to Johnson's assumption that ULAE costs are independent of claim size and nature.)

- ULAE amounts spent opening claims are proportional to the ultimate cost of claims being reported.

- ULAE amounts spent maintaining claims are proportional to payments made.

- ULAE amounts spent closing claims are proportional to the ultimate cost of claims being closed.

Conger and Nolibos state that the appropriateness and sensitivity of these assumptions warrant further analysis, both as a matter of general research, and for a particular application of either method. For their particular application, the dollar proportionality was an assumption that produced reasonable indications of unpaid ULAE.

Mechanics of Generalized Approach

In the generalized approach, Conger and Nolibos define $U_1 + U_2 + U_3 = 100\%$, where:

- U_1 – percentage of ultimate ULAE spent opening claims
- U_2 – percentage of ultimate ULAE spent maintaining claims
- U_3 – percentage of ultimate ULAE spent closing claims

In conducting an analysis of unpaid claims and expenses, the actuary would determine reasonable ranges for U_1, U_2, and U_3 and would test the sensitivity of the final estimate of unpaid ULAE to variations within those ranges.

It is worthwhile noting that the values of U_1, U_2, and U_3 could vary significantly from insurer to insurer and between lines of business. For example, a litigation-intense liability book of business might have a strong concentration of activity close to the time of claim settlement and payment. This contrasts with greater front-end costs associated with workers' compensation claims. Conger and Nolibos developed a range of values for U_1, U_2, and U_3 for a particular insurer and line of business based on interviews with claims personnel. They used the resulting ranges to test the consistency of the resulting ULAE ratios and the sensitivity of the ULAE ratios to different choices of U_1, U_2, and U_3. Time and motion studies, as described by Joanne Spalla,[102] could also be used to develop an empirical basis for the parameters.

For a particular time period *T*, Conger and Nolibos define *M*, the total amount spent on ULAE during a time period *T*, to be

$M = (U_1 \times R \times W) + (U_2 \times P \times W) + (U_3 \times C \times W)$, where

- *R* – ultimate cost of claims reported during *T*
- *P* – claims paid during *T*
- *C* – the ultimate cost of claims closed during *T*
- *W* – ratio of ultimate ULAE to ultimate claims (L)

Conceptually, the time period *T* could represent activity occurring between t_1 and t_2 related to a particular accident year or for all accident years, where t_1 and t_2 are selected points in time.

Conger and Nolibos algebraically derive the ratio $W = M / B$ by defining *B*, the claims basis for the time period *T* to be:

$$B = (U_1 \times R) + (U_2 \times P) + (U_3 \times C)$$

Thus, $M = B \times W$, and $W = M / B$.

Each component of the claims basis can be understood conceptually as the value of the claims underlying the ULAE payments. Thus,

- $U_1 \times R$ represents claims basis for ULAE spent setting up new claims
- $U_2 \times P$ represents claims basis for ULAE spent maintaining open claims
- $U_3 \times C$ represents claims basis for ULAE spent closing existing claims

In practice, insurers typically measure and report *M*, the ULAE payments during a period, on a calendar year basis. Once U_1, U_2, and U_3 are estimated or selected, the claims basis *B* can be calculated from claim amounts *R*, *P*, and *C,* that can typically be determined from data and calculations underlying an actuarial analysis for estimating unpaid claims. In particular, *M* (total ULAE payments) and *B* (claim basis) can be calculated for historical calendar periods. By computing the ratio *W* (equal to M / B, where both *M* and *B* are expressed on a calendar year basis), we obtain ratios of ULAE to claims by calendar year. We then select an overall ratio of ULAE-to-claims, identified as W^*, which is used in estimating future ULAE payments.

Ultimate ULAE (*U*) for a group of accident years can be estimated as:

$U = W^* \times L$, where

- W^* is the selected ultimate ULAE-to-claims ratio
- *L* is the independently estimated ultimate claims for the same group of accident years

Using this approach for estimating ultimate ULAE, Conger and Nolibos suggest three different ways to estimate unpaid ULAE for a group of accident years. First, they note that unpaid ULAE

[102] *CAS Forum*, Fall 1999.

could be calculated simply by subtracting the amount of ULAE already paid (M) from the estimate of ultimate ULAE (U).

Unpaid ULAE = (W^* x L) - M

Conger and Nolibos do not prefer this method as it presents both practical and conceptual difficulties. From a practical perspective, it may be difficult to quantify the historical paid ULAE that corresponds only to the accident year claims represented by L. Conceptually, this approach has some similarities to, and shares the potential distortions of, an expected claims ratio approach to estimating unpaid claims. In the expected claim technique, unpaid claims are estimated based on a predetermined expected claims ratio multiplied by earned premium less claims paid to date. As the period matures, the unpaid claim estimate can become increasingly distorted if actual paid claims do not approach the predetermined value of expected ultimate claims.

The method preferred by Conger and Nolibos is similar to a Bornhuetter-Ferguson technique in that an a priori provision of unpaid ULAE is calculated.

Unpaid ULAE = W^* x (L - B)

To assist in understanding this method, Conger and Nolibos present the derivation of this estimate (for a particular group of accident years). Assume that

- $R(t)$ – ultimate cost of claims known at time t
- $P(t)$ – total amount paid at time t
- $C(t)$ – ultimate cost of claims closed at time t

Thus, unpaid ULAE can be estimated based on the following:

Unpaid ULAE = W^* x $\{U_1 \text{ x } [L - R(t)] + U_2 \text{ x } [L - P(t)] + U_3 \text{ x } [L - C(t)]\}$, where

Each component of the unpaid ULAE formula represents a provision for the ULAE associated with:

- Opening claims not yet reported

- Making payments on currently active claims and on those claims that will be reported in the future

- Closing "unclosed" claims (i.e., those claims that are open at time t and those claims that will be reported and opened in the future)

By mathematically rearranging the equation, Conger and Nolibos obtain:

Unpaid ULAE = W^* x (L - B)

This methodology assumes that the amount of ULAE paid to date and the unpaid ULAE are not directly related, except to the extent that these payments influence the selection of the ratio W^*. This is similar to the assumption underlying the Bornhuetter-Ferguson technique.[103]

[103] See Chapter 9 for a complete presentation of the Bornhuetter-Ferguson technique.

The third and final method noted by Conger and Nolibos is similar to the claims development method. Unpaid ULAE could be estimated by the following formula:

$$\text{Unpaid ULAE} = M \text{ x } (L / B - 1.00)$$

They note that such an approach implies that unpaid ULAE are proportional to paid amounts reported to date. Aside from the practical difficulty of establishing the ULAE amounts paid that correspond to accidents occurring during a particular period, this method, similar to the paid claims development method, may be overly responsive to random fluctuations in ULAE emergence.

Application of Generalized Approach to Claim Counts

Conger and Nolibos note that the generalized approach can also be used with claim counts or transaction counts. The formula for a claim count basis used in the determination of unpaid ULAE is:

$b = (v_1 \text{ x } r) + (v_2 \text{ x } o) + (v_3 \text{ x } c)$, where

- r represents reported claim counts
- o represents open claim counts
- c represents closed claim counts
- v_1 is the estimate of the relative cost of handling the reporting of a claim (for one year)
- v_2 is the estimate of the relative cost of managing an open claim (for one year)
- v_3 is the estimate of the relative cost of closing a claim (for one year)

As in Johnson's paper, Conger and Nolibos suggest that is not necessary to determine the actual costs of the various claim activities but instead their relative magnitudes. For example, Johnson assumes that $v_1 = 2$, $v_2 = 1$, and $v_3 = 0$.

Using estimated v_1, v_2, and v_3, we can then select w^* representing the ratio of ULAE to the claim count basis based on the historical data $w = M / b$, where M still represents ULAE payments. After selecting a value of w^* (or a series of w^*_i which reflect future inflation adjustments), the unpaid ULAE can be estimated as:

$$\text{Unpaid ULAE} = \Sigma\, w^*_i \text{ x } [(v_1 \text{ x } r_i) + (v_2 \text{ x } o_i) + (v_3 \text{ x } c_i)], \text{ where}$$

- r_i represents the number of claims to be reported in each calendar year i
- o_i represents the number of open claims at the end of calendar year i
- c_i represents the claims to be closed during calendar year i
- i represents the series of future calendar year-ends until all claims are closed

In each case, only claims occurring on or before the valuation date should be considered. Note that a claim that stays open for a number of years is counted multiple times in the summation. This is consistent with the assumption that there are ULAE payments each year as long as a claim stays open.

The above formula for claim counts is equivalent to that presented by Wendy Johnson. The formula could be adapted to reflect the Rahardjo and Mango-Allen concepts of cost varying over time by stratifying the claims activities more finely than just reporting, opening, and closing.

Simplification of Generalized Approach

Conger and Nolibos note that in many cases, the estimation of R (ultimate cost of reported claims) and C (ultimate cost of closed claims) may not be a trivial exercise.

Another way to think about the ultimate costs of reported claims (R) is as the ultimate for the accident period ending on that date, reduced for the pure IBNR amounts, which represent the ultimate cost of not yet reported claims. Analogously, the ultimate cost of closed claims (C) as of a certain evaluation point represents the final cost of claims that are closed as of the valuation date including any subsequent payments. (Many times this may simply be equal to the paid on closed if the line of business does not have subsequent payments.)

Conger and Nolibos present a simplification where estimates of R and C are not required. First, they use the estimate of ultimate claims for the accident year as a proxy for the ultimate costs of claims reported in the calendar year. The calendar year amount can be expressed exactly as the sum of the corresponding accident year ultimate claims and the pure IBNR at the beginning of the year less the pure IBNR at the end of the year. The actuary can evaluate the error in this approximation based on review of changes in exposures between accident years and the characteristics of the coverage being analyzed and make adjustments based on judgment as necessary. For example, given the minimal delay in the reporting of U.S. workers compensation claims, they state that one can often assume that the pure IBNR component of the ultimate is not likely to vary much from one accident year to the next. Thus, the accident year ultimate claims are likely a reasonable approximation for the true value of the parameter R.

Second, if no particular additional effort is required to close an existing claim, then they note that the actuary can assume that U_3 equals zero. This assumption is not appropriate for all lines of business; for example, professional liability or employment practices liability are lines of business where a significant portion of the claims-related expenses will be incurred with its settlement.

If it is appropriate, for a particular line of business, to assume that $U_3 = 0$, then $U_1 + U_2 =$ 100%, and we can approximate B, the claims basis for each calendar year as

$$Est.\ B = (U_1 \text{ x } A) + (U_2 \text{ x } P), \text{ where}$$

A represents the ultimate claims for the accident year. We then calculate observed W values for each year as

$$W = M \,/\, Est.\ B$$

After a review of these observed ULAE ratios, we select an appropriate ratio W^* for estimating unpaid ULAE. The next step is to estimate pure IBNR (perhaps by analyzing claim reporting patterns and ultimate severities) and deduct this estimate from L to obtain an estimate of the ultimate costs of claims reported to date (R). Unpaid ULAE is then calculated according to the formulas previously presented:

Unpaid ULAE = W^* x $\{L - [(U_1 \text{ x } R) + (U_2 \text{ x } P)]\}$, which can be expressed as

Unpaid ULAE = W^* x $[U_1 \text{ x } (L - R) + U_2 \text{ x } (L - P)\}$

Practical Difficulties with the Generalized Approach

The generalized approach is consistent with the assumption that the claims adjusting activities associated with reopening and reclosing a claim have no cost. An alternative approach is to assume that the ultimate cost of closed claims C equals the sum of total amounts paid on closed claims as of the evaluation date. Under this approach, the cost of reclosing a claim is assumed to be equal to the cost of closing a claim of the same size. However, this alternative approach still fails to capture the cost of reopening claims.

In cases where reopenings of claims are more than negligible, and the ULAE cost of such reopenings (and subsequent reclosings) is not immaterial, the actuary could obtain a separate provision for the cost of future claims handling activities related to claims that are closed as of the evaluation of unpaid ULAE. Conger and Nolibos suggest that this provision could perhaps be based on a study of the frequency of reopenings and average cost in ULAE of handling the reopened claims.

As noted previously, the estimation of R and C, the ultimate cost of reported and closed claims, may not be trivial. Conger and Nolibos state that they have not attempted to measure the relative accuracy of the generalized method (as compared to other dollar-based methods) in an inflationary environment. They also identify two other issues that warrant further investigation: the effect of reopened claims on the accuracy of the estimates of unpaid ULAE, and how to modify the approach to properly reflect the change over time in the quantity or cost of resources dedicated to the handling of a claim, as that claim ages.

Mango-Allen Refinement

Donald F. Mango and Craig A. Allen discuss a variation of the Kittel refinement to the classical technique in their 1999 paper.[104] They specifically suggest a possible variation on the application of the formula when the actuary is working with a line of business where the actual historical calendar period claims are volatile, perhaps due to the random timing associated with the reporting or settlement of large claims. In this case, Mango and Allen suggest replacing the actual calendar period claims with expected claims for those historical calendar periods. They explain that the actuary can estimate the expected paid claims by applying selected reporting and payment patterns to a set of accident year estimated ultimate claims. This type of adjustment would be most useful for lines of business with a relatively small number of claims of widely varying sizes.

[104] *CAS Forum*, Fall 1999.

Key Assumptions of Mango-Allen Refinement to the Classical Technique

One key assumption of the Mango-Allen refinement of the classical technique is that an insurer's ULAE-to-claim relationship is derived based on a review of the ratio of paid ULAE-to-*expected* paid claims. This differs from the classical technique where paid ULAE is compared to *actual* paid claims.

The second key assumption of the classical technique remains valid for the Mango-Allen refinement. The relative volume and cost of future claims management activity on not-yet-reported claims and reported-but-not-yet-closed claims is expected to be proportional to the dollars of IBNR and case outstanding, respectively. Specifically, we assume that one-half of expenses are sustained when opening a claim and one-half of expenses when closing a claim.

Mechanics of Mango-Allen Refinement to the Classical Technique

We present the Mango-Allen refinement to the classical technique in Exhibit III for New Small Insurer, a new insurer specializing in lawyers' professional liability coverage. There are five steps in this technique:

- Estimate calendar year expected paid claims
- Develop ratio of historical calendar year paid ULAE-to-expected calendar year paid claims
- Review historical ratios for trends or patterns
- Select a ratio of ULAE-to-claims applicable to future claims payments
- Apply 50% of the selected ULAE ratio to case outstanding and 100% of the selected ULAE ratio to IBNR

In Exhibit III, Sheet 1, we begin the analysis by estimating expected paid claims for each of the four calendar years in the experience period (i.e., 2005 through 2008). Expected calendar year payments are based on direct earned premium multiplied by an expected claims ratio and the percentage expected to be paid in each year. Since New Small Insurer is a new company without credible historical claims experience, we rely on the claims ratio underlying the pricing analyses as well as insurance industry benchmark payment patterns.

Once calendar year expected paid claims are determined, the analysis proceeds in a similar fashion as the classical technique. (See Exhibit III, Sheet 2.) We observe that the ratios of paid ULAE-to-actual paid claims are much more volatile than the ratios of paid ULAE-to-expected paid claims. We observe a pronounced downward trend in the paid ULAE-to-expected paid claims ratios. We seek to understand the reasons behind this trend by reviewing the assumptions underlying the development of expected paid claims and through discussions with management about actual paid ULAE.

One explanation could be that the industry-based payments pattern for developing expected paid claims may be too fast for this particular insurer. We recognize that until a sufficient volume of credible experience is developed, we are challenged in the selection of appropriate development patterns. Another explanation of the variability and downward trends could be related to large claims. We know from a review of claims data that there are several open claims for the most recent accident years in litigation with large case outstanding values and minimal payments to date.

After discussion with management about the specific categories of costs underlying the paid ULAE, its expectations for the upcoming several years, and a review of current claims data, we select a ratio of 0.07 for estimating unpaid ULAE. Thus, for New Small Insurer, we estimate unpaid ULAE at 12/31/08 of $457,975 using total IBNR and $236,761 using pure IBNR.

$$\$457{,}975 = [(0.070 \text{ x } 50\% \text{ x } \$225{,}000) + (0.070 \text{ x } 100\% \text{ x } \$6{,}430{,}000)]$$

$$\$236{,}761 = \{[0.070 \text{ x } 50\% \text{ x } (\$225{,}000 + (6{,}430{,}000 - 109{,}588))] + [0.070 \text{ x } 100\% \text{ x } \$109{,}588]\}$$

When the Mango-Allen Refinement Works and When it Does Not

The Mango-Allen refinement is a valuable alternative for insurers with limited experience or highly volatile claims payment experience. For such insurers, a method using reported claims instead of paid claims may provide a more stable base for projection purposes. However, for organizations with a sufficient volume of paid claims experience, the additional calculations required to estimate expected paid claims may not be necessary as the relative improvement to the accuracy of projected unpaid ULAE may not justify the time and costs involved.

Count-Based Techniques

Mango and Allen describe two major drawbacks of the use of claims as a base for comparison relative to the use of claim counts for estimating unpaid ULAE.[105] First, the amount of ULAE is not solely dependent on the magnitude of the accompanying claim dollars. ULAE is also dependent on the average claim size. For example, we expect that the ULAE required to settle a one million-dollar claim is probably less than the ULAE required to settle ten $100,000 claims. However, the classical technique with its use of a paid-to-paid ratio does not recognize this difference.

The second disadvantage noted by Mango and Allen is that the estimate of unpaid ULAE becomes a “rider” on the estimate of unpaid claims, responding to whatever volatility is present in the estimate of ultimate claims. In practice, we do not expect the unpaid ULAE to respond fully to fluctuations in claim amounts. Mango and Allen cite the example of a sudden drop in claim counts or in the value of claims. We would not expect an immediate drop in the overhead expenses or the number of claims management personnel.

In this section, we briefly describe several approaches that have been developed since the mid-1960s. One of the most significant challenges an actuary faces in using count-based techniques is the availability of accurate and consistent claim count data or refined transaction and expense information for an insurer.

A key assumption in count-based techniques is that the same kind of transaction costs the same amount of ULAE regardless of the claim size. Conger and Nolibos note that because count-based

[105] *CAS Actuarial Society Forum*, Fall 1999.

techniques typically include some parameter to reflect the cost of ongoing management and maintenance of claims, they also imply that a claim that stays open longer will cost proportionately more than a quick-closing claim, at least with respect to some component of ULAE.

Early Count Techniques

Conger and Nolibos discuss a 1967 proposal for a count-based ULAE technique by R.E. Brian in the Insurance Accounting and Statistical Association Proceedings. Brian suggested breaking the ULAE process into five kinds of transactions:

- Setting up new claims
- Maintaining outstanding claims
- Making a single payment
- Closing a claim
- Reopening a claim

In the Brian technique, the actuary projects the future number of each type of transaction. Brian estimated that each of these transactions would carry a similar cost, and suggested estimating the cost per transaction using ratios of historical ULAE expenditures to the number of claim transactions occurring during the same calendar periods.

The primary assumption of this technique, which Conger and Nolibos identify as a weakness is that each of the five kinds of claims transactions requires similar ULAE resources and expenditures. The weakness of this assumption could easily be remedied by refining the formula to allow for different costs for the different types of transactions. A more significant weakness of this technique is the practical difficulty in estimating both the number of future transactions and the average cost of each transaction. Data supporting these projections (reliable and consistent claim count and claim transaction data) is often not readily available.

Wendy Johnson Technique

In her paper "Determination of Outstanding Liabilities for Unallocated Loss Adjustment Expenses,"[106] Wendy Johnson follows a similar approach to Brian's but focuses on two key transactions: reporting and maintenance. Johnson, like Brian, then projects the future number of newly reported claims, as well as the number of claims that will be in a pending status each year – and thus will require maintenance work during the year. Also like Brian, Johnson estimates the cost of each transaction by comparing historical aggregate ULAE expenditures to the number of transactions occurring in the same time period.

The Johnson technique allows for an explicit differential in the amount of ULAE resource or cost required for different types of claim transactions. She provides a specific medical malpractice example in which, based on qualitative input, the process of opening a claim costs \$*x* and the process of maintaining existing claims costs an additional \$*x*.

[106] *CAS Discussion Paper Program*, May 1988.

Alternative weights as well as additional transaction types could be introduced directly into Johnson's formula. The benefit of Johnson's approach is that it only requires the actuary to estimate the *relative* amount of resources required for each transaction type and does not require the actuary to perform detailed time-and-motion studies to calculate the *actual* cash cost of each transaction type.

The mechanics of the Johnson technique involve estimating the ULAE cost per claim activity by calculating weighted claim counts (using the relative transaction costs as weights) based on historical data and comparing those weighted claim counts to the total ULAE costs in the same historical period. In this technique, we then obtain the estimate of unpaid ULAE by projecting the number of, and the ULAE cost associated with, weighted claim counts at each subsequent year-end, related only to claims occurring prior to the reserve valuation date.

Mango-Allen Claim Staffing Technique

Mango and Allen introduce a claim staffing technique to respond to shortcomings they observed in the Johnson method.[107] They state that the technique is closer to a "transaction-based method." They calculate estimated unpaid ULAE using future claim staff workload levels and a new projection base, which is equal to the sum of calendar year opened, closed, and pending claims (OCP claims).
Actuaries using the claim staffing technique project the following four components:

- Future calendar year OCP claims
- Future calendar year claim staff workloads, which are expressed as OCP claims per staff member
- Future calendar year claim staff count
- Future calendar year ULAE per claim staff member

Future calendar year ULAE payments, which include consideration of inflation, are equal to the product of future claim staff count and future ULAE per claim staff member. The estimated unpaid ULAE is the sum of future calendar year ULAE payments.

Mango and Allen cite three characteristics of OCP claims that make their use as a base for the claim staffing method appealing:

1. *It is a reasonable proxy for claims department activity.* It is arguably directly proportional to levels of claim activity, especially number of staff and workload levels of the staff.
2. *It is claim count based.* As mentioned above, paid loss is not a particularly effective or responsive base for projecting ULAE. Claims counts (if case complexity issues are addressed) bear a more direct relationship to claim staff activity.
3. *It is derivable from typical reserve study information.* Projected opened, closed and pending claims are derivable from ultimate claim counts, a claim reporting pattern and a claim closing pattern.[108]

[107] *CAS Forum*, Fall 1999.
[108] *CAS Forum*, Fall 1999.

Conger and Nolibos note that the estimate of unpaid ULAE is likely to be quite sensitive to the magnitude of the selected parameters. In addition, the estimates will be influenced by parameters not explicitly considered in the article, such as the implicit assumption that equal amounts of ULAE resources are required to open, close, and handle one average claim for a year.

Rahardjo

In her paper "A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation,"[109] Kay Kellogg Rahardjo discusses the fact that different levels of work effort are required for handling claims in the first 30 days than for claims that have been open for five years. One focus of Rahardjo's paper is the length of time for which workers compensation claims remain open, which she defines to be the "duration." She states: "As duration increases, so does the expense of handling the claim for the remainder of the claim's life."

Rahardjo also presents a methodology for pricing claims-handling services which is applicable to third-party claims administrators (TPAs). Self-insurance and large deductible plans are now commonplace means of financing risk. However, few self-insureds handle their own risks; instead they outsource those responsibilities to TPAs. Thus, Rahardjo's technique could be useful to such organizations in need of a method for estimating the cost of future TPAs claims handling (i.e., unpaid ULAE).

Spalla

Joanne Spalla asserts that manual time-and-motion studies are no longer necessary to determine the costs of various claim-related activities and transactions. Since so many claims-related activities are computer-supported, she suggests using modern claim department information systems to track the time spent on individual claims by level of employee.

By combining individual claim management activities into somewhat more macroscopic transactions, it is feasible to calculate the average cost of each type of claim transaction. These average claim costs, loaded for overhead and other costs that are not captured by the computerized tracking systems, can be applied within analytical frameworks as described by Rahardjo and Mango-Allen (claim staffing technique).

A benefit of working with the underlying cost data that Spalla describes is that it allows for more detailed analysis of the claim activity costs. Using the detailed information, the actuary can determine which types of claim transactions and which stages of the claim life cycle have relatively similar (or different) costs. This insight can then assist the actuary in selecting different costs for different transactions for the purpose of estimating unpaid ULAE.

Conger and Nolibos suggest "that the actuary using Spalla's method consider an equally important additional step as a 'reality check': if the selected costs per transaction were applied to the numbers of transactions that were undertaken last year, would the result match that period's actual total ULAE expenditures?"

While Spalla describes determining the actual cost, the approach could also be used to quantify the relative amount of cost per transaction as compared to the cost of other kinds of claim

[109] *CAS Forum*, Summer 1996.

transactions. This relativity is less subject to annual change than the dollar cost per transaction or per activity. With relativities, the actuary could then use the general approaches described in Rahardjo and Mango-Allen, but now with some quantitative basis for the magnitude of the parameters.

Triangle-Based Techniques

Actuaries can also estimate ULAE using triangle-based development techniques. A key difference between triangle analysis of claims experience and ULAE experience is the method used to assign ULAE to individual cells (accident year by evaluation year) of the triangle. Since "actual" ULAE by accident year is not observable, at least not for all categories of ULAE, the actuary will need to formulate assumptions for the creation of the paid ULAE triangle. This allocation of ULAE payments is typically based on the pattern of claim payments, which can be observed. It is important to recognize, however, that the accident year triangles of ULAE may be distorted if either the method of allocating calendar ULAE to accident years changes over time or if the claims payment patterns change.

In the paper "Testing of Loss Adjustment (Allocated) Expense Reserves,"[110] R.S. Slifka suggests using a time-and-motion study to estimate the claim department's allocation of resources between current accident year claims and prior accident year claims. This relationship between the "cost" of current year's claim management activities and prior years' claim management activities can be used then to estimate the future payment activities. Assume for example that a time and motion study suggests that:

- 60% of the current accident year's ULAE remains unpaid
- 15% of the prior accident year's ULAE remains unpaid
- 5% of the second prior accident year's ULAE remains unpaid

The total unpaid ULAE is estimated as 80% (60% + 15% + 5%) of a typical calendar year's ULAE payment. Conger and Nolibos note that although this technique presumes a steady state, it can be refined to reflect volume growth as well as the effects of inflation.

A third technique is the construction of paid ULAE triangles based on time and motion studies. For example, assume that time and motion studies suggest that 50% of ULAE is paid at the time a claim is reported and the remaining 50% is paid in proportion to claim payments. An actuary can then assign historical calendar ULAE to accident year-calendar year cohorts: 50% according to the distribution of reported claims across current accident year, prior accident year, second prior accident year, and so on; and 50% according to the distribution of paid claims, as indicated by an appropriate accident year claims payment pattern. Once the ULAE triangle is constructed, the actuary can apply the traditional development technique to estimate ultimate ULAE and indicated unpaid ULAE.

While triangular methods can theoretically be used to project ultimate ULAE and indicated unpaid expenses, in practice, ULAE triangle projections are rarely used by actuaries.

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[110] *Proceedings of the IASA*, 1968.

Comparison Example

In their paper "Estimating ULAE Liabilities: Rediscovering and Expanding Kittel's Approach," Conger and Nolibos provide an example of a U.S. workers compensation insurer who has been in operations for six years. In Exhibit IV, Sheet 1, we summarize the calendar year and accident year experience data from their example and have named it PQR Insurer.

Over the course of its six years of operations, paid ULAE averaged approximately 18% of claims. Observing the downward trend in the paid-to-paid ratios in Exhibit IV, Sheet 2, Column (6), an actuary using the traditional technique may select a ULAE ratio of 16% and derive estimated unpaid ULAE of $41.6 million. In Column (7), we use the Kittel refinement and estimate unpaid ULAE of $29.9 million.

For PQR Insurer, Conger and Nolibos found that ULAE expenditures are concentrated more heavily towards the front end of the claim than are the claim payments. Consider a hypothetical extreme, in which all ULAE is incurred at the moment the claim occurs, with the amount of the ULAE being proportional to the size of the claim. In this hypothetical situation, the appropriate relationship to examine would be the ratio of ULAE to ultimate claims for an accident period.[111] They also observe that the growth of PQR Insurer will result in an overstatement of the estimated unpaid ULAE using the traditional technique.

Interviews with management of PQR Insurer and examination of the flows of work and allocation of resources in the claims department suggested that approximately 60% to 70% of the work for a claim is concentrated at the time the claim is reported, and 30% to 40% of the work is spread over the remaining life of the claim. For PQR Insurer, no particular extra degree of effort is required to close the claim. Since ULAE expenditures are heavier at the beginning of the claim's life cycle, it is not surprising that the estimated unpaid ULAE using the Kittel refinement results in a lower estimate of unpaid ULAE ($29.9 million) than the traditional technique ($41.6 million).

In Exhibit IV, Sheet 3, we present the Conger and Nolibos generalized method with U_1 equal to 60%, U_2 equal to 40%, and U_3 equal to 0%. Columns (2) through (4) are based on the calendar year historical experience presented in Exhibit IV, Sheet 1. The claims basis in Column (5) is equal to 60% of the ultimate on claims reported in the year (R) and 40% of paid claims (C). The ULAE ratio in Column (6) is equal to paid ULAE in column (2) divided by the claims basis in Column (5). A ULAE ratio of 10% is selected based on a review of the historical experience by year. The estimated unpaid ULAE is calculated in Line (9) using the three approaches described in the previous section:

- Expected claim method = [(selected ULAE ratio x ultimate claims) – total paid ULAE to date]

- Bornhuetter-Ferguson method = [selected ULAE ratio x (ultimate claims – total claims basis)]

- Development method = {[(ultimate claims / total claims basis) – 1.00] x total paid ULAE to date}

[111] The reader should recognize elements of the suggested simplification of the generalized method in the discussion of this extreme situation.

In Exhibit IV, Sheet 4, we present similar calculations assuming that U_1 equal to 70%, U_2 equal to 30%, and U_3 equal to 0%.

The final exhibit presents the Conger and Nolibos simplified generalized approach. We present a range of estimated unpaid ULAE assuming that pure IBNR is equal to either 4% of the latest accident year ultimate claims or 6% of the latest accident year ultimate claims.

In practice, many actuaries only use one method to estimate unpaid ULAE. In determining which method to use, an actuary should have a selection criterion for assessing the various alternative methods. One approach many actuaries rely on is to evaluate the results in terms of the number of years of payments indicated by the unpaid estimate. The expected number of future year payments will vary depending on the types of insurance in insurer's portfolio. For example, for short-tail lines of insurance, the actuary may expect the estimate of unpaid ULAE to represent one to two years of additional calendar year payments. However, for long-tail lines of coverage, the estimated unpaid ULAE may be expected to represent three to four years of payments.

Chapter 17 - Unallocated Loss Adjustment Expenses Exhibit I
XYZ Insurer - Classical Technique
Development of Unpaid ULAE

Calendar Year	Paid ULAE	Paid Claims	Ratio of Paid ULAE to Paid Claims
(1)	(2)	(3)	(4)
2004	14,352,000	333,000,000	0.043
2005	15,321,000	358,000,000	0.043
2006	16,870,000	334,000,000	0.051
2007	17,112,000	347,000,000	0.049
2008	17,331,000	391,000,000	0.044
Total	80,986,000	1,763,000,000	0.046

(5) Selected ULAE Ratio	0.045
(6) Case Outstanding at 12/31/08	603,000,000
(7) Total IBNR at 12/31/08	316,000,000
(8) Pure IBNR at 12/31/08	19,000,000
(9) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	27,787,500
(10) Estimated Unpaid ULAE at 12/31/08 Using Pure IBNR	21,105,000

Column and Line Notes:
(2) and (3) Based on data from XYZ Insurer.
(4) = [(2) / (3)].
(5) Selected based on ULAE ratios in (4).
(6) Based on data from XYZ Insurer.
(7) Based on actuarial analysis at 12/31/08 for all lines combined.
(8) Estimated assuming pure IBNR is equal to 5% of accident year 2008 ultimate claims. Ultimate claims for all lines combined for accident year 2008 are $380 million for XYZ Insurer.
(9) = {[(5) x 50% x (6)] + [(5) x 100% x (7)]}.
(10) = {[(5) x 50% x ((6) + (7) - (8))] + [(5) x 100% x (8)]}.

Chapter 17 - Unallocated Loss Adjustment Expenses Exhibit II
XYZ Insurer - Kittel Technique
Development of Unpaid ULAE

Calendar Year	Paid ULAE	Paid Claims	Incurred Claims	Average Paid and Inc. Claims	ULAE Ratio - Paid ULAE to Paid Claims	ULAE Ratio - Paid ULAE to Avg Paid and Inc. Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2004	14,352,000	333,000,000	535,213,000	434,106,500	0.043	0.033
2005	15,321,000	358,000,000	492,265,000	425,132,500	0.043	0.036
2006	16,870,000	334,000,000	435,985,000	384,992,500	0.051	0.044
2007	17,112,000	347,000,000	432,966,000	389,983,000	0.049	0.044
2008	17,331,000	391,000,000	475,300,000	433,150,000	0.044	0.040
Total	80,986,000	1,763,000,000	2,371,729,000	2,067,364,500	0.046	0.039

(8) Selected ULAE Ratio	0.040
(9) Case Outstanding at 12/31/08	603,000,000
(10) Total IBNR at 12/31/08	316,000,000
(11) Pure IBNR at 12/31/08	19,000,000
(12) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	24,700,000
(13) Estimated Unpaid ULAE at 12/31/08 Using Pure IBNR	18,760,000

Column and Line Notes:
(2) through (4) Based on data from XYZ Insurer.
(5) = [Average of (3) and (4)].
(6) = [(2) / (3)].
(7) = [(2) / (5)].
(8) Selected based on ULAE ratios in (7).
(9) Based on data from XYZ Insurer.
(10) Based on actuarial analysis at 12/31/08 for all lines combined.
(11) Estimated assuming pure IBNR is equal to 5% of accident year 2008 ultimate claims.
Ultimate claims for all lines combined for accident year 2008 are $380 million for XYZ Insurer.
(12) = {[(8) x 50% x (9)] + [(8) x 100% x (10)]}.
(13) = {[(8) x 50% x ((9) + (10) - (11))] + [(8) x 100% x (11)]}.

Chapter 17 - Unallocated Loss Adjustment Expenses
New Small Insurer - Mango-Allen Refinement Technique
Development of Expected Paid Claims in Calendar Year

Accident Year	Direct Earned Premium	Expected Claims Ratio	Expected Claims	Expected Payment Percentage in Calendar Year 2005	2006	2007	2008	Expected Claims Paid in Calendar Year 2005	2006	2007	2008
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2005	4,300,000	55%	2,365,000	12%	15%	15%	15%	283,800	354,750	354,750	354,750
2006	4,250,000	55%	2,337,500		12%	15%	15%		280,500	350,625	350,625
2007	4,420,000	55%	2,431,000			12%	15%			291,720	364,650
2008	3,985,000	55%	2,191,750				12%				263,010
Total	16,955,000		9,325,250					283,800	635,250	997,095	1,333,035

Column Notes:
(2) Based on information provided by New Small Insurer.
(3) Based on actuarial analysis conducted for pricing purposes.
(4) = [(2) x (3)].
(5) through (8) Based on actuarial analysis of insurance industry benchmark paid claims development experience.
(9) = [(4) x (5)].
(10) = [(4) x (6)].
(11) = [(4) x (7)].
(12) = [(4) x (8)].

Development of Unpaid ULAE

Calendar	Paid	Paid Claims		ULAE Ratio Paid ULAE-to-Paid Claims	
Year	ULAE	Actual	Expected	Actual	Expected
(1)	(2)	(3)	(4)	(5)	(6)
2005	55,000	1,253,450	283,800	0.044	0.194
2006	62,500	86,000	635,250	0.727	0.098
2007	70,000	410,650	997,095	0.170	0.070
2008	80,000	309,600	1,333,035	0.258	0.060
Total	267,500	2,059,700	3,249,180	0.130	0.082

(7) Selected ULAE Ratio	0.070
(8) Case Outstanding at 12/31/08	225,000
(9) Total IBNR at 12/31/08	6,430,000
(10) Pure IBNR at 12/31/08	109,588
(11) Estimated Unpaid ULAE at 12/31/08 Using Total IBNR	457,975
(12) Estimated Unpaid ULAE at 12/31/al Using Pure IBNR	236,761

Column and Line Notes:
(2) and (3) Based on data from New Small Insurer.
(4) Developed in Exhibit III, Sheet 1.
(5) = [(2) / (3)].
(6) = [(2) / (4)].
(7) Selected based on ULAE ratios in (6) and input of management of New Small Insurer.
(8) Based on claims data from New Small Insurer.
(9) Based on actuarial analysis at 12/31/08.
(10) Estimated assuming pure IBNR is equal to 5% of accident year expected claims.
(11) = {[(7) x 50% x (8)] + [(7) x 100% x (9)]}.
(12) = {[(7) x 50% x ((8) + (9) - (10))] + [(7) x 100% x (10)]}.

PQR Insurer
Summary of Input Parameters ($000)

	Calendar Year			Ult on Claims	Accident Year		
Year	Paid ULAE	Paid Claims	Reported Claims	Reported in Calendar Year	Ultimate Claims	IBNR at 12/31/08	Reported Claims
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2003	1,978	4,590	19,534	27,200	28,600	257	28,343
2004	4,820	14,600	57,125	76,700	79,200	1,742	77,458
2005	8,558	38,390	85,521	106,900	108,400	5,095	103,305
2006	12,039	58,297	128,672	154,300	156,700	16,140	140,560
2007	13,143	86,074	145,070	163,100	163,400	34,477	128,923
2008	15,286	105,466	163,626	176,400	177,100	56,141	120,959
Total	55,824	307,417	599,548	704,600	713,400	113,852	599,548

Note: Claims include allocated claim adjustment expenses.

Column Notes:
(2) through (4) Based on data from PQR Insurer. Reported claims represent paid claims, case outstanding, and estimated IBNR.
(5) through (7) Based on actuarial analysis at year-end 2008.
(8) Based on data from PQR Insurer. Includes paid claims, case outstanding, and estimated IBNR.

Chapter 17 - Unallocated Loss Adjustment Expenses
PQR Insurer
Classical and Kittel Techniques ($000)

Exhibit IV
Sheet 2

					ULAE Ratio - Paid ULAE to	
Calendar Year	Paid ULAE	Paid Claims	Reported Claims	Average of Paid and Rptd Claims	Paid Claims Traditional	Avg Paid & Rptd Claims Kittel
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2003	1,978	4,590	19,534	12,062	0.431	0.164
2004	4,820	14,600	57,125	35,863	0.330	0.134
2005	8,558	38,390	85,521	61,956	0.223	0.138
2006	12,039	58,297	128,672	93,485	0.207	0.129
2007	13,143	86,074	145,070	115,572	0.153	0.114
2008	15,286	105,466	163,626	134,546	0.145	0.114
Total	55,824	307,417	599,548	453,484	0.182	0.123

(8) Selected ULAE Ratio	0.160	0.115
(9) Case Outstanding at 12/31/08	292,130	292,130
(10) IBNR at 12/31/08	113,853	113,853
(11) Estimated Unpaid ULAE at 12/31/08	41,587	29,891

<u>Column and Line Notes:</u>
(2) through (4) From Exhibit IV, Sheet 1.
(5) = [Average of (3) and (4)].
(6) = [(2) / (3)].
(7) = [(2) / (5)].
(8) Selected based on ULAE ratios in (6) and (7).
(9) Based on data from PQR Insurer.
(10) Based on actuarial analysis at 12/31/08 for all lines combined.
(11) = {[(8) x 50% x (9)] + [(8) x 100% x (10)]}.

Chapter 17 - Unallocated Loss Adjustment Expenses Exhibit IV
PQR Insurer Sheet 3
Conger and Nolibos Generalized Approach - 60/40 Assumption ($000)

Calendar Year	Paid ULAE	Ult on Claims Reported in Calendar Year	Paid Claims	Claims Basis	ULAE Ratio
(1)	(2)	(3)	(4)	(5)	(6)
2003	1,978	27,200	4,590	18,156	0.109
2004	4,820	76,700	14,600	51,860	0.093
2005	8,558	106,900	38,390	79,496	0.108
2006	12,039	154,300	58,297	115,899	0.104
2007	13,143	163,100	86,074	132,290	0.099
2008	15,286	176,400	105,466	148,026	0.103
Total	55,824	704,600	307,417	545,727	0.102

(7) Selected ULAE Ratio	0.100
(8) Ultimate Claims	713,400
(9) Indicated Unpaid ULAE Using:	
(a) Expected Claim Method	15,516
(b) Bornhuetter-Ferguson Method	16,767
(c) Development Method	17,152

Column and Line Notes:
(2) through (4) From Exhibit IV, Sheet 1.
(5) = {[(3) x 60%] + [(4) x 40%]}.
(6) = [(2) / (5)].
(7) Selected based on ULAE ratios in (6).
(8) From Exhibit IV, Sheet 1.
(9a) = {[(7) x (8)] - (Total in (2))}.
(9b) = {(7) x [(8) - (Total in (5))]}.
(9c) = {{[(8) / (Total in (5))] - 1.00} x (Total in (2))}.

Chapter 17 - Unallocated Loss Adjustment Expenses
PQR Insurer
Conger and Nolibos Generalized Approach - 70/30 Assumption ($000)

Calendar Year	Paid ULAE	Ult on Claims Reported in Calendar Year	Paid Claims	Claims Basis	ULAE Ratio
(1)	(2)	(3)	(4)	(5)	(6)
2003	1,978	27,200	4,590	20,417	0.097
2004	4,820	76,700	14,600	58,070	0.083
2005	8,558	106,900	38,390	86,347	0.099
2006	12,039	154,300	58,297	125,499	0.096
2007	13,143	163,100	86,074	139,992	0.094
2008	15,286	176,400	105,466	155,120	0.099
Total	55,824	704,600	307,417	585,445	0.095

(7) Selected ULAE Ratio	0.100
(8) Ultimate Claims	713,400
(9) Indicated Unpaid ULAE Using:	
(a) Expected Claim Method	15,516
(b) Bornhuetter-Ferguson Method	12,795
(c) Development Method	12,201

Column and Line Notes:
(2) through (4) From Exhibit IV, Sheet 1.
(5) = {[(3) x 70%] + [(4) x 30%]}.
(6) = [(2) / (5)].
(7) Selected based on ULAE ratios in (6).
(8) From Exhibit IV, Sheet 1.
(9a) = {[(7) x (8)] - (Total in (2))}.
(9b) = {(7) x [(8) - (Total in (5))]}.
(9c) = {{[(8) / (Total in (5))] - 1.00} x (Total in (2))}.

Conger and Nolibos Simplified Generalized Approach - 60/40 Assumption ($000)

Year	Cal Year Paid ULAE	Acc Year Ultimate Claims	Cal Year Paid Claims	Claims Basis	ULAE Ratio
(1)	(2)	(3)	(4)	(5)	(6)
2003	1,978	28,600	4,590	18,996	0.104
2004	4,820	79,200	14,600	53,360	0.090
2005	8,558	108,400	38,390	80,396	0.106
2006	12,039	156,700	58,297	117,339	0.103
2007	13,143	163,400	86,074	132,470	0.099
2008	15,286	177,100	105,466	148,446	0.103
Total	55,824	713,400	307,417	551,007	0.101

(7) Selected ULAE Ratio	0.100
(8) Ultimate Claims	713,400
(9) Estimated Pure IBNR Based on	
(a) 4% of Latest Accident Year Ultimate Claims	7,084
(b) 6% of Latest Accident Year Ultimate Claims	10,626
(10) Indicated Unpaid ULAE Using	
(a) 4% of Latest Accident Year Ultimate Claims	16,664
(b) 6% of Latest Accident Year Ultimate Claims	16,877

Column and Line Notes:
(2) through (4) From Exhibit IV, Sheet 1.
(5) = {[(3) x 60%] + [(4) x 40%]}.
(6) = [(2) / (5)].
(7) Selected based on ULAE ratios in (6).
(8) From Exhibit IV, Sheet 1.
(9a) = [4% x (accident year 2008 ultimate claims in (3))].
(9b) = [6% x (accident year 2008 ultimate claims in (3))].
(10a) = {(7) x [60% x (9a)] + {40% x [(8) - (Total in (4))]}}.
(10b) = {(7) x [60% x (9b)] + {40% x [(8) - (Total in (4))]}}.

APPENDICES – STATEMENT OF PRINCIPLES AND ACTUARIAL STANDARDS OF PRACTICE

* * * * * *

Actuaries practicing in the U.S. are subject to the professional requirements of the CAS and the Academy; actuaries practicing in Canada must meet the professional requirements of the CIA. The requirements for these organizations come in the form of Standards of Practice, Educational Notes, Statement of Principles, and other professional guidelines. In this part, we address some of the key professional obligations of the actuary that are related to reserving as promulgated by the CAS and the Academy.

According to the NAIC's "Quarterly and Annual Statement Instructions for the year 2007, Property/Casualty":

> The Statement of Actuarial Opinion, the AOS, and the supporting Actuarial Report and Workpapers, should be consistent with the appropriate Actuarial Standards of Practice (ASOPs), including but not limited to ASOPs 9, 23, and 36, as promulgated by the Actuarial Standards Board, and Statements of Principles adopted by the Casualty Actuarial Society.

In Appendices A through C, we include, in their entirety, the CAS Statement of Principles and ASOP 9. ASOP 23 relates to data quality and ASOP 36 to Statements of Actuarial Opinion for P&C Loss and LAE Reserves; these two ASOPs can be found on the Academy's Web Site.

APPENDIX A – STATEMENT OF PRINCIPLES REGARDING PROPERTY AND CASUALTY LOSS AND LOSS ADJUSTMENT EXPENSE RESERVES

The CAS adopted the "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves" (CAS Statement of Principles) in May 1988. In this appendix, we include the CAS Statement of Principles in its entirety. Throughout this text we relied on the definitions included in the Statement of Principles. In Parts 3 and 4 of this book, we expand on the principles and considerations cited below.

* * * * *

The purpose of this statement is to identify and describe principles applicable to the evaluation and review of loss and loss adjustment expense reserves. Because of their size and the uncertainties in the estimation process, the evaluation of these reserves requires the use of proper actuarial and statistical procedures. The financial condition of a property and casualty insurer cannot be assessed accurately without sound reserve estimates.

This statement consists of three parts:

Definitions
Principles
Considerations

The definitions in the next section apply to both claims reserves and loss adjustment expense reserves. For the purpose of this statement the terms "loss" and "claim" are used interchangeably, and the term "insurer" is meant to represent any risk bearer for property and casualty exposures, whether an insurance company, self-insured entity or other.

I. Definitions

A *claims reserve* is a provision for its related liability. A total claims reserve is composed of five elements, although the five elements may not necessarily be individually quantified:

— case reserve
— provision for future development on known claims
— reopened claims reserve
— provision for claims incurred but not reported
— provision for claims in transit (incurred and reported but not recorded)

Before these five elements are discussed, certain key dates and terms need to be defined.

The *accounting date* is the date that defines the group of claims for which liability may exist, namely all insured claims incurred on or before the accounting date. The accounting date may be any date selected for a statistical or financial reporting purpose.

The *valuation date* is the date through which transactions are included in the data base used in the evaluation of the liability, regardless of when the analysis is performed. For a defined group of claims as of a given accounting date, reevaluation of the same liability may be made as of successive valuation dates. A valuation date may be prior to, coincident with or subsequent to the accounting date.

The *carried claims reserve* is the amount shown in a published statement or in an internal statement of financial condition.

An *estimated claims reserve* is the result of the application of a particular claims reserving evaluation procedure. An estimated claims reserve for a given accounting date likely will change from one valuation date to another.

A division is often required between reserves for known claims and reserves for claims which have been incurred but not reported (IBNR). The *reserve for known claims* represents the amount, estimated as of the valuation date, that will be required for future payments on claims that already have been reported to the insurer. (The *reserve for known claims* is also sometimes referred to by other labels such as the reported reserve, the reserve for claims adjusted or in the process of adjustment, or the reserve for unpaid claims excluding IBNR.) The *IBNR reserve* represents the amount that must be provided for future payments on insured losses that have occurred but that have not been reported.

The *case reserve* is defined as the sum of the values assigned to specific known claims whether determined by claims adjusters or set by formula. (The term *case reserve* is sometimes used in place of the reserve for known claims. However, as defined, the case reserve does not include the provision for future development on known claims.) *Adjusters' estimates* are the aggregate of the estimates made by claims personnel for individual claims, based on the facts of the particular claims. *Formula reserves* are reserves established for groups of claims for which certain classifying information is provided. Formula reserving may be applied to individual claims or to aggregations of claims with similar characteristics through use of average claim values or factors applied to representative statistics (for example, premiums in force or earned premiums).

Development is defined as the change between valuation dates in the observed values of certain fundamental quantities that may be used in the claims reserve estimation process. For example, the observed number of reported claims associated with losses occurring with a particular calendar period often will be seen to increase from one valuation date to the next until all claims have been reported. The pattern of accumulating claims represents the development of the number of claims.

In a similar fashion the amount of claim payments for losses occurring within a specific calendar period also will be seen to increase at succeeding valuation dates. In this case the pattern of accumulating payments represents the development of claim costs and is usually referred to by the term *paid development*. The concept of development also applies to incurred losses. *Incurred development* is defined as the difference between estimates of incurred costs at two valuation dates for a defined group of claims.

The *provision for future development on known claims* relates to incurred development on those claims reported to an insurer on or before a specific accounting date that are still open on that accounting date. Incurred development on such claims can be either increasing or decreasing.

The *reopened claims reserve* is a provision for future payments on claims closed as of the accounting date that may be reopened due to circumstances not foreseen at the time the claims were closed. In some instances, post-closing payments or recoveries for claims not actually reopened may be included with the development on known claims.

For many insurers a claim is considered to be reported when it is first recorded in the accounting records of the insurer. Conceptually, two elements form the *IBNR reserve*. The first of these elements is the *provision for claims incurred but not reported*, referred to as the *"pure" IBNR*. This provision results from the normal delay that occurs in reporting losses. The second element is the *provision for claims in transit*, which are incurred and reported but not recorded. This provision represents the additional time consumed by the insurer's recording procedures. As a practical matter it is not always feasible to measure these two elements separately, but it is important to understand the effect reporting procedures can have on the amount of IBNR reserve. For some insurers claims in transit are considered known claims. The IBNR reserve must provide for the ultimate value of IBNR claims including the development which is expected to occur on these claims after reporting.

Loss adjustment expenses include allocated loss adjustment expenses and unallocated loss adjustment expenses. *Allocated loss adjustment expenses* are those expenses, such as attorneys' fees and other legal costs, that are incurred in connection with and are assigned to specific claims. *Unallocated loss adjustment expenses* are all other claim adjustment expenses and include salaries, utilities and rent apportioned to the claim adjustment function but not readily assignable to specific claims. The definition of allocated and unallocated loss adjustment expenses for reserving purposes varies among insurers, and an individual insurer's practice for reserving may not always conform to its definition for statistical reporting or ratemaking purposes.

Since allocated expenses are assigned to specific claims, all of the analyses performed on claims data can also be performed on allocated loss expense data. Thus, the allocated loss adjustment expense reserve can be divided into known and IBNR components. All of the concepts discussed in the preceding paragraphs, as well as each of the five elements of the claims reserve, have similar meanings with regard to the allocated loss adjustment expense reserve.

Although the same statistical procedures normally do not apply to unallocated expenses, the unallocated loss adjustment expense reserve can still be divided into know reserve and IBNR components, and the concept of a particular valuation date is meaningful.

II. Principles

1) An actuarially sound claims reserve for a defined group of claims as of a given valuation date is a provision, based on estimates derived from reasonable assumptions and appropriate actuarial methods, for the unpaid amount required to settle all claims, whether reported or not, for which liability exists on a particular accounting date.

2) An actuarially sound loss adjustment expense reserve for a defined group of claims as of a given valuation date is a provision, based on estimates derived from reasonable assumptions and appropriate actuarial methods, for the unpaid amount required to investigate, defend and effect the settlement of all claims, whether reported or not, for which loss adjustment expense liability exists on a particular accounting date.

3) The uncertainty inherent in the estimation of required provisions for unpaid claims or loss adjustment expenses implies that a range of reserves can be actuarially sound. The true value of the liability for losses or loss adjustment expenses at any accounting date can be known only when all attendant claims have been settled.

4) The most appropriate reserve within a range of actuarially sound estimates depends on both the relative likelihood of estimates within the range and the financial reporting context in which the reserve will be presented.

Although specific reserve requirements may vary, the same basic principles apply in each context in which the reserves are stated, including statutory balance sheets, statements of opinion on claims reserves and reports to shareholders or securities regulators. Guidance in the application of these principles is provided in the Considerations section of this statement.

III. Considerations

Understanding the trends and changes affecting the data base is prerequisite of the application of actuarially sound reserving methods. A knowledge of changes in underwriting, claims handling, data processing and accounting, as well as changes in the legal and social environment, affecting the experience is essential to the accurate interpretation and evaluation of observed data and the choice of reserving methods.

A knowledge of the general characteristics of the insurance portfolio for which reserves are to be established also is important. Such knowledge would include familiarity with policy provisions that may have a bearing on reserving, as well as deductibles, salvage and subrogation, policy limits and reinsurance.

Data Organizations

The categorization of claims by time unit is extremely important. The successful organization of a data base for reserving revolves around five key dates:

— *accident date*, which is the date on which the loss occurred, or for those losses that cannot be identified with a single isolated event, the date on which the loss is deemed to have occurred

— *report date*, which is the date on which the loss is first reported to the insurer (in practice it is often taken to be the recorded date)

— *recorded date*, which is the date on which the loss is first entered in the statistical records of the insurer

— *accounting date*

— *valuation date*

Commonly, insurers compile claim data by accident periods (accident year, accident quarter, accident month, etc.), which group together all claims with accident dates falling within particular fiscal periods; or by policy periods, which group all claims relating to policies written during particular fiscal periods. Claim information by accident year is required for various financial reporting schedules. Many insurers also compile claim data by report periods, which group together all claims with report dates failing within specified fiscal periods.

Claims with report dates equal to or prior to a particular accounting date would be classified as known or reported claims with respect to the accounting date, but claims with report dates later than a particular accounting date and with accident dates equal to or earlier than the accounting date would be classified as IBNR with respect to the accounting date.

The preceding paragraph gives the precise definition of IBNR claims. In practice a broader definition is sometimes used in which the IBNR reserve denotes the provision for late reported claims, development on known claims and a provision for reopened claims.

The ambiguity regarding the definition of IBNR can result from the differing strategies insurers may employ in approaching claims reserving. The two common strategies are the report period approach and the accident period approach. In the report period approach the adequacy of existing reserves on reported claims is estimated on the basis of the historical results. Further analysis is required in order to measure the emergence of IBNR claims. In a pure accident period approach the ultimate cost of all claims, both reported and unreported, arising from each accident period is estimated. This approach results in an estimate of the claims reserve without segregation of claims incurred but not reported. The estimated claims reserve is then apportioned between reserves for IBNR and known claims on a suitable basis. Because accident period techniques do not necessarily require separate treatment of reported and unreported claims, their use can lead to a broader definition of IBNR as mentioned above.

The method of assigning report dates to reopened claims can also affect the IBNR reserve. Because reopened claims are generated from claims previously reported and closed, there is general agreement that the provision for this liability should be included in the reserve for known claims. Some insurers, however, establish new report dates for reopened claims and thereby consider the provision for these claims as a component of the IBNR reserve.

Homogeneity

Claims reserving accuracy often is improved by subdividing experience into groups exhibiting similar characteristics, such as comparable claim experience patterns, settlement patterns or size of loss distributions. For a heterogeneous product, such as commercial multi-peril or miscellaneous liability insurance, consideration should be given to segregating the experience into more homogeneous groupings. Other example applications concern the distinctions between personal and commercial risks and between primary and excess coverage. Additionally, subdividing or combining the data so as to minimize the distorting effects of operational or procedural changes should be fully explored.

Credibility

Credibility is a measure of the predictive value that the actuary attaches to a body of data. The degree to which consideration is given to homogeneity is related to the consideration of credibility. Credibility is increased by making groupings more homogeneous or by increasing the number of claims analyzed within each group. A group of claims should be large enough to be statistically reliable. Obtaining homogeneous groupings requires refinement and partitioning of the total data. There is a point at which partitioning divides data into groups too small to provide credible development patterns. Each situation requires a balancing of the homogeneity and amount of data in each grouping. Thus, line and coverage definitions suitable for the establishment of reserves for large insurers can be in much finer detail than in the case of small insurers. Where a very small group of claims is involved, use of external information such as industry aggregates may be necessary.

Data Availability

Data should meet requirements for the proper evaluation of reserves. Existing information systems may impose constraints while more suitable data are being developed. Whatever data are used in analysis of reserves, they must reconcile to the insurer’s financial records. If reserves are established in less detail than necessary for reporting requirements, procedures for property assigning the reserves to required categories must be developed.

Emergence Patterns

The delay between the occurrence of claims and the recording of claims depends upon both the line of business and the insurer’s practices. In general, property claims are reported quickly, whereas the reporting of liability claims may be substantially delayed.

A review of the insurer’s claims practices should be made to assure that assumptions regarding the claims process are appropriate. If a change in claims procedures is identified, its impact on emergence patterns should be evaluated.

Settlement Patterns

The length of time that it normally takes for reported claims to be settled will affect the choice of the claims reserving methods. Lines of business for which claims settle quickly generally are less subject to reserve uncertainty. A claim arising under collision coverage, for example, tends to be settled quickly, and the amount of settlement is usually close to the original estimate. Conversely, a bodily injury liability claim often requires a long time to settle. Moreover, the amount of settlement often varies considerably from the original estimate, since it depends on the interaction of complex variables such as the type and severity of the injury and the intricacies of the judicial process.

Development Patterns

The pattern of development on known claims should be carefully reviewed. An insurer’s claims procedures will affect the manner in which the case reserves develop for any group of claims, and changes in claims practices may affect the consistency of historical developments. Further, the length of time to settlement may affect the observed development.

If reserves have been established at present values, the payments of claims, by themselves, cause an appearance of upward development apart from development due to other factors. To interpret development patterns correctly, the development history should be restated to remove the effect of discounting.

Frequency and Severity

The same total dollars of losses may arise from a few very large claims or from many small claims. Reserve estimates will tend to be more accurate for losses resulting from a high frequency/low severity group of claims than from a low frequency/high severity group of claims. Therefore, the evaluation of reserves for low frequency/high severity groups of claims will ordinarily require more extensive analysis. If the exposure for the group of claims being considered includes the potential for claims of a magnitude not present in historical data, adjustments should be made to reflect the expectation of such claims.

Reopened Claims Potential

The tendency for closed claims to reopen varies substantially among lines of business. Judicial opinions and legislation can affect the reporting of claims, as can changes in an insurer's procedures.

Claims-Made

Some coverages may be provided on a policy form covering claims reported during a certain period rather than claims arising out of occurrences during that period. Claims-made data should be segregated from experience on occurrence policies. It may be necessary to augment claims-made statistics with appropriate report period statistics generated under occurrence programs.

Certain provisions may modify the claims-made policy upon fulfillment of conditions stipulated in the contract. Review of the contract wording is necessary to determine the appropriate reserve, if any, for occurrences prior to the policy effective date or claims reported after the policy expiration.

Aggregate Limits

For certain insurance coverages, such as products and professional liability, aggregate policy limits may act to restrict total potential incurred losses and therefore reserve requirements. In the review of groups of claims where aggregate limits apply, modeling techniques or audit tests of the data will reveal to what extent limit ceilings have been reached and assist in determining how reserve projections may have to be modified.

Salvage, Subrogation, and Collateral Sources

For a proper evaluation of an insurer's total reserve position, the potential impact of salvage and subrogation on the group of claims under consideration should be evaluated even though statutory accounting may prohibit a deduction from claims reserves. In addition, the impact of coinsurance, deductibles, coordination of benefits, second injury fund recoveries, as well as any other collateral sources, should be considered.

Generally Accepted Accounting Principles

Reports to shareholders and to securities regulators are governed by generally accepted accounting principles (GAAP). GAAP reserves may be defined differently from statutory reserves. For example, GAAP reserves are ordinarily reduced by anticipated salvage and subrogation. The same principles of analysis used for statutory estimates can be applied to GAAP reserve estimates.

Reinsurance

Reserves are affected by the types of reinsurance plans and retentions that were and are in force, and the impact of changes in net retentions should be evaluated. To determine the effect of reinsurance it may be appropriate to analyze direct and ceded experience separately. The recoverability of ceded reinsurance is a further consideration; generally, it is addressed separately from the reserve evaluation process.

Portfolio Transfers, Commutations and Structured Settlements

Portfolio transfers, commutations and structured settlements generally recognize the time value of money. Such transactions should be evaluated for their impact on the claims reserves and the development patterns.

Pools and Associations

The loss liabilities of an insurer depend to some degree on forces beyond its control, such as business obtained through participation in voluntary and non-voluntary underwriting pools and associations. The operating and reserving policies of these organizations vary, and adjustments to reserves reported by the pools and associations may be warranted.

Operational Changes

The installation of a new computer system, an accounting change, a reorganization of claims responsibility or changes in claims handling practices or underwriting programs are examples of operational changes that can affect the continuity of the claims experience. The computation of the reserves should reflect the impact of such changes.

Changes in Contracts

Changes in contract provisions, such as policy limits, deductibles or coverage attachment points, may alter the amounts of claims against an insurer. Such contractual changes may affect both the frequency and severity of claims.

External Influences

Due regard should be given to the impact of external influences. External influences include the judicial environment, regulatory and legislative changes, residual or involuntary market mechanisms, and economic variables such as inflation.

Discounting

There are circumstances where claims reserves are stated on a present value basis. To calculate or evaluate such reserves, it is generally appropriate to perform an analysis on an undiscounted basis and then apply the effect of discounting.

Provision for Uncertainty

A reserve estimate should take into account the degree of uncertainty inherent in its projection. A reserve stated at its ultimate value may include an implicit provision for uncertainty due to the time value of money. If a reserve is to be stated at a present value, it may be appropriate to include an explicit provision for uncertainty in its undiscounted amount. Further, an explicit provision for uncertainty may be warranted when the estimated ultimate reserve value is subject to a high degree of variability.

Reasonableness

The incurred losses implied by the reserves should be measured for reasonableness against relevant indicators, such as premiums, exposures or numbers of policies, and expressed wherever possible in terms of frequencies, severities, and claim ratios. No material departure from expected results should be accepted without attempting to find an explanation for the variation.

Loss-Related Balance Sheet Items

The claims reserve analysis may have implications for other loss-related balance sheet items. These include contingent commissions, retrospective premium adjustments, policyholder dividends, premium deficiency reserves, minimum statutory reserves and the deduction for unauthorized reinsurance.

Loss Reserving Methods

Detailed discussion of the technology and applicability of current claims reserving practices is beyond the scope of this statement. Selection of the most appropriate method of reserve estimation is the responsibility of the actuary. Ordinarily the actuary will examine the indications of more than one method when estimating the loss and loss adjustment expense liability for a specific group of claims.

Standards of Practice

This statement provides the principles of claims reserving. The actuary should also be familiar with standards of practice, which address the application of these principles.

APPENDIX B – ACTUARIAL STANDARD OF PRACTICE NO. 43 PROPERTY/CASUALTY UNPAID CLAIM ESTIMATES

In June 2007, the Actuarial Standards Board (ASB) adopted the Actuarial Standard of Practice No. 43 Property/Casualty Unpaid Claim Estimates (ASOP 43). Previously, no ASOP existed to provide guidance to actuaries developing property/casualty unpaid claim estimates. To address this issue, the ASB charged the Subcommittee on Reserving of the ASB Casualty Committee to create this ASOP.

In this appendix, we include ASOP 43 in its entirety. We addressed many of the concepts included in ASOP 43 throughout this text.

* * * * *

Actuarial Standard of Practice No. 43

Property/Casualty Unpaid Claim Estimates

Standard of Practice

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose – This actuarial standard of practice (ASOP) provides guidance to actuaries when performing professional services relating to the estimation of loss and loss adjustment expense for unpaid claims for property/casualty coverages. Any reference to "unpaid claims" in this standard includes (unless explicitly stated otherwise) the associated unpaid claim adjustment expense even when not accompanied by the estimation of unpaid claims.

1.2 Scope – This standard applies to actuaries when performing professional services related to developing unpaid claim estimates only for events that have already occurred or will have occurred, as of an accounting date, exclusive of estimates developed solely for ratemaking purposes. This standard applies to the actuary when estimating unpaid claims for all classes of entities, including self-insureds, insurance companies, reinsurers, and governmental entities. This standard applies to estimates of gross amounts before recoverables (such as deductibles, ceded reinsurance, and salvage and subrogation), estimates of amounts after such recoverables, and estimates of amounts of such recoverables.

This standard applies to the actuary only with respect to unpaid claim estimates that are communicated as an actuarial finding (as described in ASOP No. 41, *Actuarial Communications*) in written or electronic form. Actions taken by the actuary's principal regarding such estimates are beyond the scope of this standard.

The terms "reserves" and "reserving" are sometimes used to refer to "unpaid claim estimates" and "unpaid claim estimate analysis." In this standard, the term "reserve" is limited to its strict definition as an amount booked in a financial statement. Services described above are covered by this standard, regardless as to whether the actuary refers to the work performed as "reserving," "estimating unpaid claims" or any other term. This standard does not apply to the estimation of items that may be a function of unpaid claim estimates or claim outcomes, such as (but not limited to) loss-based taxes, contingent commissions and retrospectively rated premiums.

This standard does not apply to unpaid claims under a "health benefit plan" covered by ASOP No. 5, *Incurred Health and Disability Claims*, or included as "health and disability liabilities" under ASOP No. 42, *Determining Health And Disability Liabilities Other Than Liabilities for Incurred Claims*. However, this standard does apply to health benefits associated with state or federal workers compensation statutes and liability policies.

With respect to discounted unpaid claim estimates for property/casualty coverages, this standard addresses the determination of the undiscounted value of such estimates. The actuary should be guided by ASOP No. 20, *Discounting of Property and Casualty Loss and Loss Adjustment Expense Reserves*, to address additional considerations to reflect the effects of discounting.

An actuary may develop an unpaid claim estimate in the context of issuing a written statement of actuarial opinion regarding property/casualty loss and loss adjustment expense reserves. This standard addresses the determination of the unpaid claim estimate. The actuary should be guided by ASOP No. 36, *Statements of Actuarial Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves*, to address additional considerations associated with the issuance of such a statement.

The actuary should comply with this standard except to the extent it may conflict with applicable law (statutes, regulations, and other legally binding authority). If compliance with applicable law requires the actuary to depart from the guidance set forth in this standard, the actuary should refer to section 4.4 regarding deviation from standard.

1.3 Cross References – When this standard refers to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called. If any amended or restated document differs materially from the originally referenced document, the actuary should consider the guidance in this standard to the extent it is applicable and appropriate.

1.4 Effective Date – This standard will be effective for any actuarial work product covered by this standard's scope produced on or after September 1, 2007.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice.

2.1 Actuarial Central Estimate – An estimate that represents an expected value over the range of reasonably possible outcomes.

2.2 Claim Adjustment Expense – The costs of administering, determining coverage for, settling, or defending claims even if it is ultimately determined that the claim is invalid.

2.3 Coverage – The terms and conditions of a plan or contract, or the requirements of applicable law, that create an obligation for claim payment associated with contingent events.

2.4 Event – The incident or activity that triggers potential for claim or claim adjustment expense payment.

2.5 Method – A systematic procedure for estimating the unpaid claims.

2.6 Model – A mathematical or empirical representation of a specified phenomenon.

2.7 Model Risk – The risk that the methods are not appropriate to the circumstances or the models are not representative of the specified phenomenon.

2.8 Parameter Risk – The risk that the parameters used in the methods or models are not representative of future outcomes.

2.9 Principal – The actuary's client or employer. In situations where the actuary has both a client and an employer, as is common for consulting actuaries, the facts and circumstances will determine whether the client or the employer (or both) is the principal with respect to any portion of this standard.

2.10 Process Risk – The risk associated with the projection of future contingencies that are inherently variable, even when the parameters are known with certainty.

2.11 Unpaid Claim Estimate – The actuary's estimate of the obligation for future payment resulting from claims due to past events.

2.12 Unpaid Claim Estimate Analysis – The process of developing an unpaid claim estimate.

Section 3. Analysis of Issues and Recommended Practices

3.1 Purpose or Use of the Unpaid Claim Estimate – The actuary should identify the intended purpose or use of the unpaid claim estimate. Potential purposes or uses of unpaid claim estimates include, but are not limited to, establishing liability estimates for external financial reporting, internal management reporting, and various special purpose uses such as appraisal work and scenario analyses. Where multiple purposes or uses are intended, the actuary should consider the potential conflicts arising from those multiple purposes and uses and should consider adjustments to accommodate the multiple purposes to the extent that, in the actuary's professional judgment, it is appropriate and practical to make such adjustments.

3.2 Constraints on the Unpaid Claim Estimate Analysis – Sometimes constraints exist in the performance of an actuarial analysis, such as those due to limited data, staff, time or other resources. Where, in the actuary's professional judgment, the actuary believes that such constraints create a significant risk that a more in-depth analysis would produce a materially different result, the actuary should notify the principal of that risk and communicate the constraints on the analysis to the principal.

3.3 Scope of the Unpaid Claim Estimate – The actuary should identify the following:

a) the intended measure of the unpaid claim estimate;

1) Examples of various types of measures for the unpaid claim estimate include, but are not limited to, high estimate, low estimate, median, mean, mode, actuarial central estimate, mean plus risk margin, actuarial central estimate plus risk margin, or specified percentile.

As defined in section 2.1, the actuarial central estimate represents an expected value over the range of reasonably possible outcomes. Such range of reasonably possible outcomes may not include all conceivable outcomes, as, for example, it would not include conceivable extreme events where the contribution of such events to an expected value is not reliably estimable. An actuarial central estimate may or may not be the result of the use of a probability distribution or a statistical analysis. This description is intended to clarify the concept rather than assign a precise statistical measure, as commonly used actuarial methods typically do not result in a statistical mean.

The terms "best estimate" and "actuarial estimate" are not sufficient identification of the intended measure, as they describe the source or the quality of the estimate but not the objective of the estimate.

2) The actuary should consider whether the intended measure is appropriate to the intended purpose or use of the unpaid claim estimate.

3) The description of the intended measure should include the identification of whether any amounts are discounted.

b) whether the unpaid claim estimate is to be gross or net of specified recoverables;

c) whether and to what extent collectibility risk is to be considered when the unpaid claim estimate is affected by recoverables;

d) the specific types of unpaid claim adjustment expenses covered in the unpaid claim estimate (for example, coverage dispute costs, defense costs, and adjusting costs);

e) the claims to be covered by the unpaid claim estimate (for example, type of loss, line of business, year, and state); and

f) any other items that, in the actuary's professional judgment, are needed to describe the scope sufficiently.

3.4 Materiality – The actuary may choose to disregard items that, in the actuary's professional judgment, are not material to the unpaid claim estimate given the intended purpose and use. The actuary should evaluate materiality based on professional judgment, taking into account the requirements of applicable law and the intended purpose of the unpaid claim estimate.

3.5 Nature of Unpaid Claims – The actuary should have an understanding of the nature of the unpaid claims being estimated. This understanding should be based on what a qualified actuary in the same practice area could reasonably be expected to know or foresee as being relevant and material to the estimate at the time of the unpaid claim estimate analysis, given the same purpose, constraints, and scope. The actuary need not be familiar with every aspect of potential unpaid claims.

Examples of aspects of the unpaid claims (including any material trends and issues associated with such elements) that may require an understanding include the following:

a) coverage;

b) conditions or circumstances that make a claim more or less likely or the cost more or less severe;

c) the underlying claim adjustment process; and

d) potential recoverables.

3.6 Unpaid Claim Estimate Analysis – The actuary should consider factors associated with the unpaid claim estimate analysis that, in the actuary's professional judgment, are material and are reasonably foreseeable to the actuary at the time of estimation. The actuary is not expected to become an expert in every aspect of potential unpaid claims.

The actuary should consider the following items when performing the unpaid claim estimate analysis:

3.6.1 Methods and Models – The actuary should consider methods or models for estimating unpaid claims that, in the actuary's professional judgment, are appropriate. The actuary should select specific methods or models, modify such methods or models, or develop new methods or models based on relevant factors including, but not limited to, the following:

a) the nature of the claims and underlying exposures;
b) the development characteristics associated with these claims;
c) the characteristics of the available data;
d) the applicability of various methods or models to the available data; and
e) the reasonableness of the assumptions underlying each method or model.

The actuary should consider whether a particular method or model is appropriate in light of the purpose, constraints, and scope of the assignment. For example, an unpaid claim estimate produced by a simple methodology may be appropriate for an immediate internal use. The same methodology may be inappropriate for external financial reporting purposes.

The actuary should consider whether, in the actuary's professional judgment, different methods or models should be used for different components of the unpaid claim estimate. For example, different coverages within a line of business may require different methods.

The actuary should consider the use of multiple methods or models appropriate to the purpose, nature and scope of the assignment and the characteristics of the claims unless, in the actuary's professional judgment, reliance upon a single method or model is reasonable given the circumstances. If for any material component of the unpaid claim estimate the actuary does not use multiple methods or models, the actuary should disclose and discuss the rationale for this decision in the actuarial communication.

In the case when the unpaid claim estimate is an update to a previous estimate, the actuary may choose to use the same methods or models as were used in the prior unpaid claim estimate analysis, different methods or models, or a combination of both. The actuary should consider the appropriateness of the chosen methods or models, even when the decision is made not to change from the previously applied methods or models.

3.6.2 Assumptions – The actuary should consider the reasonableness of the assumptions underlying each method or model used. Assumptions generally involve significant professional judgment as to the appropriateness of the methods and models used and the parameters underlying the application of such methods and models. Assumptions may be implicit or explicit and may involve interpreting past data or projecting future trends. The actuary should use assumptions that, in the actuary's professional judgment, have no known significant bias to underestimation or overestimation of the identified intended measure and are not internally inconsistent. Note that bias with regard to an expected value estimate would not necessarily be bias with regard to a measure intended to be higher or lower than an expected value estimate.

The actuary should consider the sensitivity of the unpaid claim estimates to reasonable alternative assumptions. When the actuary determines that the use of reasonable alternative assumptions would have a material effect on the unpaid claim estimates, the actuary should notify the principal and attempt to discuss the anticipated effect of this sensitivity on the analysis with the principal.

When the principal is interested in the value of an unpaid claim estimate under a particular set of assumptions different from the actuary's assumptions, the actuary may provide the principal with the results based on such assumptions, subject to appropriate disclosure.

3.6.3 Data – The actuary should refer to ASOP No. 23, *Data Quality,* with respect to the selection of data to be used, relying on data supplied by others, reviewing data, and using data.

3.6.4 Recoverables – Where the unpaid claim estimate analysis encompasses multiple types of recoverables, the actuary should consider interaction among the different types of recoverables and should adjust the analysis to reflect that interaction in a manner that the actuary deems appropriate.

3.6.5 Gross vs. Net – The scope of the unpaid claim estimate analysis may require estimates both gross and net of recoverables. Gross and net estimates may be viewed as having three components, which are the gross estimate, the estimated recoverables, and the net estimate. The actuary should consider the particular facts and circumstances of the assignment when choosing which components to estimate.

3.6.6 External Conditions – Claim obligations are influenced by external conditions, such as potential economic changes, regulatory actions, judicial decisions, or political or social forces. The actuary should consider relevant external conditions that are generally known by qualified actuaries in the same practice area and that, in the actuary's professional judgment, are likely to have a material effect on the actuary's unpaid claim estimate analysis. However, the actuary is not required to have detailed knowledge of or consider all possible external conditions that may affect the future claim payments.

3.6.7 Changing Conditions – The actuary should consider whether there have been significant changes in conditions, particularly with regard to claims, losses, or exposures, that are likely to be insufficiently reflected in the experience data or in the assumptions used to estimate the unpaid claims. Examples include reinsurance program changes and changes in the practices used by the entity's claims personnel to the extent such changes are likely to have a material effect on the results of the actuary's unpaid claim estimate analysis. Changing conditions can arise from circumstances particular to the entity or from external factors affecting others within an industry. When determining whether there have been known, significant changes in conditions, the actuary should consider obtaining supporting information from the principal or the principal's duly authorized representative and may rely upon their representations unless, in the actuary's professional judgment, they appear to be unreasonable.

3.6.8 Uncertainty – The actuary should consider the uncertainty associated with the unpaid claim estimate analysis. This standard does not require or prohibit the actuary from measuring this uncertainty. The actuary should consider the purpose and use of the unpaid claim estimate in deciding whether or not to measure this uncertainty. When the actuary is measuring uncertainty, the actuary should consider the types and sources of uncertainty being measured and choose the methods, models, and assumptions that are appropriate for the measurement of such uncertainty. For example, when measuring the variability of an unpaid claim estimate covering multiple components, consideration should be given to whether the components are independent of each other or whether they are correlated. Such types and sources of uncertainty surrounding unpaid claim estimates may include uncertainty due to model risk, parameter risk, and process risk.

3.7 Unpaid Claim Estimate – The actuary should take into account the following with respect to the unpaid claim estimate:

3.7.1 Reasonableness – The actuary should assess the reasonableness of the unpaid claim estimate, using appropriate indicators or tests that, in the actuary's professional judgment, provide a validation that the unpaid claim estimate is reasonable. The reasonableness of an unpaid claim estimate should be determined based on facts known to, and circumstances known to or reasonably foreseeable by, the actuary at the time of estimation.

3.7.2 Multiple Components – When the actuary's unpaid claim estimate comprises multiple components, the actuary should consider whether, in the actuary's professional judgment, the estimates of the multiple components are reasonably consistent.

3.7.3 Presentation – The actuary may present the unpaid claim estimate in a variety of ways, such as a point estimate, a range of estimates, a point estimate with a margin for adverse deviation, or a probability distribution of the unpaid claim amount. The actuary should consider the intended purpose or use of the unpaid claim estimate when deciding how to present the unpaid claim estimate.

3.8 Documentation – The actuary should consider the intended purpose or use of the unpaid claim estimate when documenting work, and should refer to ASOP No. 41.

Section 4. Communications and Disclosures

4.1 Actuarial Communication – When issuing an actuarial communication subject to this standard, the actuary should consider the intended purpose or use of the unpaid claim estimate and refer to ASOP Nos. 23 and 41.

In addition, consistent with the intended purpose or use, the actuary should disclose the following in an appropriate actuarial communication:

a) the intended purpose(s) or use(s) of the unpaid claim estimate, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses, if any, as described in section 3.1;

b) significant limitations, if any, which constrained the actuary's unpaid claim estimate analysis such that, in the actuary's professional judgment, there is a significant risk that a more in-depth analysis would produce a materially different result, as described in section 3.2;

c) the scope of the unpaid claim estimate, as described in section 3.3;

d) the following dates: (1) the accounting date of the unpaid claim estimate, which is the date used to separate paid versus unpaid claim amounts; (2) the valuation date of the unpaid claim estimate, which is the date through which transactions are included in the data used in the unpaid claim estimate analysis; and (3) the review date of the unpaid claim estimate, which is the cutoff date for including information known to the actuary in the unpaid claim estimate analysis, if appropriate. An example of such communication is as follows: "This unpaid claim estimate as of December 31, 2005 was based on data evaluated as of November 30, 2005 and additional information provided to me through January 17, 2006.";

e) specific significant risks and uncertainties, if any, with respect to whether actual results may vary from the unpaid claim estimate; and

f) significant events, assumptions, or reliances, if any, underlying the unpaid claim estimate that, in the actuary's professional judgment, have a material effect on the unpaid claim estimate, including assumptions provided by the actuary's principal or an outside party or assumptions regarding the accounting basis or application of an accounting rule. If the actuary depends upon a material assumption, method, or model that the actuary does not believe is reasonable or cannot determine to be reasonable, the actuary should disclose the dependency of the estimate on that assumption/method/model and the source of that assumption/method/model. The actuary should use professional judgment to determine whether further disclosure would be appropriate in light of the purpose of the assignment and the intended users of the actuarial communication.

4.2 Additional Disclosures – In certain cases, consistent with the intended purpose or use, the actuary may need to make the following disclosures in addition to those in section 4.1:

a) In the case when the actuary specifies a range of estimates, the actuary should disclose the basis of the range provided, for example, a range of estimates of the intended measure (each of such estimates considered to be a reasonable estimate on a stand-alone basis); a range representing a confidence interval within the range of outcomes produced by a particular model or models; or a range representing a confidence interval reflecting certain risks, such as process risk and parameter risk.

b) In the case when the unpaid claim estimate is an update of a previous estimate, the actuary should disclose changes in assumptions, procedures, methods or models that the actuary believes to have a material impact on the unpaid claim estimate and the reasons for such changes to the extent known by the actuary. This standard does not require the actuary to measure or quantify the impact of such changes.

4.3 Prescribed Statement of Actuarial Opinion – This ASOP does not require a prescribed statement of actuarial opinion as described in the *Qualification Standards for Prescribed Statements of Actuarial Opinion* promulgated by the American Academy of Actuaries. However, law, regulation, or accounting requirements may also apply to an actuarial communication prepared under this standard, and as a result, such actuarial communication may be a prescribed statement of actuarial opinion.

4.4 Deviation from Standard – If, in the actuary's professional judgment, the actuary has deviated materially from the guidance set forth elsewhere in this standard, the actuary can still comply with this standard by applying the following sections as appropriate:

4.4.1 Material Deviations to Comply with Applicable Law – If compliance with applicable law requires the actuary to deviate materially from the guidance set forth in this standard, the actuary should disclose that the assignment was prepared in compliance with applicable law, and the actuary should disclose the specific purpose of the assignment and indicate that the work product may not be appropriate for other purposes. The actuary should use professional judgment to determine whether additional disclosure would be appropriate in light of the purpose of the assignment and the intended users of the actuarial communication.

4.4.2 Other Material Deviations – The actuary's communication should disclose any other material deviation from the guidance set forth in this standard. The actuary should consider whether, in the actuary's professional judgment, it would be appropriate and practical to provide the reasons for, or to quantify the expected impact of, such deviation. The actuary should be prepared to explain the deviation to a principal, another actuary, or other intended users of the actuary's communication. The actuary should also be prepared to justify the deviation to the actuarial profession's disciplinary bodies.

Appendix 1 – Background and Current Practices

Note: This appendix is provided for informational purposes but is not part of the standard of practice.

Background

This standard defines issues and considerations that an actuary should take into account when estimating unpaid claim and claim adjustment expense for property and casualty coverages or hazard risks. The *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves* was adopted by the Board of Directors of the Casualty Actuarial Society in May 1988. The *Statement of Principles* has served as the primary guidance regarding estimation of unpaid property and casualty claim and claim adjustment expense amounts providing both principles and considerations related to practice. In conjunction with the development of this standard, the *Statement of Principles* is undergoing revision to focus on principles rather than also discussing considerations.

A decision was made to exclude unpaid claim estimates developed for ratemaking purposes from the scope of this standard. This was done to avoid placing inappropriate requirements on unpaid claim estimates in the ratemaking context, and to keep the scope workable by excluding additional considerations only applicable to the ratemaking context. Ratemaking requires more of a hypothetical analysis of possible future events than an analysis of the cost of past events. Hence, the selection and evaluation of assumptions and methods for ratemaking purposes may be different from the selection and evaluation of such for past event unpaid claim estimates.

Current Practices

Actuaries are guided by the *Statement of Principles Regarding Property and Liability Loss and Loss Adjustment Expense Reserves* of the Casualty Actuarial Society. Other ASOPs issued by the Actuarial Standards Board pertaining to claim and claim adjustment expense estimates have included ASOP No. 9, *Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations*; ASOP No. 20, *Discounting of Property and Casualty Loss and Loss Adjustment Expense Reserves*; ASOP No. 23, *Data Quality*; ASOP No. 36, *Statement of Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves,* and ASOP No. 41, *Actuarial Communications*. In addition, since 1993, the Casualty Practice Council of American Academy of Actuaries has published practice notes addressing current National Association of Insurance Commissioners' requirements for the statement of actuarial opinion. The practice notes describe some current practices and show illustrative wording for handling issues and problems. While these practice notes (and future practice notes issued after the effective date of this standard) can be updated to react in a timely manner to new concerns or requirements, they are not binding, and they have not gone through the exposure and adoption process of the standards of actuarial practice promulgated by the Actuarial Standards Board.

There are also numerous educational papers in the public domain relevant to the topic of unpaid claim estimates, including those published by the Casualty Actuarial Society. Some of these are refereed and others are not. While these may provide useful educational guidance to practicing actuaries, none is an actuarial standard.

APPENDIX C – ACTUARIAL STANDARD OF PRACTICE NO. 9 DOCUMENTATION AND DISCLOSURE IN PROPERTY AND CASUALTY INSURANCE RATEMAKING, LOSS RESERVING, AND VALUATIONS

The Actuarial Standards Board (ASB) adopted Actuarial Standard of Practice No. 9 Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations (ASOP 9) in January 1991 as developed by the Casualty Committee of the ASB.

In this appendix we include only Sections 1 through 6 of ASOP 9. ASOP 9 also includes three appendices which are the Statements of Principles for ratemaking, claims reserving, and valuation. The Statement of Principles related to claims reserving is contained in Appendix A of this text.

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Actuarial Standard of Practice No. 9
Documentation and Disclosure in Property and Casualty Insurance Ratemaking, Loss Reserving, and Valuations
Preamble

Section 1 – Purpose, Scope, and Effective Date

1.1 Purpose – The purpose of this standard of practice is to define the documentation and disclosure required of an actuary in property and casualty insurance ratemaking, claims reserving, and valuations.

1.2 Scope – This standard of practice is limited to the practices that relate to the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking*, the *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*, and the *Statement of Principles Regarding Property and Casualty Valuations* as adopted by the Casualty Actuarial Society (CAS).

1.3 Effective Date – This standard became effective July 14, 1989, for documentation and disclosure in ratemaking and claims reserving. Its effective date for valuations was May 1, 1991.

Section 2 – Definitions

2.1 Actuarial Report – A document, or other presentation, prepared as a formal means of conveying the actuary’s professional conclusions and recommendations, of recording and communicating the methods and procedures, and of ensuring that the parties addressed are aware of the significance of the actuary’s opinion or findings.

2.2 Actuarial Work Product – The result of an actuary's work. The term applies to the following actuarial communications, whether written or oral: statements of actuarial opinion, actuarial reports, statements of actuarial review, and required actuarial documents.

2.3 Required Actuarial Document – An actuarial communication of which the formal content is prescribed by law or regulation.

2.4 Statement of Actuarial Opinion – A formal statement of the actuary's professional opinion on a defined subject. It outlines the scope of the work but normally does not include descriptive details.

2.5 Statement of Actuarial Review – A formally communicated appraisal of actuarial work done by another person.

Section 3 – Background and Historical Issues

Professional documentation and communication are essential components of actuarial practice. In the absence of specific standards of practice, the amount of documentation and disclosure has varied. As the nature of casualty actuarial work has become more complex and more open to and available for public review, the need to formalize standards has increased. The CAS has adopted a *Statement of Principles Regarding Property and Casualty Insurance Ratemaking*, a *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*, and a *Statement of Principles Regarding Property and Casualty Valuations*. Those statements serve as guides to this standard. This standard states that the methodology and material assumptions utilized in ratemaking, reserving, and valuations should be documented and, in some cases, available for disclosure.

This standard addresses the following issues:

- the extent to which an actuarial work product should be documented
- the persons to whom that documentation should be available
- the extent to which deviations from standards of practice should be documented
- the requirement that actuaries sign work products within their responsibility
- the requirement that actuaries disclose the names of others upon whose work they have relied

Section 4 – Current Practices and Alternatives

Current practices have been governed by the *Guides and Interpretative Opinions as to Professional Conduct* promulgated by the American Academy of Actuaries, the CAS, the Conference of Actuaries in Public Practice, and the Society of Actuaries. Current practices have varied with individual interpretations of those *Guides* and *Opinions*.

Section 5 – Analysis of Issues and Recommended Practices

5.1 Introduction – Ratemaking, claims reserving, and valuations take place in a variety of settings depending upon the legal and regulatory environment involved. The form and content of any actuarial communication should meet the needs of the particular circumstances, taking into account the knowledge and understanding of the users and the actuary's relationship to the users. Users may be either direct or indirect. A client or employer is the direct user of the actuary's service, as distinguished from an indirect user. The direct user selects the actuary and communicates directly with the actuary about qualifications, work, and recommendations.

5.2 Extent of Documentation – This standard requires documentation of an actuarial work product whether or not there is a legal or regulatory requirement for the documentation. Appropriate records, worksheets, and other documentation of the actuary's work should be maintained by the actuary and retained for a reasonable period of time. Documentation should be sufficient for another actuary practicing in the same field to evaluate the work. The documentation should describe clearly the sources of data, material assumptions, and methods. Any material changes in sources of data, assumptions, or methods from the last analysis should be documented. The actuary should explain the reason(s) for and describe the impact of the changes.

5.3 Prevention of Misuse – Information prepared by an actuary may be used by another person in a way that may influence the actions of a third-party. If someone other than an actuary might convey such information to any such indirect users, the actuary should recognize the risk of misquotation, misinterpretation, or other misuse of its actuarial aspects. The actuary should take reasonable steps to ensure that an actuarial work product is presented fairly, that the presentation as a whole is clear in its actuarial aspects, and that the actuary is identified as the source of the actuarial aspects and as the individual who is available to answer questions. An actuarial report is customarily considered to be presented fairly if it describes the data, material assumptions, methods, and material changes in these with sufficient clarity that another actuary practicing in the same field could make an appraisal of the reasonableness and validity of the report.

5.4 Disclosure of Conflict with Professional Judgment, and of Advocacy – If the service requested by a client or employer produces a result that conflicts materially with the actuary's professional judgment, the actuary should advise the client or employer of the conflict and should include appropriate qualifications or disclosures in any related actuarial communication. When an actuary acts, or may seem to be acting, as advocate for a client or employer, the nature of that relationship should be disclosed to directly interested parties.

5.5 Availability of Documentation – Documentation should be available to the actuary's client or employer, and it should be made available to other persons when the client or employer so requests, assuming appropriate compensation, and provided such availability is not otherwise improper. Ownership of documentation is normally established by the actuary and the client or employer, in accordance with law.

5.6 Conflicting Interests – The actuary does not normally have an obligation to communicate with any person other than the client or employer. If aware of any significant conflict between the interests of indirect users and the interests of the client or employer, the actuary should advise the client or employer of the conflict and should include appropriate qualifications or disclosures in any related actuarial communication.

5.7 Signature on Work Product – When required by law or regulation or when called upon by the client or employer to provide documentation of work, the actuary should provide such disclosure in writing. Any such disclosure must be signed with the name of the actuary responsible for the work. The name of an organization with which the actuary is affiliated may be incorporated into the signature. The actuary's responsibilities to comply with this standard are not affected by the form of the signature.

5.8 Reliance on Another – An actuary who makes an actuarial communication assumes responsibility for it, except to the extent the actuary disclaims responsibility by stating reliance on another person. Reliance on another person means using that person's work without assuming responsibility therefor. A communication should define the extent of any such reliance.

5.9 Waiver of Fee – The waiving of a fee for professional services, either partially or totally, does not relieve the actuary of the need to observe professional standards.

Section 6 – Communications and Disclosures

Deviation from Standard – An actuary who uses a procedure which differs from this standard must include, in the actuarial communication disclosing the result of the procedure, an appropriate and explicit statement with respect to the nature, rationale, and effect of such use.

Changes implemented on July 30, 2010

1) Add chapter 17.
2) Correct page number for chapter 11 in table of contents.

Changes implemented on July 22, 2009

1) Include hyperlinks (from the table of content) and bookmarks.
2) Change the word “affect” to “effect” throughout the text where appropriate.
3) (p.327-328) Chapter 13 Exhibit III Sheets 12-13
    a. Corrections to the projected ultimate claims for frequency-severity methods #1 and #3.
4) (p.344) Chapter 14 Exhibit II Sheet 3
    a. Change the word “no” to “on” for footnote (2).
5) (p.355-359) Chapter 15 Exhibit I Sheets 2-5
    a. Corrections to the projected ultimate claims for frequency-severity method #3.

Errata

The CAS online publication *Estimating Unpaid Claims Using Basic Techniques* by Jacqueline Frank Friedland contains an error.

Chapter 17, page 388, under "Challenges of the Classical Technique," 2nd paragraph.

The original text below highlights the wording to be corrected:

> Some actuaries address this challenge by adjusting the percentages applied to the case outstanding and the IBNR to reflect their expectations for the particular company. For example, an actuary of an insurer with a portfolio of long-tail professional liability coverage, which is characterized by very long-tailed liabilities and substantial claims-handling work during the life of the claim, estimates unpaid ULAE assuming ratios of 25% applied to case outstanding and 75% to IBNR, which includes development on case outstanding. Thus, they assume a greater proportion of the expenses are related to closing the claims rather than opening claims.

The corrected text is highlighted below and should read as follows:

> Some actuaries address this challenge by adjusting the percentages applied to the case outstanding and the IBNR to reflect their expectations for the particular company. For example, an actuary of an insurer with a portfolio of long-tail professional liability coverage, which is characterized by very long-tailed liabilities and substantial claims-handling work during the life of the claim, estimates unpaid ULAE assuming ratios of 25% applied to opening the claims and 75% to closing the claims (implying 75% of the ULAE ratio applied to case outstanding and 100% to IBNR, which includes development on case outstanding). Thus, they assume a greater proportion of the expenses are related to closing the claims rather than opening claims.

(Rescinded by the Board of Directors of the CAS December 2020)
(Reinstated May 2021, for reference for U.S.-regulated ratemaking)

Statement of Principles Regarding Property and Casualty Insurance Ratemaking

(Adopted by the Board of Directors of the CAS May 1988)

The purpose of this Statement is to identify and describe principles applicable to the determination and review of property and casualty insurance rates. The principles in this Statement are limited to that portion of the ratemaking process involving the estimation of costs associated with the transfer of risk. This Statement consists of four parts:

I. DEFINITIONS
II. PRINCIPLES
III. CONSIDERATIONS
IV. CONCLUSION

The principles contained in this Statement provide the foundation for the development of actuarial procedures and standards of practice. It is important that proper actuarial procedures be employed to derive rates that protect the insurance system's financial soundness and promote equity and availability for insurance consumers.

Although this Statement addresses property and casualty insurance ratemaking, the principles contained in this Statement apply to other risk transfer mechanisms.

I. DEFINITIONS

Ratemaking is the process of establishing rates used in insurance or other risk transfer mechanisms. This process involves a number of considerations including marketing goals, competition and legal restrictions to the extent they affect the estimation of future costs associated with the transfer of risk. This Statement is limited to principles applicable to the estimation of these costs. Such costs include claims, claim settlement expenses, operational and administrative expenses, and the cost of capital. Summary descriptions of these costs are as follows:

—*Incurred losses* are the cost of claims insured.

—*Allocated loss adjustment expenses* are claims settlement costs directly assignable to specific claims.

—*Unallocated loss adjustment expenses* are all costs associated with the claim settlement function not directly assignable to specific claims.

—*Commission and brokerage expenses* are compensation to agents and brokers.

—*Other acquisition expenses* are all costs, except commission and brokerage, associated with the acquisition of business.

—*Taxes, licenses and fees* are all taxes and miscellaneous fees except federal income taxes.

—*Policyholder dividends* are a non-guaranteed return of premium charged to operations as an expense.

—*General administrative expenses* are all other operational and administrative costs.

—The *underwriting profit and contingency provisions* are the amounts that, when considered with net investment and other income, provide an appropriate total after-tax return.

II. PRINCIPLES

Ratemaking is prospective because the property and casualty insurance rate must be developed prior to the transfer of risk.

> Principle 1: A *rate* is an estimate of the expected value of future costs.

Ratemaking should provide for all costs so that the insurance system is financially sound.

> Principle 2: A rate provides for all costs associated with the transfer of risk.

Ratemaking should provide for the costs of an individual risk transfer so that equity among insureds is maintained. When the experience of an individual risk does not provide a credible basis for estimating these costs, it is appropriate to consider the aggregate experience of similar risks. A rate estimated from such experience is an estimate of the costs of the risk transfer for each individual in the class.

> Principle 3: A rate provides for the costs associated with an individual risk transfer.

Ratemaking produces cost estimates that are actuarially sound if the estimation is based on Principles 1, 2, and 3. Such rates comply with four criteria commonly used by actuaries: reasonable, not excessive, not inadequate, and not unfairly discriminatory.

> Principle 4: A rate is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

III. CONSIDERATIONS

A number of ratemaking methodologies have been established by precedent or common usage within the actuarial profession. Since it is desirable to encourage experimentation and innovation in ratemaking, the actuary need not be completely bound by these precedents. Regardless of the ratemaking methodology utilized, the material assumptions should be documented and available for disclosure. While no ratemaking methodology is appropriate in all cases, a number of considerations commonly apply. Some of these considerations are listed below with summary descriptions. These considerations are intended to provide a foundation for the development of actuarial procedures and standards of practice.

Exposure Unit—The determination of an appropriate exposure unit or premium basis is essential. It is desirable that the exposure unit vary with the hazard and be practical and verifiable.

Data—Historical premium, exposure, loss and expense experience is usually the starting point of ratemaking. This experience is relevant if it provides a basis for developing a reasonable indication of the future. Other relevant data may supplement historical experience. These other data may be external to the company or to the insurance industry and may indicate the general direction of trends in insurance claim costs, claim frequencies, expenses and premiums.

Organization of Data—There are several acceptable methods of organizing data including calendar year, accident year, report year and policy year. Each presents certain advantages and disadvantages; but, if handled properly, each may be used to produce rates. Data availability, clarity, simplicity, and the nature of the insurance coverage affect the choice.

Homogeneity—Ratemaking accuracy often is improved by subdividing experience into groups exhibiting similar characteristics. For a heterogeneous product, consideration should be given to segregating the experience into more homogeneous groupings. Additionally, subdividing or combining the data so as to minimize the distorting effects of operational or procedural changes should be fully explored.

Credibility—*Credibility* is a measure of the predictive value that the actuary attaches to a particular body of data. Credibility is increased by making groupings more homogeneous or by increasing the size of the group analyzed. A group should be large enough to be statistically reliable. Obtaining homogeneous groupings requires refinement and partitioning of the data. There is a point at which partitioning divides data into groups too small to provide credible patterns. Each situation requires balancing homogeneity and the volume of data.

Loss Development—When incurred losses and loss adjustment expenses are estimated, the development of each should be considered. The determination of the expected loss development is subject to the principles set forth in the Casualty Actuarial Society's *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*.

Trends—Consideration should be given to past and prospective changes in claim costs, claim frequencies, exposures, expenses and premiums.

Catastrophes—Consideration should be given to the impact of catastrophes on the experience and procedures should be developed to include an allowance for the catastrophe exposure in the rate.

Policy Provisions—Consideration should be given to the effect of salvage and subrogation, coinsurance, coverage limits, deductibles, coordination of benefits, second injury fund recoveries and other policy provisions.

Mix of Business—Consideration should be given to distributional changes in deductibles, coverage limitations or type of risks that may affect the frequency or severity of claims.

Reinsurance—Consideration should be given to the effect of reinsurance arrangements.

Operational Changes—Consideration should be given to operational changes such as changes in the underwriting process, claim handling, case reserving and marketing practices that affect the continuity of the experience.

Other Influences—The impact of external influences on the expected future experience should be considered. Considerations include the judicial environment, regulatory and legislative changes, guaranty funds, economic variable, and residual market mechanisms including subsidies of residual market rate deficiencies.

Classification Plans—A properly defined classification plan enables the development of actuarially sound rates.

Individual Risk Rating—When an individual risk's experience is sufficiently credible, the premium for that risk should be modified to reflect the individual experience. Consideration should be given to the impact of individual risk rating plans on the overall experience.

Risk—The rate should include a charge for the risk of random variation from the expected costs. This risk charge should be reflected in the determination of the appropriate total return consistent with the cost of capital and, therefore, influences the underwriting profit provision. The rate should also include a charge for any systematic variation of the estimated costs from the expected costs. This charge should be reflected in the determination of the contingency provision.

Investment and Other Income—The contribution of net investment and other income should be considered.

Actuarial Judgment—Informed actuarial judgments can be used effectively in ratemaking. Such judgments may be applied throughout the ratemaking process and should be documented and available for disclosure.

IV. CONCLUSION

The actuary, by applying the ratemaking principles in this Statement, will derive an estimation of the future costs associated with the transfer of risk. Other business considerations are also a part of ratemaking. By interacting with professionals from various fields including underwriting, marketing, law, claims, and finance, the actuary has a key role in the ratemaking process.

BASIC RATEMAKING

Fifth Edition, May 2016

Geoff Werner, FCAS, MAAA
Claudine Modlin, FCAS, MAAA
Willis Towers Watson

With significant contributions from: Alice Gannon, FCAS, MAAA; Serhat Guven, FCAS, MAAA; Christine Gennett, ACAS, MAAA; Jeff Kucera, FCAS, MAAA; Brett Nunes, ASA, MAAA; and Dave Otto, FCAS, MAAA

Expertise. Insight.
Solutions.

Basic Ratemaking

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VERSION 5, MAY 2016

This text outlines basic property/casualty insurance ratemaking concepts and techniques. It is intended to be a single educational text to prepare actuarial candidates practicing around the world for basic ratemaking. A key concept in the text is the fundamental insurance equation, which balances the expected future income and outgo of an insurance operation. Various chapters discuss the individual components of the equation (e.g., premium, loss, expense, profit), and other chapters review how to assess whether the equation is in balance in the aggregate and by customer segment. The text focuses on quantitative analysis as well as practical considerations in the ratemaking process. Finally, the text provides consistent definitions of terms and examples that underlie the ratemaking techniques discussed.

FOREWORD

Ratemaking is a key driver of property and casualty (P&C) insurance profitability and hence a primary actuarial responsibility. Actuaries employ a variety of ratemaking techniques depending on specific circumstances. For example, techniques used to price short-tailed lines of insurance (e.g., personal automobile) are different than techniques used in long-tailed lines (e.g., workers compensation). Even within the same insurance product, actuarial techniques may differ due to regulatory requirements and data limitations. Furthermore, actuarial techniques are constantly evolving due to enhanced information and advances in technology.

This text is not intended to document every technique used for P&C insurance ratemaking. Instead, the purpose of this text is to provide an overview of basic ratemaking techniques used in the industry. As such, actuaries should continue to increase the depth and breadth of their knowledge to be able to discern the most appropriate technique for a given situation.

ACKNOWLEDGMENTS

The completion of this text required significant effort from many individuals other than the primary authors. The authors want to acknowledge the following individuals for researching and summarizing existing ratemaking material, offering alternative ratemaking techniques, and reviewing countless drafts:

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> All of the authors who developed the materials from the prior Ratemaking examination; EMB relied heavily upon that material when creating this text.
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REFERENCE MATERIAL

The objective of the CAS in creating a new basic ratemaking text was to replace the series of readings that existed on the syllabus of basic education as of 2007 with a single educational publication. As such, the authors relied heavily on a series of published articles and texts that are contained in the Bibliography at the end of the text. Specific references to each of these sources are also present in individual chapters.

ROUNDING

Rounding procedures have been applied in a manner consistent with the number of decimals shown in the text and tables (or per rounding procedures specifically outlined in the text). Small discrepancies may exist between the text and table entries when the text is summarizing multiple calculations within a table or further dissecting calculations in a table for illustrative purposes.

ORGANIZATION OF THIS TEXT

This text is organized into sixteen chapters plus six appendices. The chapters discuss various ratemaking concepts and techniques, and provide simple examples. Each chapter concludes with a narrative summary as well as an outline of key concepts covered in the chapter. The appendices provide in-depth practical examples of some of the techniques discussed throughout the text. In order to reinforce the concepts and techniques discussed in the body of the text, the authors suggest Appendices A-D be read upon completion of Chapter 8, and Appendices E-F be read upon completion of Chapters 9-10.

Below is a summary of the content of each chapter and appendix.

Chapter 1 provides an overview of P&C insurance ratemaking, highlighting the unique relationship between price, cost, and profit. This overview includes basic P&C insurance terms and commonly used insurance ratios. This chapter also introduces the fundamental insurance equation, a key concept that is referenced frequently in other chapters. This concept states that premium charged for policies written during a future time period should be appropriate to cover the losses and expenses expected for those policies while achieving the targeted profit.

Chapter 2 discusses the P&C insurer rating manual, an aid for anyone who needs to understand the process of calculating an insurance premium. The four main components of P&C insurer rating manuals are rules, rate pages, rating algorithms, and underwriting guidelines. The chapter also includes three rating manual examples for different insurance lines of business.

Chapter 3 discusses ratemaking data, both internal and external to the insurance company, and introduces methods of data organization. An example of internal data requirements is provided, as well as sources of external data.

Chapter 4 discusses insurance exposures, the basic unit that measures a policy's exposure to loss and therefore serves as the basis for the calculation of premium. The chapter outlines criteria for selecting exposure bases, methods and quantitative examples for defining and aggregating exposures, and circumstances requiring a measurement of exposure trend.

Chapter 5 focuses on premium, the price the insured pays for the insurance product and one of the key elements of the fundamental insurance equation. The chapter discusses different ways to define and aggregate premium (including quantitative examples) and introduces standard techniques to adjust historical premium data to make it relevant for estimating future premium in the context of ratemaking. These adjustments include current rate level, premium development in consideration of premium audits, and premium trend. These adjustments to premium are relevant in loss ratio analysis.

Chapter 6 is dedicated to losses and loss adjustment expenses. Losses are amounts paid or owed to claimants under the provisions of the insurance contract. This chapter outlines the different types of insurance losses, reviews how loss data is aggregated for ratemaking analysis, and defines common metrics involving losses. This chapter also describes the various adjustments to historical loss data to make it relevant for estimating future losses. These include adjustments for extraordinary events, changes in benefit levels, changes in loss estimates as claims mature, and changes in cost levels over time. Finally, the chapter discusses the treatment of loss adjustment expenses in ratemaking.

Chapter 7 covers methods for projecting underwriting expenses and addresses how to incorporate the cost of reinsurance and an underwriting profit provision in the rates.

Chapter 8 demonstrates how to combine the various estimated components of the fundamental insurance equation (i.e., premium, loss, expense) to ascertain the appropriate overall rate level (or rate level change) for the future policy period. The two overall rate level methods discussed are the pure premium and loss ratio methods. The methods are mathematically equivalent, but each offers advantages and disadvantages in certain circumstances.

Chapter 9 covers rate adequacy at the individual risk (or risk segment) level. The chapter discusses the concept of risk segmentation via rating variables and outlines criteria to consider when using a certain risk characteristic as a rating variable. The chapter also reviews the application of univariate methods to historical data to calculate rate differentials (or changes to existing rate differentials) for each rating variable. This process is known as classification ratemaking.

Chapter 10 is an extension of Chapter 9 that specifically addresses multivariate classification ratemaking techniques. The chapter discusses the benefits of multivariate approaches and provides a basic explanation of the mathematical foundation of one commonly used multivariate method, generalized linear models (GLMs). Sample output with explanation is provided for GLM results as well as associated statistical diagnostics. The chapter also reviews some commonly used data mining techniques.

Chapter 11 addresses additional classification ratemaking techniques that were developed to address the unique qualities of some rating variables or risk characteristics. These include territory boundary analysis, increased limits factors, deductibles, size of risk for workers compensation insurance, and the concept of insurance to value and how it affects the adequacy of rates.

Chapter 12 provides a broad overview of the credibility procedures used in ratemaking. This includes methods for incorporating credibility in an actuarial estimate, desirable qualities for the complement of credibility (the related data that is blended with the original actuarial estimate), and methods and examples for determining the complement of credibility.

Chapter 13 explores other items company management should consider, along with the actuarial indications discussed in the previous chapters, to determine what rates to charge in practice. These considerations include regulatory constraints, operational constraints, and market conditions.

Chapter 14 discusses non-pricing and pricing solutions to an imbalanced fundamental insurance equation (i.e., current rates do not produce an average premium that is equivalent to the sum of expected costs and target underwriting profit). In regards to pricing solutions, the chapter discusses how to calculate final rates for an existing product, as well as how to develop rates for a new product by referencing other data sources. The chapter concludes with comments regarding the importance of communicating expected rate change results to key stakeholders and monitoring results after implementation.

Chapter 15 covers additional ratemaking methods commonly used by commercial insurers. The methods are divided into two categories: those that alter the rate calculated from the rating manual and those that are employed by insurers to calculate a premium unique to a particular large commercial risk. The former category includes experience rating and schedule rating, and the latter category includes loss-rated composite risks, large deductible policies, and retrospective rating.

Chapter 16 discusses the adoption of claims-made policies, with particular attention to the medical malpractice line of business. This alternative to occurrence policies shortens the time period from coverage inception to claim settlement. For the ratemaking actuary, this translates to a shorter forecast period and therefore reduced pricing risk.

Appendices A-D provide illustrative examples of overall rate level analyses for personal automobile, homeowners, medical malpractice, and workers compensation lines of business. The examples incorporate many of the ratemaking concepts and techniques discussed in Chapters 1-8.

Appendices E-F provide illustrative examples of classification ratemaking analysis using the univariate and multivariate techniques discussed in Chapters 9 and 10, respectively.

TEXT NOTATION

The text contains a significant number of formulae. The following is a summary of the key notation that appears throughout the text. Actual references in the text may specify more precise definitions (e.g., L could be used to describe accident year reported losses, policy year ultimate losses, etc.).

X = Exposures

$P; \overline{P}$ = Premium; Average premium (P divided by X)

$P_c; \overline{P_c}$ = Premium at current rates; Average premium at current rates (P_C divided by X)

$P_I; \overline{P_I}$ = Indicated premium; Average indicated premium (P_I divided by X)

$P_P; \overline{P_P}$ = Premium at proposed rates; Average premium at proposed rates (P_P divided by X)

$L; \overline{L}$ = Losses; Pure Premium (L divided by X)

$E_L; \overline{E_L}$ = Loss Adjustment Expense (LAE); Average LAE per exposure (E_L divided by X)

$E_F; \overline{E_F}$ = Fixed underwriting expenses; Average underwriting expense per exposure (E_F divided by X)

E_V = Variable underwriting expenses

F = Fixed expense ratio (E_F divided by P)

V = Variable expense provision (E_V divided by P)

Q_C = Profit percentage at current rates

Q_T = Target profit percentage

B_C = Current base rate

B_P = Proposed base rate

$R1_{C,i}$ = Current relativity for the i^{th} level of rating variable $R1$

$R1_{P,i}$ = Proposed relativity for the i^{th} level of rating variable $R1$

A_C = Current fixed additive fee

A_P = Proposed fixed additive fee

TABLE OF CONTENTS

CHANGES TO TEXT RELATIVE TO VERSION 4 ARE LISTED IMMEDIATELY FOLLOWING APPENDIX F

CHAPTER 1: INTRODUCTION

In a free market society, an entity offering a product for sale should try to set a price at which the entity is willing to sell the product and the consumer is willing to purchase it. Determining the supplier-side price to charge for any given product is conceptually straightforward. The simplest model focuses on the idea that the price should reflect the costs associated with the product as well as incorporate an acceptable margin for profit. The following formula depicts this simple relationship between price, cost, and profit:

$$\text{Price} = \text{Cost} + \text{Profit}.$$

For many non-insurance goods and services, the production cost is known before the product is sold. Therefore, the initial price can be set so that the desired profit per unit of product will be achieved.

Insurance is different from most products as it is a promise to do something in the future if certain events take place during a specified time period. For example, insurance may be a promise to pay for the rebuilding of a home if it burns to the ground or to pay for medical treatment for a worker injured on the job. Unlike a can of soup, a pair of shoes, or a car, the ultimate cost of an insurance policy is not known at the time of the sale. This places the classic equation in a somewhat different context and introduces additional complexity into the process of price setting for an insurance company.

The purpose of this text is to outline the fundamentals of setting insurance prices, which is referred to as ratemaking in the property and casualty (P&C) insurance industry. In addition to the ratemaking concepts outlined in each chapter, the appendices to this text provide realistic numeric examples of ratemaking analysis.

RATING MANUALS

The price the insurance consumer pays is referred to as premium, and the premium is generally calculated based on a given rate per unit of risk exposed. Insurance premium can vary significantly for risks with different characteristics. The rating manual is the document that contains the information necessary to appropriately classify each risk and calculate the premium associated with that risk. The final output of the ratemaking process is the information necessary to modify existing rating manuals or create new ones.

The earliest rating manuals were very basic in nature and provided general guidelines to the person responsible for determining the premium to be charged. Over time, rating manuals have increased in complexity. For some lines, the manuals are now extremely complex and contain very detailed information necessary to calculate premium. Furthermore, many companies are creating manuals electronically in lieu of paper copies. Chapter 2 includes more detailed information and specific examples of rating manuals.

BASIC INSURANCE TERMS

This section provides a brief definition of terms that are fundamental to understanding insurance ratemaking. Chapters 3 through 7 provide more detailed definitions and address how such data is compiled and adjusted for ratemaking analysis.

Exposure

An **exposure** is the basic unit of risk that underlies the insurance premium. The exposure measure used for ratemaking purposes varies considerably by line of business. For example, one house insured for one year represents one exposure for homeowners insurance. Annual payroll in hundreds of dollars represents the typical exposure unit for U.S. workers compensation insurance. There are four different ways that insurers measure exposures: written, earned, unearned, and in-force exposures.

- **Written exposures** are the total exposures arising from policies issued (i.e., underwritten or written) during a specified period of time, such as a calendar year or quarter.
- **Earned exposures** represent the portion of the written exposures for which coverage has already been provided as of a certain point in time.
- **Unearned exposures** represent the portion of the written exposures for which coverage has not yet been provided as of that point in time.
- **In-force exposures** are the number of insured units that are exposed to loss at a given point in time.

Chapter 4 includes an example demonstrating the different exposure measures and how they are aggregated for ratemaking analysis.

Premium

Premium is the amount the insured pays for insurance coverage. The term can also be used to describe the aggregate amount a group of insureds pays over a period of time. Like exposures, there are written, earned, unearned, and in-force premium definitions.

- **Written premium** is the total premium associated with policies that were issued during a specified period.
- **Earned premium** represents the portion of the written premium for which coverage has already been provided as of a certain point in time.
- **Unearned premium** is the portion of the written premium for which coverage has yet to be provided as of a certain point in time.
- **In-force premium** is the full-term premium for policies that are in effect at a given point in time.

Chapter 5 includes an example demonstrating the different premium measures and how they are aggregated, as well as various adjustments to historical premium for ratemaking analysis.

Claim

An **insurance policy** involves the insured paying money (i.e., premium) to an insurer in exchange for a promise to indemnify the insured for the financial consequences of an event covered by the policy. If the event is covered by the policy, the insured (or other individual as provided in the insurance policy) makes a demand to the insurer for indemnification under the policy. The demand is called a **claim** and the individual making the demand is called a **claimant**. The claimant can be an insured or a third party alleging injuries or damages that are covered by the policy.

The date of the event that caused the loss is called the **date of loss** or **accident date** (also sometimes called **occurrence date**). For most lines of business and perils, the accident is a sudden event. For some lines and perils, the loss may be the result of continuous or repeated exposure to substantially the same general hazard conditions; in such cases, the accident date is often the date when the damage, or loss, is apparent. Until the claimant reports the claim to the insurer (i.e., the **report date**) the insurer is unaware of the claim. Claims not currently known by the insurer are referred to as **unreported claims** or **incurred but not reported (IBNR) claims**. After the report date, the claim is known to the company and is classified as a reported claim. Until the claim is settled, the reported claim is considered an open claim. Once the claim is settled, it is categorized as a closed claim. In some instances, further activity may occur after the claim is closed, and the claim may be re-opened.

Loss

Loss is the amount of compensation paid or payable to the claimant under the terms of the insurance policy. The actuarial community occasionally uses the terms losses and claims interchangeably. This text uses the term claim to refer to the demand for compensation, and loss to refer to the amount of compensation. This terminology is more common in ratemaking contexts, particularly as the loss ratio (to be defined later in this chapter) is one of the fundamental ratemaking metrics.

The terms associated with losses are paid loss, case reserve, reported or case incurred loss, IBNR/IBNER reserve, and ultimate loss. **Paid losses**, as the name suggests, are those amounts that have been paid to claimants. When a claim is reported and payment is expected to be made in the future, the insurer establishes a **case reserve**, which is an estimate of the amount of money required to ultimately settle that claim. The case reserve excludes any payments already made. The amount of the case reserve is monitored and adjusted as payments are made and additional information is obtained about the damages. **Reported loss** or case incurred loss is the sum of the paid losses and the current case reserve for that claim:

$$\text{Reported Losses} = \text{Paid Losses} + \text{Case Reserve}.$$

Ultimate loss is the amount of money required to close and settle all claims for a defined group of policies. The aggregate sum of reported losses across all known claims may not equal the ultimate loss for many years. Reported losses and ultimate losses are different for two reasons. First, at any point in time, there may be unreported claims. The amount estimated to ultimately settle these unreported claims is referred to as an **incurred but not reported (IBNR) reserve**. Second, the accuracy of case reserves on reported claims is dependent on the information known at the time the reserve is set; consequently, the reported losses on existing claims may change over time. The **incurred but not enough reported (IBNER) reserve** (IBNER is also known as development on known claims) is the difference between the amount estimated to ultimately settle these reported claims and the aggregate reported losses at the time the losses are evaluated. Therefore, estimated ultimate loss is the sum of the reported loss, IBNR reserve and IBNER reserve:

$$\text{Estimated Ultimate Losses} = \text{Reported Losses} + \text{IBNR Reserve} + \text{IBNER Reserve}.$$

Loss Adjustment Expense

In addition to the money paid to the claimant for compensation, the insurer generally incurs expenses in the process of settling claims; these expenses are called **loss adjustment expenses (LAE)**. Loss adjustment expenses can be separated into **allocated loss adjustment expenses (ALAE)** and **unallocated loss adjustment expenses (ULAE)**:[1]

$$\text{LAE} = \text{ALAE} + \text{ULAE}.$$

ALAE are claim-related expenses that are directly attributable to a specific claim; for example, fees associated with outside legal counsel hired to defend a claim can be directly assigned to a specific claim. ULAE are claim-related expenses that cannot be directly assigned to a specific claim. For example, salaries of claims department personnel are not readily assignable to a specific claim and are categorized as ULAE.

Chapter 6 reviews loss and LAE data in detail, and outlines the various adjustments to such data for ratemaking analyses.

Underwriting Expenses

In addition to loss adjustment expenses (i.e., claim-related expenses), companies incur other expenses in the acquisition and servicing of policies. These are generally referred to as underwriting expenses (or operational and administrative expenses). Companies usually classify these expenses into the following four categories:

- Commissions and brokerage
- Other acquisition
- General
- Taxes, licenses, and fees

Commissions and brokerage are amounts paid to insurance agents or brokers as compensation for generating business. Typically, these amounts are paid as a percentage of premium written. It is common for commissions to vary between new and renewal business and may be based on the quality of the business written or the volume of business written or both.

Other acquisition costs are expenses other than commissions and brokerage expenses paid to acquire business. This category, for example, includes costs associated with media advertisements and mailings to prospective insureds.

General expenses include the remaining expenses associated with the insurance operations and any other miscellaneous costs. For example, this category includes costs associated with the general upkeep of the home office.

[1] Depending on the purpose, LAE can be separated into numerous different components. For example, statutory financial reporting separates LAE into defense and cost containment (DCC) and adjusting and other (A&O) expenses.

Taxes, licenses, and fees include all taxes and miscellaneous fees paid by the insurer excluding federal income taxes. Premium taxes and licensing fees are examples of items included in this category.

Underwriting Profit

As mentioned earlier, the ultimate cost of an insurance policy is not known at the time of the sale. By writing insurance policies, the company is assuming the risk that premium may not be sufficient to pay claims and expenses. The company must support this risk by maintaining capital, and this entitles it to a reasonable expected return (profit) on that capital. The two main sources of profit for insurance companies are underwriting profit and investment income. Underwriting profit, or operating income, is the sum of the profits generated from the individual policies and is akin to the profit as defined in most other industries (i.e., income minus outgo). Investment income is the income generated by investing funds held by the insurance company.

Chapter 7 outlines the derivation of underwriting expense provisions and how to incorporate the underwriting expenses and underwriting profit in ratemaking analysis. The derivation of the underwriting profit provision in consideration of investment income and a target return on equity is beyond the scope of this text.

FUNDAMENTAL INSURANCE EQUATION

Earlier in the chapter, the basic economic relationship for the price of any product was given as follows:

$$\text{Price} = \text{Cost} + \text{Profit}.$$

This general economic formula can be tailored to the insurance industry using the basic insurance terminology outlined in the preceding section. Premium is the "price" of an insurance product. The "cost" of an insurance product is the sum of the losses, claim-related expenses, and other expenses incurred in the acquisition and servicing of policies. Underwriting profit is the difference between income and outgo from underwriting policies, and this is analogous to the "profit" earned in most other industries. Insurance companies also derive profit from investment income, but a detailed discussion of this topic is beyond the scope of this text.

Making those substitutions, the prior formula is transformed into the fundamental insurance equation:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

The goal of ratemaking is to assure that the fundamental insurance equation is appropriately balanced. In other words, the rates should be set so that the premium is expected to cover all costs and achieve the target underwriting profit. This is covered in the second principle of the CAS "Statement of Principles Regarding Property and Casualty Insurance Ratemaking" (CAS Committee on Ratemaking Principles, p. 6), which states "A rate provides for all costs associated with the transfer of risk." There are two key points to consider in regards to achieving the appropriate balance in the fundamental equation:

1. Ratemaking is prospective.
2. Balance should be attained at the aggregate and individual levels.

Ratemaking is Prospective

As stated earlier, insurance is a promise to provide compensation in the event a specific loss event occurs during a defined time period in the future. Therefore, unlike most non-insurance products, the costs associated with an insurance product are not known at the point of sale and as a result need to be estimated. The ratemaking process involves estimating the various components of the fundamental insurance equation to determine whether or not the estimated premium is likely to achieve the target profit during the period the rates will be in effect.

It is common ratemaking practice to use relevant historical experience to estimate the future expected costs that will be used in the fundamental insurance equation; this does not mean actuaries are setting premium to recoup past losses. The first principle in the CAS "Statement of Principles Regarding Property and Casualty Insurance Ratemaking" states that "A *rate* is an estimate of the expected value of future costs" (CAS Committee on Ratemaking Principles, p. 6). Historic costs are only used to the extent that they provide valuable information for estimating future expected costs. When using historic loss experience, it is important to recognize that adjustments will be necessary to convert this experience into that which will be expected in the future when the rates will be in effect. For example, if there are inflationary pressures that impact losses, the future losses will be higher than the losses incurred during the historical period. Failure to recognize the increase in losses can lead to an understatement of the premium needed to achieve the target profit.

There are many factors that can impact the different components of the fundamental insurance equation and that should be considered when using historical experience to assess the adequacy of the current rates. The following are some items that may necessitate a restatement of the historical experience:

- Rate changes
- Operational changes
- Inflationary pressures
- Changes in the mix of business written
- Law changes

The key to using historical information as a starting point for estimating future costs is to make adjustments as necessary to project the various components to the level expected during the period the rates will be in effect. There should be a reasonable expectation that the premium will cover the expected losses and expenses and provide the targeted profit for the entity assuming the risk. Later chapters will discuss various techniques to adjust past experience for these and other items.

Overall and Individual Balance

When considering the adequacy or redundancy of rates, it is important to ensure that the fundamental insurance equation is in balance at both an overall level as well as at an individual or segment level.

Equilibrium at the aggregate level ensures that the total premium for all policies written is sufficient to cover the total expected losses and expenses and to provide for the targeted profit. If the proposed rates are either too high or too low to achieve the targeted profit, the company can consider decreasing or increasing rates uniformly. Two methods for calculating the overall adequacy of current rates are discussed in detail in Chapter 8.

In addition to achieving the desired equilibrium at the aggregate level, it is important to consider the equation at the individual risk or segment level. Principle 3 of the CAS "Statement of Principles Regarding Property and Casualty Insurance Ratemaking" states "A rate provides for the costs associated with an individual risk transfer" (CAS Committee on Ratemaking Principles, p. 6). A policy that presents significantly higher risk of loss should have a higher premium than a policy that represents a significantly lower risk of loss. For example, in workers compensation insurance an employee working in a high-risk environment (e.g., a steel worker on high-rise buildings) is expected to have a higher propensity for insurance losses than one in a low-risk environment (e.g., a clerical office employee). Typically, insurance companies recognize this difference in risk and vary premium accordingly. Failure to recognize differences in risk will lead to rates that are not equitable. Chapters 9 through 11 discuss how insurance companies vary rates to recognize differences between insureds.

BASIC INSURANCE RATIOS

Insurers and other interested parties (such as insurance regulators, rating agencies, and investors) rely on a set of basic ratios to monitor and evaluate the appropriateness of an insurance company's rates. This section provides a brief introduction to these ratios, which are further discussed in later chapters.

Frequency

Frequency is a measure of the rate at which claims occur and is normally calculated as:

$$\text{Frequency} = \frac{\text{Number of Claims}}{\text{Number of Exposures}}.$$

For example, if the number of claims is 100,000 and the number of earned exposures is 2,000,000, then the frequency is 5% (= 100,000 / 2,000,000). Normally, the numerator is the number of reported claims and the denominator is the number of earned exposures. As other variations may be used depending on the specific needs of the company, it is important to clearly document the types of claims and exposures used.

Analysis of changes in claims frequency can identify general industry trends associated with the incidence of claims or the utilization of the insurance coverage. It can also help measure the effectiveness of specific underwriting actions.

Severity

Severity is a measure of the average cost of claims and is calculated as:

$$\text{Severity} = \frac{\text{Losses}}{\text{Number of Claims}}.$$

Thus, if the total loss dollars are $300,000,000 and the number of claims is 100,000, then the severity is $3,000 (= $300,000,000 / 100,000). Severity calculations can vary significantly. For example, paid severity is calculated using paid losses on closed claims divided by closed claims. Reported severity, on the other hand, is calculated using reported losses and reported claims. Additionally, ALAE may be included or excluded from the numerator. Consequently, it is important to clearly document the types of losses and claims used in calculating the ratio.

Analyzing changes in severity provides information about loss trends and highlights the impact of any changes in claims handling procedures.

Pure Premium (or Loss Cost)

Pure premium (also known as loss cost or burning cost) is a measure of the average loss per exposure and is calculated as:

$$\text{Pure Premium} = \frac{\text{Losses}}{\text{Number of Exposures}} = \text{Frequency} \times \text{Severity}.$$

The term pure premium is unique to insurance and most likely was derived to describe the portion of the risk's expected costs that is "purely" attributable to loss.

Continuing with the example above, if total loss dollars are $300,000,000 and the number of exposures is 2,000,000, then the pure premium is $150 (= $300,000,000 / 2,000,000 = 5.0% x $3,000). Typically, pure premium is calculated using reported losses (or ultimate losses) and earned exposures. The reported losses may or may not include ALAE and/or ULAE. As companies may choose to use other inputs depending on the specific needs, it is important to document the inputs chosen.

Changes in pure premium highlight industry trends in overall loss costs due to changes in both frequency and severity.

Average Premium

The previous ratios focused on the loss portion of the fundamental insurance equation. However, it is also very important to analyze the premium side. A typical ratio is average premium, which is calculated as follows:

$$\text{Average Premium} = \frac{\text{Premium}}{\text{Number of Exposures}}.$$

For example, if the total premium is $400,000,000 and the total exposures are 2,000,000, then the average premium is $200 (=$400,000,000 / 2,000,000). It is important that the premium and the exposures be on the same basis (e.g., written, earned, or in-force).

Changes in average premium, if adjusted for rate change activity, highlight changes in the mix of business written (e.g., shifts toward higher or lower risk characteristics reflected in rates).

Loss Ratio

Loss ratio is a measure of the portion of each premium dollar used to pay losses and is calculated as:

$$\text{Loss Ratio} = \frac{\text{Losses}}{\text{Premium}} = \frac{\text{Pure Premium}}{\text{Average Premium}}.$$

For example, if the total loss dollars are \$300,000,000 and the total premium is \$400,000,000, then the loss ratio is 75% (= \$300,000,000 / \$400,000,000). Typically, the ratio uses total reported losses and total earned premium; however, other variations are common. For example, companies may include LAE in the calculation of loss ratios (commonly referred to as loss and LAE ratios). Once again, it is important to clarify the inputs being used.

Historically, most companies monitor and analyze the loss and LAE ratio as a primary measure of the adequacy of the rates overall and for various key segments of the portfolio.

Loss Adjustment Expense Ratio

The loss adjustment expense (LAE) ratio compares the amount of claim-related expense to total losses and is calculated as follows:

$$\text{LAE Ratio} = \frac{\text{Loss Adjustment Expenses}}{\text{Losses}}.$$

The loss adjustment expenses include both allocated and unallocated loss adjustment expenses. Companies may differ as to whether paid or reported (incurred) figures are used. It is important to recognize that the LAE are being divided by total losses and not by premium, so the loss and LAE ratio is not the sum of the loss ratio and the LAE ratio, but rather is the loss ratio multiplied by the sum of one plus the LAE ratio.

Companies monitor this ratio over time to determine if costs associated with claim settlement procedures are stable or not. A company may compare its ratio to those of other companies as a benchmark for its claims settlement procedures.

Underwriting Expense Ratio

The underwriting (UW) expense ratio is a measure of the portion of each premium dollar used to pay for underwriting expenses, and it is calculated as follows:

$$\text{UW Expense Ratio} = \frac{\text{UW Expenses}}{\text{Premium}}.$$

Often the company will subdivide the major underwriting expense categories into expenses that are generally incurred at the onset of the policy (e.g., commissions, other acquisition, taxes, licenses, and fees) and expenses that are incurred throughout the policy (e.g., general expenses). For the purpose of calculating the underwriting expense ratio, the former expenses are measured as a ratio to written premium and the latter expenses are measured as a ratio to earned premium. This is done to better match the expense payments to the premium associated with the expense and to better estimate what percentage of future policy premium should be charged to pay for these costs. The individual expense category ratios are then added to calculate the overall underwriting expense ratio.

A company will monitor this ratio over time and compare actual changes in the ratio to expected changes based on general inflation. A company may even compare its ratio to other companies' ratios as a benchmark for policy acquisition and service expenditures.

Operating Expense Ratio

The operating expense ratio (OER) is a measure of the portion of each premium dollar used to pay for loss adjustment and underwriting expenses and is calculated as:

$$\text{OER} = \text{UW Expense Ratio} + \frac{\text{LAE}}{\text{Earned Premium}}.$$

The OER is used to monitor operational expenditures and is key to determining overall profitability.

Combined Ratio

The combined ratio is the combination of the loss and expense ratios, and historically has been calculated as:

$$\text{Combined Ratio} = \text{Loss Ratio} + \frac{\text{LAE}}{\text{Earned Premium}} + \frac{\text{Underwriting Expenses}}{\text{Written Premium}}.$$

In calculating the combined ratio, the loss ratio should not include LAE or it will be double counted.

As mentioned in the section on underwriting expense ratio, some companies may compare underwriting expenses incurred throughout the policy to earned premium rather than to written premium. In this case, the companies may choose to define combined ratio as:

$$\text{Combined Ratio} = \text{Loss Ratio} + \text{OER}.$$

The combined ratio is a primary measure of the profitability of the book of business.

Retention Ratio

Retention is a measure of the rate at which existing insureds renew their policies upon expiration. The retention ratio is defined as follows:

$$\text{Retention Ratio} = \frac{\text{Number of Policies Renewed}}{\text{Number of Potential Renewal Policies}}.$$

If 100,000 policies are invited to renew in a particular month and 85,000 of the insureds choose to renew, then the retention ratio is 85% (= 85,000 / 100,000). There are a significant number of variations in how retention ratios are defined. For example, some companies exclude policies that cancel due to death and policies that an underwriter non-renews, while others do not.

Retention ratios and changes in the retention ratios are monitored closely by product management and marketing departments. Retention ratios are used to gauge the competitiveness of rates and are very closely examined following rate changes or major changes in service. They are also a key parameter in projecting future premium volume.

Close Ratio

The close ratio (also known as hit ratio, quote-to-close ratio, or conversion rate) is a measure of the rate at which prospective insureds accept a new business quote. The close ratio is defined as follows:

$$\text{Close Ratio} = \frac{\text{Number of Accepted Quotes}}{\text{Number of Quotes}}.$$

For example, if the company provides 300,000 quotes in a particular month and generates 60,000 new policies from those quotes, then the close ratio is 20% (= 60,000 / 300,000). Like the retention ratio, there can be significant variation in the way this ratio is defined. For example, a prospective insured may receive multiple quotes and companies may count that as one quote or may consider each quote separately.

Close ratios and changes in the close ratios are monitored closely by product management and marketing departments. Closed ratios are used to determine the competitiveness of rates for new business.

SUMMARY

This chapter introduces insurance ratemaking, which is unique because the cost of the insurance product is not known at the time the product is sold. The goal of insurance ratemaking is to assure the fundamental insurance equation is balanced; in other words, the premium should cover all expected costs and should achieve the targeted underwriting profit during the period the rates will be in effect. Two key considerations of this goal are that ratemaking is performed on a prospective basis and should ensure that the fundamental insurance equation is balanced both on an overall level as well as at an individual or segment level. Finally, this chapter outlined basic insurance terms and ratios.

KEY CONCEPTS IN CHAPTER 1

1. Relationship between price, cost and profit

2. Rating manuals

3. Basic insurance terms
    a. Exposure
    b. Premium
    c. Claim
    d. Loss
    e. Loss adjustment expense
    f. Underwriting expense
    g. Underwriting profit

4. Goal of ratemaking
    a. Fundamental insurance equation
    b. Ratemaking is prospective
    c. Overall and individual balance

5. Basic insurance ratios
    a. Frequency
    b. Severity
    c. Pure premium
    d. Average premium
    e. Loss ratio
    f. Loss adjustment expense ratio
    g. Underwriting expense ratio
    h. Operating expense ratio
    i. Combined ratio
    j. Retention ratio
    k. Close ratio

CHAPTER 2: RATING MANUALS

As stated in Chapter 1, the rating manual is the insurer's documentation of how to appropriately classify each risk and calculate the applicable premium associated with that risk. The final output of the ratemaking process is the information necessary to modify an existing rating manual or create a new one. In today's highly computerized environment, most insurance premiums are calculated by an automated system, but a written rating manual is still a useful aid for anyone who needs to understand the process of calculating an insurance premium. This includes insurance agents/brokers as well as insurance regulators who may require the manual as part of the rate regulation process. This chapter addresses what rate manuals typically include and gives examples of the different components for various lines of business.

The price a consumer pays for an insurance policy is referred to as the premium. A consumer's premium is generally calculated based on a given rate per unit of exposure. This rate, however, can vary significantly for risks with different characteristics. For most lines of business, the following information is necessary to calculate the premium for a given risk:

- Rules
- Rate pages (i.e., base rates, rating tables, and fees)
- Rating algorithm
- Underwriting guidelines

Generally speaking, the first three items are found in a company's rating manual, and the underwriting guidelines are maintained in a separate proprietary underwriting manual.

The following sections provide more detail on each of the components and contain simple rating examples for several lines of business.

RULES

Rating manual rules typically contain qualitative information that is needed to understand and apply the quantitative rating algorithms contained later in the manual. Since it is intended to be an aid in calculating premium, the manual and the rules therein are not meant to replicate the detail of the legal insurance contract itself.

The rules often begin with definitions related to the risk being insured. For example, rules for a homeowners insurer may define what is considered a primary residence. The rules also provide a summary of policy forms offered to the insured (if more than one form is offered), summarize what is covered by each (e.g., types of liability or damage), and outline any circumstances for limitation or exclusion of coverage. The rules may also outline various premium determination considerations (e.g., minimum premium, down payments, refunds in the event of cancellation).

An important and often lengthy portion of the rules defines how to properly classify a risk before the rating algorithm can be applied. As will be discussed in later chapters, classification ratemaking groups risks with similar characteristics and varies the rate accordingly. These risk characteristics are represented by rating variables with categories pre-defined by the insurer. In some cases, the categories are clear and need not be explained (for example, the limit of liability selected). In other cases, further explanation for the classification is required; for example, a homeowners manual may need to clarify whether a recently renovated old home qualifies for the new home discount. A workers compensation manual may list how to classify risks into specific classification codes (salespersons/outside, bank employees, janitorial services, etc.). Without clear classification criteria, the rating algorithm will be ambiguous and could result in improper premium calculation.

Rating manual rules may also contain information about optional insurance coverage, often referred to as endorsements or riders. This includes a definition of the optional coverage, any restrictions on such coverage, and any applicable classification rules. The rules may contain the rating algorithm for the optional coverage as well.

In addition to these rules, a company may have a set of underwriting guidelines that specifies additional acceptability criteria (e.g., a company may choose not to write a risk with two or more convictions of driving under the influence). While the underwriting guidelines can be contained in the rules, it is more common to include them in a separate underwriting manual.

RATE PAGES

For most lines of insurance, the rate varies significantly based on the characteristics associated with the risk. The rate pages generally contain the numerical inputs (e.g., base rates, rating tables, and fees) needed to calculate the premium.

A base risk is a specific risk profile pre-defined by the insurer. The base risk often represents a set of risk characteristics that are most common, though it can also be chosen based on reasons more related to marketing objectives. For example, the base risk selected by an insurer for personal automobile collision coverage may be an adult, married male, with a $500 deductible, who lives in a very populated area, etc. Though the company may have more policies with a $250 deductible, its objective is to encourage new insureds to purchase a deductible of $500 or higher. If the base is set at the $500 deductible, the agent/broker will most likely use this deductible in the initial premium quote. If the insured requests a comparison quote with a $250 deductible it will result in a higher premium, which may serve as a psychological deterrent to the insured. Another example may be a multi-product discount for homeowners who have an auto policy with the same insurer. Even if the majority of homeowner policyholders qualify for the discount, the insurer may choose not to use that as the base risk and hence the discount is not reflected in the initial quote. By doing so, the company can offer and market a discount to those insureds with multiple products. If, on the other hand, the company set the base equal to those who qualify for the discount, then there will be an increase in premium for those who do not qualify for the discount. Although the premium charged is the same in either case, a discount has more positive appeal than an increase in premium.

The base rate is the rate that is applicable to the base risk. As such, it is not usually the average rate. If the insurance product contains multiple coverages that are priced separately as in personal automobile insurance, then there is typically a separate base risk, base rate, and rating tables applicable to each coverage.

By definition, the rate for all risk profiles other than the base profile varies from the base rate. The rate variation for different risk characteristics is achieved by modifying the base rate by a series of multipliers or addends or some unique mathematical expression as defined in the rating algorithm. The characteristics are referred to as rating variables, and the rate variations are contained in rating tables. Certain rating variables may be referred to as discounts/surcharges or credits/debits. The variations from the base rate are often referred to as relativities, factors, or multipliers (if applied to the rating algorithm multiplicatively) or addends (if applied to the base rate or some other figure in an additive or subtractive fashion).

Table 2.1 provides some examples of typical rating variables used for various insurance products. The number and nature of rating variables used varies significantly by line of business and from insurer to insurer**.**

2.1 Typical Rating Variables

Type of Insurance	Rating Variables
Personal Automobile	Driver Age and Gender, Model Year, Accident History
Homeowners	Amount of Insurance, Age of Home, Construction Type
Workers Compensation	Occupation Class Code
Commercial General Liability	Classification, Territory, Limit of Liability
Medical Malpractice	Specialty, Territory, Limit of Liability
Commercial Automobile	Driver Class, Territory, Limit of Liability

Prior to the use of the computers for quoting insurance rates, it was typical for companies to calculate the rate for several of the most common combinations of rating characteristics and produce a set of pre-printed rates for the producer. The math was simply done by the company to minimize the calculations required by the agent/broker. As rating algorithms have become more complex and computers have become more common and powerful, this practice has become less common. Rather than final rates, rate pages today contain all the building blocks necessary to calculate rates.

In addition to varying risk characteristics, the premium charged must consider expenses incurred in the acquisition and servicing of insurance policies. Some expenses vary by the amount of premium (e.g., commission is usually a percentage of the premium) and some expenses are fixed regardless of the premium (e.g., the cost of issuing a policy). In some cases, a company will include an explicit expense fee in the rating algorithm to account for the fixed expenses and then incorporate a provision within the base rate to account for the variable expenses. In other cases, a company may incorporate all expenses via a provision within the base rates. When there is no explicit fee, the company may have a minimum premium that assures the premium charged is adequate to cover the expenses and perhaps some amount for minimal expected losses.

RATING ALGORITHMS

The rating algorithm describes in detail how to combine the various components in the rules and rate pages to calculate the overall premium charged for any risk that is not specifically pre-printed in a rate table. The algorithm is very specific and includes explicit instructions, such as:

- the order in which rating variables should be considered

- how the effect of rating variables is applied in the calculation of premium (e.g., multiplicative, additive, or some unique mathematical expression)
- the existence of maximum and minimum premiums (or in some cases the maximum discount or surcharge that can be applied)
- specifics associated with any rounding that takes place.

If the insurance product contains multiple coverages, then separate rating algorithms by coverage may apply.

The nature and complexity of rating algorithms for insurance policies can vary significantly by insurer and by product. A few simplified examples are included later in this chapter for illustrative purposes.

UNDERWRITING GUIDELINES

Underwriting guidelines are a set of company-specific criteria that can affect decisions made prior to calculating a rate (e.g., whether or not to accept the risk) or can alter aspects of the premium calculation. In particular, underwriting guidelines may be used to specify:

- **Decisions to accept, decline, or refer risks.** The underwriting guidelines may specify that risks with a certain set of characteristics (e.g., a household with two or more losses in the last 12 months) may not be eligible for insurance or the application must be referred to a senior underwriter.
- **Company placement.** Some insurance groups utilize distinct companies within their corporate structure to sell similar products at different prices to risks with different underwriting characteristics. For example, an insurance group may designate one of its companies to provide personal automobile insurance to preferred or low-risk drivers and another company to provide personal automobile insurance to nonstandard or high-risk drivers. In this case, the underwriting guidelines will provide information necessary to place the insured in the most appropriate company within the group. The practice of establishing separate companies to achieve this purpose is usually due to either regulatory issues (cannot get approval for the full spectrum of desired rates within one company) or different distribution systems (one company may sell through agents and another may sell directly to the consumer).
- **Tier placement.** Companies may establish rating “tiers” in jurisdictions that permit companies to charge different rates within a single company to risks with different underwriting characteristics. The underwriting guidelines specify the rules necessary to properly assign the insured to the correct tier. The rating algorithm and rate pages specify how the tier placement affects the premium calculation.
- **Schedule rating credits/debits.** Commercial lines products often use schedule rating to vary premium from the manual rates. The manual rate is the rate calculated directly from the rate tables and factors in the manual. Schedule rating involves the application of credits and debits to the manual rate for the presence or absence of characteristics. In some cases, the schedule rating criteria is very specific and no judgment is required or permitted. Other times, the schedule includes subjective factors allowing the underwriter to use judgment in the selection of credits or debits applied.

Historically, underwriting criteria were subjective in nature (as opposed to the more objective rating variables) and required underwriters to personally assess the risk and make subjective judgments. There has been a trend over time (especially for personal lines products) to designate new explanatory variables as underwriting criteria, which can then be used for placement into rating tiers or separate companies. As such, the line between rating and underwriting characteristics has become blurred.

While they are covered in this section of this chapter, the underwriting guidelines may not be part of the rating manual and may not be publicly available, unless required by statute. When possible, insurance companies consider their underwriting guidelines to be proprietary and take steps to keep them confidential. The trend to designate new explanatory variables as underwriting criteria has given some companies a competitive advantage by reducing the transparency of the rating algorithm.

Table 2.2 provides some examples of typical underwriting characteristics that companies use for various insurance products. The list is not intended to be exhaustive. The number and nature of underwriting characteristics used varies significantly by line of business and from insurer to insurer.

2.2 Examples of Typical Underwriting Characteristics

Type of Insurance	Underwriting Characteristics
Personal Automobile	Insurance Credit Score, Homeownership, Prior Bodily Injury Limits
Homeowners	Insurance Credit Score, Prior Loss Information, Age of Home
Workers Compensation	Safety Programs, Number of Employees, Prior Loss Information
Commercial General Liability	Insurance Credit Score, Years in Business, Number of Employees
Medical Malpractice	Patient Complaint History, Years Since Residency, Number of Weekly Patients
Commercial Automobile	Driver Tenure, Average Driver Age, Earnings Stability

HOMEOWNERS RATING MANUAL EXAMPLE

The following is an example of a simple rating algorithm[2] for a homeowners policy with the Wicked Good Insurance Company (Wicked Good or WGIC). Homeowners insurance covers damage to the property, contents, and outstanding structures, as well as loss of use, liability and medical coverage, The perils covered and amount of insurance provided is detailed in the policy contract. WGIC writes one home per policy. WGIC’s homeowners rating manual can be used to calculate the premium for a homeowners insurance policy. The following are excerpts from WGIC’s homeowners rating manual.

Base Rates

The exposure base for homeowners insurance is a home insured for one year. Table 2.3 shows the base rate for WGIC. This is the all-peril base rate.[3]

2.3 Base Rate

Coverage	Base Rate
All Perils Combined	$500

[2] This algorithm contains many elements commonly used in the industry, but is not meant to represent all rating algorithms. Insurers may use more variables or different variables, and combine them in different ways than expressed here.

[3] The rating plan described has a single base rate that is used for all perils and the relativities all apply to that one base rate. Recently, homeowners companies have begun to implement rating plans that have separate base rates for each major peril covered and the individual rating variable relativities are applied to the applicable base rate (e.g., burglar alarm discount applies to the theft base rate only).

Rating and Underwriting Characteristics

Amount of Insurance

Amount of insurance (AOI) is one of the key rating variables for homeowners insurance. AOI represents the amount of coverage purchased to cover damage to the dwelling and is the maximum amount the insurer expects to pay to repair or replace the home. Table 2.4 shows the rate relativities to be applied to Wicked Good's base rate depending on the amount of insurance purchased. According to the table, the base rate corresponds to a home with an amount of insurance of $200,000, which consequently has an AOI rate relativity of 1.00.

2.4 Amount of Insurance (AOI) Rating Table

AOI (in thousands)	Rate Relativity
$ 80	0.56
$ 95	0.63
$110	0.69
$125	0.75
$140	0.81
$155	0.86
$170	0.91
$185	0.96
$200	1.00
$215	1.04
$230	1.08
$245	1.12
$260	1.16
$275	1.20
$290	1.24
$305	1.28
$320	1.32
$335	1.36
$350	1.39
$365	1.42
$380	1.45
$395	1.48
$410	1.51
$425	1.54
$440	1.57
$455	1.60
$470	1.63
$485	1.66
$500	1.69
Additional $15K	0.03

If a policyholder purchases $425,000 of insurance for his home, a rate relativity of 1.54 will be applied to the base rate. Straight-line interpolation is generally used for values not explicitly displayed in the table.

Territory

The location of the home is another major determinant of homeowners insurance risk and is, therefore, a key rating variable. Homeowners insurers typically group similar geographic units (e.g., zip codes) together to form rating territories. WGIC grouped zip codes into five distinct rating territories. The rate relativities for each territory are shown in Table 2.5.

2.5 Territorial Rating

Territory	Rate Relativity
1	0.80
2	0.90
3	1.00
4	1.10
5	1.15

Because Territory 3 is the base territory, the Territory 3 relativity is 1.00 and all other territories are expressed relative to Territory 3.

Protection Class and Construction Type

Wicked Good's homeowners rates also vary by fire protection class and type of construction. The protection class is a ranking based on the quality of fire protection and the availability of water in the district. Class 1 indicates the highest quality protection while class 10 refers to the lowest quality protection.

2.6 Protection Class / Construction Type Rating Table

	Construction Type	
Protection Class	Frame	Masonry
1-4	1.00	0.90
5	1.05	1.00
6	1.10	1.05
7	1.15	1.10
8	1.25	1.15
9	2.10	1.75
10	2.30	1.90

Within each protection class, there is a separate relativity based on construction type. The two construction types identified are frame and masonry. Frame construction, which relies on lumber and wood products, is more susceptible than masonry to some types of loss, such as fire or hail loss; therefore, the frame relativities are higher than the masonry relativities across every protection class. The base rate for this two-way variable is Protection Class 1-4 Frame (though Protection Class 5 Masonry coincidentally has a relativity of 1.00).

Underwriting Tier

WGIC uses numerous underwriting characteristics that are not explicitly shown in the rating manual. The underwriting characteristics are used to place insurance policies into one of four distinct underwriting tiers based on the overall riskiness of the exposure to loss. The following table shows the relativity for each of the four tiers:

2.7 Underwriting Tier Rating Table

Tier	Rate Relativity
A	0.80
B	0.95
C	1.00
D	1.45

Tier D, which is considered the most risky, has the highest rate relativity.

Deductible

The policyholder can choose the deductible, the amount of each covered loss the insured must pay. The rate relativities for each deductible are displayed in the following table.

2.8 Deductible Rating Table

Deductible	Rate Relativity
$250	1.00
$500	0.95
$1,000	0.85
$5,000	0.70

Miscellaneous Credits

Wicked Good offers discounts for new homes, insureds who are claims-free in the previous five years, and insureds with multiple policies (i.e., they have an auto or excess liability policy with WGIC in addition to a homeowners policy). The following table shows the discount applicable for each of these characteristics.

2.9 Miscellaneous Credits

Miscellaneous Credit	Credit Amount
New Home Discount	20%
5-Year Claims-Free Discount	10%
Multi-Policy Discount	7%

Frequently, companies with a significant number of discounts will have a maximum discount percentage that can be accumulated. For this example, Wicked Good does not limit the overall cumulative discount based on all miscellaneous credits.

Additional Optional Coverages

Homeowners policies place a limit on the amount of insurance by coverage (e.g., dwelling, contents, other structures, medical, and liability) though the policyholder can elect to purchase additional coverage. It is also common for the policy to limit the amount of coverage provided for certain types of losses (e.g., jewelry, cash, electronic equipment); these are referred to as inside limits. The limited coverage is considered sufficient for most policyholders. Those with a greater exposure to specific types of loss are encouraged to buy additional coverage. Also, policyholders may seek to extend the type of loss covered under the homeowners policy (e.g., to include coverage for the liability of operating a daycare in the home or to extend the perils covered for jewelry, watches, and furs losses). There are numerous other examples of how policyholders may choose to increase (or even decrease) their coverage.

In the following example, the basic homeowners policy includes a $100,000 limit for liability coverage and a $500 limit for medical coverage. This is referred to as a split limit,[4] and is often expressed as $100,000 / $500. In addition, a $2,500 inside limit applies to jewelry losses within the contents coverage. Each of these is a limit for losses occurring from a single event. If desired, the insured can purchase additional coverage. The following tables show the additional premium charged if the policyholder elects to purchase additional higher limits:

2.10 Increased Jewelry Coverage

Jewelry Coverage Rate	
Limit	**Additive**
$ 2,500	Included
$ 5,000	$35
$10,000	$60

2.11 Increased Liability/Medical Limits

Liability/Medical Rate	
Limit	**Additive**
$100,000/$500	Included
$300,000/$1,000	$25
$500,000/$2,500	$45

Expense Fee

WGIC has an explicit expense fee in the rating manual that is intended to cover fixed expenses incurred in the acquisition and servicing of insurance policies.

The expense fee is $50 per policy, as shown in Table 2.12.

2.12 Expense Fee

Policy Fee
$50

[4] Note that in other lines of business, split limits may refer to a per person (claimant) limit and a per occurrence limit, or may refer to a per occurrence and aggregate limit.

Homeowners Rating Algorithm for WGIC

The rating algorithm details how to combine all of the rate page information to calculate the final premium for a homeowners policy for WGIC:

Total Premium = All-Peril Base Rate

x AOI Relativity

x Territory Relativity

x Protection Class / Construction Type Relativity

x Underwriting Tier Relativity

x Deductible Credit

x [1.0 - New Home Discount – Claims-Free Discount]

x [1.0 - Multi-Policy Discount]

+ Increased Jewelry Coverage Rate

+ Increased Liability/Medical Coverage Rate

+ Policy Fee.

It is common for companies to designate a rounding procedure after each step. WGIC rounds to the penny after each step and to the whole dollar at the final step.

Homeowners Rate Calculation Example for WGIC

WGIC is preparing a renewal quote for a homeowner currently insured with Wicked Good. The policy has the following risk characteristics:

- Amount of insurance = $215,000
- The insured lives in Territory 4.
- The home is frame construction located in Fire Protection Class 7.
- Based on the insured's credit score, tenure with the company, and prior loss history, the policy has been placed in Underwriting Tier C.
- The insured opts for a $1,000 deductible.
- The home falls under the definition of a new home as defined in Wicked Good's rating rules.
- The insured is eligible for the five-year claims-free discount.
- There is no corresponding auto or excess liability policy written with WGIC.
- The policyholder opts to increase coverage for jewelry to $5,000 and to increase liability/medical coverage limits to $300,000/$1,000.

The appropriate figures from Tables 2.3 - 2.12 in WGIC's rating manual are shown in the following table:

2.13 Entries from Rating Manual

Entries from Rating Manual	
Base Rate	$500
AOI Relativity	1.04
Territory Relativity	1.10
Protection Class / Construction Type Relativity	1.15
Underwriting Tier Relativity	1.00
Deductible Credit	0.85
New Home Discount	20%
Claims-Free Discount	10%
Multi-Policy Discount	0%
Increased Jewelry Coverage Rate	$35
Increased Liability/Medical Coverage Rate	$25
Expense Fee	$50

The rating algorithm from the rating manual can be applied to calculate the final premium for the policy:

$$\$501 = \$500 \times 1.04 \times 1.10 \times 1.15 \times 1.00 \times 0.85 \times [1.0 - 0.20 - 0.10] \times [1.0 - 0] + \$35 + \$25 + \$50.$$

MEDICAL MALPRACTICE RATING MANUAL EXAMPLE

Rating algorithms for commercial lines policies can also vary significantly based on the insurer and the line of business. Medical malpractice insurance is a type of professional liability policy that provides coverage to healthcare professionals in the event of a malpractice claim.

The following is a simplified example of a rating algorithm for a medical malpractice policy issued by WGIC for its Nurses Professional Liability program. WGIC's rating manual can be used to calculate the premium. The following are excerpts from WGIC's medical malpractice rating manual.

Base Rates

The exposure base for medical malpractice insurance is a medical professional insured for one year. The following table in Wicked Good's rating manual shows the base rates for annual medical malpractice coverage for its nurses program. WGIC's base rates vary depending on whether the professional is employed or operates his or her own practice.

2.14 Base Rates

	Annual Rate Per Nurse
Employed	$2,500
Self-Employed	$3,000

As shown in Table 2.14, the base rate for a self-employed nurse is higher than the base rate for an employed nurse.

Rating and Underwriting Characteristics

Specialty Factor

The policy premium varies based on the medical specialty. A low-risk specialty requires a lower premium than a high-risk specialty due to the lower likelihood of incurring a loss and the decreased severity of potential losses. Wicked Good varies the malpractice premium based on the specialties shown in Table 2.15.

2.15 Specialty Rating Table

Specialty	Rate Relativity
Psychiatric	0.80
Family Practice	1.00
Pediatrics	1.10
Obstetrics	1.30
All Other Specialties	1.05

Nurses practicing in obstetrics have the highest rate relativity due to their higher exposure to loss.

Part-time Status

By rule, professionals who work 20 hours or less per week are considered part-time professionals. For all part-time professionals, Wicked Good has determined that the rate should be 50% of the base rate shown in Table 2.16.

2.16 Part-time Rating Table

	Rate Relativity
Full-time	1.00
Part-time	0.50

Territory

Wicked Good varies the rate based on the location of the medical professional's practice. Table 2.17 shows the rate relativities that apply to the base rate to calculate the rate for a nurse in a specific territory.

2.17 Territory Rating Table

Territory	Rate Relativity
1	0.80
2	1.00
3	1.25
4	1.50

Claims-free Discount

Individual insureds who have been a policyholder with WGIC for at least three consecutive years immediately preceding the effective date of the current policy may qualify for a claims-free discount. To qualify for the claims-free discount, the individual insured cannot have cumulative reported losses in excess of $5,000 over the prior three years. The amount of the claims-free discount is 15%.

Schedule Rating

Many commercial lines insurers incorporate a schedule rating plan into their rating algorithms to adjust the rate based on additional specific objective criteria or the underwriter's judgment. Typically, this adjustment is applied to the manual rate, which is the rate calculated based on the rate tables and factors in the manual. An underwriter will credit (i.e., reduce the manual rate) for characteristics that reduce the exposure to loss and debit (i.e., increase the manual rate) for characteristics that increase the exposure to loss.

WGIC's schedule rating plan includes the following credits and debits.

A. Continuing Education – A credit of up to 25% for attendance at approved continuing education courses and seminars. The total hours spent at courses and seminars must be at least 15 hours in the prior 12 months.

B. Procedure – A debit of up to 25% for nurses who have professional licenses and/or scope of practice in high-risk exposure areas such as invasive surgery or pediatric care.

C. Workplace Setting – A debit of up to 25% for nurses that work in high-risk workplace settings, such as surgical centers and nursing homes.

Wicked Good also applies a maximum aggregate schedule rating credit or debit of 25%.

Limit Factors

The insured applying for coverage can choose different limits of coverage. WGIC offers different per claim and annual aggregate limits for its Nurse's Professional Liability program. The per claim limit is the total amount the insurer will pay for all losses from a single claim covered during the policy period. The annual aggregate limit is the total amount the insurer will pay annually for all events covered in the policy period. The limit options are often expressed in the rating manual as split limits (e.g., \$100K/\$300K implies \$100K per claim and \$300K annual aggregate). The following are the relativities corresponding to each limit option:

2.18 Limit Rating Table

Limit Option	Rate Relativity
\$100K/\$300K	0.60
\$500K/\$1M	0.80
\$1M/\$3M	1.00
\$2M/\$4M	1.15

Since defense costs can be a significant expense in a medical malpractice claim, companies may choose to issue policies that specifically include or exclude loss adjustment expenses in consideration of the policy limit. If the allocated loss adjustment expenses are included in the limit, then the total liability losses and allocated loss adjustment expenses paid by the insurer will not exceed the limit. In this example, WGIC pays all such adjustment costs in addition to the limit shown.

Deductible

The insured can choose to have a deductible to reduce the professional liability premium. The deductible represents the amount of each covered loss the insured must pay. The following table shows the deductible options available and the associated credit.

2.19 Deductible Rating Table

Deductible (Per Claim)	Credit
None	0%
$1,000	5%
$5,000	8%

Claims-made Factor

WGIC writes claims-made medical malpractice policies as opposed to occurrence policies. The major difference between claims-made and occurrence coverage is that the coverage trigger is the date the claim is reported rather than the date the event occurs. A policyholder who buys a claims-made policy for the first time is only offered coverage for claims occurring after the start of the policy and reported during the year. When the claims-made policy is renewed, coverage is provided for claims occurring after the original inception date and reported during the policy period. The claims-made maturity factors (also known as step factors) adjust the premium to recognize these coverage differences. In addition, extended reporting coverage covers claims that occur during the coverage period but are reported after the policy terminates. This coverage is generally purchased before a claims-made policy is going to terminate. For example, a doctor who retires may purchase extended reporting coverage to cover claims reported after the medical malpractice policy terminates. The additional premium for this coverage is calculated by applying the extended reporting factors to the otherwise applicable mature policy premium according to the years of prior claims-made coverage. More detail on claims-made coverage is provided in Chapter 16.

WGIC's table of claims-made factors and extended reporting factors are as follows:

2.20A Claims-Made Maturity Factors

Maturity	Factor
1st Year	0.200
2nd Year	0.400
3rd Year	0.800
4th Year	0.900
5th Year	0.950
6th Year	0.975
Mature	1.000

2.20B Extended Reporting Factors

Years of Prior Claims-made Coverage	Factor
12 Month	0.940
24 Month	1.700
36 Month	2.000
48 Month	2.250
60 Month	2.400

Group Credit

Wicked Good offers a discount for medical practices that insure more than one nurse under one policy, such as a group practice. The size of the credit depends on the number of nurses that are insured under the policy. The credits are as follows:

2.21 Group Credit

Number of Nurses	Credit
1	0%
2 – 14	5%
15+	10%

The final premium including the group credit should be calculated for each nurse and aggregated for all professionals to determine the premium for the group policy.

Minimum Premium

The rating manual specifies that the minimum premium for each nurse, after the application of all discounts, is $100.

Medical Malpractice Rating Algorithm for WGIC

The rating algorithm specifies that the rating variables in the rating manual are to be applied multiplicatively, not additively, in consecutive order. Also according to the manual, premium is rounded to the nearest penny after each step and to the nearest dollar amount at the end to determine the final premium per professional. The rating algorithm is as follows:

Total Premium per Professional = Higher of

(Base Rate per Nurse

x Specialty Relativity

x Part-time Status Relativity

x Territory Relativity

x (1.0 - Claims-free Discount)

x (1.0 +/- Schedule Rating Debit/Credit)

x Limit Relativity

x (1.0 - Deductible Credit)

x Claims-made Factor

x (1.0 - Group Credit))

and

Minimum Premium specified in the rating manual ($100

for WGIC).

The total premium for a policy with multiple professionals is the sum of the premium for the individual professionals on the policy.

Medical Malpractice Rate Calculation Example for WGIC

A practice of five nurses recently applied for medical malpractice coverage with WGIC. Wicked Good's quoted premium is $6,500 for a single policy covering the five professionals, after the application of all adjustments. The practice has recently added a psychiatric nurse, and has requested a new quote from WGIC to cover all six professionals on a single policy. Assume the following characteristics:

- The new nurse is an employed professional who works 15 hours per week.
- He was previously covered by an occurrence policy and is applying for a claims-made policy with WGIC.
- He practices in Wicked Good's Territory 3.
- He attended five hours of approved continuing education courses in the prior 12 months.
- He holds a professional license in senior care, which is considered high risk. He also works in a senior care facility. The underwriter has chosen to apply debits of 25% for each of these criteria, but the maximum aggregate debit allowable is 25%.
- The policy has $1M/$3M of coverage with a $1,000 deductible per claim.

The following rating tables from Wicked Good's rating manual can be used to calculate the premium that should be charged for this policy:

2.22 Entries from Rating Manual

Entries from Rating Manual	
Employed Annual Rate	$2,500
Specialty Relativity	0.80
Part-time Status Relativity	0.50
Territory 3 Relativity	1.25
Schedule Rating (subject to 25% maximum)	0%+25%+25% (capped at 25%)
Limit Relativity for $1M/$3M	1.00
Credit for $1000 Deductible	5%
Claims-made Factor	0.20
Group Credit	5%
Minimum Premium	$100

As per the rating algorithm from the rating manual, the premium for the individual nurse is calculated as follows:

$$\$282 = \$2{,}500 \times 0.80 \times 0.50 \times 1.25 \times [1.00 + 0.25] \times 1.00 \times [1.00 - 0.05] \times 0.20 \times [1.00 - 0.05].$$

This amount is above the minimum premium per nurse of $100 so the minimum premium does not apply. The total premium for the six individuals combined is as follows:

$6,782 = $6,500 + $282.

U.S. WORKERS COMPENSATION RATING MANUAL EXAMPLE

Workers compensation insurance is required for most U.S. employers[5] to indemnify employees who are injured on the job. Because employee welfare is so important, workers compensation is a heavily regulated line of business in every U.S. state. As part of the regulation, insurers are required to submit statistical information on worker's compensation losses and premium in significant detail. The National Council on Compensation Insurance (NCCI) is a U.S. organization that collects workers compensation data from insurers and aggregates the data for ratemaking purposes. The NCCI is the licensed rating and statistical organization for most states, but several states have independent bureaus or operate as monopolistic plans. The NCCI provides workers compensation insurers with loss cost estimates, which is the portion of the rates that covers the expected future losses and loss adjustment expenses for a policy. Workers compensation insurers must calculate their own rates by adjusting the NCCI loss costs to account for their underwriting expenses and any perceived difference in loss potential.

The end result of the workers compensation ratemaking analysis is a rate manual, showing the manual premium for each risk. The premium actually collected by the insurer is referred to as net premium, and it incorporates the manual rates, premium discounts, individual risk rating modifications (e.g., schedule rating, experience rating), and expense constants.

WGIC writes workers compensation insurance for small companies with 50 employees or less. It relies heavily on NCCI for the overall loss costs as well as for many of the rating tables, but is able to determine the expense provision needed to profitably write the business.

The following is a simple premium calculation example for a U.S. workers compensation policy.

Class Rate

The purpose of the classification system is to group employers with similar operations that have a similar exposure to loss based on the job duties performed by the employees. There are over 400 different classes recognized by the NCCI for which they collect data. Table 2.23 shows the class rates applicable for a specific operation (in this case, retirement living centers) that Wicked Good writes. These class rates are based on the NCCI class rates, adjusted for WGIC's expenses and perceived differences in loss potential.

2.23 Class Rates

Class	Rate per $100 of Payroll
8810-Clerical	0.49
8825-Food Service Employees	2.77
8824-Health Care Employees	3.99
8826-All Other Employees	3.79

[5] Workers compensation eligibility requirements vary by state.

The process of calculating a premium begins with determining which classes best describe the activities of the company seeking insurance. Then, with data obtained for the prospective insured, Wicked Good estimates the amount of exposure ($100s of payroll) expected for each class during the policy period. The premium for the class is determined by applying the rate per $100 of payroll from Table 2.23 to the estimated payroll for each class. These results are aggregated across all classes for which the prospective insured has exposures, and the resulting premium is called the manual premium.

Rating and Underwriting Characteristics

Experience Rating

Under manual rating, all insureds are grouped according to their business operation or classification. The manual rates are averages reflecting the usual conditions found in each class. Although each class contains similar risks, each risk within a class is different to some extent. Experience rating is designed to reflect these differences in loss potential.

Experience rating generally only applies for larger policies, which inherently are believed to have more stable loss experience. In fact, NCCI designates minimum aggregate manual premium for a company to be eligible for experience rating. Additionally, regulators mandate that experience rating be used if the employer meets the industry eligibility requirements.

When experience rating is used, the insurer compares the policy's prior loss experience to the expected statewide average for the same classes. The manual premium will be adjusted upward if the actual losses for the company are higher than expected and downward if the actual losses are lower than expected. The adjustment is referred to as the experience modification. More detail on experience rating is contained in Chapter 15.

Since WGIC only insures small companies, experience rating is not applicable to its insureds.

Schedule Rating

As described earlier for medical malpractice, schedule rating specifies a range of credits and debits that an underwriter can apply to modify the manual premium. While some schedule rating schemes are very objective, WGIC has a set of potential credits and debits that require the underwriter to apply judgment in the underwriting process. The underwriter uses judgment based on professional experience and internal guidelines to select a value between the maximum and minimum for each attribute. The following table shows the range of schedule credits and debits that Wicked Good's underwriters can apply:

2.24 Schedule Rating

Range of Modification					
Premises	**Classification Peculiarities**	**Medical Facilities**	**Safety Devices**	**Employees — Selection, Training, Supervision**	**Management — Safety Organization**
+/-10%	+/-10%	+/-5%	-5% - 0%	+/-10%	+/-5%

The overall maximum credit or debit that an underwriter can apply to a single policy is 25%. The policy must have an annual manual premium of at least $1,000 to qualify for schedule rating.

Premium Credits

Wicked Good offers various additional premium credits to its insureds for other factors that may reduce the risk of a workers compensation claim or limit the cost of a claim once an injury has occurred.

2.25 Premium Credits

Factor	Credit
Pre-employment Drug Screening	5%
Employee Assistance Program	10%
Return-to-Work Program	5%

These credits are not subject to any overall maximum credit.

Expenses

Expense Constant

Insurers may add a fixed fee to all policies to cover expenses common to all workers compensation policies. This fee, often referred to as an expense constant, does not vary by policy size and covers expenses that are not included in the manual rate.

Wicked Good's expense constant is $150 per policy.

Premium Discount

The manual rate includes an allowance for administrative expenses that vary with the size of the policy. Not all expenses increase uniformly as the premium increases; for example, a company with $200,000 of payroll may not generate twice the administrative expenses for the insurer as a $100,000 payroll insured. To adjust for this expense savings, workers compensation insurers reduce the premium for large insureds through the use of premium discounts.

Since Wicked Good only writes policies for small companies, it does not offer premium discounts.

Minimum Premium

The workers compensation rating manual specifies that the minimum premium for any policy is $1,500.

Workers Compensation Rating Algorithm for WGIC

The components of the rating manual can be combined using a single rating algorithm to calculate the final premium for a given policy.

Total Premium = Higher of

$$[\sum_{i=1}^{N}(\text{Class}_i \text{ rate x \$Payroll for class}_i / 100) \text{ where } N = \text{number of classes}$$

x (1.0+ Schedule Rating Factor)

x (1.0- Pre-Employment Drug Screening Credit)

x (1.0- Employee Assistance Program Credit)

x (1.0- Return-to-Work Program Credit)

+ Expense Constant]

and

Minimum Premium specified in the rating manual ($1,500 in this example).

Also according to the manual, premium is rounded to the nearest penny after each step and to the nearest dollar amount at the end to determine the total premium. Note that experience rating factors and premium discounts do not appear in Wicked Good Company's rating algorithm because these rating variables do not apply to its book of business.

Workers Compensation Rate Calculation Example for WGIC

A retirement living center has requested a quote. The following are characteristics of the retirement living center:

2.26 Payroll by Class

Class	Payroll
8810 – Clerical	$35,000
8825 - Food Service Employees	$75,000
8824 - Health Care Employees	$100,000
8826 - All Other Employees & Salespersons, Drivers	$25,000

- The center has trained its entire staff in first aid, and first aid equipment is available throughout the building.
- The center has been inspected by Wicked Good, and the premises are clean and well-maintained.
- The center requires all employees to be drug-tested prior to employment.

The first step in determining the premium is to compute the aggregate manual premium. The following table shows the computation of the manual premium for each class:

2.27 Manual Premium by Class

Class	Payroll	Payroll/$100	Rate per $100 of Payroll	Class Manual Premium
8810 Clerical	$35,000	$350	0.49	$171.50
8825 - Food Service Employees	$75,000	$750	2.77	$2,077.50
8824 - Health Care Employees	$100,000	$1,000	3.99	$3,990.00
8826 - All Other Employees	$25,000	$250	3.79	$947.50
Total	$235,000			$7,186.50

The manual premium for each class is calculated as the payroll divided by $100 multiplied by the applicable rate per $100 of payroll. The total manual premium for the policy is the sum of the manual premium for each class:

$7,186.50 = $171.50 + $2,077.50 + $3,990.00 + $947.50.

The underwriter has determined that the following credits should apply based on the retirement living center's characteristics:

2.28 Schedule Rating Modifications

Modification					
Premises	**Classification Peculiarities**	**Medical Facilities**	**Safety Devices**	**Employees — Selection, Training, Supervision**	**Management —Safety Organization**
-10%	0%	0%	-2.5%	-5%	0%

The total credit (i.e., reduction to manual premium) for schedule rating is 10% + 2.5% + 5% = 17.5%. The credit takes into account the first aid equipment, staff training, and cleanliness of the premises. The credit is less than the maximum allowable credit of 25%; therefore, the entire 17.5% credit is applied to the manual premium. The schedule rating factor that should be applied to the manual premium is:

0.825 =1.000 - 0.175.

The following other factors apply to the policy:

2.29 Entries from Wicked Good's Rating Manual

Entries from Rating Manual	
Pre-employment Drug Screening Credit	5%
Employee Assistance Program Credit	0%
Return-to-Work Program Credit	0%
Expense Constant	$150

The Employee Assistance Program credit and Return-to-Work credit do not apply to the policy because the center does not have those programs. The following is the total premium for the policy:

$$\$5{,}782 = \$7{,}186.50 \times 0.825 \times (1.0 - 0.05) \times (1.0 - 0) \times (1.0 - 0) + \$150.$$

Since \$5,782 is greater than the minimum premium per policy of \$1,500, the total premium for the policy is \$5,782.

SUMMARY

The rating manual is an aid for anyone who needs to understand the process of calculating an insurance premium. For most lines of business, the manual includes the rules, rate pages, rating algorithm, and possibly the underwriting guidelines.

The rules contain items such as key definitions and summaries of what the contract covers, instructions on how to classify risks for premium rating, and information on optional coverages. Rules may also contain underwriting guidelines, or these may be provided separately.

The rate pages generally contain the numerical inputs needed to calculate the premium. These include base rates, rating tables, and fees.

The rating algorithm is the precise mathematical expression of how to calculate the premium using the inputs from the rate pages.

Underwriting guidelines document company-specific rules around risk selection, risk placement, and additional premium adjustments from underwriting characteristics. Underwriting guidelines are typically not part of the rating manual (and therefore not publicly available) unless required by statute.

KEY CONCEPTS IN CHAPTER 2

1. Basic components of a rate manual
    a. Rules
    b. Rate pages
    c. Rating algorithm
    d. Underwriting guidelines

2. Simple rating examples
    a. Homeowners
    b. Medical malpractice
    c. U.S. workers compensation

CHAPTER 3: RATEMAKING DATA

One of the most significant underpinnings of the ratemaking process is data. The quality of the final rates depends largely on the quality and quantity of data available.

Most ratemaking work involves analyzing the adequacy of rates for existing insurance products. In this case, companies generally use internal historical data or industry historical data to project future profitability. To facilitate a good review, it is imperative that the company collects and maintains pertinent and consistent historical data. When pricing a new insurance product, the actuary will need to search for internal information that may have some relationship to the new product or acquire relevant external data.

This chapter provides high-level specifications for ratemaking data, introduces data aggregation methods, and provides insights on external data. Often an actuary is required to perform ratemaking analysis with more limited data than is discussed in this chapter. In those cases, an actuary must understand the impact of not having particular information and should examine the sensitivity of the results of the analysis to the various assumptions. With this understanding and the data that is available, the actuary can determine data specifications in a manner that minimizes distortions in the results of the study.

INTERNAL DATA

Data requirements are a function of the type of ratemaking analyses being undertaken. For example, it is not essential to know the individual characteristics for each policy or risk to perform an analysis of the adequacy of the overall rates for a given product. On the other hand, a full multivariate classification analysis requires significant historical detail about each item being priced (e.g., an individual risk, policy, or class of policies).

Typically, ratemaking analyses are performed on existing insurance products and primarily involve the use of internal historical data to project the future profitability. (External data is sometimes used as a benchmark to provide context to the internal historical data in cases where internal data may be sparse or unstable.) There are generally two types of internal data involved in a ratemaking analysis. The first is risk information, such as exposures, premium, claim counts, losses, and explanatory characteristics about the policy or the claim. The second type of information is accounting information, such as underwriting expenses and ULAE, which are typically available only at an aggregate level.

Data retrieval mechanisms for ratemaking analysis vary considerably from company to company. Some actuaries have access to a data mart specifically designed for ratemaking analyses. Other actuaries must access general company databases containing detailed transactional information and manipulate the data to make it more appropriate for ratemaking analysis. There are a myriad of scenarios that fit between these two extremes.

The following sections outline one particular set of database specifications for risk information and accounting information. These specifications are not intended to be data mart recommendations or guidelines but rather an example of what an actuary may encounter when retrieving company data for ratemaking purposes. The actuary should review the nuances of the individual insurance product and desired ratemaking analysis to conclude whether existing data specifications are adequate. In addition, the actuary should review the data for appropriateness for its intended purpose and reasonableness and comprehensiveness of the data elements. More detailed information on the actuary's responsibility with respect to data quality is contained in "Actuarial Standard of Practice No. 23, Data Quality" (Actuarial Standards Board of the American Academy of Actuaries).

Risk Data

Ratemaking analysis ultimately requires information about policy exposure and premium linked with the corresponding claim and loss information. Company databases, however, typically record this information in two separate databases: a policy database and a claim database.

Policy Database

The policy database is defined according to records (i.e., individual policies or some further subdivision of the policy) and fields (i.e., explanatory information about the record). The way a record is defined for a particular product's policy database depends on the exposure measure and the way premium is typically calculated. The following are examples of policy database organization for different lines of business:

- In homeowners insurance, a record may be a home for an annual policy period.
- In U.S. workers compensation insurance, rating is based on the payroll of relevant industry classifications so separate records are often maintained at the classification level.[6]
- In personal auto insurance, separate records are typically created for each coverage—though this could also be handled via a coverage indicator field in the database. Separate records also may be created for each individual auto on a policy (if multiple autos are insured on one policy); moreover, separate records may be maintained for individual operators on each auto. In summary, an auto policy insuring two drivers on two cars for six coverages could involve 24 records (or four records if coverage is handled as a field).

In addition to the various subdivisions mentioned above, records are also subdivided according to any changes in the risk(s) during the policy period. If a policy is amended during the policy term, then separate records are created for the partial policy periods before and after the change. Examples will be provided later to better illustrate this requirement.

The following are fields typically present for each record on the policy database:

- **Policy identifier**
- **Risk identifier(s):** As mentioned earlier, products may only insure one risk per policy, and policy identifier is sufficient. For other products that insure multiple risks on a policy, unique risk identifiers are required. As in the example above, vehicle number and operator number may be necessary for personal auto databases.
- **Relevant dates:** Each individual record contains the original effective and termination dates for the policy or coverage within a policy. If separate records are maintained for individual risks and/or individual coverages on the policy, the start date of each risk/coverage is recorded. For example, if collision coverage for a new car is added to an existing auto policy, a record is added with the relevant start date noted. In addition, if separate records are maintained for midterm amendments (e.g., a change in the deductible), the date of the amendment is recorded.

[6]Some workers compensation carriers record policy information at the individual employee level, but this is not common.

- **Premium:** This is typically the written premium associated with each record. If the line of business has multiple coverages, this information is recorded by coverage (represented either as a separate record or via a coverage indicator field). For example, personal auto insurance databases track premium separately for bodily injury, property damage, comprehensive, collision, etc. Earned and in-force premium can be calculated from the information on the record.
- **Exposure:** This is typically the written exposure associated with each record. If the line of business has multiple coverages, this information is recorded by coverage.
- **Characteristics**: Characteristics include rating variables, underwriting variables, and any other available information regarding the risk represented by the record. Some characteristics describe the policy as a whole (e.g., the year the policy originated with the company) and as such are the same for every record associated with a particular policy and period of exposure. Other characteristics describe individual risks (e.g., make/model of automobile) and consequently vary between different records on the same policy.

As separate records are generated for midterm adjustments, the characteristics corresponding to each record are those that were in effect during the relevant period of exposure (e.g., if records are split to reflect a deductible change, the first record shows the initial deductible and the subsequent record(s) shows the new deductible).

Frequently, risk characteristic information is captured in multiple databases across the company and, as such, may be difficult to obtain and merge. For some rating characteristics, it is advantageous to capture a stable element from which the rating characteristic can be derived. For example, age of driver is a typical rating variable for personal automobile insurance; however, it is better to capture the date of birth of the driver on the data record because the driver's date of birth will not change from one policy period to the next but the driver's age will.

The following example homeowners policies can help clarify the construction of the policy database:

- Policy A is written on January 1, 2010, with an annual premium of $1,100. The home is located in Territory 1 and the insured has a $250 deductible. The policy remains unchanged for the full term of the policy.
- Policy B is written on April 1, 2010, with an annual premium of $600. The home is located in Territory 2 and the insured has a deductible of $250. The policy is canceled on December 31, 2010.
- Policy C is written on July 1, 2010, with an annual premium of $1,000. The home is located in Territory 3 and has a deductible of $500. On January 1, 2011, the insured decreases the deductible to $250. The full annual term premium after the deductible change is $1,200.

Policy A expired at its original expiration date and had no changes, thus the entire policy can be represented with one record.

Policy B was canceled before the policy expired. This is represented by two records. The first record for Policy B contains the information known at the inception of the policy (e.g., one exposure and $600 in written premium). The second record represents an adjustment for the cancelation such that when aggregated, the two records show a result net of cancellation. As the policy was canceled 75% of the way through the policy period, the second record should show -0.25 exposure and -$150 (=25% x -$600) of written premium.

Policy C expired at the original expiration date, but has a mid-term adjustment; this is represented by three records. The first record includes all the information at policy inception. The second record negates the portion of the original policy that is unearned at the time of the amendment (i.e., -0.50 exposure and -$500 premium and deductible equal to $500). The third record represents the information applicable to the portion of the policy written with the new deductible (i.e., +0.50 exposure and +$600 premium and deductible equal to $250).

Table 3.1 is an example policy database for the three policies described above.

3.1 Policy Database

Policy	Original Effective Date	Original Termination Date	Transaction Effective Date	Ded	Terr	Other Chars	Written Exposure	Written Premium
A	01/01/10	12/31/10	01/01/10	$250	1	…	1.00	$1,100
B	04/01/10	03/31/11	04/01/10	$250	2	…	1.00	$600
B	04/01/10	03/31/11	12/31/10	$250	2	…	-0.25	-$150
C	07/01/10	06/30/11	07/01/10	$500	3	…	1.00	$1,000
C	07/01/10	06/30/11	01/01/11	$500	3		-0.50	-$500
C	07/01/10	06/30/11	01/01/11	$250	3	…	0.50	$600

*For illustrative purposes this is ordered by policy rather than transaction effective date.

In a more sophisticated data mart, information for Policy B would be aggregated to one record that shows a “net” exposure of 0.75 and “net” written premium of $450. Similarly, information for Policy C would be aggregated to two records representing before and after the deductible change. The first record would reflect the period of time with the $500 deductible and would have a “net” exposure of 0.50 and “net” written premium of $500. The second record reflecting the period of time with the $250 deductible would be identical to the third record in the original example. The exposure is 0.50 and written premium is $600. This type of transaction aggregation is required for statistical ratemaking analysis such as generalized linear models (discussed in more detail in Chapter 10).

Claims Database

Most companies maintain a separate database to capture all available information about the claims on a specific policy. In a claims database, each record generally represents a transaction tied to a specific claim (e.g., a payment or a change in reserve). The fields contain dates or other explanatory information with respect to that claim. Similar to the policy database, claims involving multiple coverages or causes of loss may be represented as separate records or via indicator fields.

The following are the fields typically present for each record on the claims database:

- **Policy identifier**
- **Risk identifier(s):** If relevant, the claim database contains a way to identify the risk that had the claim. This will be necessary to match the claim to the corresponding record in the policy database.
- **Claim identifier:** The claim database contains a unique identifier for each specific claim. This same identifier is used if the claim has multiple claim transaction records.
- **Claimant identifier:** The claim database contains a unique identifier for each specific claimant on a particular claim.

- **Relevant loss dates:** The claim record includes fields for the date of loss, the date the company was notified of the loss (i.e., the report date), and the date of the transaction for the specific record (e.g., date of a loss payment, reserve change, or claim status change).
- **Claim status**: This field is used to track whether the claim is open (i.e., still an active claim) or closed (i.e., has been settled). For some insurance products it may be common for claims to be re-opened. If that is the case, it may be advantageous to add the re-opened and re-closed status descriptions.
- **Claim count:** This field identifies the number of claims by coverage associated with the loss occurrence. Alternatively, if each record or a collection of records defines a single claim by coverage, aggregating claim counts can be accomplished without this explicit field.
- **Paid loss:** This field captures the payments made for each claim record. If there are multiple coverages, perils or types of loss, the loss payments can be tracked in separate fields or separate records. Additionally, if the product is susceptible to catastrophic losses (e.g., hurricanes for property coverage), then catastrophic payments are tracked separately either through a separate record or an indicator included on the record.
- **Event identifier:** This field identifies any extraordinary event (e.g., catastrophe) involving this particular claim.
- **Case reserve:** This field includes the case reserve or the change in the case reserve at the time the transaction is recorded. For example, if a payment of $500 is made at a particular date, and this triggers a simultaneous change in the case reserve, a record is established for this transaction and the paid loss and case reserve fields are populated accordingly. As with paid losses, the case reserve is recorded in separate fields or records by coverage, peril or type of loss and by catastrophe or non-catastrophe claim, if applicable.
- **Allocated loss adjustment expense:** Expenses incurred handling claims are called loss adjustment expenses (LAE) and are commonly separated into allocated and unallocated loss adjustment expenses. Allocated loss adjustment expenses (ALAE) are expenses that can be assigned to a specific claim and are included on the claim database. If ALAE can be subdivided into finer categorization, additional fields may be used accordingly. Unallocated loss adjustment expenses (ULAE) cannot be assigned to a specific claim and are handled elsewhere. For many insurance products, companies do not set ALAE reserves and only payments are tracked on the database. If the company sets a case reserve for ALAE, it is maintained in the database. As with losses, this is captured separately by coverage or peril and by catastrophe or non-catastrophe, if applicable.
- **Salvage/subrogation:** Companies may be able to recoup some payments made to the insured. If a company replaces property, the company assumes ownership of the damaged property. The damaged property may then be reconditioned and sold to offset part of the payments made for the loss; these recoveries are called salvage. When a company pays for an insured's loss, the company receives the rights to subrogate (i.e., to recover any damages from a third party who was at fault or contributed fault to the loss event). Any salvage or subrogation that offsets the loss is tracked and linked to the original claim, if possible.
- **Claim characteristics:** Companies may collect characteristics associated with the claims (e.g., type of injury, physician information). If this information is available, it is included on the claim database to the extent the analyst may want to study the characteristic. However, it is important to note that while studying the impacts of these characteristics on average claim size may be interesting for certain purposes (e.g., loss reserve studies), only characteristics known for every prospective or existing policyholder at the time of policy quotation are usable in the rating algorithm.

The following example policies can help clarify these data requirements.

- Policy A: A covered loss occurs on January 10, 2010. The claim is reported to the insurance company on January 15, 2010, and an initial case reserve of $10,000 is established. An initial payment of $1,000 is made on March 1, 2010, with a corresponding $1,000 reduction in the case reserve. A final payment of $9,000 is made on May 1, 2010, and the claim is closed.
- Policy B: No claim activity.
- Policy C: A covered loss occurs on October 1, 2010, is reported on October 15, 2010, and a case reserve of $18,000 is established. The insurer makes a payment of $2,000 on December 15, 2010, and reduces the case reserve to $17,000. An additional payment of $7,000 is made on March 1, 2011, and the case reserve is reduced to $15,000. The claim is closed on March 1, 2012, when the insurer makes a final payment of $15,000 and receives a $1,000 salvage recovery by selling damaged property.
- Policy C: A second loss occurs on February 1, 2011. The claim is reported on February 15, 2011, and an initial reserve of $15,000 is set. On December 1, 2011, the company pays a law firm $1,000 for fees related to the handling of the claim. The claim is closed on that date with no loss payments made.

The claim associated with Policy A generates three separate records: one when the claim is reported and the initial reserve is set, one when the first payment is made, and one when the last payment is made. There are no records for Policy B as no claims were reported. Policy C had two separate claims. The first claim generates four records: one when the claim is reported and the initial reserve is set, and three for the three different dates that payments and reserve adjustments are made. The second claim generates a record on the date it is reported and the initial reserve is set and a subsequent record on the date the claim is closed.

Table 3.2 is an example claims database for the claim activity on the three policies described above.

3.2 Claim Database

Policy	Claim Number	Accident Date	Report Date	Transaction Date	Claim Status	Claim Chars	Loss Payment	Case Reserve	Paid ALAE	Salvage/ Subrogation
A	1	01/10/10	01/15/10	01/15/10	Open	…	$ -	$10,000	$ -	$ -
A	1	01/10/10	01/15/10	03/01/10	Open	…	$1,000	$9,000	$ -	$ -
A	1	01/10/10	01/15/10	05/01/10	Closed	…	$9,000	$ -	$ -	$ -
C	2	10/01/10	10/15/10	10/15/10	Open	…	$ -	$18,000	$ -	$ -
C	2	10/01/10	10/15/10	12/15/10	Open	…	$2,000	$17,000	$ -	$ -
C	2	10/01/10	10/15/10	03/01/11	Open	…	$7,000	$15,000	$ -	$ -
C	2	10/01/10	10/15/10	03/01/12	Closed	…	$15,000	$ -	$ -	$1,000
C	3	02/01/11	02/15/11	02/15/11	Open	…	$ -	$15,000	$ -	$ -
C	3	02/01/11	02/15/11	12/01/11	Closed	…	$ -	$ -	$1,000	$ -

*For illustrative purposes this is ordered by policy rather than transaction date.

Accounting Information

Some data required for ratemaking is not specific to any one policy. In the case of a company selling multiple products, some data may not even be specific to any one product. The salary of the CEO is a good example of a specific expense that cannot be allocated to line of business or individual policy. More generally, underwriting expenses and unallocated loss adjustment expenses fall into this category and should be tracked at the aggregate level.

Underwriting expenses are expenses incurred in the acquisition and servicing of the policies. These expenses include general expenses, other acquisition expenses, commissions and brokerage, and taxes, licenses, and fees. While it may be possible to assign some of these expenses —like commissions —to specific policies, most of these expenses cannot be assigned. For example, general expenses include some of the costs associated with the company's buildings, and other acquisition expenses include items like advertising costs.

Loss adjustment expenses (LAE) are expenses incurred in the process of settling claims.

Allocated loss adjustment expenses (ALAE) are directly attributable to a specific claim and are, therefore, captured on the claim extract.

Unallocated loss adjustment expenses (ULAE), on the other hand, cannot be assigned to a specific claim. ULAE include items like the cost of a claim center or salaries of employees responsible for maintaining claims records. Since ULAE cannot be assigned to a specific claim, these too are tracked at the aggregate level.

Generally speaking, companies track the underwriting and unallocated loss adjustment expenses paid by calendar year. Further subdivision to items such as line of business and state may also be approximated. These aggregate figures can be used to determine expense provisions that will be used in the ratemaking process.

DATA AGGREGATION

The aforementioned policy, claim, and accounting databases must be aggregated for use in the ratemaking analysis. By maintaining data at a detailed level, the data can be aggregated in a variety of ways to support the different types of analyses described within this text. This section is intended to provide some basics of aggregating data. More detailed descriptions will be provided in later chapters.

When aggregating data for ratemaking purposes, three general objectives apply:

- Accurately match losses and premium for the policy
- Use the most recent data available
- Minimize the cost of data collection and retrieval.

Four common methods of data aggregation are calendar year, accident year, policy year, and report year. Each method differs in how well it achieves the objectives outlined above. Note that the methods will be discussed in terms of annual accounting periods though other periods (e.g., monthly, quarterly) can be used, too. Also, with the exception of calendar year aggregation, the annual period does not need to be a calendar year (e.g., January 1 to December 31) but could be a fiscal year (e.g., July 1 to June 30) as well.

Calendar year aggregation considers all premium and loss transactions that occur during the twelve-month calendar year without regard to the date of policy issuance, the accident date, or the report date of the claim. Calendar year earned premium and earned exposure implies all premium and exposures earned during that twelve month period. Hence, at the end of the calendar year, all premium and exposures are fixed. Calendar year paid losses consider all loss paid during the calendar year regardless of occurrence date or report date. Reported losses for the calendar year are equal to paid losses plus the change in case reserves during that twelve-month calendar year. At the end of the calendar year, all reported losses are fixed.

The advantage of calendar year aggregation is that data is available quickly once the calendar year ends. This information is typically collected for other financial reporting so it represents no additional expense to aggregate the data this way for ratemaking purposes. The main disadvantage of calendar year aggregation is the mismatch in timing between premium and losses. Premium earned during the calendar year come from policies in force during the year (written either in the previous calendar year or the current calendar year). Losses, however, may include payments and reserve changes on claims from policies issued years ago. Calendar year aggregation for ratemaking analysis may be most appropriate for lines of business or individual coverages in which losses are reported and settled relatively quickly, such as homeowners.

Accident year aggregation of premium and exposures follow the same precept as calendar year premium and exposures—and in fact, the method is often referred to as calendar-accident year or fiscal-accident year. Accident year aggregation of losses considers losses for accidents that have occurred during a twelve-month period, regardless of when the policy was issued or the claim was reported. Accident year paid losses include loss payments only for those claims that occurred during the year. Similarly, reported losses for accident year consist of loss payments made plus case reserves only for those claims that occurred during the year. At the end of the accident year, reported losses can and often do change as additional claims are reported, claims are paid, or reserves are changed.

Accident year aggregation represents a better match of premium and losses than calendar year aggregation. Losses on accidents occurring during the year are compared to premium earned on policies during the same year. Since accident year is not closed (fixed) at the end of the year, however, future development on those known losses needs to be estimated. Selecting a valuation date several months after the end of the year allows the emergence of some development in the data and therefore may improve estimation of ultimate losses.

Policy year aggregation, which is sometimes referred to as underwriting year, considers all premium and loss transactions on policies that were written during a twelve-month period, regardless of when the claim occurred or when it was reported, reserved, or paid. All premium and exposures earned on policies written during the year are considered part of that policy year's earned premium and earned exposures. Premium and exposures are not fixed until after the expiration date of all policies written during the year. Policy year paid losses include payments made on those claims covered by policies written during the year. Similarly, reported losses for the policy year consist of payments made plus case reserves only for those claims covered by policies written during the year. At the end of the policy year, losses can and often do change as additional claims occur, claims are paid, or reserves are changed.

Policy year aggregation represents the best match between losses and premium. Losses on policies written during the year are compared with premium earned on those same policies. Given that policy year exposures are not fully earned until after the end of the year (e.g., policy year exposures for a product with an annual policy term are not fully earned until 24 months after the start of the policy year), data takes longer to develop than both calendar year and accident year.

Report year aggregation is the fourth method. This method is similar to calendar-accident year except the losses are aggregated according to when the claim was reported, as opposed to when the claim occurred. This method is typically used for commercial lines products using claims-made policies (e.g., medical malpractice), which is discussed in more detail in Chapter 16.

The individual chapters dedicated to exposure, premium, and loss go into considerably more detail about aggregating different statistics (e.g., written and earned premium; paid and reported losses) under each of these aggregation methods.

Overall versus Classification Analysis

If the purpose of the ratemaking analysis is to review the adequacy of the overall rate level, the data can be highly summarized. Generally speaking, the premium, losses, and exposures can be aggregated by year (i.e., calendar year, accident year, policy year, report year) for the product and location (e.g., state) being analyzed.

On the other hand, if a classification analysis is being performed, then the data must be at a more granular level. For a traditional univariate classification analysis, the data can be aggregated by year (typically accident year or policy year) for each level of the rating variable being studied. For example, if it is a territorial analysis, then the premium, losses, and exposures should be aggregated by year for each territory. In the case of a multivariate analysis (i.e., a simultaneous analysis of multiple variables), it is preferable to organize data at the individual policy or risk level. Alternatively, the data can be aggregated by year for each unique combination of rating variables being studied. If numerous rating variables are being considered, the aggregation (and compression) may be minimal and not worth undertaking.

Limited Data

As mentioned earlier, actuaries are sometimes required to perform ratemaking analysis when the preferred data described above is not available. In such cases, the actuary must work with the data that is available and use actuarial judgment to overcome the data deficiencies. For example, earned premium by territory is normally used for an analysis of auto territorial relativities. If the company does not have earned premium by territory, the actuary may use in-force premium by territory to estimate the earned premium by territory.

EXTERNAL DATA

When pricing a new line of business, it may be necessary to use external data. Even when pricing an existing line of business, it is often helpful to supplement internal data with external data. The most commonly used sources of external information include data calls or statistical plan data, other aggregated insurance industry data, competitors' rate filings, and third-party data unrelated to insurance. As with internal data, it is the actuary's responsibility to select the data with due consideration of reasonableness, appropriateness, comprehensiveness, and other factors from the Actuarial Standards of Practice No. 23, Data Quality (Actuarial Standards Board of the American Academy of Actuaries) before using it.

Statistical Plans

As discussed above, companies use data for internal business purposes (e.g., ratemaking analysis). Data is also required by regulators. In the U.S., property and casualty insurance is regulated at the state level, and regulators frequently require companies to file statistical data in a consistent format. Normally, state regulators do not need detailed data for their purposes and the required statistical plan is a summary-based plan.

One example of a statistical plan is The Texas Private Passenger Automobile Statistical Plan, as promulgated by the Texas Commissioner of Insurance. For many years, Texas used a benchmark rate system for setting personal automobile premium. The state set benchmark rates from which companies could deviate. The benchmark rates were determined based on an analysis of statistical data provided by insurance companies writing personal automobile insurance in Texas. Texas required statistical data that was aggregated by territory, deductible, and driver class. In addition to being used as the basis for setting the benchmark rates, the data was publicly available and was used by companies to supplement internal analyses.

To comply with various states' requirements for aggregated industry data as well as for the industry's needs for aggregated data, certain industry service organizations have been formed to collect and aggregate data from a group of participating companies writing the same insurance product. For example, the National Council for Compensation Insurance (NCCI) and Insurance Services Office, Inc (ISO) are two such organizations that meet the U.S. industry's need for aggregated data. In addition to collecting and summarizing data, these organizations analyze the aggregated data and make the results of the analysis available to the participating companies. Alternatively, the participating companies may be able to request the aggregated data to perform their own independent analysis.

Because this information is used for detailed actuarial analysis, these statistical plans tend to collect data at the transactional level; consequently, the organizations have the flexibility to perform in-depth analysis at both the overall and segment levels.

In addition to these statistical plans, state regulators may initiate ad hoc data calls to address a specific need. Normally, this information is publicly available and can be a good source of additional ratemaking information for companies. For example, several state regulators have requested closed claim information on medical malpractice claims, and medical malpractice insurers may request the data to supplement their own data.

Other Aggregated Industry Data

Many insurance companies voluntarily report data to various organizations so that it can be aggregated and used by the insurance industry and in some cases by regulators, public policy makers, or the general public. For example, a large percentage of U.S. personal lines companies report quarterly loss data for the "Fast Track Monitoring System." Fast Track reports are often used by insurance companies and U.S. state regulators to analyze loss trends.

Another example of an organization that collects, aggregates, and analyzes insurance data is the Highway Loss Data Institute (HLDI). HLDI, which is sponsored by several U.S. personal auto insurance companies, compiles insurance data reported by member companies and provides detailed information related to loss information by type of car to member companies and public policy makers. HLDI also provides highly summarized information that can be useful to insurers as well as the general public. One such example is information on which make and model cars have the highest incident of auto injury.

Examples of other organizations that collect, report, and analyze insurance industry data are the Insurance Research Council (IRC), the Institute for Business and Home Safety (IBHS), and the National Insurance Crime Bureau (NICB). A more comprehensive list of aggregated industry data providers is beyond the scope of this text.

Competitor Rate Filings/Manuals

Depending on the jurisdiction, competitor rate filings may be available to the public. For example, U.S. companies may be required to submit rate filings to the appropriate regulatory body when changing rates or rating structures for some insurance products. Rate filings normally include actuarial justification for requested rate changes and the manual pages needed to rate a policy.

In the simplest scenario, the filed rate change may involve a change to base rates only. Even in this case, the filing may still include helpful information related to overall indicated loss cost levels and trends in losses and expenses. If, however, the company is making changes to rating variable differentials (e.g., driver age relativities, territorial relativities, amount of insurance relativities), then the filing may also include information about the indicated relationships between the different levels for each rating variable undergoing a change.

Companies may also be required to include the manual pages necessary to rate policies. As discussed in Chapter 2, the manual contains the rules, rating structures, and rating algorithms in use by the company. This information can be analyzed to estimate the overall average premium level charged by the company and the premium differences due to different characteristics. Often, it can be very difficult to get a complete copy of a competitor's rate manual. First, companies do not file a complete manual with each change, but rather file only the pages that are changing; therefore, it may take several filings to piece together a complete manual. Additionally, companies often create underwriting tiers for which most jurisdictions do not require companies to file the underwriting rules used to assign risks to the tiers. Since it is common for the underwriting tier rules to have a significant impact on the final premium, the rating manual without the underwriting rules is incomplete information.

Even if complete information is available, a company must take great care when relying on information from a competitor's rate filing. Each company has different insureds, goals, expense levels, and operating procedures. If the differences are material, then the competitor information may not be relevant. For example, a personal automobile insurer specializing in writing preferred or super-preferred drivers typically has different rates and rating variables than a non-standard personal automobile insurer. In a more extreme case, commercial lines products often entail discretionary pricing and underwriting rules that would make accurate estimation of a competitor's final premium even more difficult.

Other Third-Party Data

Ratemaking analysis is often supplemented with third-party data that is not specific to insurance. The most commonly used types of third-party data are economic data and geo-demographic data, but other sources are relevant, too.

Insurers may not have enough internal data to accurately project trends in expenses, premium, or losses. If that is the case, companies may supplement internal data with sources like the Consumer Price Index (CPI). Companies may examine the CPI at the component level (e.g., medical cost and construction cost indices) to find trends that are relevant to the insurance product being priced.

Insurance companies may also study geo-demographic data (i.e., average characteristics of a particular area). In the U.S., census data is frequently used to supplement insurance data. For example, population density can be an important predictor of the frequency of accidents. Other examples of geo-demographic data that may be useful include the following: weather indices, theft indices, and average annual miles driven.

Another prime example of third-party data used by insurance companies is credit data. Starting in the 1990s, personal lines insurers began to evaluate the insurance loss experience of risks with different credit scores. Insurers determined that credit is an important predictor of risk and began to vary rates accordingly. More recently, commercial lines companies have analyzed similar data available for corporations. In addition to credit, there is a wealth of information available related to different insurance products. The following are a few such examples for different insurance products:

- Personal automobile insurance: vehicle characteristics, department of motor vehicle records
- Homeowners insurance: distance to fire station
- Earthquake insurance: type of soil
- Medical malpractice: characteristics of hospital in which doctor practices
- Commercial general liability: type of owner (proprietor, stock)
- Workers compensation: OSHA inspection data.

SUMMARY

Data is required for all ratemaking, and the quality of the ratemaking conclusions is heavily dependent on the quality of the data used. For existing insurance products, it is important that companies track policy and claim data at the individual policy, risk, or risk segment level. By doing so, companies have the flexibility to aggregate data in different ways (e.g., calendar year, accident year, policy year, report year) and determine the granularity of the data needed depending on the type of analysis being performed (e.g., overall rate level analysis or classification analysis).

Companies often consider external data, if available. More specifically, companies may examine data from statistical plans and data calls, other aggregated insurance data, competitor rate filings, and data from other third-party sources. These types of data can be useful in pricing new lines of business or in supplementing internal data.

KEY CONCEPTS IN CHAPTER 3

1. Internal data
    a. Policy database
    b. Claim database
    c. Accounting data

2. Data aggregation
    a. Calendar year
    b. Accident year
    c. Policy year
    d. Report year

3. External data
    a. Data calls and statistical plans
    b. Other insurance industry aggregated data
    c. Competitor information
    d. Other third-party data

CHAPTER 4: EXPOSURES

Insurance provides indemnification in the event of a claim due to a loss within the limitations of the policy. An exposure is the basic unit that measures a policy's exposure to loss. It is logical, therefore, that the exposure serves as the basis for the calculation of premium. Base rates, as discussed in Chapter 2, are typically expressed as a rate per exposure. The premium is calculated as the base rate multiplied by the number of exposures and adjusted by the effect of rating variables and sometimes other fees.

This chapter covers:

- Criteria that should be considered when selecting an exposure base
- Special treatment of exposure for large commercial risks
- Methods of aggregating exposures (calendar year and policy year) and defining exposures (written, earned, unearned, and in-force)
- Brief discussion on measuring trends in inflation-sensitive exposure bases.

CRITERIA FOR EXPOSURE BASES

A good exposure base should meet the following three criteria: it should be directly proportional to expected loss, it should be practical, and it should consider any preexisting exposure base established within the industry.

Proportional to Expected Loss

The exposure base chosen should be directly proportional to expected loss. In other words, all else being equal, the expected loss of a policy with two exposures should be twice the expected loss of a similar policy with one exposure. However, this does not mean that the exposure base is the only item by which losses may systematically vary. In general, expected loss will vary by a substantial number of factors and these other factors should be used as rating or underwriting variables to further reflect these risk level differences. The factor with the most direct relationship to the losses should be selected as the exposure base. This also makes the exposure base more easily understood by the insured.

Consider homeowners insurance as an example. Intuitively, the expected loss for one home insured for two years is two times the expected loss of the same home insured for one year. The expected loss for homes does vary by a significant number of other characteristics, including the amount of insurance purchased. While the expected loss for a $200,000 home is higher than that for a $100,000 home, it may not necessarily be two times higher. So based on the criterion that the exposure base should be the factor most directly proportional to the expected loss, number of house years is the preferred exposure base, and amount of insurance should be used as a rating variable.[7]

If an exposure base is proportional to the expected loss, then the exposure base should be responsive to any change in exposure to risk. Another example can more clearly demonstrate how the exposure base for some insurance products can be responsive to even small changes in exposure. Payroll is the

[7] In the U.K. and other countries, some homeowners insurers use amount of insurance or number of bedrooms as an exposure base and adjust the rating algorithm to account for the fact that these variables are not directly proportional to expected loss.

commonly used exposure base for workers compensation insurance. As the number of workers increases (decreases) or the average number of hours worked increases (decreases), both payroll and the risk of loss increase (decrease) too. Thus, the exposure base (i.e., payroll) moves in proportion to expected losses, and the premium will change with this exposure base change as well.

Practical

The exposure base should be practical. In other words, the selected base should be objective and relatively easy and inexpensive to obtain and verify. By meeting these criteria, the exposure base will be consistently measured.

A well-defined and objective exposure base also precludes policyholders and producers/underwriters from manipulating exposure information for their own benefit through intentional dishonest disclosure. For example, asking a personal auto policyholder to declare estimated annual miles provides more opportunity for dishonesty than the use of car-years. This circumstance is referred to as moral hazard. Advances in technology, however, may change the choice of exposure base for personal auto insurance. Onboard diagnostic devices can accurately track driving patterns and transmit this information to insurance companies. As this technology becomes more prevalently used, personal auto insurers may consider miles driven as an alternative exposure base. In fact, some commercial long haul trucking carriers have implemented miles driven as an exposure base.

For products liability, the exposure base that is intuitively the most proportional to expected loss is the number of products currently in use. While companies normally know how many products were sold during specific time periods, it is difficult for most companies to accurately track how many of their products are actually being used during the period covered by the insurance policy. Therefore, the number of products in use is not a practical exposure base. Consequently, a gross sales figure is used as the exposure base for products liability insurance as it is a reasonable and practical proxy for products in use. Of course, gross sales will be a better proxy for a consumable good that is only in use for a short period of time (e.g., a cup of coffee) than a durable good that will be used for many years (e.g., a lawnmower).

Historical Precedence

Over time, the industry may discover a more accurate or practical exposure base than the one currently in use (e.g., the example of miles driven discussed in the previous section). While the advantages may be clear, any change in an exposure base should be very carefully considered prior to implementation for several reasons. First, any change in exposure base can lead to large premium swings for individual insureds. Second, a change in exposure base will require a change in the rating algorithm, which depending on the unique circumstances, may require a significant effort to adjust the rating systems, manuals, etc. Third, ratemaking analysis is normally based on several years of data. A change in exposure base may necessitate significant data adjustments for future analyses.

Workers compensation has historically used payroll as an exposure base. In the 1980s, there was a lot of pressure to change the exposure base to hours worked for medical coverage in order to correct perceived inadequacies of the exposure base for union companies with higher pay scales. Although hours worked made intuitive sense, the exposure base was not changed at that time, and one of the major reasons cited was concerns regarding the transition. Instead, the rating variables and rating algorithm were adjusted to address the inequities. This debate over the choice of workers compensation exposure base continues to reemerge.

The following table shows the exposure bases currently used for different lines of business. Multi-peril package policies such as commercial general liability use different exposure bases for pricing different aspects of the package policy.

4.1 Typical Exposure Bases

Line of Business	Typical Exposure Bases
Personal Automobile	Earned Car Year
Homeowners	Earned House Year
Workers Compensation	Payroll
Commercial General Liability	Sales Revenue, Payroll , Square Footage, Number of Units
Commercial Business Property	Amount of Insurance Coverage
Physician's Professional Liability	Number of Physician Years
Professional Liability	Number of Professionals (e.g., Lawyers or Accountants)
Personal Articles Floater	Value of Item

EXPOSURES FOR LARGE COMMERCIAL RISKS

Large commercial risks present unique challenges for ratemaking and for the use of more conventional exposure bases. As a result, ratemaking for large commercial risks is often done via composite rating and loss-rated composite rating.

Composite rating is used for some large commercial risks when the amount of exposure is difficult to track throughout the policy period. For example, some commercial multi-peril policies use different exposure measures for each aspect of coverage (e.g., sales revenue for general liability, amount of insurance or property value for commercial business property). The policy premium is initially calculated using estimates for each exposure measure along with the relevant rating algorithms for each coverage. These individual exposure estimates, however, are expected to change throughout the course of the policy term. Rather than auditing each exposure measure, a proxy measure is used to gauge the overall change in exposure to loss. For example, if property value is chosen as the proxy exposure measure, a 20% increase in property value during the policy term would trigger a premium adjustment of 20% for the whole policy's premium.

In loss-rated composite rating, premium is calculated based on the individual risk's historical loss experience (i.e., without any use of standard rating algorithms). In that case, the implicit exposure base is the risk. This rating technique is discussed in more detail in Chapter 15.

AGGREGATION OF EXPOSURES

Methods of Aggregation for Annual Terms

As described in Chapter 3, four common methods of data aggregation are calendar year, accident year, policy year, and report year. In regards to aggregating exposures, there are only two methods applicable: calendar year (which is the same as calendar-accident year) and policy year.

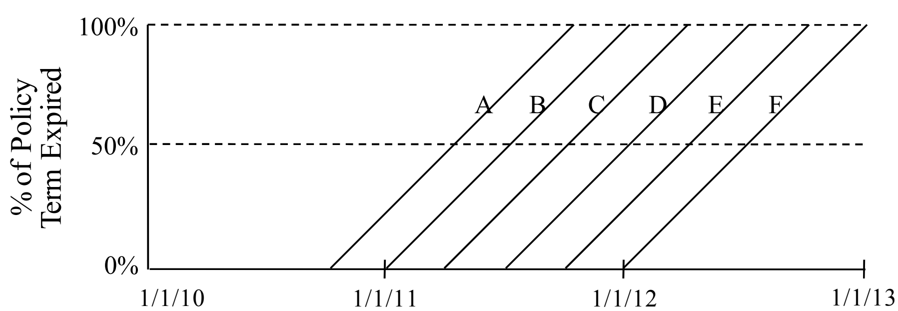
Example policies will be used to demonstrate these concepts. For simplicity, the example chosen (homeowners insurance) uses policies for which there is generally one exposure per policy. These example policies have annual terms; examples using semi-annual terms will be provided later in this chapter.

4.2 Policies

Policy	Effective Date	Expiration Date	Exposure
A	10/01/10	09/30/11	1.00
B	01/01/11	12/31/11	1.00
C	04/01/11	03/31/12	1.00
D	07/01/11	06/30/12	1.00
E	10/01/11	09/30/12	1.00
F	01/01/12	12/31/12	1.00

The aforementioned policies can be represented pictorially (see Figure 4.3). The x-axis represents time, and the y-axis represents the percentage of the policy term that has expired.[8] Each diagonal line represents a different policy. At the onset of the policy, 0% of the policy term has expired; thus, that point is located on the lower x-axis at the effective date. At the conclusion of the policy, 100% of the policy term has expired; thus, that point is located on the upper x-axis at the expiration date. The line connecting the effective and expiration points depicts the percentage of the policy term that has expired at each date.

4.3 Example Policies



Calendar Year Aggregation and Accident Year Aggregation consider all exposures during the twelve-month calendar year without regard to the date of policy issuance; calendar and accident year exposures are generally the same[9] and the text will use the term calendar year exposure. At the end of the calendar year, all exposures are fixed. Since calendar year considers any transactions that occurred on or after the first day of the year, but on or before the last day of the year, calendar years are represented graphically as squares in the following picture.

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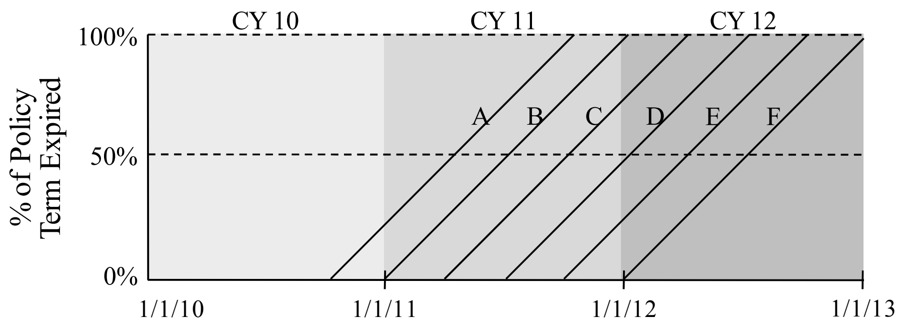
[8] This assumes the policy is earned evenly throughout the policy period. Some products (e.g., warranties) do not earn evenly.

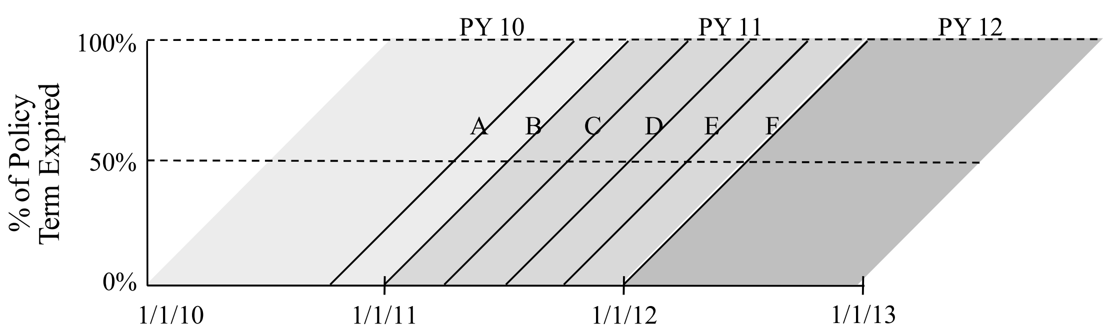
[9] There are some limited cases when the calendar and accident year exposures will not be equivalent. Policies that undergo audits will be discussed in the Premium Development section in the Premium Chapter.

4.4 Calendar Year Aggregation



Policy year aggregation, which is sometimes referred to as underwriting year, considers all exposures on policies with effective dates during the year. Thus, this is represented graphically using a parallelogram starting with a policy written on the first day of the policy year and ending with a policy written on the last day of the policy year:

4.5 Policy Year Aggregation

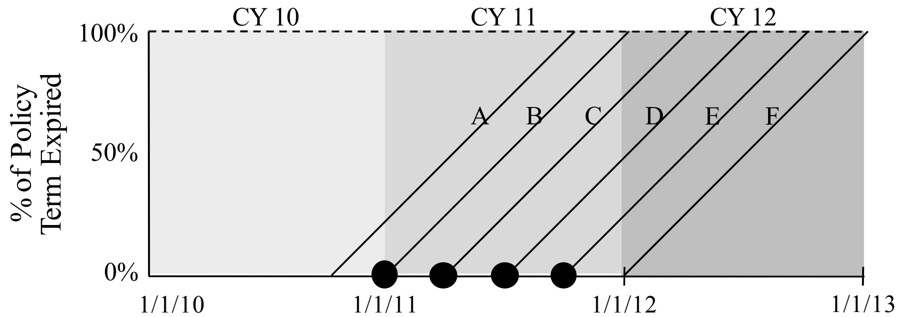


As demonstrated in the graph, the policy year takes significantly longer to close. For that reason, most ratemaking analysis focuses on calendar year exposures.

In addition to aggregating by calendar or policy year, exposures can be defined in four basic ways: written, earned, unearned, and in-force exposures.

Written exposures are the total exposures arising from policies issued (i.e., underwritten or, more informally, written) during a specified period of time, such as a calendar quarter or a calendar year. For example, the written exposure for Calendar Year 2011 is the sum of the exposures for all policies that had an effective date in 2011. As can be seen in Figure 4.6, Policies B, C, D and E all have effective dates (shown as large circles on the horizontal axis) in 2011, and their entire exposure contributes to Calendar Year 2011 written exposure. In contrast, Policies A and F have effective dates in years 2010 and 2012, respectively, and do not contribute to Calendar Year 2011 written exposure.

4.6 Calendar Year Written Exposures



The following table summarizes the distribution of written exposure to each calendar year:

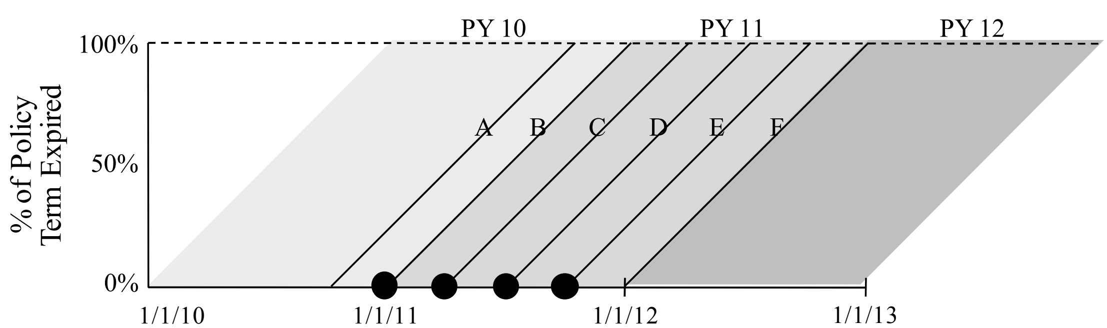
4.7 Calendar Year Written Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Written Exposures CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	1.00	1.00	0.00	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	0.00
D	07/01/11	06/30/12	1.00	0.00	1.00	0.00
E	10/01/11	09/30/12	1.00	0.00	1.00	0.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	1.00	4.00	1.00

Note each policy only contributes written exposure to a single calendar year in this example. If a policy cancels midterm, the policy will contribute written exposure to two different calendar years if the date of the cancellation is in a different calendar year than the original effective date. For example, if Policy D is cancelled on March 31, 2012 (i.e., after 75% of the policy has expired), then Policy D will contribute one written exposure to Calendar Year 2011 and -0.25 written exposure to Calendar Year 2012.

The following figure shows written exposure in the context of policy year aggregation.

4.8 Policy Year Written Exposure



The following table summarizes the distribution of written exposure to each policy year:

4.9 Policy Year Written Exposures a/o 12/31/12

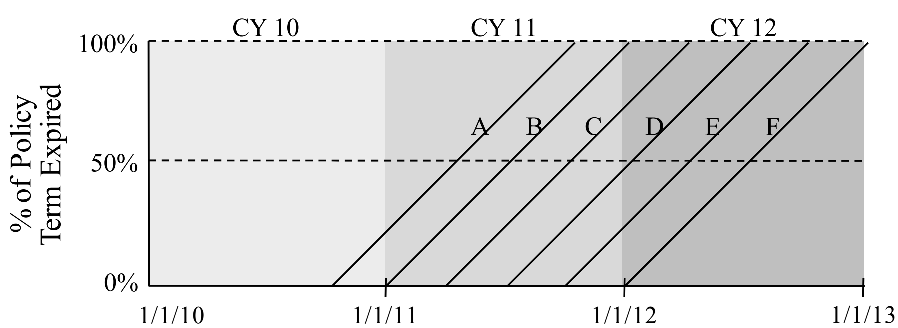
Policy	Effective Date	Expiration Date	Exposure	Written Exposures PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	1.00	1.00	0.00	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	0.00
D	07/01/11	06/30/12	1.00	0.00	1.00	0.00
E	10/01/11	09/30/12	1.00	0.00	1.00	0.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	1.00	4.00	1.00

Since policy year written exposure is aggregated by policy effective dates, the original written exposure and the written exposure due to the cancellation are all booked in the same policy year. As mentioned above, this contrasts with calendar year in which written exposure and cancellation exposure can apply to two different calendar years depending on when the cancellation occurs.

Earned exposures represent that portion of the written exposures for which coverage has already been provided as of a certain point in time. This example inherently assumes that the probability of a claim is evenly distributed throughout the year. For instance, if all policies were written on January 1 for a period of one year, the earned exposures as of May 31 would be 5/12 of the written exposures.

To better understand the difference between calendar and policy year earned exposure, first reconsider the calendar year picture:

4.10 Calendar Year Earned Exposure



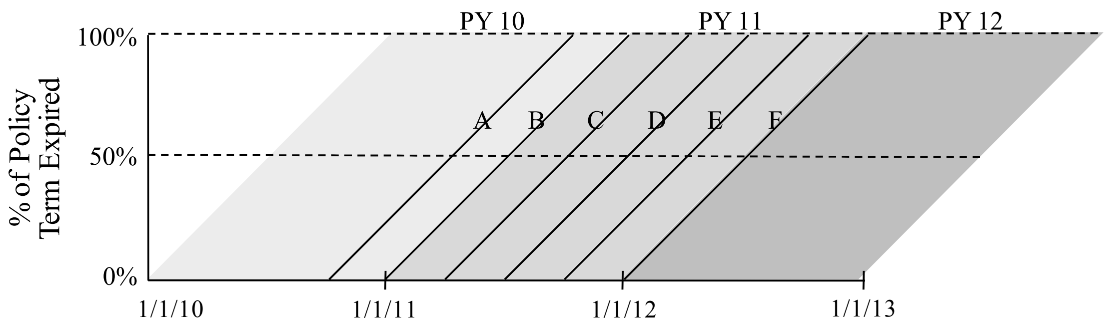
For Policy C in our example, 75% of the policy period is earned in 2011 and 25% of the policy period is earned in 2012; thus, Policy C contributes 0.75 (= 75% x 1.00) of earned exposure to Calendar Year 2011 and 0.25 earned exposure to Calendar Year 2012. The following chart summarizes the distribution of earned exposure to each calendar year:

4.11 Calendar Year Earned Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Earned Exposures CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	1.00	0.25	0.75	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	0.75	0.25
D	07/01/11	06/30/12	1.00	0.00	0.50	0.50
E	10/01/11	09/30/12	1.00	0.00	0.25	0.75
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	0.25	3.25	2.50

In contrast, the following picture relates to policy year earned exposure.

4.12 Policy Year Earned Exposure



As can be seen in the picture, all earned exposure is assigned to the year the policy was written and increases in relation to time. By the time the policy year is complete (24 months after the beginning of the policy year for annual policies), the policy year earned and written exposures are equivalent. Unlike calendar year earned exposure, exposure for one policy cannot be earned in two different policy years. The following table shows the policy year earned exposures for policy years 2010 through 2012 as of December 31, 2012.

4.13 Policy Year Earned Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Earned Exposures PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	1.00	1.00	0.00	0.00
B	01/01/11	12/31/11	1.00	0.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	0.00
D	07/01/11	06/30/12	1.00	0.00	1.00	0.00
E	10/01/11	09/30/12	1.00	0.00	1.00	0.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	1.00	4.00	1.00

The assumption of an even earning pattern does not hold true for lines such as warranty and those affected by seasonal fluctuations in writings (e.g., boat owners insurance). As such, actuaries analyzing these lines often specify other earning pattern assumptions based on historical experience.

Unearned exposures represent the portion of the written exposures for which coverage has not yet been provided as of that point in time. This applies to individual policies as well as groups of policies. For an individual policy at a certain point in time, the following formula depicts the relationship between written, earned, and unearned exposures:

Written Exposures = Earned Exposures + Unearned Exposures.

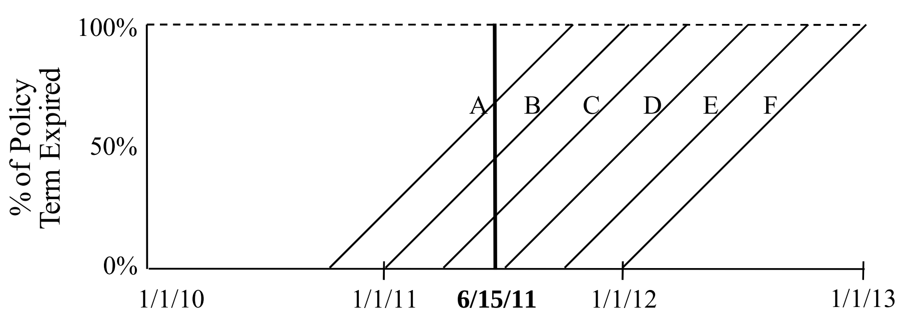
For groups of policies, the formula depends on the method of data aggregation. Policy year aggregation as of a certain point in time would follow the formula immediately above. Calendar year aggregation, however, would need to consider the unearned exposures at the beginning of the calendar year and at the end of the calendar year as follows:

CY Unearned Exposures = CY Written Exposures – CY Earned Exposures + Unearned Exposures as of the beginning of CY.

In-force exposures are the number of insured units that are exposed to having a claim at a given point in time. In other words, they represent the exposure to loss as a snapshot in time with no consideration for the duration of the exposure. The in-force exposure as of June 15, 2011, is the sum of insured units that have an inception date on or before June 15, 2011, and an expiration date after June 15, 2011. Not all insurance companies define "insured unit" the same way. Most companies define insured units to be the count of items exposed to loss at a given point in time. For example, if an automobile policy insures three cars, that one policy could contribute three in-force exposures at a given point in time. Alternatively, some companies may define insured unit in terms of the number of policies (the auto example above would have one in-force exposure under this definition) or the written exposures (in the auto example, there could be three in-force exposures if the term is annual, or 1.5 in-force exposures if the term is semi-annual).

A vertical line drawn at the valuation date will intersect the policies that are in-force on that date. As can be seen in Figure 4.14, Policies A, B, and C are all in effect on June 15, 2011, and each contributes to the in-force exposures as of that date.

4.14 In-Force Exposure



Assuming the "insured unit" refers to the number of houses exposed to loss, the following chart shows the in-force exposure for the example policies at three different valuation dates:

4.15 In-force Exposure by Date

Policy	Effective Date	Expiration Date	Number of Houses Insured	In-Force Exposure a/o 01/01/11	06/15/11	01/01/12
A	10/01/10	09/30/11	1.00	1.00	1.00	0.00
B	01/01/11	12/31/11	1.00	1.00	1.00	0.00
C	04/01/11	03/31/12	1.00	0.00	1.00	1.00
D	07/01/11	06/30/12	1.00	0.00	0.00	1.00
E	10/01/11	09/30/12	1.00	0.00	0.00	1.00
F	01/01/12	12/31/12	1.00	0.00	0.00	1.00
Total			6.00	2.00	3.00	4.00

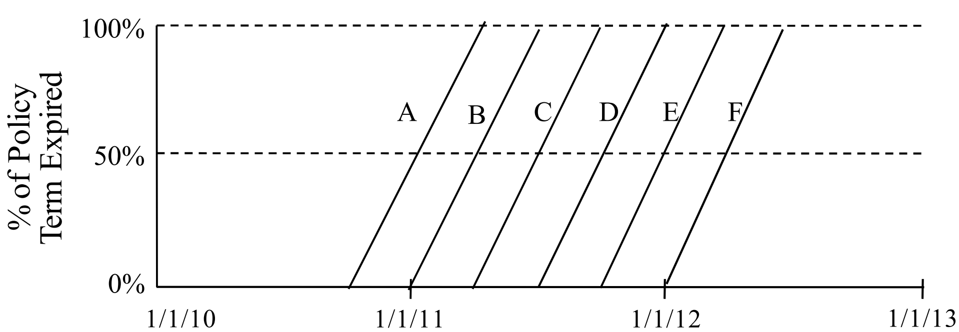
Policy Terms Other Than Annual

The preceding example illustrated the concepts of written, earned, unearned, and in-force exposures based on the assumption of annual policies. If the policy term is shorter or longer than a year, then the aggregation for each type of exposure will be calculated differently than outlined above. For example, if the policies are six-month policies, each policy would represent one-half of a written exposure. The picture and tables for calendar year and policy year aggregation of semi-annual policies are shown below.

4.16 Six-Month Policies

Policy	Effective Date	Expiration Date	Exposure
A	10/01/10	03/31/11	0.50
B	01/01/11	06/30/11	0.50
C	04/01/11	09/30/11	0.50
D	07/01/11	12/31/11	0.50
E	10/01/11	03/31/12	0.50
F	01/01/12	06/30/12	0.50

4.17 Example Policies



4.18 Calendar Year Written Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Written Exposures CY 2010	CY 2011	CY 2012
A	10/01/10	03/31/11	0.50	0.50	0.00	0.00
B	01/01/11	06/30/11	0.50	0.00	0.50	0.00
C	04/01/11	09/30/11	0.50	0.00	0.50	0.00
D	07/01/11	12/31/11	0.50	0.00	0.50	0.00
E	10/01/11	03/31/12	0.50	0.00	0.50	0.00
F	01/01/12	06/30/12	0.50	0.00	0.00	0.50
Total			3.00	0.50	2.00	0.50

4.19 Calendar Year Earned Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Earned Exposures CY 2010	CY 2011	CY 2012
A	10/01/10	03/31/11	0.50	0.25	0.25	0.00
B	01/01/11	06/30/11	0.50	0.00	0.50	0.00
C	04/01/11	09/30/11	0.50	0.00	0.50	0.00
D	07/01/11	12/31/11	0.50	0.00	0.50	0.00
E	10/01/11	03/31/12	0.50	0.00	0.25	0.25
F	01/01/12	06/30/12	0.50	0.00	0.00	0.50
Total			3.00	0.25	2.00	0.75

4.20 Policy Year Written Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Written Exposures PY 2010	PY 2011	PY 2012
A	10/01/10	03/31/11	0.50	0.50	0.00	0.00
B	01/01/11	06/30/11	0.50	0.00	0.50	0.00
C	04/01/11	09/30/11	0.50	0.00	0.50	0.00
D	07/01/11	12/31/11	0.50	0.00	0.50	0.00
E	10/01/11	03/31/12	0.50	0.00	0.50	0.00
F	01/01/12	06/30/12	0.50	0.00	0.00	0.50
Total			3.00	0.50	2.00	0.50

4.21 Policy Year Earned Exposures a/o 12/31/12

Policy	Effective Date	Expiration Date	Exposure	Earned Exposures PY 2010	PY 2011	PY 2012
A	10/01/10	03/31/11	0.50	0.50	0.00	0.00
B	01/01/11	06/30/11	0.50	0.00	0.50	0.00
C	04/01/11	09/30/11	0.50	0.00	0.50	0.00
D	07/01/11	12/31/11	0.50	0.00	0.50	0.00
E	10/01/11	03/31/12	0.50	0.00	0.50	0.00
F	01/01/12	06/30/12	0.50	0.00	0.00	0.50
Total			3.00	0.50	2.00	0.50

Assuming insured units are defined as number of homes insured at a point in time, each semi-annual policy can contribute to one in-force exposure.

4.22 In-force Exposure by Date

Policy	Effective Date	Expiration Date	Number of Houses Insured	In-Force Exposure a/o 01/01/11	06/15/11	01/01/12
A	10/01/10	03/31/11	1.00	1.00	0.00	0.00
B	01/01/11	06/30/11	1.00	1.00	1.00	0.00
C	04/01/11	09/30/11	1.00	0.00	1.00	0.00
D	07/01/11	12/31/11	1.00	0.00	0.00	0.00
E	10/01/11	03/31/12	1.00	0.00	0.00	1.00
F	01/01/12	06/30/12	1.00	0.00	0.00	1.00
Total			6.00	2.00	2.00	2.00

Calculation of Blocks of Exposures

The preceding section illustrated how to convert the total exposure of individual policies into written, in-force, earned, and unearned exposures. Advances in computing power have enabled such techniques to be applied to individual policies. On the other hand, some companies may have policy information summarized on a monthly or quarterly basis and will need to calculate the exposures for the block of policies using this summarized data. In such a case, it is customary for the practitioner to treat all policies as if they were written on the mid-point of the period. For example, when data is summarized on a monthly basis, all policies are assumed to be written on the 15th of the month. This practice is often referred to as the "15th of the month" rule or the "24ths" method. This will be a good approximation as long as policies are written uniformly during each time period. If this approach is applied to longer periods (e.g., quarters or years), the assumption of uniform writings is less likely to be reasonable.

To clarify the application of this rule, consider the following example in which a company begins writing annual policies in 2010 and writes 240 exposures each month.

The in-force exposures represent the total exposures from active policies at a given point in time. While it is reasonable to assume that some of the 240 exposures written in July were in-force as of the first day of the month, the "15th of the month" rule assumes that none of the exposures from the July policies contribute to the in-force exposures as of July 1, 2010. This is because the rule assumes all the July policies are written on July 15th. Table 4.23 shows the in-force exposures as of July 1, 2010; January 1, 2010; and July 1, 2011, respectively.

4.23 Aggregate In-force Calculation

Written Month	Exposure	Assumed Effective Date	In-force Exposures a/o 07/01/10	01/01/11	07/01/11
Jan-10	240	01/15/10	240	240	0
Feb-10	240	02/15/10	240	240	0
Mar-10	240	03/15/10	240	240	0
Apr-10	240	04/15/10	240	240	0
May-10	240	05/15/10	240	240	0
Jun-10	240	06/15/10	240	240	0
Jul-10	240	07/15/10	0	240	240
Aug-10	240	08/15/10	0	240	240
Sep-10	240	09/15/10	0	240	240
Oct-10	240	10/15/10	0	240	240
Nov-10	240	11/15/10	0	240	240
Dec-10	240	12/15/10	0	240	240
Total	2,880		1,440	2,880	1,440

As discussed earlier, the earned exposures represent the portion of the policy for which coverage has already been provided as of a certain point in time. Since the assumption is that all policies for a given month are written on the 15th of the month, the written exposures for annual policies will be earned over a 13-month calendar period: 1/24 of the exposure will be earned in the second half of the month in which it was written, 1/12 (or 2/24) of the exposure will be earned in each of the next 11 months (i.e., months 2 through 12), and the final 1/24 of the exposure will be earned in the first half of month 13. Table 4.24 shows the distribution of earned exposures to Calendar Years 2010 and 2011, respectively.

4.24 Aggregate Earned Exposure Calculation

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Assumed				
Written	Exposures	Effective	Earning Percentage		Earned Exposures	
Month	Written	Date	2010	2011	2010	2011
Jan-10	240	01/15/10	23/24	1/24	230	10
Feb-10	240	02/15/10	21/24	3/24	210	30
Mar-10	240	03/15/10	19/24	5/24	190	50
Apr-10	240	04/15/10	17/24	7/24	170	70
May-10	240	05/15/10	15/24	9/24	150	90
Jun-10	240	06/15/10	13/24	11/24	130	110
Jul-10	240	07/15/10	11/24	13/24	110	130
Aug-10	240	08/15/10	9/24	15/24	90	150
Sep-10	240	09/15/10	7/24	17/24	70	170
Oct-10	240	10/15/10	5/24	19/24	50	190
Nov-10	240	11/15/10	3/24	21/24	30	210
Dec-10	240	12/15/10	1/24	23/24	10	230
Total	2,880				1,440	1,440

(4) = Portion of exposure earned in 2010.

(5) = Portion of exposure earned in 2011.

(6) = (2) x (4)

(7) = (2) x (5)

Though the above examples demonstrate the "15th of the month" rule on calendar year data, the same principles apply to policy year aggregation.

EXPOSURE TREND

As will be discussed in several subsequent chapters, the fundamental insurance equation requires that income (premium) equals outgo (loss and loss adjustment expenses and underwriting expenses), and target profit during the period in which the rates will be in effect. The chapters on premium and loss discuss trending procedures to adjust historical figures to the levels expected in the future.

For some lines of business, the exposure measure used is sensitive to time-related influences such as inflation. For example, payroll and sales revenue are highly influenced by inflationary pressures. In these lines of business, it may be prudent to measure the trend in historical exposures over time in order to project exposure levels in the future. These trends can be measured via internal insurance company data (e.g., workers compensation payroll) or via industry indices (e.g., average wage index). The way in which exposure trend impacts the calculation of the overall rate level indication depends on several factors such as whether the loss ratio or pure premium method is employed and how loss trends are calculated. The details will not be discussed in this chapter, but will be revisited in Chapters 5 and 6.

SUMMARY

Exposures are the basic unit used to measure risk. As such, the rate is defined as a price per unit of exposure. The exposure base used for a particular insurance product should be proportional to loss and practical to use. Furthermore, it is desirable that the exposure base used is consistent over time.

Exposures can be categorized as written, in-force, earned, or unearned and aggregated according to calendar year or policy year. Written exposure refers to the number of exposures associated with policies written during a specified period of time. In-force exposure refers to the number of exposures associated with all policies that are in effect on a given date. Earned exposure is the portion of the written exposure that corresponds to the portion of the policy period that has already expired. Unearned exposure is the portion of the written exposure that corresponds to the remaining or unexpired portion of the policy. The actual exposure used depends on the analysis being performed. When policy data is pre-summarized at the quarterly or monthly level, exposures are approximated by assuming each policy is written at the mid-point of the period (e.g., the "15th of the month" rule for monthly data). Finally, when using inflation-sensitive exposure bases, it may be necessary to project future exposure levels, and this will be discussed further in subsequent chapters.

KEY CONCEPTS IN CHAPTER 4

1. Definition of an exposure
2. Criteria of a good exposure base
    a. Proportional to expected loss
    b. Practical
    c. Considers historical precedence
3. Exposure bases for large commercial risks
4. Exposure aggregation
    a. Calendar year v. policy year
    b. Written, earned, unearned, in-force
5. Calculation for blocks of exposure (“15^{th} of the month” rule)
6. Exposure trend

CHAPTER 5: PREMIUM

The goal of ratemaking is to determine rates that will produce premium for a future policy period equivalent to the sum of the expected costs (i.e., losses and expenses) and the target underwriting profit. In other words, the goal is to balance the fundamental insurance equation:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

This chapter covers the premium component of the fundamental insurance equation. Premium is the price the insured pays for the insurance product. The ratemaking process requires estimation of premium for a future policy period. This process generally begins with historical premium and applies a series of adjustments. The first adjustment is to bring the historical premium to the rate level currently in effect. Without this adjustment, any rate changes during or after the historical period will not be fully reflected in the historical premium and will distort the projection. A second adjustment is to develop premium to ultimate levels if the premium is still changing. A third adjustment is to project the historical premium to the premium level expected in the future. This accounts for changes in the mix of business that have occurred or are expected to occur after the historical experience period. These concepts are explained in detail in this chapter; in addition, Appendices A, C, and D provide realistic numeric examples from various lines of business of the premium adjustments made in ratemaking analysis.

As will be discussed in depth in the chapter on overall rate level indication, there are two general approaches to evaluate whether the rates underlying the company's premium adequately cover expected losses, expenses, and target underwriting profit: the pure premium approach and the loss ratio approach. Only the loss ratio approach requires the actuary to estimate the premium to be collected during the future time period; therefore, if the actuary plans to utilize the pure premium approach, the adjustments included within this chapter are not required.[10]

This chapter covers in detail:

- The different ways to define and aggregate premium
- Standard techniques used to adjust historical premium to current rate level
- Standard techniques used to develop historical premium to ultimate level
- Standard techniques used to measure and apply premium trend

PREMIUM AGGREGATION

Methods of Aggregation for Annual Terms

The methods for aggregating and defining premium are the same as discussed in the last chapter on exposures. For completeness, the following simple example is included to demonstrate these concepts:

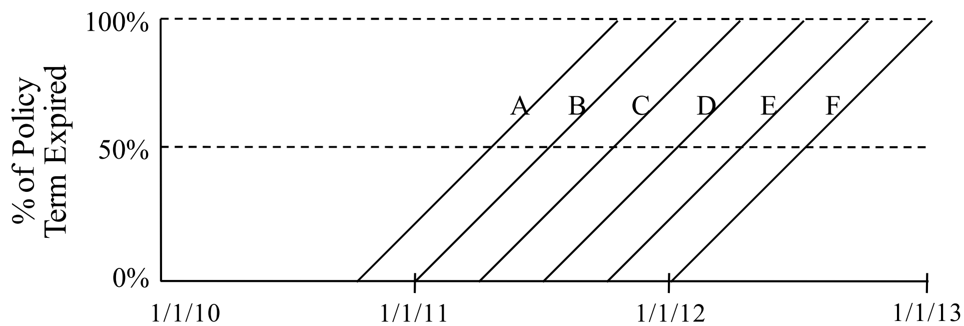
[10] However, the actuary may wish to calculate the expected premium underlying current rates to compare it to the needed premium output from the pure premium approach. The reasons for this should be clearer in the chapter discussing implementation issues.

5.1 Policies

Policy	Effective Date	Expiration Date	Premium
A	10/01/10	09/30/11	$200
B	01/01/11	12/31/11	$250
C	04/01/11	03/31/12	$300
D	07/01/11	06/30/12	$400
E	10/01/11	09/30/12	$350
F	01/01/12	12/31/12	$225

As with exposures, it is helpful to demonstrate the concepts using a graphical representation where time is reflected on the x-axis and the percentage of the policy that has expired is on the y-axis; Figure 5.2 shows the pictorial representation of each policy's duration from inception to expiration:

5.2 Example Policies

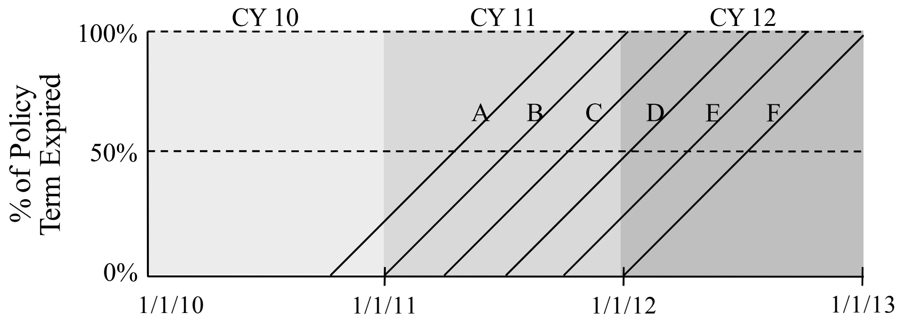


As described in Chapter 3, four common methods of data aggregation are calendar year, accident year, policy year, and report year. In regards to premium aggregation, there are only two methods applicable: calendar year and policy year. Report year is a loss concept only.

Calendar Year Aggregation and Accident Year Aggregation consider all premium transactions that occur during the twelve-month calendar year without regard to the date of policy issuance; calendar year and accident year premium are typically equivalent and the text will use the term calendar year premium.[11] At the end of the calendar year, the calendar year premium is fixed. Since calendar year considers any transactions that occurred on or after the first day of the year, but on or before the last day of the year, calendar years are represented graphically as squares, as shown in Figure 5.3.

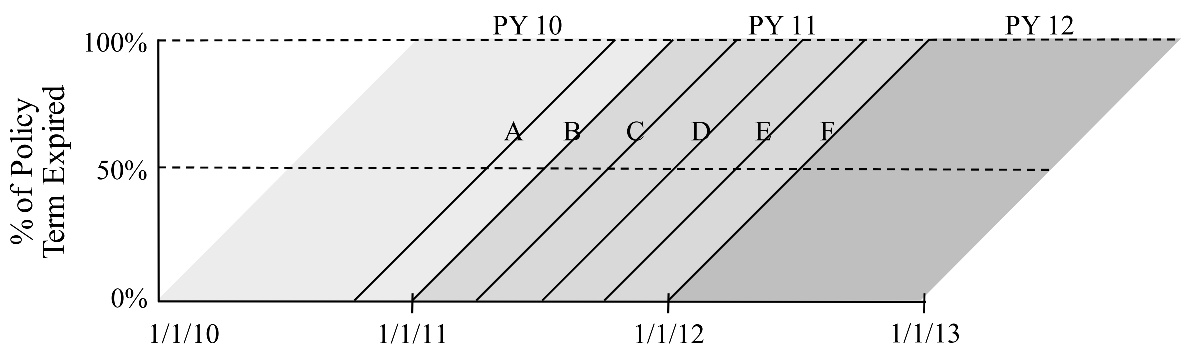
[11] There are some limited cases when the calendar and accident year premium will not be equivalent. This will be discussed in the Premium Development section later in this chapter.

5.3 Calendar Year Aggregation



Policy year aggregation, which is sometimes referred to as underwriting year, considers all premium transactions on policies with effective dates during the year. Thus, this is represented graphically using a parallelogram starting with a policy written on the first day of the policy year and ending with a policy written on the last day of the policy year:

5.4 Policy Year Aggregation

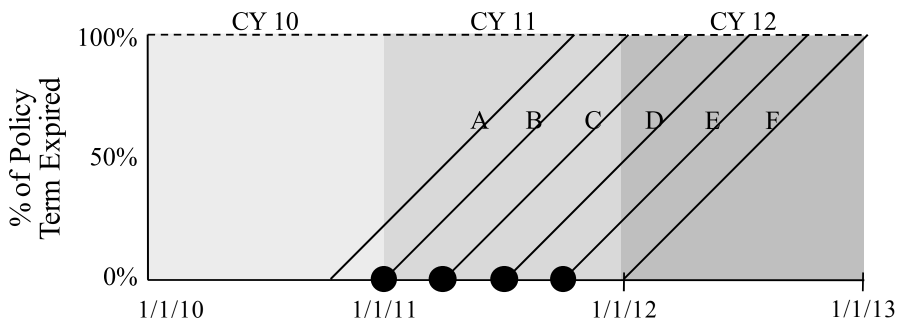


As can be seen clearly in the graph, the policy year assuming annual policies takes 24 months to complete. In contrast, the calendar year premium is fixed after 12 months. For that reason, most ratemaking analysis focuses on premium data aggregated by calendar year (and losses are generally aggregated on an accident year basis).

In addition to aggregating by calendar or policy year, premium can be defined in four basic ways: written premium, earned premium, unearned premium, and in-force premium.

Written premium is the total amount of premium for all policies written during the specified period. In other words, the key in determining written premium is the inception date of the policy (i.e., the base of each line in the figure). For example, the written premium for Calendar Year 2011 is the sum of the premium for all policies that had an effective date in 2011. As can be seen in Figure 5.5, Policies B, C, D, and E all have effective dates in 2011 (shown as large circles on the horizontal axis), and their entire premium contributes to Calendar Year 2011 written premium. In contrast, Policies A and F have effective dates in years 2010 and 2012, respectively, and do not contribute to Calendar Year 2011 written premium.

5.5 Calendar Year Written Premium



The following table summarizes the distribution of written premium to each calendar year:

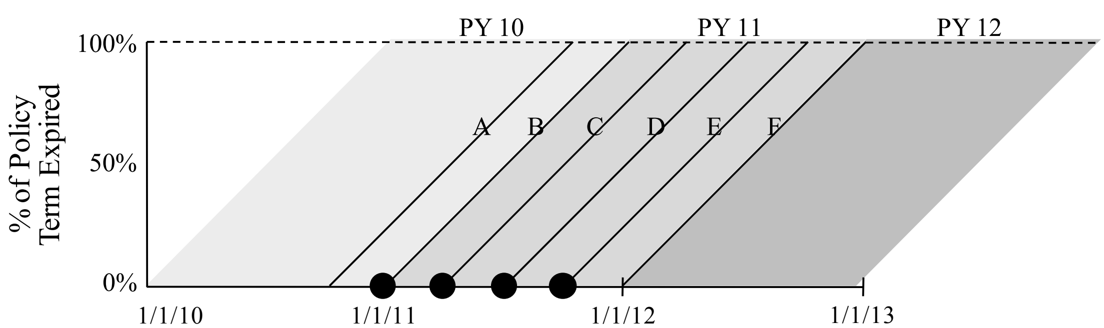
5.6 Calendar Year Written Premium a/o 12/31/12

Policy	Effective Date	Expiration Date	Premium	Written Premium CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	$ 200.00	$ 200.00	$ -	$ -
B	01/01/11	12/31/11	$ 250.00	$ -	$ 250.00	$ -
C	04/01/11	03/31/12	$ 300.00	$ -	$ 300.00	$ -
D	07/01/11	06/30/12	$ 400.00	$ -	$ 400.00	$ -
E	10/01/11	09/30/12	$ 350.00	$ -	$ 350.00	$ -
F	01/01/12	12/31/12	$ 225.00	$ -	$ -	$ 225.00
Total			$1,725.00	$ 200.00	$1,300.00	$ 225.00

Note each policy only contributes written premium to a single calendar year in our example. If a policy has a mid-term adjustment that affects the premium, the policy will contribute written premium to two different calendar years if the date of the mid-term adjustment is in a different calendar year than the original effective date. For example, if Policy D is cancelled on March 31, 2012 (i.e., after 75% of the policy has expired), then Policy D will contribute $400 to Calendar Year 2011 written premium and -$100 (= 25% x -$400) to Calendar Year 2012 written premium.

The following figure shows written premium in the context of policy year aggregation.

5.7 Policy Year Written Premium



The following table summarizes the distribution of written premium to each policy year:

5.8 Policy Year Written Premium a/o 12/31/12

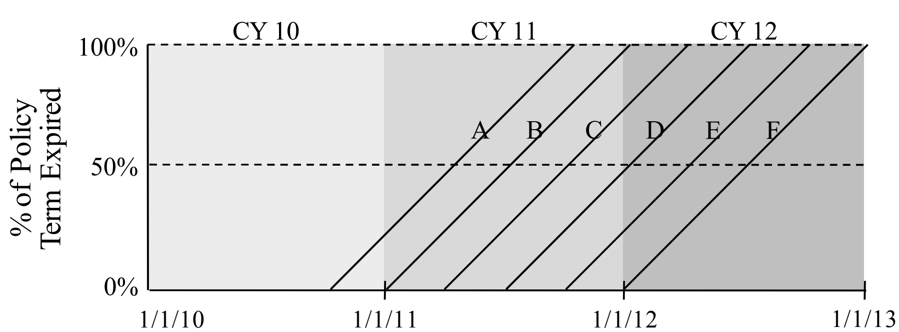
Policy	Effective Date	Expiration Date	Premium	Written Premium PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	$ 200.00	$ 200.00	$ -	$ -
B	01/01/11	12/31/11	$ 250.00	$ -	$ 250.00	$ -
C	04/01/11	03/31/12	$ 300.00	$ -	$ 300.00	$ -
D	07/01/11	06/30/12	$ 400.00	$ -	$ 400.00	$ -
E	10/01/11	09/30/12	$ 350.00	$ -	$ 350.00	$ -
F	01/01/12	12/31/12	$ 225.00	$ -	$ -	$ 225.00
Total			$1,725.00	$ 200.00	$1,300.00	$ 225.00

Since policy year written premium is aggregated by policy effective dates, the original written premium and the written premium due to the cancellation are all booked in the same policy year. This contrasts with calendar year in which written premium and cancellation premium can apply to two different calendar years depending on when the cancellation occurs.

Earned premium is the amount of the premium the insurance company has already earned in relation to how much of the policy period has already expired. Stated another way, the earned premium is the premium for the coverage that has already been provided. This is important because earned premium represents the portion of the total premium that the insurance company is entitled to retain should the policy be canceled.[12]

To better understand the difference between calendar and policy year earned premium, first reconsider the calendar year picture:

5.9 Calendar Year Earned Premium



For Policy C in our example, 75% of the policy is earned in 2011 and 25% of the policy is earned in 2012; thus, Policy C contributes $225 (= 75% x $300) of earned premium to Calendar Year 2011 and $75

[12] Policies may contain a short rate table that entitles the company to retain an amount of premium that is greater than the pro rata amount of premium for the time expired on the coverage period. This is intended to reflect that some of the premium is designated to cover expenses incurred at the onset of the policy or to reflect that the insured risk may have much greater exposure to loss in part of the year (e.g., boat owners policies in many climates have the greatest exposure to loss in the summer months).

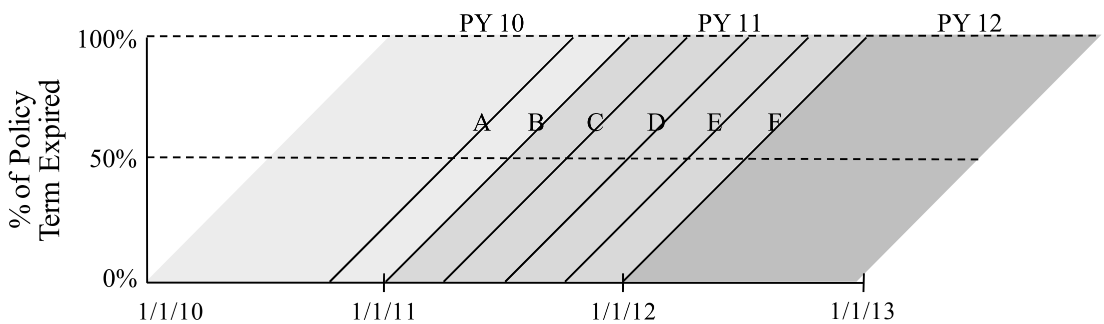
of earned premium to Calendar Year 2012. The following chart summarizes the distribution of earned premium to each calendar year:

5.10 Calendar Year Earned Premium a/o 12/31/12

Policy	Effective Date	Expiration Date	Premium	Earned Premium CY 2010	CY 2011	CY 2012
A	10/01/10	09/30/11	$ 200.00	$ 50.00	$ 150.00	$ -
B	01/01/11	12/31/11	$ 250.00	$ -	$ 250.00	$ -
C	04/01/11	03/31/12	$ 300.00	$ -	$ 225.00	$ 75.00
D	07/01/11	06/30/12	$ 400.00	$ -	$ 200.00	$ 200.00
E	10/01/11	09/30/12	$ 350.00	$ -	$ 87.50	$ 262.50
F	01/01/12	12/31/12	$ 225.00	$ -	$ -	$ 225.00
Total			$1,725.00	$ 50.00	$ 912.50	$ 762.50

In contrast, the following picture relates to policy year earned premium.

5.11 Policy Year Earned Premium



As can be seen in the picture above and the table below, all earned premium is assigned to the year the policy was written and increases in relation to time until the policy year is complete. By the time the policy year is complete (24 months after inception), the policy year earned and written premium are equivalent. Unlike calendar year earned premium, premium for one policy cannot be earned in two different policy years. Also, the policy year premium is not fixed at the completion of the policy year. Premium for lines of business subject to premium audits will continue to develop after the end of the policy year period.

5.12 Policy Year Earned Premium a/o 12/31/12

Policy	Effective Date	Expiration Date	Premium	Earned Premium PY 2010	PY 2011	PY 2012
A	10/01/10	09/30/11	$ 200.00	$ 200.00	$ -	$ -
B	01/01/11	12/31/11	$ 250.00	$ -	$ 250.00	$ -
C	04/01/11	03/31/12	$ 300.00	$ -	$ 300.00	$ -
D	07/01/11	06/30/12	$ 400.00	$ -	$ 400.00	$ -
E	10/01/11	09/30/12	$ 350.00	$ -	$ 350.00	$ -
F	01/01/12	12/31/12	$ 225.00	$ -	$ -	$ 225.00
Total			$1,725.00	$ 200.00	$1,300.00	$ 225.00

Unearned premium is simply the portion of the premium that has not yet been earned at a given point in time. The importance of this figure is that it is the amount of the total premium that the company has not yet earned and the insured is entitled to get back in the event of a cancellation (subject to short rate table adjustments). At any time during the life of the policy, the written premium is simply the sum of the earned premium and unearned premium as shown in this formula:

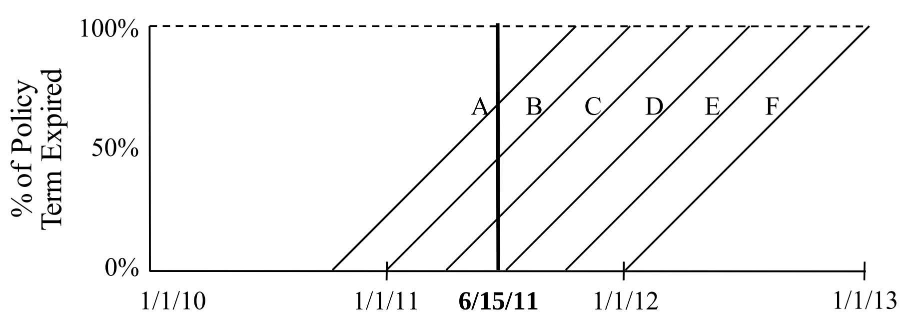
$$\text{Written Premium} = \text{Earned Premium} + \text{Unearned Premium}.$$

For aggregating premium across groups of policies, the formula depends on the method of data aggregation. Policy year aggregation would follow the formula immediately above. Calendar year aggregation, however, would need to consider the unearned premium at the beginning of the calendar year and at the end of the calendar year as follows:

CY Unearned Premium = CY Written Premium – CY Earned Premium + Unearned Premium as of the beginning of the CY.

In-force premium is the total amount of full-term premium for all policies in effect at a given date. More specifically, the in-force premium as of June 15, 2011, is the sum of full-term premium for all policies that have an inception date on or before June 15, 2011, and an expiration date on or after June 15, 2011. A vertical line drawn at the valuation date will intersect the policies that are in-force on that date. As can be seen in Figure 5.13, Policies A, B, and C are all in effect on June 15, 2011, and each contributes to the total in-force premium as of that date.

5.13 In-Force Premium



The following chart shows the in-force premium for a few example dates:

5.14 In-force Premium by Date

Policy	Effective Date	Expiration Date	Premium	In-Force Premium as of As of 1/1/11	As of 6/15/11	As of 1/1/12
A	10/01/10	09/30/11	$ 200.00	$ 200.00	$ 200.00	$ -
B	01/01/11	12/31/11	$ 250.00	$ 250.00	$ 250.00	$ -
C	04/01/11	03/31/12	$ 300.00	$ -	$ 300.00	$ 300.00
D	07/01/11	06/30/12	$ 400.00	$ -	$ -	$ 400.00
E	10/01/11	09/30/12	$ 350.00	$ -	$ -	$ 350.00
F	01/01/12	12/31/12	$ 225.00	$ -	$ -	$ 225.00
Total			$1,725.00	$ 450.00	$ 750.00	$1,275.00

The calculation of in-force premium is slightly more complicated in the case of a mid-term adjustment. Assume Policy D (which is in-force from July 1, 2011 to June 30, 2012) is changed on January 1, 2012, and the applicable full-term premium increases from $400 to $800. This policyholder will ultimately pay $600 (=$400 x 0.5 + $800 x 0.5). The in-force premium is the full-term premium for the policy that is in-force at that point in time. So, the in-force premium is $400 for an in-force date between July 1, 2011, and December 31, 2011, and $800 for an in-force date between January 1, 2012, and June 30, 2012.

As in-force premium is the best estimate of the company's mix of business as of a given date, the most recent in-force premium is often used to measure the impact of a rate change on an existing portfolio of customers.

Policies Other Than Annual

The preceding example illustrated premium aggregation techniques assuming all policies are annual. If the policy terms are not annual, the aggregation concepts are applied the same way. Since the techniques associated with aggregating calendar year written and earned exposures on semi-annual policies were demonstrated in Chapter 4, they will not be repeated here with respect to premium.

Actuaries should interpret in-force premium carefully when considering (or comparing) portfolios that write policies with different terms. For example, if two insurers write the same volume of written premium, but one insurer writes annual term policies and the other writes semi-annual term policies, the in-force premium of the insurer writing semi-annual term policies will be half that of the other carrier. Adjustments can be made to make the companies' in-force numbers more comparable, but this detail is beyond the scope of this text.

Calculation of Blocks of Policies

In reality, companies write many more than six policies; consequently, actuaries often have to perform these aggregation techniques on many policies at once. In such a case, it is customary for the practitioner to treat all policies as if they were written at the mid-point of the period (such as the 15^{th} of the month for monthly data); this practice is often referred to as the "15^{th} of the month" rule. This is a good approximation as long as policies are written uniformly during each time period. If this approach is applied to longer periods (e.g., quarters or years), the assumption of uniform writings is less likely to be reasonable. This rule was discussed in detail in Chapter 4.

ADJUSTMENTS TO PREMIUM

In order for historical premium to be useful in projecting future premium, it must first be brought to current rate level. The policies underlying the experience period may have been written using rates that are no longer in effect. Adjustments need to be made to the historical premium for rate increases (decreases) that occurred during or after the historical experience period or the projected premium will be understated (overstated). This is referred to as adjusting the premium "to current rate level" or putting the premium "on-level." Two current rate level methods, extension of exposures and the parallelogram method, are described in detail in this section.

In addition to a current rate level adjustment, historical premium must be developed to ultimate. This is especially relevant in the case of analysis performed on incomplete policy years or premium that has yet to undergo audit. Historical premium should also be adjusted for actual or expected distributional changes. This is referred to as premium trend. One-step and two-step trending are discussed in detail in this section.

Current Rate Level

To illustrate the need for a current rate level adjustment, consider the simple scenario in which all policies were written at a rate of $200 during the historical period. After the historical period, there was a 5% rate increase so the current rate in effect is $210. Assume the "true" indicated rate for the future ratemaking time period is $220. If the practitioner fails to consider the 5% increase already implemented and compares the historical rate (i.e., $200) to the indicated rate (i.e., $220), the practitioner will conclude that rates need to be increased by 10%. Implementing this indicated rate change will result in a new rate of $231 (= $210 x 1.10), which is excessive. If instead, the practitioner restates the historical premium to the present rate level of $210 and compares that to the indicated rate, the practitioner will correctly deduce that rates only need to be increased 4.8% (= $220 / 210 - 1.00).

This section discusses two methods for adjusting premium to the current rate level: extension of exposures and the parallelogram method.

Simple Example

Before describing the two methods for adjusting premium to current rate level, the details underlying a simple rate change example will be summarized and later used to illustrate the mechanics of each method.

In this simple example, assume that all policies have annual terms and premium is calculated according to the following rating algorithm:

$$\text{Premium} = \text{Exposure} \times \text{Rate per Exposure} \times \text{Class Factor} + \text{Policy Fee}.$$

The class factor has three values, or levels (X, Y, and Z), each with a distinct rate differential.

The following three rate changes occurred during or after the historical experience period.

- July 1, 2010: the base rate was increased and this resulted in an overall average rate level increase of 5%.[13]
- January 1, 2011: the base rate and policy fee were adjusted resulting in an overall average rate level increase of 10%.
- April 1, 2012: the policy fee and class Y and Z rate relativities were changed resulting in an overall average rate level decrease of -1%.

The details of each rate level are as follows:

[13] The reader may be confused by the overall average rate changes provided in this example [e.g., how a 5.6% (=950/900-1.00) change in rate per exposure results in an overall average rate change of 5.0%]. The overall average rate change considers the average change in the total premium per policy, which is a function of the rate per exposure, the number of exposures per policy, the applicable class factors, and the policy fee. These detailed inputs have not been provided; the overall average rate change should be taken as a given for the purpose of illustrating premium at current rate level techniques.

5.15 Rate Change History

Rate Level Group	Effective Date	Overall Average Rate Change	Rate Per Exposure	Class Factor X	Class Factor Y	Class Factor Z	Policy Fee
1	Initial	--	$ 900	1.00	0.60	1.10	$ 1,000
2	07/01/10	5.0%	$ 950	1.00	0.60	1.10	$ 1,000
3	01/01/11	10.0%	$ 1,045	1.00	0.60	1.10	$ 1,100
4	04/01/12	-1.0%	$ 1,045	1.00	0.70	1.05	$ 1,090

Extension of Exposures

The extension of exposures method involves rerating every policy to restate the historical premium to the amount that would be charged under the current rates.

Extension of exposures has the advantage of being the most accurate current rate level method, assuming the actuary has access to the detailed data required. In the past, extension of exposures was practically impossible due to the significant number of calculations required to rerate each policy. Given the tremendous increase in computing power, the only remaining hurdle is associated with gathering the required data. To adjust premium to the current rate level using the extension of exposures technique, the practitioner needs to know the applicable rating characteristics for every policy in the historical period. Often companies do not have that information readily available.

Returning to the example, assume the actuary wishes to adjust the historical premium for Policy Year 2011 to the current rate level. Assume one such policy was effective on March 1, 2011 and had 10 class Y exposures. The actual premium charged for the policy was based on the rates effective on January 1, 2011, and was $7,370 (= 10 x $1,045 x 0.60 + $1,100). To put the premium on-level, substitute the current base rate, class factor, and policy fee in the calculations; this results in an on-level premium of $8,405 (= 10 x $1,045 x 0.70 + $1,090). This same calculation is performed for every policy written in 2011 and then aggregated across all policies.

If a group of policies has the exact same rating characteristics, they can be grouped for the purposes of the extension of exposures technique. This type of grouping is—practically speaking—only relevant in lines with relatively simple rating algorithms and very few rating variables.

In some commercial lines products, underwriters can apply subjective debits and credits to manual premium. This complicates the use of the extension of exposures technique since it may be difficult to determine what debits and credits would be applied under today's schedule rating guidelines. The actuary may consider measuring how credit and debit practices have changed by reviewing distributions of debits and credits over recent years.

Parallelogram Method

The parallelogram method, which is sometimes called the geometric method, is undertaken on a group of policies and is less accurate than extension of exposures. The method assumes that premium is written evenly throughout the time period, an assumption that should be evaluated with each analysis. The parallelogram method involves adjusting the aggregated historical premium by an average factor to put the premium on-level. Application of the method varies by policy term, method of aggregation (calendar year versus policy year), and whether the rate change affects policies midterm or only policies with effective dates occurring after the change. Examples of each are provided.

Standard Calculations

The objective of the parallelogram method is to replace the average rate level for a given historical year with the current rate level. The major steps for the parallelogram method are as follows:

1. Determine the timing and amount of the rate changes during and after the experience period and group the policies into rate level groups according to the timing of each rate change.
2. Calculate the portion of the year's earned premium corresponding to each rate level group.
3. Calculate the cumulative rate level index for each rate level group.
4. Calculate the weighted average cumulative rate level index for each year.
5. Calculate the on-level factor as the ratio of the current cumulative rate level index and the average cumulative rate level index for the appropriate year.
6. Apply the on-level factor to the earned premium for the appropriate year.

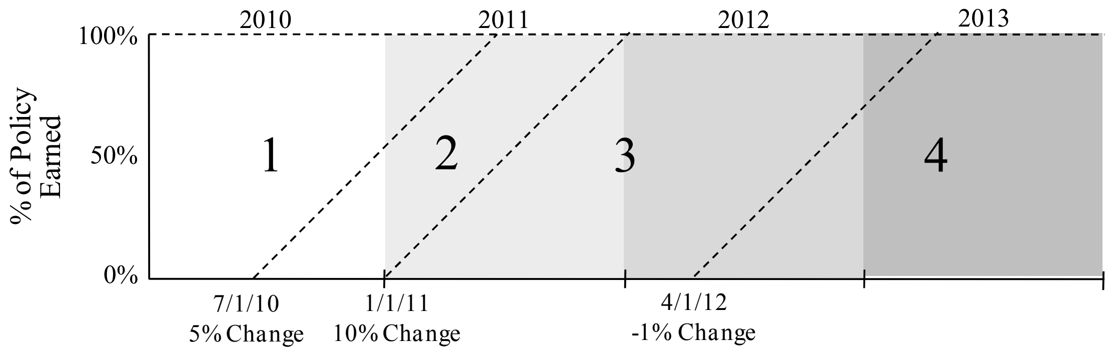
For the parallelogram method, the exact rates are not required as the calculations only use the overall average percent rate changes. Returning to our example, Table 5.16 contains the relevant information for Step 1: the effective date and overall rate change amount for four different rate level groups. In this example, the policies are annual and the rate changes apply to policies effective on or after the date (i.e., do not apply to policies in mid-term).

5.16 Step 1

Rate Level Group	Effective Date	Overall Average Rate Change
1	Initial	--
2	07/01/10	5.0%
3	01/01/11	10.0%
4	04/01/12	-1.0%

For Step 2, it is helpful to view these rate changes in graphical format. Assume the actuary is trying to adjust each calendar year's earned premium to current rate level. As noted earlier in the chapter, calendar years are represented by squares. The rate changes in this example only impact policies written on or after the effective date; therefore, each rate change is represented by a diagonal line. The slope of the diagonal line depends on the term of the policy; the example shown assumes annual policies. The numbers 1, 2, 3, and 4 represent the rate level group in effect.

5.17 Rate Changes assuming CY EP with Annual Policies



Once the picture is drawn, the next step is to calculate the portion of each calendar year's earned premium (the area within the square) that corresponds to each unique rate level group. Considering Calendar Year 2011, there are three areas: the area representing earned premium on policies written after January 1, 2010 and prior to the July 1, 2010 rate change (area of rate level group 1 in Calendar Year 2011), the area representing earned premium on policies written on or after July 1, 2010 and before January 1, 2011 (area of rate level group 2 in Calendar Year 2011), and the area representing earned premium on policies written on or after January 1, 2011 and before January 1, 2012 (area of rate level group 3 in Calendar Year 2011). Simple geometry,[14] as well as the assumption that the distribution of policies written is uniform over time, is used to calculate the portion of the square represented by each rate level area. For example, area 1 in Calendar Year 2011 is a triangle with area equal to ½ x base x height. The base and height are both six months (January 1, 2011 to June 30, 2011) so the area (in months) is 18 (= ½ x 6 x 6). This area's portion of the entire calendar year square is 0.125 (=18 / (12 x 12)). The math is simplified if restating the base and height as portions of a year (0.125 = ½ x ½ x ½). Also, some areas (e.g., area 2 in Calendar Year 2011) are easier to calculate as one minus the sum of the remaining areas. The areas of the three rate levels in Calendar Year 2011 are summarized below:

- Area 1 in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 2 in CY 2011: 0.375 = 1.00 - (0.125 + 0.500)
- Area 3 in CY 2011: 0.500 = 0.50 x 1.00 x 1.00

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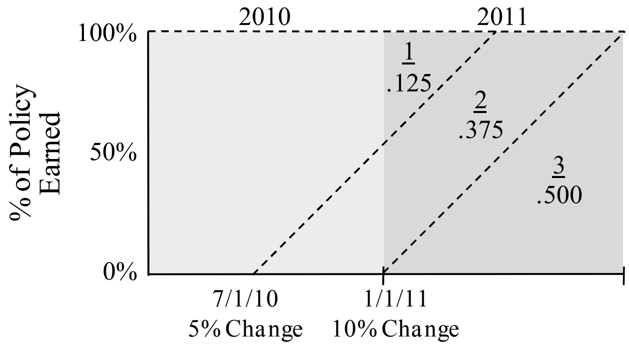
[14] The following geometric formulae may be used in the parallelogram method:
Area of a triangle: ½ x base x height
Area of a parallelogram: base x height
Area of a trapezoid: ½ x ($base_1$ + $base_2$) x height

5.18 Areas in 2011 assuming CY EP with Annual Policies)



Step 3 of the procedure involves determining the cumulative rate level index for each distinct rate level group. The first rate level group is assigned the rate level of 1.00. The cumulative rate level index of each subsequent group is the prior group's cumulative rate level index multiplied by the rate level for that group. For example, the cumulative rate level index for the second rate level group is 1.05 (= 1.00 x 1.05). The third rate level group's cumulative rate level index is 1.155 (= 1.05 x 1.10). The following table shows the cumulative rate level indices for each group in our example.

5.19 Step 3

Rate Level Group	(1) Effective Date	(2) Overall Average Rate Change	(3) Rate Level Index	(4) Cumulative Rate Level Index
1	Initial	--	1.00	1.0000
2	7/1/10	5.0%	1.05	1.0500
3	1/1/11	10.0%	1.10	1.1550
4	4/1/12	-1.0%	0.99	1.1435

(4)= (Previous Row4) x (3)

Step 4, the calculation of the average rate level index for each year, is the weighted average of the cumulative rate level indices in Step 3, using the areas calculated in Step 2 as weights. For example, the average rate level index for Calendar Year 2011 is:

$$1.0963 = 1.000 \text{ x } 0.125 + 1.0500 \text{ x } 0.375 + 1.1550 \text{ x } 0.500.$$

Step 5 is the calculation of the on-level factor, defined as follows:

$$\text{On - Level Factor for Historical Period} = \frac{\text{Current Cumulative Rate Level Index}}{\text{Average Rate Level Index for Historical Period}}.$$

The numerator considers the most recent cumulative rate level index (i.e., not just the most recent within the historical experience period) from Step 3. The denominator is the result of Step 4.

For the simple example, the following is the on-level factor for Calendar Year 2011 earned premium, assuming annual policies:

$$1.0431 = \frac{1.1435}{1.0963}.$$

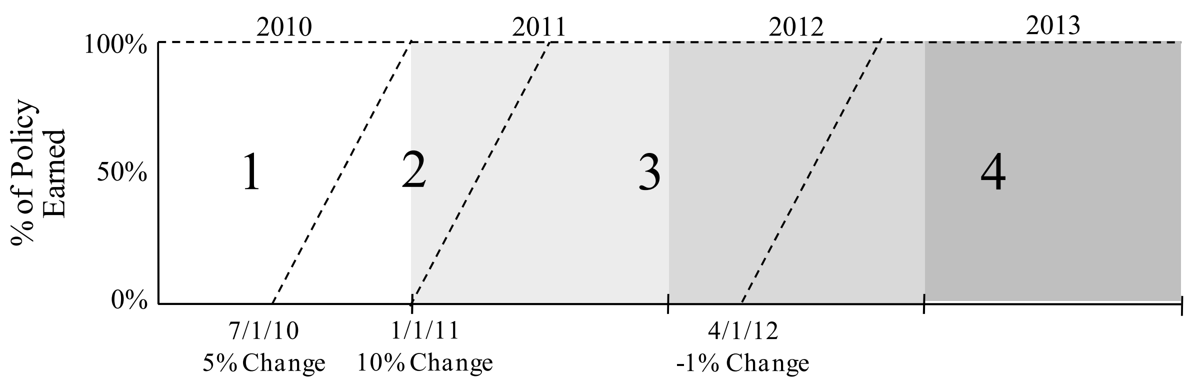
In Step 6, this on-level factor is applied to the Calendar Year 2011 earned premium in order to bring it to current rate level.

$$\text{CY11EP at current rate level} = \text{CY11EP} \times 1.0431.$$

Standard Calendar Year Calculations for Six-Month Policies

If the policy term in the example is six months rather than annual (as is common in personal automobile coverage), then the pictorial representation of the rate level groups is as follows:

5.20 Rate Changes assuming CY EP with 6-Month Policies



In this case, the areas (Step 2) for Calendar Year 2011 are as follows:

- Area 1 in CY 2011: N/A
- Area 2 in CY 2011: 0.250 = 0.50 x 0.50 x 1.00
- Area 3 in CY 2011: 0.750 = 1.00 - 0.250

The cumulative rate level indices (Step 3) are the same as those used for the annual policies.

The following is the average rate level index (Step 4) for Calendar Year 2011 assuming semi-annual policies:

$$1.1288 = 1.0500 \times 0.250 + 1.1550 \times 0.750$$

The on-level factor (Step 5) to adjust Calendar Year 2011 earned premium to current rate level assuming semi-annual policies is:

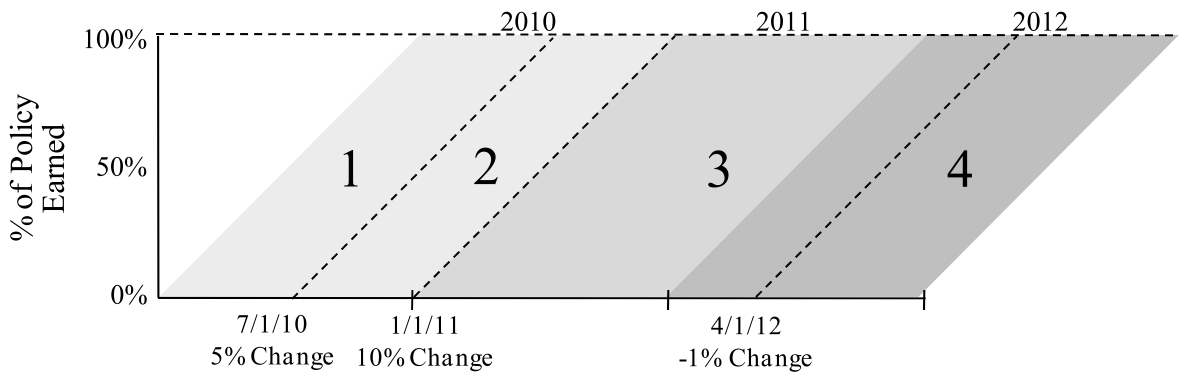
$$1.0130 = \frac{1.1435}{1.1288}.$$

The on-level adjustment for semi-annual policies is smaller than for annual policies because the semi-annual rate changes earn more quickly.

Standard Policy Year Calculations for Annual Policies

If the actuary is performing a policy year analysis, parallelograms are used instead of squares. The lines representing the rate changes are still diagonal. The following picture shows the policy year adjustment assuming the same rate changes and an annual policy term:

5.21 Rate Changes assuming PY EP with Annual Policies



As Policy Year 2011 has one rate level applied to the whole year, it is more helpful to show an example for Policy Year 2012, which has two rate level groups. The area of each parallelogram is base x height. For example, area 3 in Policy Year 2012 has a base of 3 months (or 0.25 of a year) and the height is 12 months (or 1.00 year). The relevant areas (Step 2) for Policy Year 2012 are as follows:

- Area 3 in PY 2012: 0.25 = 0.25 x 1.00
- Area 4 in PY 2012: 0.75 = 0.75 x 1.00

The cumulative rate level indices (Step 3) are the same as those used in the calendar year example.

The average rate level index (Step 4) for Policy Year 2012 is:

$$1.1464 = 1.1550 \times 0.25 + 1.1435 \times 0.75.$$

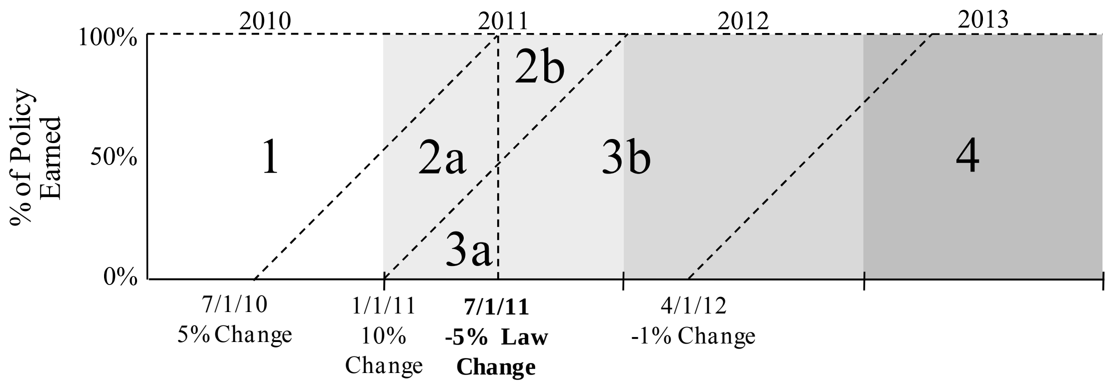
The following is the on-level factor (Step 5) to adjust Policy Year 2012 earned premium to current rate level:

$$0.9975 = \frac{1.1435}{1.1464}.$$

Rate Changes Mandated by Law

The previous example considers standard rate changes whereby the effective date of the rate change applies to policies effective on or after that date. In some cases, rate changes are in response to law changes that may mandate the rate change be applied to all policies on or after a specific date, even those that are currently in-force. In that special case, the rate level change is represented as a vertical line rather than a diagonal line. For illustrative purposes, assume a law change mandates a rate decrease of 5% on July 1, 2011, that is applicable to all policies, including policies currently in-force. Assuming annual policies and the standard rate changes laid out earlier, the pictorial representation is as follows:

5.22 Rate and Law Change assuming CY EP with Annual Policies



Notice that the vertical line splits rate level groups 2 and 3 into two pieces each. Applying standard geometry, the areas for this example are as follows:

- Area 1 in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 2a in CY 2011: 0.250 = 0.50 - 0.125 - 0.125
- Area 2b in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 3a in CY 2011: 0.125 = 0.50 x 0.50 x 0.50
- Area 3b in CY 2011: 0.375 = 0.50 - 0.125

The rate level indices are also affected by the inclusion of the -5% law change which impacts the rate level indices associated with the portion of areas 2b, 3b, and 4. The cumulative rate level indices associated with each group are as follows:

5.23 Step 3 with Benefit Change

Rate Level Group	Cumulative Rate Level Index
1	1.0000
2a	1.0500
2b	0.9975
3a	1.1550
3b	1.0973
4	1.0863

The on-level factor is still the current cumulative rate level index divided by the average cumulative rate level index of the historical period. For the example, the calculation is as follows:

$$1.0171 = \frac{1.0863}{1.0000 \times 0.125 + 1.0500 \times 0.250 + 0.9975 \times 0.125 + 1.1550 \times 0.125 + 1.0973 \times 0.375}.$$

The calculations associated with law changes in the case of semi-annual policies or policy year earned premium are the same, just with different geometric shapes.

Comments on the Parallelogram Method

There are two problems associated with the parallelogram method. The first issue is that the method assumes policies are written evenly throughout the year. While that assumption may be reasonable for some lines of business, it can be inappropriate for other lines. For example, boat owners policies are generally purchased in the first half of the year prior to the start of boat season. Thus, the distribution of inception dates for pleasure boat owners policies is generally not uniform throughout the year. The parallelogram method can be performed using more refined periods of time than a year—for example, quarters or months. This alleviates the effect of uneven earnings to some degree. Another technique to adjust for this is to calculate the actual distribution of writings and use these to determine more accurate weightings to calculate the historical average rate level. To do this, the policies are aggregated based on which rate level was applicable rather than based on a standard time period (i.e., a month, year, or quarter). The premium for each rate level group is adjusted together based on subsequent rate changes.

The second issue with the parallelogram method is that it is generally applied at the aggregate level using a series of overall average changes. So, while the overall premium may be adjusted to an approximated current rate level, the premium for certain classes will not be on-level if the implemented rate changes varied by class. Consequently, the adjusted premium will likely be unacceptable for any classification ratemaking analysis. This is a major shortcoming that has forced many companies to abandon this approach in favor of the extension of exposures approach. This is especially true for lines with complex rating structures that are changed regularly, like personal lines automobile and homeowners.

Premium Development

In some cases, the actuary may not know the ultimate amount of premium for the experience period at the time the analysis is being performed. When this occurs, the actuary must estimate how the premium will develop to ultimate. Common scenarios include when an actuary is using an incomplete year of data or when the line of business uses premium audits.

Actuaries try to balance stability and responsiveness when determining the data to be used for a ratemaking analysis. At times, the actuary may feel it is prudent to use a year that is not yet complete; this is more common for policy year analysis due to the long time it takes for the policy year to close. Assume a ratemaking analysis is performed on policy year data before all policies written in that year have expired (e.g., Policy Year 2011 as of December 31, 2011). While the actuary knows which policies have been written, the actuary does not know which policies may have changes or be cancelled during the policy term. Thus, the actuary must estimate how premium will develop to ultimate. Typically this is done by analyzing historical patterns of premium development to better understand the effect of cancelations and mid-term amendments on the policy year premium.

Another example of premium development occurs in lines that utilize premium audits. Typically, the insured will pay premium based on an estimate of the total exposure. Once the policy period is completed and the actual exposure is known, the final premium is calculated. For example, workers compensation premium depends on payroll and the final workers compensation premium is determined by payroll audits about three to six months after the policy expires. Actuaries study the pattern of premium development, which can depend on several factors including:

- The type of plan permitted by the jurisdiction or offered by the carrier
- The stability of the historical relationship between the original premium estimate and the final audited premium
- Internal company operations (auditing procedures, marketing strategy, accounting policy, etc.).

Calendar year data is final at the end of the calendar year, whereas accident year and policy year data may still be developing. Thus, premium development factors to adjust for premium audits are necessary to determine the ultimate premium when analyzing policy year or accident year data.

Consider the policy year example below.

- A workers compensation carrier writes one policy per month in 2011.
- Estimated premium for each policy is booked at policy inception for $500,000.
- Premium on every policy develops upward by 8% at the first audit, six months after the policy expires.

At December 31, 2012, the six policies written in the first half of 2011 have completed their audits, but the six policies written in the second half of the year have not. The Policy Year 2011 premium as of December 31, 2012, is:

$$\$6,240,000 = 6 \times \$500,000 \times 1.08 + 6 \times \$500,000.$$

At December 31, 2013, all twelve policies have completed their final audits so the final premium is:

$$\$6,480,000 = 12 \times \$500,000 \times 1.08.$$

From December 31, 2012, (24 months after the start of the policy year) to December 31, 2013, (36 months after the start of the policy year), the premium development factor is

$$1.0385 \text{ } (= \$6.48 \text{ million} / \$6.24 \text{ million}).$$

If this 24-36 month development pattern is relatively stable across other policy years, the actuary will feel confident adjusting future policy year premium at 24 months of development by this factor to bring the premium to its ultimate value.

Premium development does not typically apply to calendar year premium as calendar year implies premium is fixed. However, some actuaries may choose to adjust calendar year premium if audit patterns are changing and a calendar year analysis is being performed.

More information on workers compensation premium development can be found in Sholom Feldblum’s paper, “Workers’ Compensation Ratemaking” (Feldblum 1993).

Exposure Trend

Rate changes are not the only thing that can change the average premium level. In fact, the average premium level can change over time due to inflation in lines of business with exposure bases that are inflation-sensitive, like payroll (for workers compensation) or receipts (general liability). For lines of business using inflation-sensitive exposures bases, it is typical to project exposures (and thus premium) to future inflationary levels. The trends used for these projections can be estimated via internal insurance company data (e.g., workers compensation payroll data) or via industry or government indices (e.g., average wage index).

Premium Trend

In addition to inflationary pressure, the average premium level can change over time due to changes in the characteristics of the policies written. These changes are referred to as distributional changes, and the resulting change in average premium level is commonly referred to as premium trend.

The following are a few representative examples of circumstances that can cause changes in the average premium level:

- A rating characteristic can cause average premium to change. For example, homeowners premium varies based on the amount of insurance purchased. This variable is generally indexed such that it increases automatically with inflation; therefore, average premium increases as well.
- A company may decide to move all existing insureds to a higher deductible. Raising the deductible decreases the amount of coverage and, therefore, the premium charged. Assuming the company moves each insured to the higher deductible upon renewal and that the renewals are spread throughout the year, there will be a decrease in average premium over the entire transition period. The trend will not be expected to continue once the transition is complete.
- One company may purchase the entire portfolio of another company. If the new risks are somewhat different than the existing book of business, that can lead to a very abrupt one-time change in the average premium. For example, if a typical homeowners insurer acquires a book of business that includes predominantly high-valued homes, the acquisition will cause a very abrupt increase in the average premium due to the increase in average home values. After the books are consolidated, no additional shifts in the business are expected.

Since the goal of ratemaking is to determine adequate rates for the future, it is important to adjust the historical premium to the level expected during the future time period. In addition to adjusting the historical premium to the current rate level, the premium also must be adjusted to reflect any premium trend. To adjust for premium trend, the actuary needs to determine how to measure any changes that have occurred, decide whether observed distributional shifts were caused by a one-time event or a shift that is expected to continue in the future, and judgmentally incorporate any additional shifts that are reasonably expected to happen in the future.

The actuary may consider examining how premium distributions by individual rating variable have shifted over time. However, this may not always be practical or conclusive. Such distributional data may not be readily available, or the actuary may find that several variables have experienced small premium shifts and the compound effect is difficult to quantify. Consequently, the analysis usually focuses on measuring all premium shifts simultaneously.

Actuaries typically examine changes in historical average premium per exposure to determine an appropriate adjustment to account for premium trend. Actuaries do not use changes in total premium because a company that is growing (or shrinking) will have increasing (or decreasing) total premium even if the distribution of types of policies remains consistent. The average premium should be calculated on an exposure basis rather than a policy basis, and it is important to calculate the average premium using the exposure base that underlies the rate.

The actuary also must decide whether to use earned or written premium. Earned premium is used in most other parts of the ratemaking analysis and may seem like a more natural choice; however, written premium data reflects shifts in the distribution more quickly than earned premium does. In other words, written premium is a leading indicator of trends that will eventually emerge in earned premium and as such, the trends observed in written premium are appropriate to apply to historical earned premium. Assuming an adequate amount of data, the actuary will often use quarterly average written premium (as opposed to annual average written premium) to make the statistic as responsive as possible.

The following table shows data typically used to estimate premium trend due to distributional changes:

5.24 Change in Average WP

(1) Quarter	(2) Written Premium at Current Rate Level	(3) Written Exposures	(4) Average Written Premium at Current Rate Level	(5) Annual Change
1Q09	$ 323,189.17	453	$ 713.44	--
2Q09	$ 328,324.81	458	$ 716.87	--
3Q09	$ 333,502.30	463	$ 720.31	--
4Q09	$ 338,721.94	468	$ 723.76	--
1Q10	$ 343,666.70	472	$ 728.11	2.1%
2Q10	$ 348,696.47	477	$ 731.02	2.0%
3Q10	$ 353,027.03	481	$ 733.94	1.9%
4Q10	$ 358,098.58	485	$ 738.35	2.0%
1Q11	$ 361,754.88	488	$ 741.30	1.8%
2Q11	$ 367,654.15	493	$ 745.75	2.0%
3Q11	$ 372,305.01	497	$ 749.10	2.1%
4Q11	$ 377,253.00	501	$ 753.00	2.0%

(4) = (2) / (3)
(5) = (4) / (Prior Year4) - 1.0

The annual changes in average written premium are used to determine the amount the historical premium needs to be adjusted to account for premium trend. Note the premium used for this table has already been adjusted to the current rate level. If that is not done, the data will show an abrupt change in the average written premium corresponding to the effective date of the rate change. Allowing that change to influence the premium trend selection essentially adjusts for current rate level twice (once in the explicit current rate level adjustment and once in trend).

There are two methods for adjusting historical data for premium trend: one-step and two-step trending.

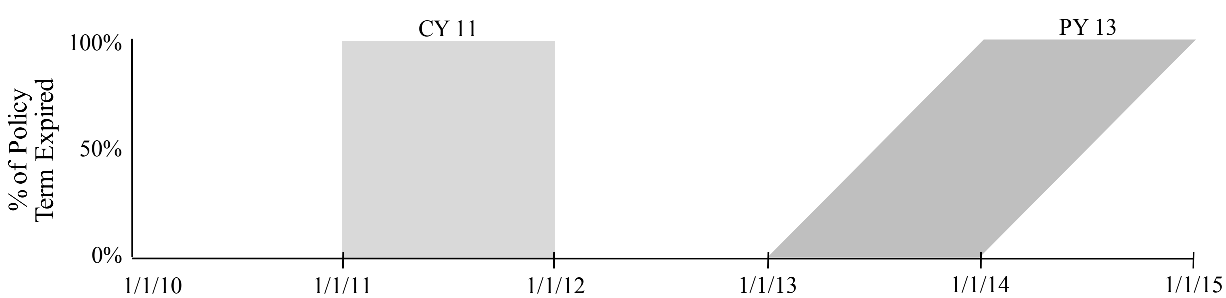
One-Step Trending

The basic one-step trending approach involves the selection of a premium trend based on the historical changes in average premium. Sometimes the actuary fits an exponential or linear trend to the data[15] to guide the selection; however, as the changes in average written premium are normally pretty consistent from one time period to the next, curve-fitting is usually not necessary. The selected trend factor is used to adjust the historical premium to the expected levels after consideration of distributional shifts.

Based on the data in Table 5.24, the actuary may make a trend selection of 2%. This is the amount the actuary expects the average premium to change annually. The actuary needs to determine the length of time the trend should be applied (i.e., the trend period). Assuming the ratemaking analysis uses written premium as the basis of the trend selection and earned premium for the overall rate level indications (which is standard), the trend period is typically measured as the length of time from the average written date of policies with premium earned during the historical period to the average written date for policies that will be in effect during the time the rates will be in effect.

Consider the case that the actuary uses Calendar Year 2011 earned premium for the analysis to estimate the rate need for annual policies that are to be written during the period of January 1, 2013 through December 31, 2013. Using concepts described earlier, this can be represented with the following figure:

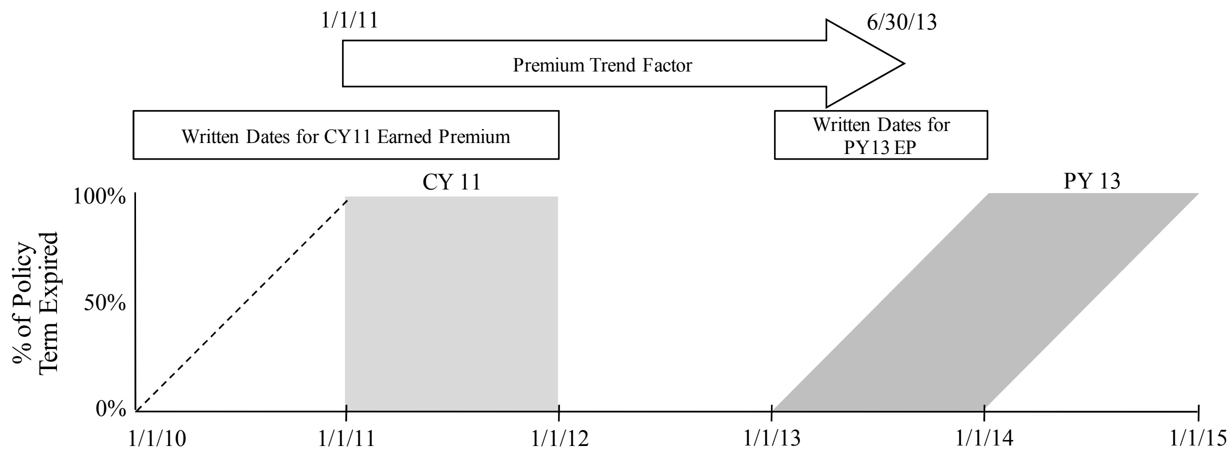
5.25 Historical and Projected Periods



The Calendar Year 2011 earned premium contains premium from policies that were written almost one year prior to the start of the calendar year (i.e., January 2, 2010) through to policies that were written on the very last day of Calendar Year 2011 (i.e., December 31, 2011). Thus, the average written date for premium earned in Calendar Year 2011 is January 1, 2011. In the projected period, policies will be written from January 1, 2013, to December 31, 2013, making the average written date June 30, 2013. Actuaries often round to the nearest half-month when determining trend lengths; this practice alleviates the need to determine the true mid-point of the experience period. Given those dates, the trend period is 2.5 years (i.e., January 1, 2011 to June 30, 2013). The following figure displays this.

[15] This technique will be discussed more fully in the loss trend section of the chapter on Losses and LAE.

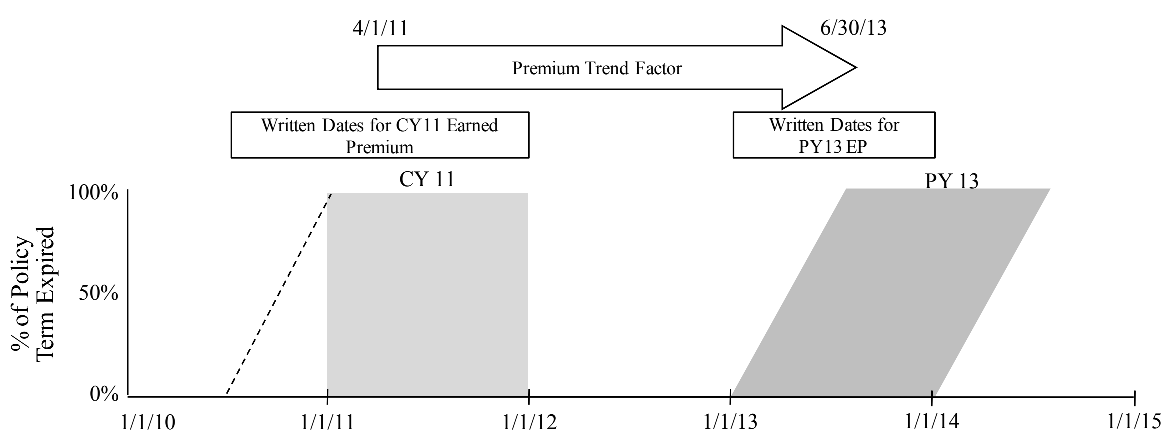
5.26 Trend Period for 12-month Terms



Alternatively, some companies determine the trend period as the length of time from the average date of premium earned in the experience period to the average date of premium earned in the projected period. Using the same annual policy term example, the average date of premium earned in the experience period is the midpoint of Calendar Year 2011, or July 1, 2011. The average date of premium earned in the projected policy year period is December 31, 2013. The trend period is still 2.5 years as each date was shifted by the same amount. Subsequent paragraphs in this chapter will refer to the first method of deriving premium trend length.

There are a few conditions that can affect the length of the premium trend period. First, if the actuary is reviewing policies that have a term other than 12 months, the average written date of policies earning in the calendar year (the "trend from" date) will be different than discussed above. For example, if the policies in the prior example were six-month policies, then the "trend from" date is April 1, 2011. The average written date of policies in the projection period (the "trend to" date) is unchanged (June 30, 2013), and the trend length is 2.25 years.

5.27 Trend Period for 1-Step Trending with 6-Month Policies



Second, if the historical premium is Policy Year 2011—rather than Calendar Year 2011—then the "trend from" date for annual policies is later and corresponds to the average written date for Policy Year 2011, or July 1, 2011. The "trend to" date does not change (June 30, 2013), and the trend length is 2 years.

Finally, if the proposed rates are expected to be in effect for more or less than one year, then the "trend to" date for annual policies will also be different than explained above. For example, if the proposed rates in the prior example are expected to be in effect for two years (from January 1, 2013 to December 31, 2014), then the "trend to" date for annual policies will be December 31, 2013, and the trend length is 3 years.

Given the original trend period calculated earlier of 2.5 years, the adjustment to Calendar Year 2011 earned premium to account for premium trend on annual policies is:

$$1.0508 \ (= (1.0 + 0.02)^{2.5}).$$

It is difficult to apply this approach when the changes in average premium vary significantly year-by-year and/or when the historical changes in average premium are significantly different than the changes that are expected in the future. For example, if the company had forced all insureds to a higher deductible at their first renewal on or after January 1, 2011, the shift would have been completed by December 31, 2011, and the observed trend will not continue into the future. When situations like this occur, companies may use a two-step trending approach.

Two-Step Trending

Two-step trending is also used in practice, especially when the company expects the premium trend to change over time. For example, some lines of business may require several historical years be used when projecting premium for ratemaking purposes. If the trend during that historical period has been significantly different from what is expected to occur in the future, it makes sense to adjust the historical data to current levels accordingly, but to apply a different trend into the forecast period to reflect what is expected to occur in the future. A particular example when the two-step trending process may be appropriate is when a homeowners insurer observes significant increases in amount of insurance during the experience period that are not expected to continue into the future.

In two-step trending, the actuary adjusts each year's historical premium to the average premium level of the most recent point in the trend data (this is called the current trend step), and then applies a separate adjustment to project this premium into the future policy period (this is called the projected trend step).

In Step 1, the actuary typically adjusts each year's historical premium to the current trend level by applying the following adjustment factor:

$$\text{Current Premium Trend Factor} = \frac{\text{Latest Average WP at Current Rate Level}}{\text{Historical Average EP at Current Rate Level}}.$$

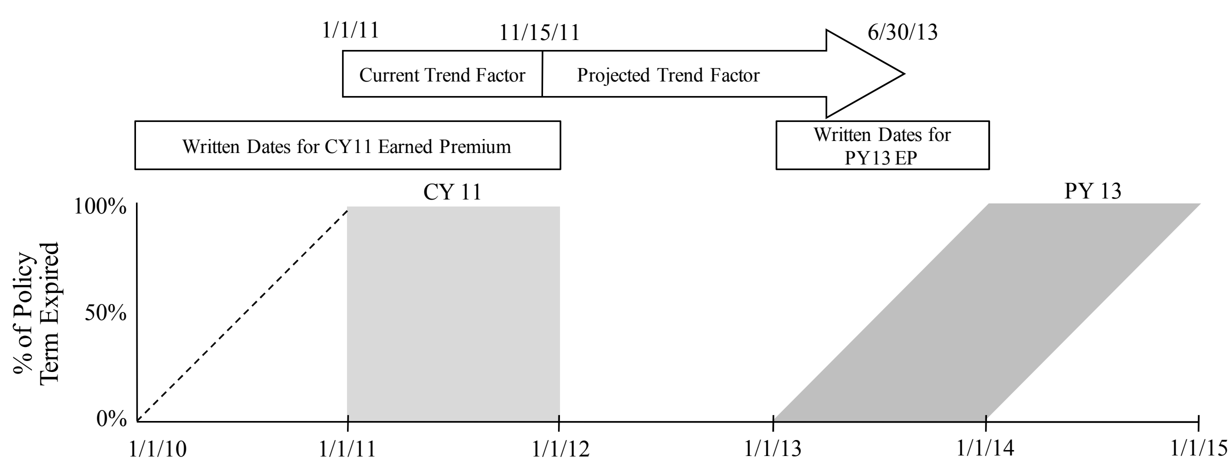
Assuming the average earned premium for Calendar Year 2011 is \$740.00, and the average written premium for the latest available quarter, Calendar Quarter 4Q2011, is \$753.00 (as shown in Table 5.24), then the current premium trend factor for Calendar Year 2011 is 1.0176 (= 753.00 / 740.00). In effect, this factor adjusts the historical Calendar Year 2011 earned premium to the average written date of the latest quarter available in the trend data. In our example, the latest average written premium data is for the fourth quarter of 2011; thus, the average written date is November 15, 2011. Note this will be the "project from" date for the second step in the process. Had the current average written premium been based on Calendar Year 2011 as opposed to the fourth quarter of 2011, then the average written date would have been June 30, 2011.

When the historical average premium is volatile, the actuary may choose to analyze several data points and select a current trend rather than use the ratio described above. For example, assume the selected current annual premium trend were 2%. The trend length is from the average written date of premium earned in the experience period (January 1, 2011, in the annual policy example) to the average written date of the latest period in the trend data (November 15, 2011, in the example), or 0.875 years. The Calendar Year 2011 earned premium would be adjusted by a current premium trend factor of 1.0175 (= $1.02^{0.875}$).

In Step 2, the actuary selects the amount the average premium is expected to change annually from the current level (as of November 15, 2011 in this example) to the level in the projected period. As in the one-step trending approach, the "trend to" date in this projection is the average written date during the period the proposed rates are expected to be in effect (June 30, 2013). Thus, the projected trend period is 1.625 years long (November 15, 2011, to June 30, 2013). Assuming the actuary selects a projected annual premium trend of -1% (e.g., he has knowledge of a campaign to increase deductible amounts), the projected trend factor is 0.9838 (= $(1.0 - 0.01)^{1.625}$).

For convenience, the following picture depicts the two-step trending periods for the annual policy example.

5.28 Trend Period for 2-Step Trending on 12-month Policies



The total premium trend factor for two-step trending is the product of the current trend factor and the projected trend factor. For this example, that is 1.0011 (= 1.0176 x 0.9838). That number is applied to the average historical earned premium at current rate level to adjust it to the projected level:

CY11 Projected EP at Current Rate Level=
CY11 EP at Current Rate Level x Current Trend Factor x Projected Trend Factor.

For convenience, the calculations are included in the following chart.

5.29 Two-Step Trending

(1)	Calendar Year 2011 Earned Premium at Current Rate Level	$	1,440,788
(2)	Calendar Year 2011 Earned Exposures		1,947
(3)	Calendar Year 2011 Average Earned Premium at Current Rate Level	$	740.00
(4)	4th Quarter of 2011 Average Written Premium at Current Rate Level	$	753.00
(5)	Step 1 (Current) Trend Factor		1.0176
(6)	Selected Projected Premium Trend		-1.0%
(7)	Projected Trend Period		1.6250
(8)	Step 2 (Projected) Trend Factor		0.9838
(9)	Total Premium Trend Factor		1.0011
(10)	Projected Premium at Current Rate Level	$	1,442,373

(3) = (1) / (2)
(5) = (4) / (3)
(8) = (1.0 + (6)) ^ (7)
(9) = (5) x (8)
(10) = (1) x (9)

SUMMARY

Estimating future premium is an important aspect of any loss ratio ratemaking analysis. Depending on the nature of the analysis, premium may be aggregated on a calendar year or policy year basis. Furthermore, the actuary may examine in-force premium, written premium, earned premium, unearned premium, or all of them.

When the actuary performs a loss ratio analysis, the actuary must project the premium that is expected during the time the proposed rates will be in effect. If the historical premium is used as a starting point for the projection, the actuary must adjust the historical premium for any rate changes, premium development, exposure trend (when applicable), and distributional shifts that occurred during or after the historical period. Failure to make these adjustments can seriously distort the loss ratio ratemaking analysis.

Appendices A-D provide realistic examples of ratemaking analysis, including the premium adjustments, that are intended to reinforce the concepts covered in this chapter.

KEY CONCEPTS IN CHAPTER 5

1. Premium aggregation
    a. Calendar year v. policy year
    b. In-force v. written v. earned v. unearned premium

2. Premium at current rate level
    a. Extension of exposures
    b. Parallelogram method

3. Premium development

4. Exposure trend

5. Premium trend
    a. One-step trending
    b. Two-step trending

CHAPTER 6: LOSSES AND LAE

As stated in Chapter 1, the fundamental insurance equation is:

Premium= Losses + LAE + UW Expenses + UW Profit.

The role of a pricing actuary is to estimate each of these components for the period during which the proposed rates will be in effect. The preceding chapter provided techniques for estimating the projected premium. Now attention is turned to the loss and loss adjustment expense components.

Amounts paid or owed to claimants under the provisions of an insurance contract are known as losses. Though some actuarial literature uses the terms losses and claims interchangeably, this text will use the term claim to refer to the demand for compensation, and loss to refer to the amount of compensation. A claimant can be the insured or a third party seeking damages covered under the terms of the insurance contract. Amounts paid by the insurance company to investigate and settle claims are called loss adjustment expenses (LAE). Losses and LAE usually represent the largest component of insurance costs and hence the largest portion of insurance premium. It is easy to understand why quantifying expected future loss and LAE costs are of utmost importance to the pricing actuary.

This chapter discusses:

- The different types of insurance losses
- How loss data is aggregated for ratemaking analysis
- Common metrics involving losses
- Adjustments made to historical loss data to make it relevant for estimating future losses in the context of ratemaking. This includes adjusting data for:
    - extraordinary loss events
    - changes in benefit levels
    - changes in the loss estimates as immature claims become mature
    - changes in loss cost levels over time
- Treatment of loss adjustment expenses

LOSS DEFINITIONS

Paid losses are those losses that have been paid to claimants. When a claim is reported to the insurance company and payment is expected to be made in the future, a **case reserve** for the expected amount is established on the claim. The case reserve may be based on a claims adjuster's estimate or may be determined by formula. The sum of paid losses and case reserves is referred to as **reported losses**, and is also known as **case incurred losses**. When reported losses are further adjusted to account for any anticipated shortfall in the case reserves (i.e., development on known claims, also known as incurred but not enough reported, or IBNER) and for claims that have not yet been reported (i.e., incurred but not reported, or IBNR), then the losses are referred to as estimated **ultimate losses**. These losses are an estimate of all of the payments the insurer will ultimately make to claimants, which is eventually a known quantity.

It is important to understand that aggregated loss measures are defined by a choice of relevant statistics (e.g., paid or reported losses), a data aggregation method (e.g., calendar, accident, policy, or report month/quarter/year), and a period of time. The period of time for data aggregation is defined by both an accounting period and a valuation date. The accounting period refers to the inventory of losses during a particular time, which is often consistent with financial statement dates—e.g., month, quarter, or calendar year. The valuation date, which can be different than the end of the accounting period, is the date as of which the losses are evaluated for analysis. It is often expressed as the number of months after the start of the accounting period (e.g., Accident Year 2010 as of 18 months implies Accident Year 2010 as of June 30, 2011). The valuation date can also be expressed relative to the end of the accounting period (e.g., six months after the close of Accident Year 2010). As valuation dates can occur prior to the end of the accounting period, the former approach is more common.

LOSS DATA AGGREGATION METHODS

As described in Chapter 3, four common methods of data aggregation are calendar year, accident year, policy year, and report year. The following summarizes each method as it pertains to aggregation of losses.

Calendar year aggregation considers all loss transactions that occur during the twelve-month calendar year without regard to the date of policy issuance, the accident date, or the report date of the claim. Calendar year paid losses include all payments made during the calendar year on any claims. Calendar year reported losses are equal to paid losses plus the change in case reserves during that twelve-month calendar year. At the end of the calendar year, all calendar year paid and reported losses are fixed.

Accident year aggregation considers all loss transactions for claims that have an occurrence date during the year[16] being evaluated, regardless of when the policy was issued or the claim was reported. Accident year paid losses are the sum of all payments made on any claims that occurred during the year (i.e., the date of accident is during that year). Accident year reported losses consist of all loss payments made plus the case reserves as of the valuation date for those claims that occurred during the year. Unlike calendar year losses, accident year losses can and do change after the end of the year as additional claims are reported, claims are paid, or reserves are changed. Since accident year is not closed (fixed) at the end of the year, future development of losses needs to be estimated.

Policy year aggregation, which is sometimes referred to as underwriting year, considers all loss transactions on policies that were written during the year, regardless of when the claim occurred or when it was reported, reserved, or paid. Policy year paid losses are the sum of all payments made on claims covered by policies written during the year. Policy year reported losses are the sum of the policy year paid losses and the case reserves as of the valuation date for claims covered by policies written during the year. Like accident year losses, policy year losses can and often do change as additional claims occur, claims are paid, or reserves are changed. Because a policy year extends until the last policy (which may be written on the last day of the year) expires, policy year claims associated with annual policies arise from a two year time period, a longer period than calendar year and accident year losses. Consequently,

[16] Some companies may aggregate losses in twelve-month periods that do not correspond to calendar years. This is generally called a fiscal accident year. In such cases, the period is referred to as 12 months ending mm/dd/yy (referred to as the accounting date).

the estimation of future development on known claims is subject to more uncertainty than accident year aggregation.

Report year is the fourth loss aggregation method. This method is similar to accident year except the losses are aggregated according to when the claim is reported, as opposed to when the claim occurs. The accident dates are maintained so the actuary can determine the lag in reporting, and the report year losses may be subdivided based on the report lag. By design, this type of aggregation results in no IBNR (incurred but not reported) claims, but a shortfall in case reserves (i.e., incurred but not enough reported, or IBNER) can exist. For standard ratemaking, report year aggregation is generally limited to the pricing of claims-made policies. Claims-made policies provide coverage based on the date the claim is reported, as opposed to the date the claim occurs. Companies may choose to write claims-made policies in lines of business for which there is often a significant lag between the date of the occurrence and the reporting of the claim (e.g., medical malpractice). Claims-made ratemaking is covered in more detail in Chapter 16.

The following example further illustrates quantifying reported losses under the different loss aggregation methods. Assume these are the only claims reported for this company and reserve levels are $0 prior to Calendar Year 2009.

6.1 Claim Transaction History

Policy Effective Date	Date of Loss	Report Date	Transaction Date	Incremental Payment	Case Reserve*
07/01/09	11/01/09	11/19/09	11/19/09	$0	$10,000
			02/01/10	$1,000	$9,000
			09/01/10	$7,000	$2,500
			01/15/11	$3,000	$0
09/10/09	02/14/10	02/14/10	02/14/10	$5,000	$10,000
			11/01/10	$8,000	$4,000
			03/01/11	$1,000	$0

*Case reserve evaluated as of transaction date.

The Calendar Year 2009 reported losses are $10,000. This is the Calendar Year 2009 paid losses (i.e., the sum of the losses paid in 2009 ($0)) plus the ending reserve at December 31, 2009 ($10,000), minus the beginning reserve in 2009 ($0).

The Calendar Year 2010 reported losses are $17,500. This is Calendar Year 2010 paid losses ($1,000 + $7,000 + $5,000 + $8,000) plus the ending reserve at December 31, 2010 ($2,500 + $4,000), minus the beginning reserve in 2010 ($10,000).

The Calendar Year 2011 reported losses are -$2,500. This is the Calendar Year 2011 paid losses ($3,000+$1,000) plus the ending reserve at December 31, 2011 ($0), minus the beginning reserve in 2011 ($2,500 + $4,000).

The Accident Year 2009 reported losses as of December 31, 2011, are $11,000, which considers transactions on the first claim only. This is the cumulative losses paid through December 31, 2011, on the first claim ($1,000 + $7,000 + $3,000) plus the case reserve estimate for this claim as of December 31, 2011 ($0). (When referring to Accident Year paid losses, the adjective *cumulative* is usually implied rather than explicit.)

The Accident Year 2010 reported losses as of December 31, 2011, are $14,000, which considers transactions on the second claim only. This is the losses paid on the second claim through December 31, 2011 ($5,000 + $8,000 + $1,000), plus the case reserve estimate for this claim as of December 31, 2011 ($0).

The Policy Year 2009 reported losses as of December 31, 2011, are $25,000, which considers transactions from both of these policies. This is the sum of the losses paid on both policies ($1,000 + $7,000 + $3,000 + $5,000 + $8,000 + $1,000), plus the case reserve estimate as of December 31, 2011 ($0).

The Policy Year 2010 reported losses as of December 31, 2011, are $0 since neither of these policies was issued in 2010.

Table 6.2 summarizes Calendar Year 2009, Accident Year 2009, and Policy Year 2009 reported losses at three different valuation points.

6.2 Reported Losses: CY09 v AY09 v PY09

	Valuation Date		
Aggregation Type	**12/31/2009**	**12/31/2010**	**12/31/2011**
Calendar Year 09	$10,000	$10,000	$10,000
Accident Year 09	$10,000	$10,500	$11,000
Policy Year 09	$10,000	$27,500	$25,000

The chart demonstrates that while the calendar year reported losses are finalized at the end of the year, accident year and policy year losses are not. In particular, policy year losses undergo significant development during the second twelve months of the 24-month policy year period. This longer lag time required to get accurate policy year estimates is considered a shortcoming of the policy year aggregation method.

The Report Year 2009 reported losses only include amounts associated with the first claim as it was reported in 2009. As of December 31, 2009, the Report Year 2009 reported losses are $10,000, which reflects the outstanding case reserve only as the paid losses at December 31, 2009, are $0. As of December 31, 2010, the Report Year 2009 reported losses are $10,500, which is the sum of all payments made ($1,000 + $7,000) and the $2,500 case reserve estimate as of the end of 2010. The second claim was reported in 2010 and, therefore, only contributes to Report Year 2010 losses.

COMMON RATIOS INVOLVING LOSS STATISTICS

Four common ratios involving loss statistics are: frequency, severity, pure premium, and loss ratio. As stated previously, each ratio is defined by a choice of relevant statistics (e.g., paid or reported losses, or earned or written premium), a data aggregation method (e.g., calendar, accident, policy, or report month/quarter/year), an accounting period, and a valuation date.

Frequency is a measure of claim incidence and is generally expressed per unit of exposure. Consider a private passenger automobile example. In a given calendar-accident year, an insurance company has 150,000 earned car years. As of six months after the close of the calendar year, it is known that 7,500 claims occurred during the calendar-accident year. The calendar-accident year reported claim frequency as of 18 months is 7,500 / 150,000 = 0.05. The numerator of this ratio can be expressed in various ways (e.g., reported, paid, or closed claims). Also, a decision should be made whether to include claims that closed without payment.

Severity is a measure of the average loss per claim. If the 7,500 claims above produced $18,750,000 of reported losses as of 18 months, the reported severity as of 18 months is $2,500 (= $18,750,000 / 7,500). The two components of this ratio, losses and claims, can be described and aggregated in various ways—e.g., paid or reported losses; reported, paid, or closed claims with or without claims that closed without payment. In addition, actuaries pricing certain lines of business may use losses developed to ultimate in their severity measures (loss development adjustments will be covered later in this chapter). The ratemaking actuary should give careful thought to how to define severity and be clear in communications to avoid confusion.

Pure premium (also known as loss cost or burning cost) is a measure of the average loss per exposure. It is calculated as the total losses divided by total exposures; this is equivalent to the product of frequency and severity. As with frequency and severity, this calculation involves a choice of relevant statistics. The choice should be consistent with those in the underlying frequency and severity ratios (e.g., if paid claims were used as the numerator of frequency, they should also be used as the denominator of severity). In the example above, the pure premium as of 18 months is $18,750,000 / 150,000 = $125 = 0.05 x $2,500.

Loss ratio is the ratio of losses (or losses and LAE) to premium, which measures the portion of each premium dollar needed to pay losses (or to pay losses and LAE). This metric varies depending on the types of premium and loss used, and the method of aggregation; furthermore, the numerator may or may not include loss adjustment expenses or be developed to ultimate loss levels. As mentioned previously, it is very important to clearly communicate how a particular metric is defined. The most common loss ratio metric is reported loss ratio, or reported losses divided by earned premium. Continuing the example outlined above, if premium earned during the calendar year is $32,000,000, the calendar-accident year reported loss ratio as of 18 months is 58.6% (= $18,750,000 / $32,000,000).

ADJUSTMENTS TO LOSSES

Losses need to be projected to the cost level expected when the rates will be in effect. This is typically done using historical losses with a series of adjustments. Preliminary adjustments may involve removing extraordinary events (e.g., individual shock losses and catastrophe losses) from historical losses and replacing them with a provision more in line with long-term expectations. Immature losses also need to be developed to reflect their ultimate settlement value. Further adjustments may be applied to restate losses to the benefit and cost levels expected during the future policy period.

This text will not prescribe a specific order for the various adjustments to historical losses. The actuary needs to consider how each adjustment is derived in order to assess the order of application. For example, if a catastrophe model outputs ultimate catastrophe losses expected in the future policy period, this provision should be added to non-catastrophe losses that have already been trended and developed to ultimate. If the catastrophe provision is added to non-catastrophe losses, and the sum is then trended and developed, the expected catastrophe losses will be over-adjusted.

Though a particular order for adjustments is not prescribed in this text, several examples of rate level indications (including the various adjustments to losses) for different lines of business are included in the appendices of this text.

Extraordinary Losses

Large Individual Losses

Excessively large individual losses happen infrequently but are somewhat expected in the insurance world. Examples of such losses, also referred to as shock losses, may include a large multi-claimant liability claim, a total loss on an exceptionally high-valued home, and a total permanent disability of a young worker. For many large companies, the size of the portfolio can dwarf the effects of shock losses, but shock losses in a smaller portfolio can introduce instability to the ratemaking process.

If actual shock losses are included in the ratemaking analysis as is, indicated rates may increase immediately after a year with shock losses and may decrease when there are no shock losses present in the experience period. Consequently, historical data used to project future losses may exclude these losses in their entirety or, more typically, may just exclude the portion above some predetermined threshold. Losses are later modified by a provision to incorporate expected shock losses based on a long-term view.

In some cases, the threshold for capping shock losses may be based on the minimum amount of insurance offered, often called the "basic limit" as it corresponds to the limit associated with the base rate. When this approach is used, the rate level indication (which will be discussed in detail in Chapter 8) is the rate level need assuming all insureds choose the basic limit. Consequently, the premium used in the rate level indication[17] must also be adjusted to the basic limit (i.e., each exposure's premium rerated as if the basic limit was purchased). The effect of the losses other than the basic limit will be considered in the classification ratemaking analysis (which will be discussed in detail in Chapter 11).

Ideally, the large loss threshold should correspond to the point at which the losses are extraordinary and their inclusion causes volatility in the rates; in some cases, that point may be significantly higher than the basic limit. For example, the basic limit for personal automobile liability insurance typically equals the amount of insurance required by the financial responsibility laws. As many insureds voluntarily select higher limits of insurance, large insurers may have a significant number of losses that exceed the basic limit.

When the losses are not capped at the basic limit, the actuary must determine the large loss threshold that best balances the following goals: including as many losses as possible and minimizing the volatility in the ratemaking analysis. One approach is to examine the size of loss distribution and set the threshold at a given percentile, such as the 99th percentile. This can be done by examining individual claim sizes in increasing order and choosing the claim amount for which 99% of the claim inventory is below that amount. Alternatively, a threshold can be chosen with respect to a certain percentage of losses rather than claim counts. For some insurance products, the amount of insurance varies based on the value of the

[17] As discussed in Chapter 8, rate level indications can be performed on a loss ratio or pure premium basis. Only the loss ratio method uses premiums in the calculation; therefore, this adjustment to basic limits premium is only necessary if performing a loss ratio indication.

insured item (e.g., property insurance). In these cases, the expected size of loss distribution may vary significantly from one policy to the next, and it may be more appropriate to use a threshold that is a percentage of the amount of insurance than to use a fixed threshold.

In terms of the fundamental insurance equation, indicated rates will be understated if actual shock losses have been removed from projected losses and no provision for shock losses has been added. The actual shock loss is typically replaced with an average expected large loss amount that is calculated based on a longer term view of the effect of such events. The length of time used to determine the true effect of such events may vary significantly for different lines of business and even from insurer to insurer. For example, a medium-sized homeowners insurer may derive a good estimate for expected large fire losses using 10 years of data, while a small personal umbrella insurer may need 20 years of data. The actuary also wants to avoid using too many years as older data becomes less relevant over time (e.g., jury awards may be much higher today than previously). If there are no data limitations, the average should be based on the number of years necessary to produce a stable and reasonable estimate without including so many years as to make the historical data irrelevant.

The following example shows a simple procedure that caps individual reported losses at $1,000,000 (these capped losses are referred to as non-excess losses) and uses the long-term average ratio of excess losses (the portion of each shock loss above the $1,000,000 threshold) to non-excess losses to determine an excess loss provision. The assumption implicit in this procedure is that while the proportion of losses attributable to extraordinary losses will be volatile in the short-run, the proportion will be stable when viewed over a sufficiently long period of time.

6.3 Excess Loss Procedure

Accident Year	(1) Reported Losses	(2) Number of Excess Claims	(3) Ground-Up Excess Losses	(4) Losses Excess of $1,000,000	(5) Non-Excess Losses	(6) Excess Ratio
1996	$ 118,369,707	5	$ 6,232,939	$ 1,232,939	$ 117,136,768	1.1%
1997	$ 117,938,146	1	$ 1,300,000	$ 300,000	$ 117,638,146	0.3%
1998	$ 119,887,865	3	$ 3,923,023	$ 923,023	$ 118,964,842	0.8%
1999	$ 118,488,983	0	$ -	$ -	$ 118,488,983	0.0%
2000	$ 122,329,298	7	$ 12,938,382	$ 5,938,382	$ 116,390,916	5.1%
2001	$ 120,157,205	3	$ 3,824,311	$ 824,311	$ 119,332,894	0.7%
2002	$ 123,633,881	0	$ -	$ -	$ 123,633,881	0.0%
2003	$ 124,854,827	1	$ 3,000,000	$ 2,000,000	$ 122,854,827	1.6%
2004	$ 125,492,840	0	$ -	$ -	$ 125,492,840	0.0%
2005	$ 127,430,355	6	$ 13,466,986	$ 7,466,986	$ 119,963,369	6.2%
2006	$ 123,245,269	3	$ 4,642,423	$ 1,642,423	$ 121,602,846	1.4%
2007	$ 123,466,498	0	$ -	$ -	$ 123,466,498	0.0%
2008	$ 129,241,078	10	$ 17,038,332	$ 7,038,332	$ 122,202,746	5.8%
2009	$ 123,302,570	0	$ -	$ -	$ 123,302,570	0.0%
2010	$ 123,408,837	3	$ 4,351,805	$ 1,351,805	$ 122,057,032	1.1%
Total	$ 1,841,247,359	42	$ 70,718,201	$ 28,718,201	$ 1,812,529,158	1.6%
			(7) Excess Loss Factor			1.016

(4)= (3) - [$1,000,000 x (2)]
(5)= (1) - (4)
(6)= (4) / (5)
(7)= 1.0 + (Tot6)

The excess loss factor in Row 7 is applied to the non-excess losses for each year in the historical experience period.

Later in this chapter the issue of loss trending is discussed. This is the process of adjusting historical losses for time-related influences such as inflation in order to project losses to the future policy period. The simple excess loss procedure outlined above is ideally performed on reported losses that have been trended to future levels. In other words, excess losses are calculated by censoring trended ground-up losses.[18] Losses in higher layers of insurance are often subject to greater inflationary pressure than losses in lower layers. Ignoring this effect introduces some bias in the excess loss procedure. More detail regarding this leveraging effect is covered later in this chapter as well.

In addition to the simple procedure outlined above, some actuaries may fit statistical distributions to empirical data and simulate claim experience in order to calculate the expected excess losses.

Catastrophe Losses

Similarly, ratemaking data often excludes losses arising from catastrophic events. Unlike shock losses that are individual high severity claims, a catastrophe denotes a natural or man-made disaster that is

[18] Alternatively, the excess loss threshold can be indexed to reflect trend, and then applied to ground-up losses that have not been trended.

unusually severe and results in a significant number of claims. This can include hurricanes, tornadoes, hail storms, earthquakes, wildfires, winter storms, explosions, oil spills and certain terrorist attacks—though this list is hardly exhaustive.

In the U.S., the Property Claims Services (PCS) unit of the Insurance Services Office (ISO) currently defines catastrophes as events that cause $25 million or more in direct insured losses to property and that affect a significant number of policyholders and insurers. Insurance companies may have alternative definitions for their own internal procedures.

Like shock losses, catastrophe losses are typically removed from ratemaking data to avoid distorting effects in any ratemaking analysis. In the process of projecting future losses, the actual catastrophe losses are replaced with an average expected catastrophe loss amount. The method used to calculate such a provision varies by type of insurance, or more specifically by the type of catastrophic loss to which the line of business is exposed. The type of catastrophic loss is often broken down into non-modeled catastrophe losses and modeled catastrophe losses.

Non-modeled catastrophe analysis is generally undertaken on events that happen with some regularity over a period of decades. For example, the most common catastrophic loss related to private passenger automobile comprehensive coverage (which covers most forms of physical damage to the insured's car other than collision) is hail storms. These storms happen with some mid-term regularity though loss projections based on a short experience period (e.g., three to five years) may lead to ratemaking instability. Without a catastrophe procedure, indicated rates will increase immediately after a bad storm year and decrease in years when no or few storms occur.

Similar to the excess loss procedure, the actuary can calculate the ratio of hail storm losses to non-storm losses over a longer experience period (e.g., 10-30 years). As discussed with the shock losses, the number of years used for this procedure should balance stability and responsiveness. For example, if the concentration of exposures in the most hail-prone area of a state has increased drastically over the past 20 years, then a catastrophe procedure based on 20 years of statewide data may understate the expected catastrophe potential. Once determined, the ratio can be used to adjust the non-catastrophe losses in consideration of future expected catastrophe loss.

Alternatively, the actuary can develop a pure premium (or loss ratio) specifically for the non-modeled catastrophe exposure. In the pure premium case, the actuary could examine the long-term ratio of cat losses to exposure (or to some inflation-sensitive measure like amount of insurance years) and apply that ratio to projected exposures (or projected amount of insurance years). Appendix B provides an example of deriving a non-modeled catastrophe pure premium. The loss ratio indication would be similar except the denominator of the long-term ratio would be earned premium, which is inflation-sensitive (though perhaps not to the same degree as the catastrophe losses), and the premium would need to be brought to current rate level.

Catastrophe models are generally used to account for events that are extremely sporadic and generate high severity claims, such as hurricanes and earthquakes. Even thirty years of data may not capture the correct expectation of the damage these events can inflict. For these types of catastrophes, sophisticated stochastic models are designed by professionals from a variety of fields (e.g., insurance professionals, meteorologists, engineers) to estimate the likelihood that events of varying magnitudes will occur and the damages that will likely result given the characteristics of the insured properties. The model is then used to estimate the expected annual catastrophe loss based on the insurer's exposure. The catastrophe loss provision produced by the model is simply added to the non-catastrophe loss amount to determine the aggregate expected losses to be used for pricing.

In most years, the actual catastrophe losses will be less than the expected annual provision, but in years with a major event or events, the actual losses will be significantly higher than the expected annual provision.

Companies typically monitor the number of policies in catastrophe-prone areas and may use non-pricing actions to control the concentration to minimize the financial impact any one event can have on the profitability of the company. For example, the company may restrict the writing of any new business, may require higher deductibles for catastrophe-related losses, or may purchase reinsurance. In addition to these non-pricing actions, the actuary may alter the underwriting profit provision in the rates to reflect the higher cost of capital needed to support the extraordinary risk caused by the higher concentration of policies.

More detailed discussion of catastrophe models and the effect on rates is beyond the scope of this text.

Reinsurance

Reinsurance is insurance purchased by primary insurance companies to transfer some of the financial risk they face. Historically, actuaries performed ratemaking analysis for primary insurance on a direct basis (i.e., without consideration of reinsurance). As reinsurance programs have become more extensive and reinsurance costs have increased substantially for some lines of business, some ratemaking analyses are now performed on a net basis (i.e., with consideration of reinsurance).

Reinsurance can be split between proportional and non-proportional covers. Proportional means the same proportion of premium and losses are transferred or "ceded" to the reinsurer; consequently, proportional reinsurance may not necessarily need to be explicitly included in the pricing consideration.

With non-proportional reinsurance, the reinsurer agrees to assume some predefined portion of the losses (which are the reinsurance recoverables). The insurer cedes a portion of the premium (which is the cost of the reinsurance). Common examples of non-proportional reinsurance include catastrophe excess-of-loss reinsurance (e.g., the reinsurer will cover 50% of the losses that exceed $15,000,000 up to $30,000,000 on their entire property book of business in the event of a catastrophe) and per risk excess-of-loss reinsurance (e.g., the reinsurer will cover the portion of any large single event that is between $1,000,000 and $5,000,000 for specified risks).

Typically, the projected losses are reduced for any expected non-proportional reinsurance recoveries. Of course, the cost of purchasing the reinsurance must be recognized, too. That is typically done by reducing the total premium by the amount ceded to the reinsurer. Alternatively, the net cost of the non-proportional reinsurance (i.e., the cost of the reinsurance minus the expected recoveries) may be included as an expense item in the overall rate level indication.

Changes in Coverage or Benefit Levels

An insurance policy provides benefits in the case of a covered event. The insurance company may initiate changes in coverage; for example, a company may expand or contract coverage with respect to the types of losses covered or may opt to increase or decrease the amount of coverage offered. Benefit levels can also be impacted by a law change or court ruling. Examples of this include caps on punitive damages for auto liability coverage and changes in the workers compensation statutory benefit levels.

In consideration of the fundamental insurance equation, future projected losses need to reflect the coverage/benefit levels expected during the time that rates will be in effect. Benefit changes can have both direct and indirect effects on losses. Direct effects, as the name implies, are a direct and obvious consequence of the benefit change. Indirect effects, on the other hand, arise from changes in claimant behavior that are a consequence of the benefit change; these are usually much more difficult to quantify than direct effects. The pricing actuary needs to understand the benefit change and its anticipated direct effect and, if possible, the indirect effect in order to adjust losses accordingly. Ideally, the historical loss data will be available by individual claim so that each claim can be restated to be consistent with the new benefit levels. This restatement can be incredibly cumbersome and therefore impractical. Other alternatives include studying the average restatement effect of groups of claims (e.g., by type of injury) or simulating loss data under the new benefit conditions.

Consider the following examples to better understand the quantification of benefit changes.

6.4 Limit Change

Claim number	(1) Losses Capped @$5,000	(2) Losses Capped @$3,000	(3) Effect of Change
1	$ 1,100	$ 1,100	0.0%
2	$ 2,350	$ 2,350	0.0%
3	$ 3,700	$ 3,000	-18.9%
4	$ 4,100	$ 3,000	-26.8%
5	$ 5,000	$ 3,000	-40.0%
6	$ 5,000	$ 3,000	-40.0%
Total	$ 21,250	$ 15,450	-27.3%

(1) Given
(2) = Min[(1), $3,000]
(3) = (2) / (1) - 1.0

Insurance companies determine the amount of coverage provided by a policy, either as a specified amount or a range of options for the policyholder. Assume the company reduces the maximum amount of coverage for jewelry, watches, and furs on a standard homeowners policy (referred to as the "inside limit") from $5,000 to $3,000. The direct effect of this change is that any claimants with jewelry, watches, and furs losses in excess of $3,000 will now only receive $3,000 rather than at most $5,000. The direct effect of this change can be easily calculated if a distribution of historical jewelry, watches, and furs losses is available. Table 6.4 shows the how the reported losses on six claims would be capped under the two different thresholds.

Given the data provided, the expected direct effect is equivalent to -27.3%, which is the ratio of all such losses capped at $3,000 to all such losses capped at $5,000, minus 1.0. If the revision were to increase the limit to $6,000 (rather than decrease it), the data provided does not have enough information since all losses were capped at the current inside limit of $5,000. In such cases, the ratemaking actuary may need to consult claims studies to obtain the gross losses.

In addition to the direct effect of a coverage change described above, there may be an indirect effect, too. Consider the example involving a decrease in coverage. Insureds who previously relied on the coverage provided under their homeowners policy may feel the reduced coverage is inadequate and consequently purchase a personal articles floater (PAF) to cover jewelry, watches, and furs. If the homeowners coverage is secondary to the PAF, the jewelry, watches, and furs losses from the homeowners policy will be further reduced as they are now covered by the PAF. As there is no way to know how many insureds will purchase the PAF and the amount of PAF coverage they will purchase, it is very difficult to accurately quantify the indirect effect.

Workers compensation benefits are governed by statutes and changes in these statutes can lead to direct and/or indirect effects on losses. For example, statutes dictate the maximum/minimum benefits, the maximum duration of benefit, the types of injuries or diseases covered, treatments that are allowed, the administrative procedures to be followed, etc. Consider the case where the workers compensation wage replacement rate increases from 60% to 65% of pre-injury wages. If this is the only change, there is a direct effect as all workers will have their wages replaced at a higher rate; the direct effect on wage replacement losses is easily quantified as +8.3% (= 65% / 60% - 1.0). There may also be an indirect benefit as workers may be more inclined to file claims and claimants may have less incentive to return to work in a timely manner. This is difficult to quantify accurately and may require the actuary's professional judgment.

Consider another example where the workers compensation maximum indemnity benefit for a particular state is changing. The assumptions include:

- The compensation rate is 66.7% of the worker's pre-injury wage.
- The state average weekly wage (SAWW) is currently $1,000.
- The minimum indemnity benefit remains at 50% of the SAWW.
- The maximum indemnity benefit is decreasing from 100% of the SAWW to 83.3% of the SAWW.
- The distribution of workers (and their wages) according to how their wages compare to the SAWW is as follows:

6.5 Benefit Example

Ratio to Average Weekly Wage	# Workers	Total Weekly Wages
<50%	7	$ 3,000
50-75%	24	$ 16,252
75-100%	27	$ 23,950
100-125%	19	$ 23,048
125-150%	12	$ 16,500
>150%	11	$ 17,250
Total	100	$ 100,000

The key to determining the direct effect is to calculate the benefits provided before and after the change.

Currently, the minimum benefit is 50% of the SAWW. Since the SAWW is $1,000, the minimum benefit is $500 (= $1,000 x 50%). Given the current compensation rate of 66.7%, the minimum benefit of $500 will be applicable to all workers who earn less than 75% of the SAWW (i.e., $500 = 66.7% x 75% x $1,000). There are 31 (= 7 + 24) employees in that category; the aggregate benefits for those 31 employees is $15,500 (= 31 x $500).

The current maximum benefit is 100% of the SAWW, or $1,000. Given the current compensation rate of 66.7%, the maximum benefit of $1,000 will be applicable to the workers who earn more than 150% of the SAWW (i.e., $1,000 = 66.7% x 150% x $1,000). The 11 employees who are subjected to the current maximum benefit constitute $11,000 (= 11 x $1,000) in benefits.

The remaining 58 (= 27 + 19 + 12) employees fall between the minimum and maximum benefits. This means their total benefits are 66.7% of their actual wages or $42,354 (= (66.7% x 23,950) + (66.7% x 23,048) + (66.7% x 16,500)).

Under the current benefit structure, the sum total of benefits is $68,854 (= $15,500 + $11,000 + $42,354).

Once the statute changes and the maximum benefit is reduced from 100% to 83.3% of the SAWW, more workers will be subjected to the new maximum benefit. Specifically workers earning approximately 125% or more of the SAWW will be subjected to the maximum (i.e., $833.75 = (66.7% x 125% x $1,000) > $833). These 23 (= 11 + 12) workers will receive $19,159 (= 23 x $833) in benefits.

The number of workers affected by the minimum benefit, 31, is not impacted by the change. Their benefits remain $15,500.

Because more workers are now impacted by the maximum, there are now only 46 (= 27 + 19) employees that receive a benefit equal to 66.7% of their pre-injury wages or:

$31,348 (= (66.7% x 23,950) + (66.7% x 23,048)).

The new sum total of benefits is $66,007 (= 19,159 + 15,500 + 31,348). The direct effect (or expected change in benefits) from revising the maximum benefit is calculated by comparing the benefits before and after the change in maximum benefit; this is estimated at -4.1% (= 66,007 / 68,854 – 1.0).

6.6 Benefit Example

(1) Ratio to Average Weekly Wage	(2) # Workers	(3) Total Weekly Wages	(4) Current Benefits	(5) Proposed Benefits
<50%	7	$ 3,000	$ 3,500	$ 3,500
50-75%	24	$ 16,252	$ 12,000	$ 12,000
75-100%	27	$ 23,950	$ 15,975	$ 15,975
100-125%	19	$ 23,048	$ 15,373	$ 15,373
125-150%	12	$ 16,500	$ 11,006	$ 9,996
>150%	11	$ 17,250	$ 11,000	$ 9,163
Total	100	$ 100,000	$ 68,854	$ 66,007
		(6) Benefit Change		-4.1%

(4) = <Min: (2) x $500
Other: (3) x 0.667
>Max: (2) x $1,000

(5) = <Min: (2) x $500
Other: (3) x 0.667
>Max: (2) x $833

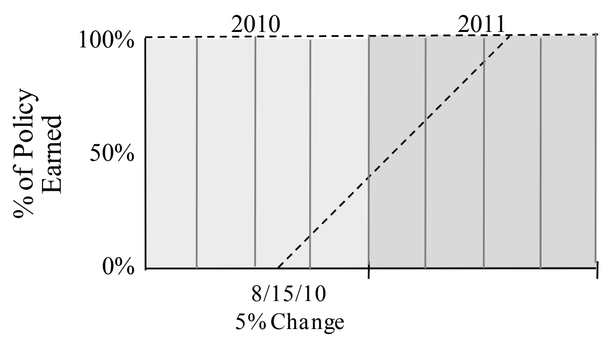
(6) = (Tot5) / (Tot4) - 1.0

If the maximum indemnity benefit is decreased, there may also be an indirect effect. The strength of the indirect effect is a function of the economic environment and the nature of the insured population, among other things. Assuming there is no data to estimate the indirect effect, it needs to be determined judgmentally.

Once the effect of the benefit change is quantified, the ratemaking actuary must consider the timing and details of the benefit change in order to adjust the historical data. For example, a benefit change may affect all claims on or after a certain date or claims arising from all policies written on or after the date. The necessary adjustment is different in each of those cases.

Techniques for calculating the appropriate adjustment are similar to the parallelogram method for deriving on-level premium in the previous chapter on premium. Figure 6.7 shows a law change implemented on August 15, 2010 that only affects losses on policies written on or after August 15, 2010. The direct effect of the change for annual policies on an accident year basis is estimated at +5%.

6.7 Affects Losses on New Annual Policies (AY Basis)



Since the law change is only applicable to losses on policies written after the implementation date, the line dividing the losses into pre- and post-change is a diagonal line representing a policy effective on the date of the law change. Note that the calendar-accident years have been divided into accident quarters. Recall that the parallelogram method assumes a uniform distribution of written premium (or in this case, of losses). The uniform distribution assumption may not be appropriate for losses that are affected by seasonality; therefore, it is prudent to measure loss adjustments at a more refined level than years. Similar to the on-level premium adjustment factor, the benefit change loss adjustment factor is:

$$\text{Adjustment}=\frac{\text{Current Loss Level}}{\text{Average Loss Level of Historical Period}}.$$

In the example displayed, the pre-change loss level is 1.00 and post-change loss level is 1.05. Focusing on the third quarter of 2010, the portion of losses assumed to be pre- and post-change are as follows:

- 3Q 2010 Post-change: 0.0078 = 0.50 x 0.125 x 0.125
- 3Q 2010 Pre-change: 0.2422 = 0.25 - 0.0078

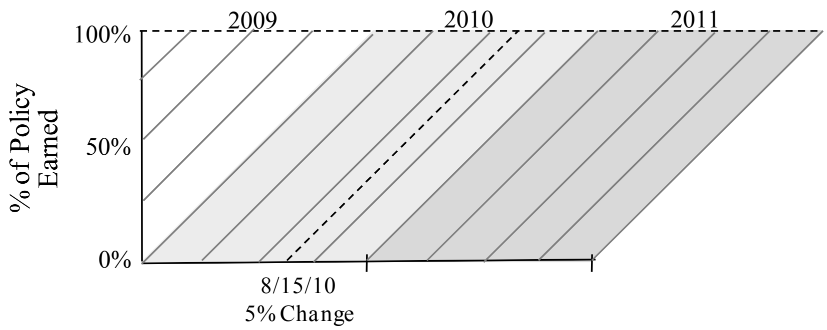
Consequently, the adjustment factor for third quarter 2010 reported losses is

$$\text{Adjustment} = \frac{1.05}{1.00 \times \left(\frac{0.2422}{0.2500}\right) + 1.05 \times \left(\frac{0.0078}{0.2500}\right)} = 1.0484.$$

The adjustment factors for the reported losses from all other quarters are calculated similarly.

Figure 6.8 shows how to measure the same law change on a policy year basis.

6.8 Affects Losses on New Annual Policies (PY Basis)



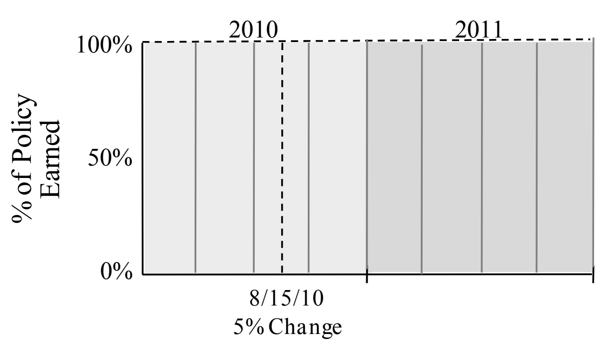
Using the same techniques, the adjustment factor applicable to the third quarter 2010 policy quarter reported losses is:

$$\text{Adjustment} = \frac{1.05}{1.00 \times \left(\frac{0.50 \times 0.25}{0.25}\right) + 1.05 \times \left(\frac{0.50 \times 0.25}{0.25}\right)} = 1.0244.$$

The reported losses from quarters prior to the third quarter need to be adjusted by a factor of 1.05. The reported losses from quarters after the third quarter are already being settled in accordance with the new law, so no adjustment is necessary.

The following figures show a benefit change that affects losses on claims that occur on or after August 15, 2010, regardless of the effective date of the policy. Figures 6.9 and 6.10 are the accident year and policy year representations, respectively.

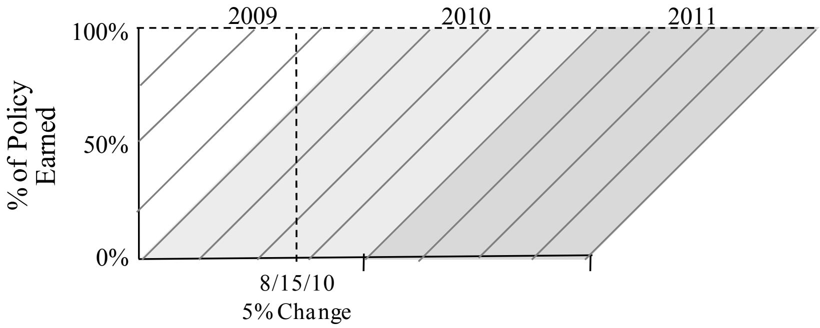
6.9 Affects all New Losses (AY Basis)



The adjustment factor that is applicable to third accident quarter 2010 losses is as follows:

$$\text{Adjustment} = \frac{1.05}{1.00 \times \left(\frac{0.50 \times 0.25}{0.25}\right) + 1.05 \times \left(\frac{0.50 \times 0.25}{0.25}\right)} = 1.0244.$$

6.10 Affects all New Losses (PY Basis)



The adjustment factor that is applicable to third policy quarter 2010 losses is as follows:

$$\text{Adjustment} = \frac{1.05}{1.00 \times \left(\frac{0.0078}{0.2500}\right) + 1.05 \times \left(\frac{0.2422}{0.2500}\right)} = 1.0015.$$

In addition to internal analysis of the effect of benefit changes, actuaries can access industry sources as well. For example, the National Council on Compensations Insurance (NCCI) publishes estimated industry effects of benefit level changes at the state level.

More detailed information on adjustments for benefit changes in workers compensation insurance can be found in Sholom Feldblum's "Workers' Compensation Ratemaking" (Feldblum 1993).

Loss Development

The cost for the insurance product, unlike other industries, is not fully known when the contract is provided or even when a claim is first reported. As a claim matures, payments are made and claim adjusters gather more information about the value of the loss until the final payment is made and the ultimate amount is known. For lines of business that settle claims quickly ("short-tailed lines," examples of which include automobile physical damage and homeowners) the ultimate amount is known rather quickly. In contrast, for some long-tailed lines (e.g., commercial general liability, workers compensation, or personal umbrella) it may take many years for the ultimate amount to be known.

As the ratemaking actuary typically uses the most recent accident year data available, the historical losses are to some degree immature and therefore the ultimate loss amount is not yet known. This is more pronounced if policy year data is used. The process of adjusting immature losses to an estimated ultimate value is known as loss development. Much of the vast library of property/casualty actuarial literature has been devoted to this topic. Explaining and comparing all known methods is beyond the scope of this text, but a cursory explanation of one commonly used method, the chain ladder method, is provided below.

The **chain ladder method** is based upon the assumption that aggregate losses will move from unpaid to paid in a pattern that is generally consistent over time; hence, historical loss development patterns can be used to predict future loss development patterns. The general mechanics of the method can be performed separately on claim counts and losses to generate ultimate values of each. For ratemaking purposes, the ultimate losses are the main concern, but a review of claim emergence and settlement patterns can shed light on how losses are developing.

The analysis can be done on various definitions of claims (e.g., reported, open, closed) and losses (e.g., paid and reported), and can also be applied to study patterns of allocated loss adjustment expenses. For ratemaking purposes in most lines of business, the general interest is the development of reported losses including allocated loss adjustment expenses.

The analysis should be undertaken on a body of homogeneous claims. This may imply a line of business or something more granular (e.g., coverages or types of losses within that line of business). Liability claims and property claims are typically analyzed separately. Experience by geography (e.g., state) may also be analyzed separately where there is sufficient volume. As will be discussed later in this section, the extraordinary losses should be removed and the losses should be adjusted for any material benefit changes.

Claims data or loss data for this method is usually organized in a triangle format as shown in Table 6.11. Each row is a different accident year. The columns represent each accident year's reported losses at successive maturities, starting at 15 months and increasing in annual increments. In this example, losses are assumed to be at ultimate levels at 75 months, so no more columns are required. Note, for some lines of business, ultimate may not be attained for several more years. Each diagonal represents a date as of which the evaluation of losses is made (the valuation date). For example, the latest diagonal represents a valuation date of March 31, 2008.

6.11 Loss Development Triangle

	Reported Losses ($000s) by AY Age (months)					
Accident Year	**15**	**27**	**39**	**51**	**63**	**75**
2002	1,000	1,500	1,925	2,145	2,190	2,188
2003	1,030	1,584	2,020	2,209	2,240	
2004	1,061	**1,560**	2,070	2,276		
2005	1,093	1,651	2,125			
2006	1,126	1,662				
2007	1,159					

The boxed value is the reported losses for accidents occurring in 2004 at 27 months of maturity (i.e., the losses paid and case reserves held as of March 31, 2006 for accidents occurring in 2004). Even before development patterns are calculated, the actuary may review the magnitude of losses at that first development age, 15 months, to determine whether loss levels at this early stage are generally consistent from year to year, with consideration for loss trends and any changes in the portfolio. If loss levels are dramatically different than expected, it may be prudent to examine a similar triangle of claim counts to see if a significantly larger or smaller than usual number of claims was reported for a particular accident year. Alternatively, inconsistent patterns in the losses at the first development period may be expected for small portfolios or long-tailed lines of business.

The development pattern is then analyzed by taking the ratio of losses held at successive maturities. This ratio is referred to as the link ratio or the age-to-age development factor. The following data triangle shows the link ratios for each accident year row as well as the arithmetic average, the geometric average,[19] and the volume-weighted average (the ratio of total reported losses at successive maturities[20] across all accident years):

6.12 Age-to-Age Loss Development Factors

	Age-to-Age Development Factors				
Accident Year	**15-27**	**27-39**	**39-51**	**51-63**	**63-75**
2002	1.50	1.28	1.11	1.02	1.00
2003	1.54	1.28	1.09	1.01	
2004	$\boxed{1.47}$	1.33	1.10		
2005	1.51	1.29			
2006	1.48				
2007					
Arithmetic average	1.50	1.30	1.10	1.02	1.00
Geometric average	1.50	1.29	1.10	1.01	1.00
Ratio of total losses	1.50	1.29	1.10	1.02	1.00
Selected factor	1.50	1.30	1.10	1.02	1.00

The boxed value shows that losses for Accident Year 2004 increased (or developed) 47% (= 1.47 – 1.0) from age 15 months to age 27 months.

The ratemaking actuary selects a suitable link ratio for each maturity, as shown in the table above. In this example, the link ratios for each development period are fairly consistent across the accident years and the all-year arithmetic average link ratios are selected.

In practice, age-to-age development factors may not be as stable as in the example outlined above and therefore simply averaging all of the historical link ratios may not be appropriate. First, if the ratemaking actuary believes the patterns may be changing over time, the actuary may prefer to rely on more recent development patterns rather than the average over a long period of time. In such cases, the actuary may select a two- or three-year average. Second, in some cases the actuary may want to make selections based on the most recent data, but the line of business may be too volatile to rely solely on a two- or three-year average. The actuary may calculate weighted average link ratios giving more weight to the more recent years. Third, development factors may vary widely between accident years or there may be a strong anomaly in one or two accident years. The actuary may consider adjusted averages that eliminate the highest and lowest development factors from the calculation. In general, the actuary should make loss development selections according to what is expected to occur in future periods.

It should be noted that reported losses tend to develop upward as losses approach ultimate. This is due in part to the emergence of new claims as well as adverse development on known claims. However, there are some lines of business where development may actually move in the opposite direction. In automobile physical damage coverages, an insurance company may declare a vehicle a total loss (i.e., pay the total limit for the car) and take the damaged car into its ownership. The damaged vehicle can then be

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[19] The geometric average is the *n*th root of the product of *n* numbers.

[20] The “ratio of total reported losses at successive maturities” compares the sums of an equal number of losses from each maturity (i.e., the most recent losses for the earlier maturity are not considered).

sold as scrap or for parts. The money received in this transaction is called "salvage" and is treated as a negative loss.

Another way development can be negative is through subrogation. Insurance companies sometimes pay losses for which another party is actually liable. After the losses are paid, the company can then approach the responsible party for indemnification of those amounts. When subrogation or salvage are common, age-to-age development factors can be less than 1.00. Development factors for reported losses can also be less than 1.00 when early case reserves are set too high.

This particular example assumes losses are ultimate at 75 months. For some lines of business, the historical data triangle may not reach ultimate. In that case, actuaries may fit curves to historical development factors to extrapolate the development beyond the patterns in the historical data or perform special studies that include more years of data. The factor that accounts for any additional development beyond that included in the standard chain ladder method is referred to as a "tail factor."

It is important that loss development patterns are reviewed carefully by the ratemaking actuary. The actuary should have knowledge of the line of business being analyzed, particularly the history of the claims handling procedures and any known events that could create an anomaly in the pattern.

The next step is to calculate age-to-ultimate development factors for each maturity. The age-to-ultimate development factor is the product of each selected age-to-age development factor and the selected age-to-age development factors for subsequent maturities (and the tail factor, if relevant). For example, the age-to-ultimate development factor for losses at age 51 months is the product of the selected age-to-age development factors for 51-63 months and 63-75 months (1.02 x 1.00).

These age-to-ultimate development factors are then applied to the reported losses at the most recent period of development (the latest diagonal in the reported loss triangle) to yield the estimated ultimate losses for each accident year, which are shown below:

6.13 Adjusting Reported Losses to Ultimate

Accident Year	(1) Accident Year Age (Months a/o 3/31/08)	(2) Reported Losses ($000s) a/o 3/31/08	(3) Age-to-Ultimate Development Factor	(4) Estimated Ultimate Losses ($000s)
2002	75	$ 2,188	1.00	$ 2,188
2003	63	$ 2,240	1.00	$ 2,240
2004	51	$ 2,276	1.02	$ 2,322
2005	39	$ 2,125	1.12	$ 2,380
2006	27	$ 1,662	1.46	$ 2,427
2007	15	$ 1,159	2.19	$ 2,538
Total		$ 11,650		$ 14,095

(4) = (2) x (3)

Extraordinary losses should be removed from the historical data used to measure loss development patterns. If an extraordinary loss is reported immediately and the ultimate amount is accurately reflected within the accident year reported losses as of 15 months, its inclusion will likely dampen the 15-27 month development pattern for that accident year.[21] If, on the other hand, the extraordinary loss is reported six months after the end of the accident year, then there will be a large jump in aggregate reported losses from 15 to 27 months, and the 15-to-27 month link ratio will be artificially high for that accident year.

Benefit or coverage changes may also distort loss development patterns. Benefit changes typically affect policies prospectively; in such cases, the effect of the change will first appear in a new accident year row. If the change impacts all claims occurring on or after a certain date, then it is possible that there will be a dramatic change in the absolute amount of losses even though the development pattern is unaffected. In the rare case that the change affects all claims not yet settled regardless of the date the loss occurred, then it may result in a shift of the aggregate loss amounts on a diagonal, which will distort the link ratios. If it is not possible to restate the losses, then any such distortions should be considered during the age-to-age development factor selection process.

The chain ladder method is only one method for calculating loss development. As mentioned earlier, the basic assumption of the chain ladder method is that the historical emergence and payment patterns are indicative of patterns expected in the future. In practice, these assumptions may not hold true. Changes in claims handling methodology or philosophy or even dramatic changes in claims staffing may result in claims being settled faster or slower than historical precedents, and this would violate the basic assumption of the chain ladder method.

In practice, actuaries use a variety of methods to develop losses to ultimate. Some methods, such as Bornhuetter-Ferguson, incorporate a priori assumptions of the expected loss ratio in order to calculate ultimate losses and consequently the outstanding reserve at a point in time. The Bornhuetter-Ferguson method is used in Appendix C. Other methods are used under particular circumstances. For example, the Berquist-Sherman method is often used when a company has experienced significant changes in claim settlement patterns or adequacy of case reserves that would distort development patterns. The method produces adjusted development patterns that are estimated to be consistent with the reserve levels and settlement rates present as of the last diagonal by restating historical development data. Stochastic methods, such as the Mack method, study the variability around loss development so actuaries can better understand the risk of adverse development. These methods are covered in more detail in literature regarding loss reserving methodologies.

In many insurance companies, different professionals may be responsible for estimating ultimate losses for the purposes of ratemaking verses establishing adequate reserve levels. Though the applications are different, the goal of estimating ultimate losses is the same. It is important that these professionals share knowledge of data, methods, and results in order to ensure consistent management of the company.

Loss Trend

In addition to projecting historical losses to an ultimate level, it is necessary to adjust the losses for underlying trends expected to occur between the historical experience period and the period for which the rates will be in effect. Claim frequencies and claim costs are both impacted by underlying factors that may change expected levels over time. These changes in frequency and severity are referred to as loss

[21] This assumes the estimate of the extraordinary loss is reasonably accurate and will change less drastically (as a percentage) than the non-excess losses. If the extraordinary loss increases by more than the normal losses, then the 15-27 month factor will actually be increased.

trends. The actuary should use the available data to estimate the loss trends in an effort to project the historical losses into the future.

Loss Trend Selections

Monetary inflation, increasing medical costs, and advancements in safety technology are examples of factors that can drive loss trends. Social influences also impact loss costs. Actuarial Standard of Practice No. 13, Trending Procedures in Property/Casualty Insurance Ratemaking (Actuarial Standards Board of the American Academy of Actuaries 2009) defines social influences as “the impact on insurance costs of societal changes such as changes in claim consciousness, court practices, and legal precedents, as well as in other non-economic factors.” Distributional changes in a book of business also affect frequencies and severities. If the proportion of risky policies is growing, loss costs will be expected to increase.

Actuaries generally measure loss trend by fitting curves to historical data. In addition to analyzing pure premium data, frequency and severity are typically analyzed separately to better understand the underlying drivers of the trend. For example, if an insurance company heavily markets a higher deductible, the resulting shift in distribution will lower frequencies but is likely to increase severities. It may be difficult to detect these changes in a pure premium analysis.

The years chosen to be included in the historical data is based on the actuary’s judgment, in consideration of both responsiveness and stability. Though the aim of the analysis is to detect the true underlying trend, influences such as the cyclical nature of insurance and random noise may be difficult to eliminate from the trend analysis. The actuary should, however, adjust the trend data for more easily quantifiable effects such as seasonality and the effect of benefit level changes, which will be addressed later.

Actuaries working in different lines of business may look at different or multiple views of the losses for analyzing trend. In more stable, short-tailed lines of business (e.g., automobile physical damage), the actuary typically analyzes calendar year paid losses for the 12 months ending each quarter. Calendar year data is readily available, the paid loss definition eliminates any distortion from changes in case reserving practices, and the use of 12-month rolling data attempts to smooth out the effect of seasonality. An actuary working on a more volatile and often long-tailed line of business (e.g., workers compensation medical) typically analyzes the trend in accident year reported losses that have already been developed to ultimate and adjusted for benefit changes.

Similar to loss development, it is prudent to undertake the trend analysis on a body of homogeneous claims; this may imply a line of business or something more granular (e.g., separating indemnity and medical losses within workers compensation insurance). Liability claims and property claims are typically analyzed separately. Experience by geography (e.g., state) may also be analyzed separately.

Regardless of loss definition used, frequency, severity, and pure premium are calculated for each time period and the change from period to period is analyzed. Linear and exponential regression models are the most common methods used to measure the trend in the data. The linear model results in a projection that increases by a constant amount for each unit change in the ratio measured (e.g., claim severities). The exponential model produces a constant rate of change in the ratio being measured. Both types of models may be appropriate when measuring increasing trends, though the linear model will eventually project negative values when measuring decreasing trends. Since there is no such thing as a negative frequency or severity in insurance, this is a shortcoming of linear trend models.

The following example shows the result of an exponential curve fit to different durations of calendar year paid frequency, severity, and pure premium data for the 12 months ending each quarter.

6.14 Exponential Loss Trend Example

Year Ending Quarter	Earned Exposure	Closed Claim Count	Paid Losses	Frequency	Annual % Change	Severity	Annual % Change	Pure Premium	Annual % Change
Mar-09	131,911	7,745	$8,220,899	0.0587	--	$ 1,061.45	--	$ 62.32	--
Jun-09	132,700	7,785	$8,381,016	0.0587	--	$ 1,076.56	--	$ 63.16	--
Sep-09	133,602	7,917	$8,594,389	0.0593	--	$ 1,085.56	--	$ 64.33	--
Dec-09	135,079	7,928	$8,705,108	0.0587	--	$ 1,098.02	--	$ 64.44	--
Mar-10	137,384	7,997	$8,816,379	0.0582	-0.9%	$ 1,102.46	3.9%	$ 64.17	3.0%
Jun-10	138,983	8,037	$8,901,163	0.0578	-1.5%	$ 1,107.52	2.9%	$ 64.04	1.4%
Sep-10	140,396	7,939	$8,873,491	0.0565	-4.7%	$ 1,117.71	3.0%	$ 63.20	-1.8%
Dec-10	140,997	7,831	$8,799,730	0.0555	-5.5%	$ 1,123.70	2.3%	$ 62.41	-3.2%
Mar-11	140,378	7,748	$8,736,859	0.0552	-5.2%	$ 1,127.63	2.3%	$ 62.24	-3.0%
Jun-11	139,682	7,719	$8,676,220	0.0553	-4.3%	$ 1,124.01	1.5%	$ 62.11	-3.0%
Sep-11	138,982	7,730	$8,629,925	0.0556	-1.6%	$ 1,116.42	-0.1%	$ 62.09	-1.8%
Dec-11	138,984	7,790	$8,642,835	0.0560	0.9%	$ 1,109.48	-1.3%	$ 62.19	-0.4%
Mar-12	139,155	7,782	$8,602,105	0.0559	1.3%	$ 1,105.38	-2.0%	$ 61.82	-0.7%
Jun-12	139,618	7,741	$8,535,327	0.0554	0.2%	$ 1,102.61	-1.9%	$ 61.13	-1.6%
Sep-12	139,996	7,720	$8,466,272	0.0551	-0.9%	$ 1,096.67	-1.8%	$ 60.48	-2.6%
Dec-12	140,141	7,691	$8,412,159	0.0549	-2.0%	$ 1,093.77	-1.4%	$ 60.03	-3.5%
Mar-13	140,754	7,735	$8,513,679	0.0550	-1.6%	$ 1,100.67	-0.4%	$ 60.49	-2.2%
Jun-13	141,534	7,769	$8,614,224	0.0549	-0.9%	$ 1,108.79	0.6%	$ 60.86	-0.4%
Sep-13	141,800	7,755	$8,702,135	0.0547	-0.7%	$ 1,122.13	2.3%	$ 61.37	1.5%
Dec-13	142,986	7,778	$8,761,588	0.0544	-0.9%	$ 1,126.46	3.0%	$ 61.28	2.1%

Number of Points	Frequency Exponential Fit	Severity Exponential Fit	Pure Premium Exponential Fit
20 point	-1.7%	0.5%	-1.2%
16 point	-1.3%	-0.1%	-1.4%
12 point	-0.7%	-0.2%	-0.9%
8 point	-1.2%	1.2%	-0.1%
6 point	-0.9%	2.5%	1.6%
4 point	-1.5%	3.3%	1.9%

Using statistical methods such as exponential regression also allows for the review of statistical diagnostics. The most commonly used diagnostic is R^2, which is a measure of the reduction of total variance about the mean that is explained by the model.

As demonstrated above, separate exponential models may be fit to the whole of the data and to more recent periods. The actuary ultimately selects the trend(s) to be used to adjust the historical data in the ratemaking experience period to the level expected when the rates will be in effect. If separate frequency and severity trends are selected, these selected trends are combined to a single pure premium trend. For example, a -1% selected annual frequency trend and a +2% selected annual severity trend combine to produce a +1% (= (1.0 - 1%) x (1.0 + 2%) - 1.0) selected annual pure premium trend.

Table 6.14 is an example of using an exponential fit. When using a linear trend approach, the actuary calculates the difference in the frequency, severity, and pure premium rather than the percentage difference. The linear fit produces a constant amount of change (rather than a percentage change). For example, the dollar change based on the 20-point linear fit on the pure premium data is -$0.75.

Catastrophe losses are normally excluded from the loss trend analysis data. If unusually large individual losses are present, the actuary may choose to remove or adjust the extraordinary losses or select loss severity trends based on basic limits loss data. If catastrophe or large losses cannot be identified, the use of 12-month rolling averages is disadvantageous since one event will transfer to multiple data points.[22] In the case of a catastrophe, the frequency and severity will each likely increase significantly when the catastrophe claims enter the trend data and decrease significantly when the catastrophe claims no longer exist in the data. Extraordinary losses tend to be singular claims, so they generally only impact severity. If the data cannot be directly adjusted, the actuary can judgmentally account for the catastrophes or extraordinary losses when making the loss trend selections.

Changes in benefit levels can also affect trend analyses. For example, if a law change increases the expected payments by 10% for all claims occurring after a certain date, it will appear as a positive severity trend until all claims are being settled under the new law. The actuary may attempt to restate the historical trend data to the benefit levels that will be in effect during the period the rates will be in effect. If the data is not restated, then the actuary should consider the impact of the benefit changes during the trend selection process. If the historical data to which selected loss trends will be applied is restated to reflect the new benefit level, then either data adjusted for benefit level should be used for the trend analysis, or the trend analysis must remove the impact of the benefit level change. The pricing actuary must take care not to “double count” the benefit level change in the projected losses.

The ratemaking actuary should use judgment in deciding whether the historical data is overly volatile or otherwise inappropriate for trending purposes. For example, the data may be too sparse or reflect non-recurring events that cannot be appropriately adjusted. Alternatively, the statistical goodness of fit of the trending procedure may be called into question. One option is to supplement the loss trend data with multi-state, countrywide, or industry trend data and consider weighting the results. Alternatively, the actuary may consider non-insurance indices, if available. For example, the medical component of the CPI (Consumer Price Index) may be relevant when selecting severity trends for insurance products related to medical expense coverage. The U.S. Bureau of Labor Statistics also publishes average weekly wage changes by state, which can be useful when selecting trends for U.S. workers compensation indemnity losses.

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[22] If catastrophe claims are paid in the first quarter of 2011, then they will affect the 12-month calendar year loss trend data for the 12 months ending the first, second, third, and fourth quarters of 2011. If the catastrophe claims are paid out over several quarters, then it will extend the impact even further.

In addition to regression models, more sophisticated techniques such as econometric models and generalized linear models may be employed for quantifying loss trends. A more detailed discussion of these methods is beyond the scope of this text.

Loss Trend Periods

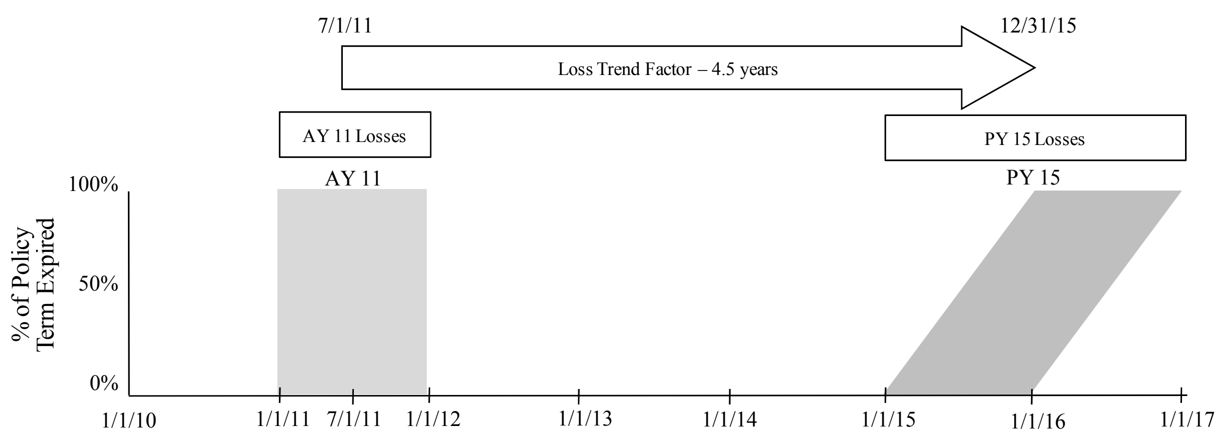
Selecting the loss trend(s) is only the first step of the trending process. Similar to premium trends, the actuary must calculate the applicable **loss trend period**. This is the period of time from the average loss occurrence date of each experience period (typically a calendar-accident year) to the average loss occurrence date for the period in which the rates will be in effect (a policy year or years). This latter period is referred to as the forecast period. The loss trend period depends on both the term of the policy and the expected duration for the new rates, typically chosen as one year.

For example, assume the following:

- The losses to be trended are from Accident Year 2011.
- The company writes annual policies.
- The proposed effective date is January 1, 2015.
- The length of time the rates are expected to be in effect is one year.

The average loss occurrence date of Calendar-Accident Year 2011 (sometimes called the "trend from" date) is assumed to be July 1, 2011. This is the midpoint of the calendar-accident year period for which the annual policies provide coverage. The average loss occurrence date for the policy year period in which rates will be in effect (sometimes called the "trend to" date) is assumed to be December 31, 2015. This is because the policies will be written between January 1, 2015, and December 31, 2015, but the coverage for these policies will extend until December 31, 2016. The midpoint of that two-year time period is December 31, 2015. Therefore, the loss trend period for Calendar-Accident Year 2011 is 4.5 years. The following picture displays this.

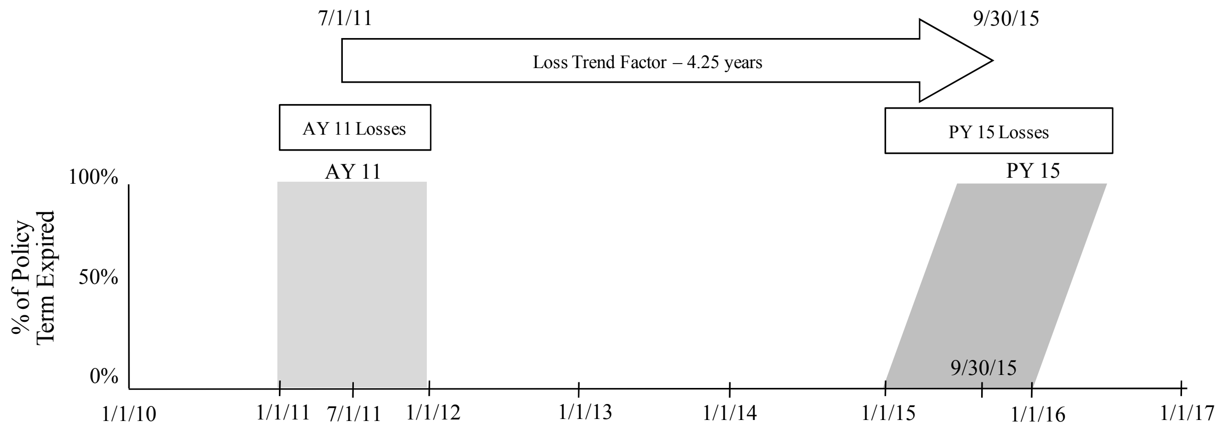
6.15 Loss Trend Period for 12-month Policy Term



The annual pure premium trend selected above, +1%, is applied to Calendar-Accident Year 2011 losses by multiplying the historical losses by $(1.01)^{4.5}$, which is referred to as a loss trend factor.

If the policy term were semi-annual rather than annual, the "trend from" date would not change, but the "trend to" date would be different. Coverage for policies written between January 1, 2015 and December 31, 2015 would extend over an 18-month period, of which the midpoint would be 9 months (i.e., September 30, 2015). The trend length would be 4.25 years, as displayed below.

6.16 Loss Trend Period for 6-month Policy Term



If the historical data were aggregated by policy year, the average loss occurrence date with respect to an annual policy term would be one year after the start of the policy year, as policies are in effect over a 24-month period. The "trend to" date is the average loss occurrence date for the policy year period in which rates will be in effect. Therefore, the trend period for Policy Year 2011 annual term policies is 4 years (January 1, 2012 to December 31, 2015), as shown in Exhibit 6.17. The Policy Year 2011 trend factor , which would be applied to Policy Year 2011 losses, is 1.0406 (= $1.01^{4.0}$).

6.17 Loss Trend Period for 12-month Policy Term and PY experience period

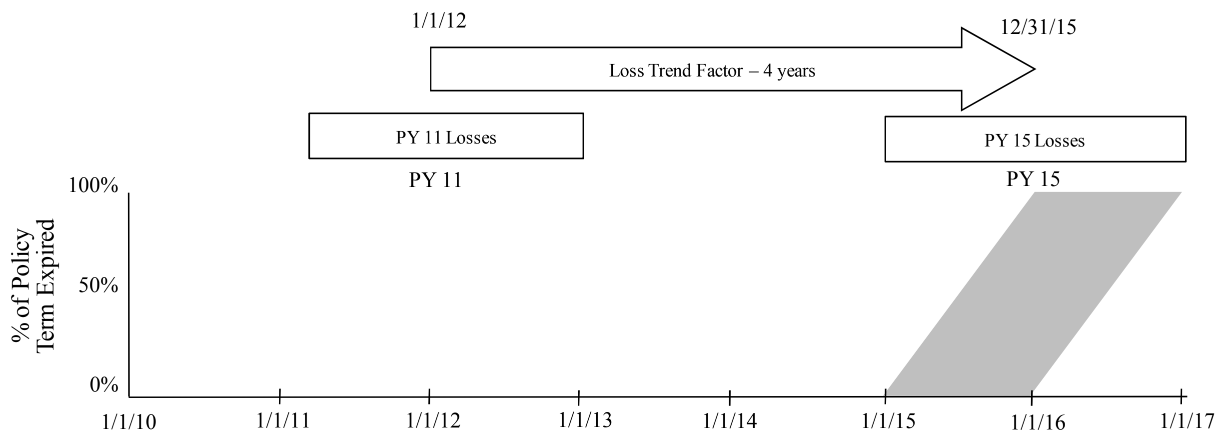
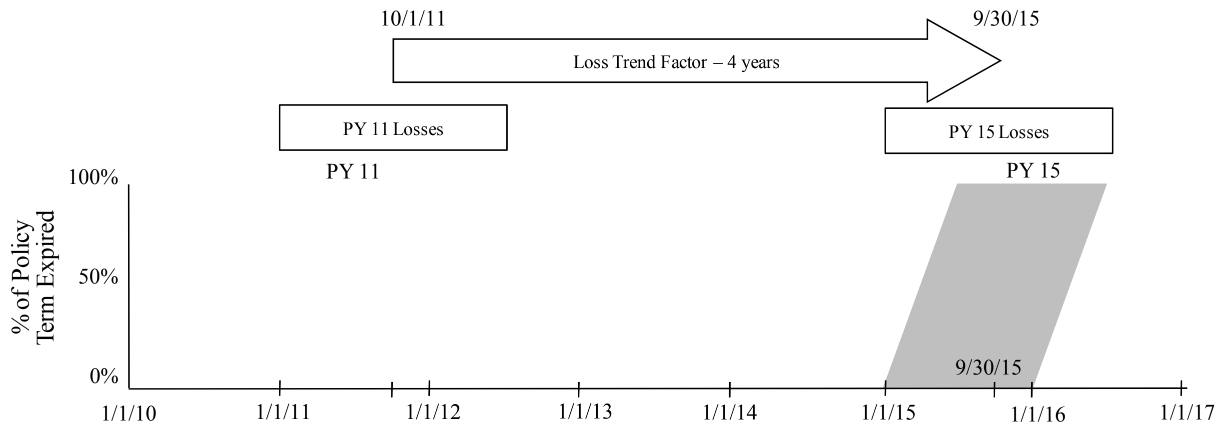


Exhibit 6.18 shows the same policy year scenario but with semi-annual policies. Both the "trend from" and "trend to" dates are three months earlier than the annual policy scenario since the average occurrence date for semi-annual policies is nine months after the start of the policy year. The trend length is still 4 years.

6.18 Loss Trend Period for 6-month Policy Term and PY experience period

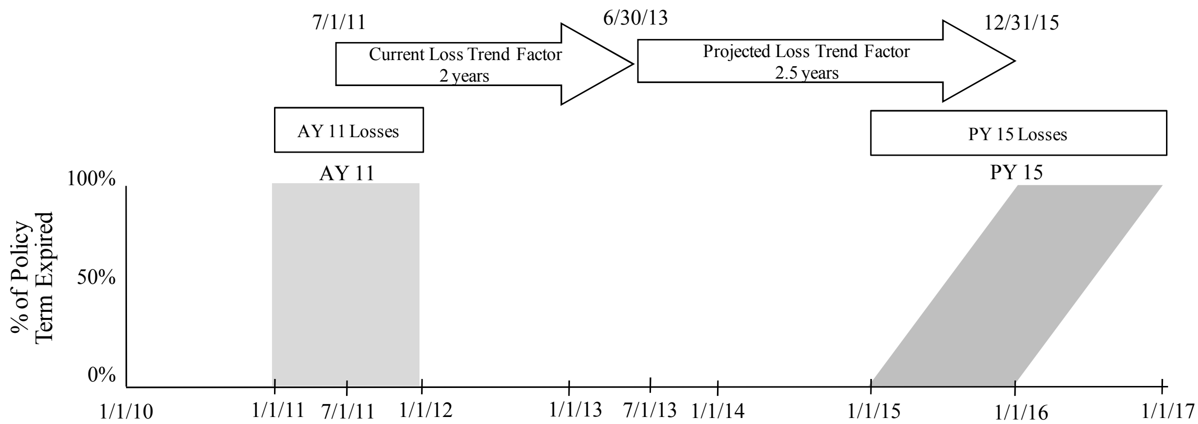


If the trend selection is based on a linear trend, then the selected trend is a constant amount rather than a percentage. In this case, the projected dollar change is calculated by multiplying the selected annual trend by the length of the trend period. For example, assume the selected annual pure premium linear trend is $1.00 per year, then the dollar increase due to 4 years of trend is $4.00 (= $1.00 x 4.0).

In some circumstances, the actuary may choose to undertake a two-step trending process. This technique is beneficial when the actuary believes that the loss trend in the historical experience period and the expected trend for the forecast period are not identical. For example, some lines of business may require several historical years be used when projecting losses for ratemaking purposes. If the trend during that historical period has been significantly different from what is expected to occur in the future, it may make sense to adjust the historical data to current levels accordingly, but to apply a different trend into the forecast period to reflect what is expected to occur in the future. Legislative changes in the trend data are a particular example when the two-step trending process may be appropriate if the trend exhibited in the historical period is clearly different from that expected in the future.

In the exponential trend data shown in Table 6.14, one can see that the historical severity trend exhibits a different pattern in more recent periods than in earlier years. First, the losses in the experience period are trended from the average accident date in the experience period to the average accident date of the last data point in the trend data. For example, the average loss occurrence date of Calendar-Accident Year 2011 (the “trend from” date) is assumed to be July 1, 2011. If the last data point in the loss trend data is the twelve months ending fourth quarter 2013, the average accident date of that period (the “trend to” date) is June 30, 2013. The current trend period is therefore 2 years. If the selected current trend is -1%, the factor to adjust Calendar-Accident Year 2011 losses to the average accident date of the latest data point is 0.98 (= $(1.0 - 1\%)^2$). Second, these trended losses are projected from the average accident date of the latest data point (the “project from” date of June 30, 2013) to the average loss occurrence date for the forecast period (assuming annual policies, the “project to” date of December 31, 2015). The length of this projection period is 2.5 years. If the loss projection trend selected is 2%, losses trended to current level are further adjusted by a factor of 1.05 (= $(1.0 + 2\%)^{2.5}$). The following picture displays this.

6.19 Two-Step Trend Periods for 12-month Policy



If calendar year data is used to measure loss trend, one of the underlying assumptions is that the book of business is not significantly increasing or decreasing in size. This assumption sometimes does not hold in reality and therefore using calendar year data to measure trend can cause over or underestimation of the trend. The problem with calendar year data is that claims (or losses) in any calendar year may have come from older accident years, yet they are matched to the most recent calendar year exposures (or claims). A change in exposure levels changes the distribution of each calendar year's claims by accident year.

The solution is to attempt to match the risk with the appropriate exposure. One alternative mentioned previously is to use econometric techniques or generalized linear models to measure trend. This will absorb changes in the size of the portfolio as well as changes in the mix of business. Another approach is to measure the trend using accident year data (in lieu of calendar year data). This is often done in commercial lines trend analysis even when the portfolio size is not changing dramatically—merely because the calendar year results are unreliable for trend purposes. The accident year losses (or claim counts) need to be developed to ultimate before measuring the trend, which introduces some subjectivity into the trend analysis.

Another alternative is to analyze the trend in incremental calendar year frequencies or severities. This involves splitting each calendar year's claim counts (or paid losses) by accident year and matching them to the exposures (or claim counts) that produced them. For example, assume Calendar Year 2010 has paid losses on claims from Accident Years 2010, 2009, and 2008. The Calendar Year 2010 frequency is the sum of all paid claim counts in Calendar Year 2010 divided by Calendar Year 2010 exposures. The alternative approach sums three incremental Calendar Year 2010 frequencies:

- Calendar Year 2010 paid claim counts from Accident Year 2010 divided by Calendar Year 2010 exposures
- Calendar Year 2010 paid claim counts from Accident Year 2009 divided by Calendar Year 2009 exposures
- Calendar Year 2010 paid claim counts from Accident Year 2008 divided by Calendar Year 2008 exposures

If the company's exposures decreased substantially during the period of 2008-2010, the company will be settling claims in 2010 produced from a larger portfolio (Accident Years 2008 and 2009) but comparing them to the smaller book than the company has today (Calendar Year 2010 exposures).

The alternative method more properly matches the older claim counts to the older exposures; moreover this method would be valid whether the portfolio is changing or not. More detail on this alternative approach to trending can be found in Chris Styrsky's paper "The Effect of Changing Exposure Levels on Calendar Year Loss Trends" (Styrsky, 2005).

Leveraged Effect of Limits on Severity Trend

When the loss experience being analyzed is subject to the application of limits, it is important that the leveraged effect of those limits on the severity trend be considered. Basic limits ratemaking was discussed in an earlier section. Recall basic limits losses are losses that have been censored at a pre-defined limit referred to as a "basic limit." Total limits losses are losses that are uncensored, and excess limits are the portion of the losses that exceed the basic limit (or the difference between total limits and basic limits losses). It is important to understand that severity trend affects each of these differently.

Consider the following simple example in which every total limits loss is subject to a 10% severity trend.

6.20 Effect of Limits on Severity Trend

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Trended Losses					
Claim Number	Total Limits Loss	Losses Capped @ $ 25,000	Excess Losses	Total Limits Loss	Total Limits Trend	Capped @ $25,000 Loss	Capped @ $25,000 Trend	Excess Losses Loss	Excess Losses Trend
1	$ 10,000	$ 10,000	$ -	$ 11,000	10.0%	$ 11,000	10.0%	$ -	N/A
2	$ 15,000	$ 15,000	$ -	$ 16,500	10.0%	$ 16,500	10.0%	$ -	N/A
3	$ 24,000	$ 24,000	$ -	$ 26,400	10.0%	$ 25,000	4.2%	$ 1,400	N/A
4	$ 30,000	$ 25,000	$ 5,000	$ 33,000	10.0%	$ 25,000	0.0%	$ 8,000	60.0%
5	$ 50,000	$ 25,000	$ 25,000	$ 55,000	10.0%	$ 25,000	0.0%	$ 30,000	20.0%
Total	$ 129,000	$ 99,000	$ 30,000	$ 141,900	10.0%	$ 102,500	3.5%	$ 39,400	31.3%

(2)= min[(1) , $25,000]
(3)= (1) - (2)
(4)= (1) x 1.10
(5)= (4) / (1) - 1.0
(6)= min[(4) , $25,000]
(7)= (6) / (2) - 1.0
(8)= (4) - (6)
(9)= (8) / (3) -1.0

As can be seen in the table above, the 10% trend in total limits losses affects basic limits losses and excess losses differently. On average, the 10% total limits trend is dampened to 3.5% when considering the basic limits losses. The two smallest losses (Claims 1 and 2) are significantly below the limit of $25,000 and were still under $25,000 even after the 10% increase. Claim 3 was below $25,000 before trend was applied, but the trend pushes the total amount of that claim above the basic limit. Consequently, only 4.2% of the trend increase is realized in the basic limit layer. Claims 4 and 5 were already in excess of $25,000, so the amount of loss under the limit is the same before and after the trend.

In contrast to the basic limits, the magnitude of the positive trend on excess losses is greater than the total limits trend. Because Claims 1 and 2 are significantly below the limit, they do not exceed the limit even after the 10% increase and do not impact the trend in the excess layer. Claim 3 was below the limit prior to the application of trend, but pierced into the excess layer after the trend. Claims 4 and 5 were already higher than the limit; consequently, the entire increase in losses associated with these claims is realized in the excess losses trend.

Table 6.21 highlights the differences in trend for each layer:

6.21 Effect of Limits on Increasing Severity Trend

Initial Loss Size	Basic Limits	Total Losses	Excess Losses
$\text{Loss} < \dfrac{\text{Limit}}{1.0 + \text{Trend}}$	Trend	Trend	Undefined
$\dfrac{\text{Limit}}{1.0 + \text{Trend}} \leq \text{Loss} < \text{Limit}$	$\dfrac{\text{Limit}}{\text{Loss}} - 1.0$	Trend	Undefined
$\text{Limit} \leq \text{Loss}$	0%	Trend	$\dfrac{[\text{Loss} \times (1.0 + \text{Trend})] - \text{Limit}}{\text{Loss} - \text{Limit}}$

In the case of positive severity trend this means:

$$\text{Basic Limits Trend} \leq \text{Total Limits Trend} \leq \text{Excess Losses Trend.}$$

In the case of negative severity trends, the relationship becomes:

$$\text{Excess Losses Trend} \leq \text{Total Limits Trend} \leq \text{Basic Limits Trend.}$$

Where severity trends have been analyzed based on total limits loss data, the resulting indicated severity trend must be adjusted before it is applied to basic limits losses for ratemaking purposes. Alternatively, some actuaries prefer to use basic limits data in analyzing severity trend.

Note that deductibles also have a leveraging effect on severity trend. The mathematics is analogous to excess losses except that the censoring is done below the deductible rather than above the limit.

Coordinating Exposure, Premium, and Loss Trends

Trends in exposure and premium were discussed in prior chapters. Whether examining loss ratios or pure premiums to determine the rate level indication, it is important to make sure that all components of the formula are trended consistently. This can be a little more challenging for lines of business with inflation-sensitive exposure bases (e.g., payroll in workers compensation, gross revenue in commercial general liability, etc.).

When deriving a pure premium rate level indication, pure premiums are projected into the forecast period. Three types of trends that are considered in that projection are changes in the likelihood of a claim happening, changes in the average cost of claims, and changes in the level of exposure.

When the company's internal frequency and severity trend data is used as the basis of the loss trend analysis, the changes in frequency (i.e., number of claims divided by exposure) account for the net effect of the change in the probability of having a claim and the change in exposure. This also holds when examining pure premium data.

When using inflation-sensitive exposure bases, the inflationary pressure on the exposure can mask part or all of the change in the likelihood of claims occurring. This makes it difficult to understand how the loss components are changing over time. In order to remove the effect of the changing exposure, the actuary may choose to examine historical frequencies (or pure premiums) that have been adjusted for exposure trend (i.e., the denominator has been adjusted by the exposure trend). This frequency trend adjusted for changes in exposure is combined with the severity trend to form a pure premium trend, which is then applied to historical losses (which have been or will be adjusted for loss development, benefit changes, extraordinary loss provisions, etc.) to project them into the period for which rates will be in effect. To maintain consistency, this projected loss measure needs to be compared to exposures that have been projected to future levels using the selected exposure trend.

When deriving a loss ratio indication, it is also important to maintain consistency among the components. Some actuaries examine patterns in historical adjusted loss ratios. This is the ratio of losses adjusted for development, benefit changes, and extraordinary losses compared to premium adjusted to current rate level. This trend in this context is sometimes referred to as a "net" trend, though use of the word "net" may be confusing as it is generally used to imply net of reinsurance. Based on the historical pattern in the adjusted loss ratios, the actuary selects a loss ratio trend to adjust the historical loss ratios to the projected policy period. One shortcoming of this approach is that trends in adjusted loss ratios over time may not be stable, and it can be more difficult for the actuary to understand what may be driving the results.

Similar to the discussion above about trending within the pure premium approach, it may be preferable to examine the individual components of the loss ratio statistic. In other words, the actuary examines changes in each component (i.e., frequency, severity, and average premium) separately and adjusts each component accordingly. Assuming the historical exposures are used to calculate the frequency (or pure premium) and average premium used in the trend analysis, each component will be adjusted consistently. Looking at patterns in historical frequency, severity, and exposure separately provides a better understanding of how each individual statistic is changing and therefore how the entire loss ratio statistic is changing.

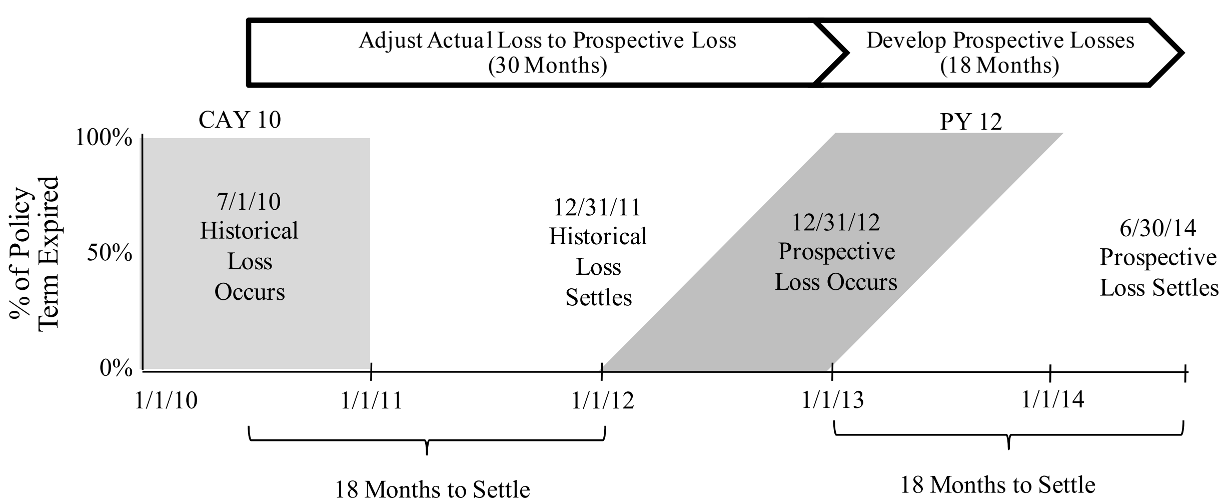
Insurers may choose to use external indices, rather than internal trend data, to select loss trends. For example, a workers compensation insurer may use an external study as the basis to estimate the expected increase in utilization and cost of medical procedures. When this is done, the loss trend selection does not implicitly account for any expected change in the insurer's premium or exposure due to an inflation-sensitive exposure base. Consequently, the exposure or premium needs to be adjusted to reflect any expected change in exposure.

Appendices A-F highlight some of the different approaches. The auto and homeowners examples do not have inflation-sensitive exposure bases and use internal trend data, so the coordination is straightforward. However, the homeowners example does include a projection of the amount of insurance years, which is necessary for the projection of the non-modeled catastrophe loading. The medical malpractice loss ratio example includes a net trend approach. Trend selections are made using internal data. The "frequency" is actually the number of claims divided by the premium, so the frequency selection accounts for pure frequency trend as well as premium trend. The workers compensation example separately applies loss and exposure trend.

Overlap Fallacy: Loss Development and Loss Trend

It may seem that trending and developing losses results in overlapping adjustments; however, this is not the case. Recall that losses in the historical experience period occurred months or years prior to the period the rates will be in effect and are not normally fully developed at the time of the analysis. Trending procedures restate losses that occurred in the past to the level expected for similar losses that will occur during the future period in consideration of inflation and other factors. Loss development procedures bring the immature losses to their expected ultimate level. It is true that loss development incorporates inflationary pressures that cause payments for reported claims to increase in the time after reporting, but this does not prove an overlap either. The timeline below provides a graphical illustration of how losses are trended and developed.

6.22 Overlap Fallacy



In this example, the historical experience period is Calendar-Accident Year 2010. The average date of claim occurrence is July 1, 2010. Assume it is typical for claims to settle within 18 months, so this "average claim" will settle on December 31, 2011. The projection period is the policy year beginning January 1, 2012 (i.e., rates are expected to be in effect for annual policies written from January 1, 2012, through December 31, 2012). The average hypothetical claim in the projected period will occur on

January 1, 2013, and settle 18 months later on June 30, 2014 (i.e., consistent with the settlement lag of 18 months). Trend adjusts the average historical claim from the loss cost level that exists on July 1, 2010, to the loss cost level expected on January 1, 2013; while trended to the new cost level, the adjusted claim is still not fully developed. Development adjusts the trended, undeveloped claim to the ultimate level, which is expected to be achieved by June 30, 2014.

In conclusion, the goal is to project the expected settlement value of the average historical claim (which occurred on July 1, 2010) as if it were to occur on December 31, 2012, and be settled on June 30, 2014. This duration of 48 months represents the 30 months of trend to adjust the cost level to that anticipated during the forecast period and the 18 months of development to project this trended value to its ultimate settlement value.

LOSS ADJUSTMENT EXPENSES

Loss adjustment expenses (LAE) are all costs incurred by a company during the claim settlement process. As such, they are more appropriately placed with a discussion of losses than with other insurance company expenses.

Claim adjusters' fees, claim department overhead, and legal defense costs are examples of LAE. Traditionally, LAE have been divided into two categories, allocated and unallocated loss adjustment expenses. **Allocated loss adjustment expenses (ALAE)** are those costs that can easily be related to individual claims. Legal fees to defend against a specific claim or costs incurred by a claim adjuster assigned to one claim are ALAE. **Unallocated loss adjustment expenses (ULAE)** are those that are more difficult to assign to particular claims, such as claim department salaries.

In 1998, the insurance industry introduced new LAE definitions in an attempt to improve financial reporting consistency between companies in the US. Instead of categorizing loss adjustment expenses by allocated or unallocated for financial reporting purposes, costs are now split into **defense cost and containment (DCC) expenses** and **adjusting and other (A&O) expenses**. DCC expenses include costs incurred in defending claims, including expert witness fees and other legal fees. A&O include all other expenses. Prior to the switch, companies with in-house attorneys sometimes coded legal expenses as ULAE, while companies using outside legal counsel coded these expenses as ALAE. This historic difference made comparing operations metrics across companies difficult. The new standardization of the definitions makes these comparisons more meaningful. Despite the change in U.S. financial reporting definitions, this text will refer to the subdivisions of ALAE and ULAE, which are more commonly used in ratemaking.

In general, ALAE or DCC vary by the dollar amount of each claim, while ULAE or A&O vary by the number of claims reported. For ratemaking purposes, ALAE are often included with losses. This includes both the losses used for projection as well as the losses used in detecting patterns of loss development and trend. Some pricing actuaries, most notably in commercial lines, may elect to study development and trend patterns separately for loss and ALAE. This is done if ALAE are significantly high for the given line of business or in order to detect any changes in ALAE patterns. It is also important for the actuary to understand whether ALAE are subject to the policy limits or not. This does not necessarily affect the treatment of ALAE in a ratemaking context, but it emphasizes the need to understand whether the ALAE data retrieved is the entire ALAE or only the portion included within the policy limits.

On the other hand, ULAE are more difficult to incorporate into the loss projection process. At any time a claims department may be working on settling claims that arise from events occurring during many historical time periods and pertaining to many lines of business. Because of this, companies need to allocate ULAE to losses in a sensible way.

A simple method for allocating ULAE is based on the assumption that ULAE expenditures track with loss and ALAE dollars consistently over time, both in terms of rate of payment and in proportion to the amount of losses paid. The procedure involves calculating the ratio of calendar year paid ULAE to calendar year paid loss plus ALAE over several years (e.g., three years or longer, depending on the line of business). This ratio (see Table 6.23) is then applied to each year's reported loss plus ALAE to incorporate ULAE. The ratio is generally calculated on losses that have not been adjusted for trend or development as this data is readily available for other financial reporting. This inherently assumes that ULAE trend and develop at the same rate as loss plus ALAE. The resulting ratio of ULAE to loss plus ALAE is then applied to loss plus ALAE that has been adjusted for extraordinary events, development, and trend. For lines of business where ALAE is not substantial (e.g. homeowners), this adjustment may be done for ALAE and ULAE combined.

6.23 ULAE Ratio

Calendar Year	(1) Paid Loss and ALAE	(2) Paid ULAE	(3) ULAE Ratio
2008	$ 913,467	$ 144,026	15.8%
2009	$ 1,068,918	$ 154,170	14.4%
2010	$ 1,234,240	$ 185,968	15.1%
Total	$ 3,216,625	$ 484,164	15.1%
		(4) ULAE Factor	1.151

(3) = (2) / (1)
(4) = 1.0 + (Tot3)

Catastrophic events can cause extraordinary loss adjustment expenses. For example, in the event of a major catastrophe, a company may have to set up temporary offices in the catastrophe area. To the extent that those costs are significant and irregular, the historical ratio will be distorted. Thus, catastrophe loss adjustment expenses are generally excluded from the standard ULAE analysis and are determined as part of the catastrophe provision.

The method described above is a dollar-based allocation method. Actuaries may also consider count-based allocation methods that assume the same kinds of transactions cost the same amount regardless of the dollar amount of the claim, and that there is a cost associated with a claim remaining over time. More detail on such methods is beyond the scope of this text.

Another ULAE allocation approach is to study how claim adjusters spend their time—working on what types of claims, what types of claim activities, lines of business, etc. This may not be an easy undertaking, but it does bring more confidence that the ULAE dollars are being allocated for ratemaking purposes according to how they are being spent in practice. Before proceeding, the actuary should consider whether the cost of the study is worth the additional accuracy gained as the effort can be very time-consuming.

SUMMARY

Losses and LAE usually represent the largest component of insurance costs and require the most attention from the pricing actuary. The pricing actuary's role is to estimate expected losses and LAE for a future policy period. This is typically done based on aggregated historical data with a series of adjustments. Losses need to be adjusted for non-recurring extreme events such as shock losses, catastrophes, and benefit changes. They also need to be adjusted to reflect ultimate settlement values and future cost levels. These latter adjustments are typically calculated based on examination of historical patterns of loss development and trend. Finally, the actuary needs to incorporate any loss adjustment expenses that will be paid to investigate and settle claims.

Examples of these loss and LAE adjustments and how they are incorporated in overall rate level analyses for various lines of business are included in Appendices A-D.

KEY CONCEPTS IN CHAPTER 6

1. Loss definitions
    a. Paid loss
    b. Case reserves
    c. Reported loss
    d. Ultimate loss

2. Loss aggregation methods
    a. Calendar year
    b. Calendar-accident year
    c. Policy year
    d. Report year

3. Common ratios involving losses
    a. Frequency
    b. Severity
    c. Pure premium
    d. Loss ratio

4. Extraordinary losses

5. Catastrophe losses
    a. Non-modeled catastrophes
    a. Modeled catastrophes

6. Reinsurance recoveries and costs

7. Changes in coverage or benefit levels

8. Loss development

9. Loss trend
    a. Loss trend selection
    b. Loss trend period
    c. Leveraging effect of limits on severity trend
    d. Coordinating exposure, premium, and loss trends

10. Overlap fallacy

11. Loss adjustment expenses (LAE)
    a. Definitions of allocated and unallocated LAE
    b. Treatment of ALAE
    c. Allocation of ULAE

CHAPTER 7: OTHER EXPENSES AND PROFIT

As stated in Chapter 1, the fundamental insurance equation is as follows:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

The role of a pricing actuary is to estimate each of these components for the period during which the proposed rates will be in effect. The preceding chapters provided techniques for estimating the projected premium and the projected losses and LAE. This chapter addresses:

- How to derive projected underwriting expense ratios
- How to incorporate the cost of reinsurance in a ratemaking analysis
- How to incorporate an underwriting profit provision in rates

SIMPLE EXAMPLE

The following simple example illustrates how expenses and profit are incorporated within the fundamental insurance equation and in the ratemaking process. Assume the following:

- The average expected loss and LAE ($\bar{L} + \bar{E}_L$) for each policy is \$180.
- Each time the company writes a policy, the company incurs \$20 in expenses ($\bar{E}_F$) for costs associated with printing and data entry, etc.
- 15% of each dollar of premium collected covers expenses that vary with the amount of premium, (V), such as premium taxes.
- Company management has determined that the target profit provision (Q_T) should be 5% of premium.

If the rates are appropriate, the premium collected will be equivalent to the sum of the expected losses, LAE, underwriting (UW) expenses (both fixed and variable), and the target underwriting profit. Using the notation outlined in the Foreword (p. vi), this can be written as:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

$$P = L + E_L + (E_F + V \times P) + Q_T \times P$$

$$P - (V + Q_T) \times P = L + E_L + E_F$$

$$P = \frac{[L + E_L + E_F]}{[1.0 - V - Q_T]}$$

$$\bar{P} = \frac{[L + E_L + E_F]/X}{[1.0 - V - Q_T]} = \frac{[\bar{L} + \bar{E}_L + \bar{E}_F]}{[1.0 - V - Q_T]}.$$

Substituting the values from the simple example into the formula yields the following premium:

$$\bar{P} = \frac{[\bar{L} + \bar{E}_L + \bar{E}_F]}{[1.0 - V - Q_T]} = \frac{[\$180 + \$20]}{[1.0 - 0.15 - 0.05]} = \$250.$$

In other words, the company should charge $250, which is made up of $180 of expected losses and loss adjustment expenses, $20 of fixed expenses, $37.50 (= 15% x $250) of variable expenses, and $12.50 (= 5% x $250) for the target UW profit. The focus of this chapter is determining the fixed expense provision (i.e., the $20), the variable expense provision (i.e., 15%), and the profit provision (i.e., 5%).

UNDERWRITING EXPENSE CATEGORIES

Companies incur expenses in the acquisition and servicing of policies. These expenses are generally referred to as underwriting expenses (or operational and administrative expenses). Companies usually classify these expenses into the following four categories:

- Commissions and brokerage
- Other acquisition
- Taxes, licenses, and fees
- General

Commissions and brokerage are amounts paid to agents or brokers as compensation for generating business. Typically, these amounts are paid as a percentage of premium written. Commission rates may vary between new and renewal business. In addition, contingent commissions vary the commission based on the quality (e.g., a loss ratio) or amount of business written (e.g., predetermined volume goals).

Other acquisition costs are expenses that are paid to acquire business other than commissions and brokerage expenses. Costs associated with media advertisements, mailings to prospective insureds, and salaries of sales employees who do not work on a commission basis are included in this category.

Taxes, licenses, and fees include all taxes and miscellaneous fees due from the insurer excluding federal income taxes. Premium taxes and licensing fees are examples of items included in this category.

General expenses include the remaining expenses associated with insurance operations and any other miscellaneous costs, excluding investment income expenses (these expenses are typically reflected as an offset to investment income and further discussion is beyond the scope of this text). For example, the general expense category includes overhead associated with the insurer's home office (e.g., building maintenance) and salaries of certain employees (e.g., actuaries).

Actuaries sometimes estimate the underwriting expense provision for ratemaking by further dividing underwriting expenses into two groups: fixed and variable. Fixed expenses are assumed to be the same for each risk, regardless of the size of the premium (i.e., the expense is a constant dollar amount for each risk or policy).[23] Typically, overhead costs associated with the home office are considered a fixed

[23] It is likely that some of these expenses do bear some relationship to risk and may vary with premium, especially in extreme circumstances. Activity-based cost studies may be able to verify the true relationship, and appropriate adjustments can be made.

expense. Variable expenses vary directly with premium; in other words, the expense is a constant percentage of the premium. Premium taxes and commissions are two examples of variable expenses. In the past, no distinction was recognized between fixed and variable expenses, and actuaries estimated all underwriting expenses in the same way. More recently, techniques have been developed to estimate fixed and variable expenses separately in cases where both types of expenses are material.

The magnitude and distribution of underwriting expenses vary significantly for different lines of business. For example, commissions tend to be much higher in lines that require a comprehensive inspection at the onset of the policy (e.g., large commercial property) than for lines that do not involve such activity (e.g., personal automobile). The expenses can even vary significantly by company within a given line of business. For example, a national direct writer may incur significant other acquisition costs for advertising. In contrast, an agency-based company may rely more heavily on the agents to generate new business; consequently, the other acquisition costs will be lower, but this will be at least partially offset by higher commission expenses.

The next sections outline three different procedures used to derive expense provisions for ratemaking:

- All Variable Expense Method
- Premium-based Projection Method
- Exposure/Policy-based Projection Method

ALL VARIABLE EXPENSE METHOD

In the past, actuaries used the All Variable Expense Method, which does not differentiate between fixed and variable underwriting expenses and treats all expenses as variable (i.e., all expenses are assumed to be a constant percentage of premium). More specifically, this method assumes that expense ratios during the projected period will be consistent with the historical expense ratios (i.e., all historical underwriting expenses divided by historical premium). This approach is still used when pricing insurance products for which the total underwriting expenses are dominated by variable expenses (i.e., many commercial lines products). Table 7.1 shows an example of this method for deriving the other acquisition expense provision of a commercial general liability insurer.

7.1 Other Acquisition Provisions Using All Variable Expense Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$72,009	$104,707	$142,072		
b Countrywide Written Premium	$1,532,091	$1,981,109	$2,801,416		
c Variable Expense % [(a)/(b)]	4.7%	5.3%	5.1%	5.0%	5.0%

To derive the expense ratio, the historical calendar year expenses are divided by either calendar year written or earned premium during that same historical experience period. The choice of whether to use written or earned premium depends on whether the expenses under consideration are generally incurred at the onset of the policy (e.g., commissions) or throughout the policy (e.g., building maintenance). Written premium is used when expenses are incurred at the inception of the policy as it reflects the premium at the onset of the policy. Earned premium is used when expenses are assumed to be incurred throughout the policy as it reflects the gradual payment of expenses that can be proportional to the earning of premium over the policy term. As acquisition expenses are generally incurred at the onset of the policy, the example displayed is based on a ratio to written premium. The choice of written or earned premium will have relatively little impact if a company's volume of business is not changing materially (since written premium will be approximately equal to earned premium). However, if a company is growing (or shrinking) significantly, written premium will be proportionately higher (or lower) than earned premium. Similarly, during a period of growth (or decline) the acquisition costs will be higher (or lower) than during a period of stable volume. Use of an appropriate premium measure provides a better match to the types of expenses incurred during the historical period.

Each year U.S. insurance companies must produce an Annual Statement and Insurance Expense Exhibit (IEE). These documents contain a significant amount of accounting data, including historical expense and premium data. However, this data may not be available in the finest level of detail necessary for ratemaking purposes. For example, the homeowners data includes renters and mobile homes data, and as a result, may not be appropriate for deriving expense provisions specifically for homeowners policies. Ideally, the actuary will have access to the source expense data at the level of detail required for each product or subline priced. Of course, the actuary should always weigh the cost of obtaining such data against the additional accuracy gained.

Typically, the choice to use countrywide or state data varies by type of expense. Other acquisition costs and general expenses are usually assumed to be uniform across all locations, so countrywide figures found in the IEE are used to calculate these ratios. The data used to derive commissions and brokerage expense ratios varies from carrier to carrier. Some carriers use state-specific data and some use countrywide figures, depending on whether the company's commission plans vary by location. Taxes, licenses, and fees vary by state and sometimes by territory within a state; therefore, the expense ratios for this category are typically based on state data from the Annual Statement.

The following table summarizes the type of data used in the calculation of the historical expense ratio for each expense category:

7.2 Data Summization for All Variable Expense Method

Expense	Data Used	Divided By
General Expense	Countrywide	Earned Premium
Other Acquisition	Countrywide	Written Premium
Commissions and Brokerage	Countrywide/State	Written Premium
Taxes, Licenses, and Fees	State	Written Premium

The actuary calculates the historical expense ratios for each category and year. Typically, the actuary will also calculate a multi-year average; the multi-year average may be a straight average or a weighted average (a straight average is used in Table 7.1). Generally, the actuary selects a ratio for each expense type based on either the latest year's ratio or a multi-year average of ratios balanced with management input, prior expense loads, and judgment. There are several additional considerations that may affect the selection. Because the ratemaking process is a projection of future costs, the actuary should select an expense ratio consistent with what is expected in the future, and this may differ from a historical ratio. Examples of this are as follows:

- If the commission structure is changing, the actuary should use the expected commission percentage, not the historical percentage.

- If productivity gains led to a significant reduction in staffing levels during the latest historical experience period, then the selected ratios should be based on the expected expenses after the reduction rather than the all-year average.
- A growing portfolio can cause expense ratios to decrease (since the volume will likely increase faster than expenses); however, if the company plans to open a new call center to handle even greater planned growth, consideration should be given to the fact that fixed costs will increase in the short-term until the planned growth is achieved.

If there were non-recurring expense items during the historical period, the actuary should examine the materiality and nature of the expense to determine how to best incorporate the expense in the rates—if at all. If the aggregate dollars spent are consistent with dollars expected to be spent on similar non-recurring projects in the future, then the expense ratios should be similar and no adjustment is warranted. However, if the expense item represents an extraordinary expense, then the actuary must decide to what extent it should be reflected in the rates. For example, assume the extraordinary expense is from a major project to improve the automated policy issuance process. The actuary may decide to reflect the expense in the rates. Assuming the new system will be used for a significant length of time, it may be appropriate to dampen the impact of the item by spreading the expense over a period of several years. On the other hand, if the actuary decides not to reflect the expense in the rates, the expense is basically funded by existing surplus.

Finally, a few states place restrictions on which expenses can be included when determining rates. The scenario above regarding whether an extraordinary expense benefits the policyholder is one such example. As another example, some states do not allow an insurer to include charitable contributions or lobbying expenses in its rates. These expenses must be excluded from the calculation of the historical expense ratios when performing the analysis for business written in the state. If such expenses are recurring, overall future income will be reduced by that state's proportion of the expenses.

In the example shown in Table 7.1, there were no extraordinary expenses and a three-year straight average expense ratio is selected.

This procedure is repeated for each of the expense categories. The sum of the selections for each expense category represents the total expense provision. This provision is used directly in the loss ratio or pure premium rate level indication formulae discussed in Chapter 8.

Potential Distortions Using this Approach

By definition, this procedure assumes that all expenses vary directly with premium and there are no fixed expenses yet some expenses may be constant or nearly constant for each risk. By treating all expenses as variable and incorporating them in the rates via a percentage loading, the expense provision in the rates varies directly with the size of the premium. Consequently, this approach understates the premium need for risks with a relatively small policy premium and overstates the premium need for risks with relatively large policy premium.

Returning to the simple example outlined at the onset of the chapter, the \$20 of fixed expense ($\overline{E}_F$) will be included as a percentage with the other 15% of variable expenses (V). Using the final premium of \$250, the \$20 can be converted into a ratio of 8% (= \$20 / \$250). Treating all expenses as variable, the premium calculation becomes:

$$\overline{P} = \frac{\left[\overline{L} + \overline{E}_{\mathrm{L}}\right]}{[1.0 - (V + (\overline{E}_{\mathrm{F}} / P) - Q_{\mathrm{T}})]} = \frac{\$180}{[1.0 - (0.15 + 0.08) - 0.05]} = \$250.$$

This approach produces the same result (i.e., $250) as the simple example that had the fixed expense included in the numerator as a fixed dollar amount, because the fixed dollar amount of $20 is exactly equivalent to 8% of $250 (i.e., this is the average risk). The following table shows the results of the two methods for risks with a range of average premiums.

7.3 Results of All Variable Expense Method

	Correct Premium			All Variable Expense Method			
Loss Cost	Fixed Expense	Variable Expense and Profit	Premium	Fixed Expense	Variable Expense and Profit	Premium	% Diff
$ 135	$ 20	20%	$ 193.75	$ -	28%	$ 187.50	-3.2%
$ 180	$ 20	20%	$ 250.00	$ -	28%	$ 250.00	0.0%
$ 225	$ 20	20%	$ 306.25	$ -	28%	$ 312.50	2.0%

As can be seen by the table, the All Variable Expense Method undercharges the risks with premium less than the average and overcharges the risks with premium more than the average.

In recognition of this inequity, companies that use this approach may implement a premium discount structure that reduces the expense loadings based on the amount of policy premium charged. This is common for workers compensation insurers and will be discussed in detail in Chapter 11. Some carriers using the All Variable Expense Method may also implement expense constants to cover policy issuance, auditing, and handling expenses that apply uniformly to all policies. The following sections discuss methods for handling fixed expenses more systematically.

PREMIUM-BASED PROJECTION METHOD

For insurance companies that have a significant amount of both fixed and variable underwriting expenses, it is logical to use a methodology that recognizes the two types of expenses separately. One such procedure for handling fixed and variable underwriting expenses separately was the method outlined by David Schofield in "Going from a Pure Premium to a Rate" (Schofield 1998). Like the All Variable Expense Method, this procedure assumes expense ratios during the projected period will be consistent with historical expense ratios (i.e., historical expenses divided by historical premium). The major enhancement is that this approach calculates fixed and variable expense ratios separately (as opposed to a single variable expense ratio) so that each can be handled more appropriately within the indication formulae.[24]

Table 7.4 shows the relevant calculations for the general expenses category.

[24] As discussed in Chapter 8

7.4 General Expense Provisions Premium-Based Projection Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$26,531,974	$28,702,771	$31,195,169		
b Countrywide Earned Premium	$450,000,000	$490,950,000	$530,000,000		
c Ratio [(a) / (b)]	5.9%	5.8%	5.9%	5.9%	5.9%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c) x (d)]					4.4%
f Variable Expense % [(c) x (1.0-(d))]					1.5%

As with the All Variable Expense Method, the first step of this procedure is to determine the percentage of premium attributable to each type of expense. A ratio is calculated for each expense category by dividing the relevant historical underwriting expenses by either written or earned premium for each year during the historical experience period. As before, the choice of premium measure depends on whether the expenses are generally incurred at the onset of the policy or throughout the policy term. In the example, general expenses are assumed to be incurred throughout the policy period, and thus are divided by earned premium.

The expense ratios are calculated for each year as well as the arithmetic average of the three years. A selection is made using the same considerations discussed earlier. For this example, the general expense ratios are very stable and the three-year average ratio is selected. In contrast, if the ratios demonstrated a trend over time, the actuary may select the most recent year's ratio or some other value.

The selected expense ratio is then divided into fixed and variable ratios. Ideally, the company has detailed expense data so that this division can be made directly, or the company has activity-based cost studies that help split each expense category appropriately. In the absence of any such data, the actuary should consult with other professionals within the company to arrive at the best possible assumptions for allocating the company's expenses. The example assumes 75% of the general expenses are fixed, and that percentage is used to split the selected general expense ratio of 5.9% into a fixed expense provision of 4.4% and a variable expense provision of 1.5%.

The fixed and variable expense ratios are summed across the different expense categories to determine total fixed and variable expense provisions. If the analyst needs the average fixed expense per exposure (which is required for the pure premium approach discussed in Chapter 8) instead of a fixed expense ratio, the fixed expense provision can be multiplied by the projected average premium (trending premium into the projection period was discussed in Chapter 5).

$$\text{Fixed Expense Per Exposure} = \text{Fixed Expense Ratio} \times \text{Projected Average Premium}.$$

Potential Distortions Using this Approach

This approach presupposes that the historical fixed and variable expense ratios will be the same as in the projected period. (Of course, the actuary can select other than the historical ratios.) Since the variable expenses (e.g., commissions) vary directly with premium, the historical variable expense ratio will likely be appropriate. However, since the fixed expenses—by definition—do not vary with premium, the fixed expense ratio will be distorted if the historical and projected premium levels are materially different. There are a few circumstances that can cause such a difference to exist.

First, recent rate changes can impact the historical expense ratios and lead to an excessive or inadequate overall rate indication. The historical fixed expense ratios are based on written or earned premium during the historical period. To the extent that rate increases (or decreases) were implemented during or after the historical period, the procedure will tend to overstate (or understate) the expected fixed expenses. The materiality of the distortion depends on the magnitude of rate changes not fully reflected in the historical premium. Also, utilizing three-year historical expense ratios increases the chances of rate changes not being fully reflected in the historical premium. One potential solution to correct this distortion in expense ratios is to restate the historical written or earned premium at current rate level, as was discussed in Chapter 5.

Second, significant differences in average premium between the historical experience period and the projected period can lead to an excessive or inadequate overall rate level indication. Again, the historical expenses are divided by the written or earned premium during that time period. To the extent that there have been distributional shifts that have increased the average premium (e.g., shifts to higher amounts of insurance) or decreased the average premium (e.g., shifts to higher deductibles) without affecting the underwriting expenses, this methodology will tend to overstate or understate the estimated fixed expense ratios, respectively. Interestingly, sometimes the distributional shift can affect both the average premium and average expense levels. For example, a company may incur additional expense by inspecting homes upon renewal; this may also increase the average premium level as inspections may cause the company to increase the amount of insurance required on the home. The magnitude of overstatement or understatement from this distortion depends on the magnitude of difference between the change in average premium and change in average fixed expenses. Using three-year historical expense ratios increases the impact of these premium changes by increasing the amount of time between the historical and projected periods. A potential solution for this is to trend the historical premium to prospective levels, as was discussed in Chapter 5.

Third, the Premium-based Projection Method can create inequitable rates for regional or nationwide carriers if countrywide expense ratios[25] are used and applied to state projected premium to determine the expected fixed expenses. This is essentially allocating fixed expenses to each state based on premium. The average premium level in states can vary due to overall loss cost differences (e.g., coastal states tend to have higher overall homeowners loss costs) as well as distributional differences (e.g., some states have a significantly higher average amount of insurance than other states). If significant variation exists in average rates across the states, a disproportionate share of projected fixed expenses will be allocated to the higher-than-average premium states. Thus, the estimated fixed expenses will be overstated in higher-than-average premium states and understated in the lower-than-average average premium states. If a company tracks fixed expenses by state and calculates fixed expense ratios for each state, then this distortion will not exist.

Return to the simple example outlined at the onset of the chapter. Assuming the historical fixed expense ratio was calculated at a time that the average premium level was \$200 rather than \$250, then the historical expense ratio is 10% (= \$20 / \$200) rather than 8% (= \$20 / \$250). If the 10% is applied to the premium at current rate level, the projected dollars of fixed expense will be \$25 (=\$10% x \$250). Consequently, the overall indicated average premium will be overstated:

[25] State-specific data is usually used for commissions and taxes, licenses, and fees.

$$\bar{P} = \frac{[\bar{L} + \bar{E}_L + \bar{E}_F]}{[1.0 - V - Q_T]} = \frac{[\$180 + \$25]}{[1.0 - 0.15 - 0.05]} = \$256.25.$$

Each of the aforementioned items can lead to material differences depending on the proportion of each premium dollar needed to pay for fixed expenses and the magnitude of the difference between the historical and projected premium levels. Instead of making the time-consuming adjustments, the actuary can use a fixed expense projection method based on exposures or number of policies.

EXPOSURE/POLICY-BASED PROJECTION METHOD

In this approach, variable expenses are treated the same way as the Premium-based Projection Method, but historical fixed expenses are divided by historical exposures or policy count rather than premium. This methodology uses the concepts outlined by Diana Childs and Ross Currie in “Expense Allocation in Insurance Ratemaking” (Currie 1980).

If fixed expenses are assumed to be constant for each exposure, the historical expenses are divided by exposures. On the other hand, if fixed expenses are assumed to be constant for each policy, then historical expenses are divided by the number of policies. Table 7.5 shows the development of the fixed and variable expenses for the general expenses category. (The example in this section uses exposures, but the procedure is exactly the same if policy counts are used instead.)

7.5 General Expense Provisions Using Exposure-Based Projection Method

	2013	2014	2015	3-Year Average	Selected
a Countrywide Expenses	$26,531,974	$28,702,771	$31,195,169		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a) x (b)]	$19,898,981	$21,527,078	$23,396,377		
d Countrywide Earned Exposures	4,378,500	4,665,500	4,872,000		
e Fixed Expense Per Exposure [(c) / (d)]	$4.54	$4.61	$4.80	$4.65	$4.65
f Variable Expense $ [(a) x (1.0-(b))]	$ 6,632,994	$ 7,175,693	$ 7,798,792		
g Countrywide Earned Premium	$450,000,000	$490,950,000	$545,250,000		
h Variable Expense % [(f) / (g)]	1.5%	1.5%	1.4%	1.5%	1.5%

As with the Premium-based Projection Method, the expenses are split into variable and fixed components. The same assumption that 75% of general expenses are fixed is used.[26] The fixed expenses are then divided by the exposures for that same time period. As general expenses in this example are assumed to be incurred throughout the policy, the expense dollars are divided by earned exposures rather than written exposures to determine an average expense per exposure for the indicated historical period.

Table 7.6 shows the data used for this procedure for each expense category.

[26] If premiums and expenses are changing at different rates, then fixed expenses as a percentage of total expenses will change over time, but that may not result in a material distortion.

7.6 Data Summization for Exposure/Policy-Based Projection Method

Expense	Data Used	Divided By Fixed	Divided By Variable
General	Countrywide	Earned Exposure	Earned Premium
Other Acquisition	Countrywide	Written Exposure	Written Premium
Commissions and Brokerage	Countrywide/State	Written Exposure	Written Premium
Taxes, Licenses, and Fees	State	Written Exposure	Written Premium

As discussed earlier, the selection of an expense ratio for each category is generally based on either the latest year or a multi-year average. Similar values for the projected average expense per exposure imply expenses are increasing or decreasing proportionately to exposures. This relationship may hold for some expenses, but may not be accurate for all fixed expenses due to economies of scale. If the company is growing and the projected average expense per exposure is declining steadily each year, then it is an indication that expenses may not be increasing as quickly as exposures due to economies of scale. If the decline is significant and the actuary believes it is because of economies of scale, then the selection should be adjusted to include the impact of economies of scale given expected growth in the book of business.[27]

As mentioned earlier, non-recurring expense items, one-time changes in expense levels, or anticipated changes in expenses should be considered in making the selection. In the example shown, the three-year average expense ratio is selected. If the rate level indication approach requires that the fixed expense be expressed as a percentage of premium (as is the case with the loss ratio approach discussed in Chapter 8), then the average fixed expense per exposure should be divided by the projected average premium.

$$\text{Projected Fixed Expense Ratio} = \frac{\text{Average Projected Fixed Expense Per Exposure}}{\text{Projected Average Premium}}.$$

The variable expenses are treated the same way under both the Premium-based and Exposure/Policy-based Projection Methods. In other words, the variable expenses are divided by the historical premium. As stated above, the three-year average variable expense provision is selected for this example.

Other Considerations/Enhancements

While the Exposure/Policy-based Projection Method does correct for the distortions inherent in the Premium-based Projection and the All Variable Expense Methods, there are still some shortcomings with this method.

First, like the Premium-based Projection Method, this method requires the actuary to split the expenses into fixed and variable portions. Today, this is generally done judgmentally. Perhaps in the future, activity-based cost studies will more accurately segregate expenses. Sensitivity testing had revealed that the overall indication is not materially impacted by moderate swings in the categorization of expenses.

Second, the method essentially allocates countrywide fixed expenses to each state based on the exposure or policy distribution by state (as it assumes fixed expenses do not vary by exposure or policy). In reality,

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[27] If the selected expense trend is based on historical internal expense data (e.g., historical changes in average expense per exposure) rather than external indices, then the trend will implicitly include the impact of economies of scale in the past. Assuming the impact of economies of scale will be the same as in the past, the projected average expense per exposure should be consistent and no further adjustment is necessary.

average fixed expense levels may vary by location (e.g., advertising costs may be higher in some locations than others). If a regional or nationwide carrier considers the variation to be material, the company should try to collect data at a finer level and make the appropriate adjustments. Once again, the cost of the data collection should be balanced against the additional accuracy gained.

Third, some expenses that are considered fixed actually vary by certain characteristics. For example, fixed expenses may vary between new and renewal business. This only affects the overall statewide rate level indication if the distribution of risks for that characteristic is either changing dramatically or varies significantly by state, or both. Even if there is no impact on the overall rate level indication, any material fixed expense cost difference not reflected in the rates will impact the equity of the two groups. To make rates equitable for the example of new versus renewal business, material differences in new and renewal provisions should be reflected with consideration given to varying persistency levels as described by Sholom Feldblum in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/Casualty Insurers" (Feldblum 1996).

Finally, the existence of economies of scale in a changing book may lead to increasing or decreasing projected average fixed expense figures. Further studies may reveal techniques for better approximating the relationship between changes in exposures/policies and expenses to assist in capturing the impact of economies of scale. Until then, internal expense trend data and actuarial judgment should suffice for incorporating the impact of economies of scale.

TRENDING EXPENSES

There is an expectation that expenses, like most monetary values, will change over time due to inflationary pressures and other factors.

Variable expenses are, by definition, assumed to be a constant percentage of the premium. For example, commissions may be 10% of premium. The historical expense ratios and other information are used to select a percentage that is to apply to the premium from policies written during the time the rates will be in effect. Thus, the variable expenses will automatically change as the premium changes, so there is no need to trend the variable expense ratio.

Fixed expenses, on the other hand, are assumed to be a constant dollar amount (i.e., an average fixed expense per exposure or policy). There is an expectation that the average fixed expenses will increase over time due to inflationary pressures.

In the Premium-based Projection Method, the fixed expense ratio is the fixed expenses divided by premium. Approaches for trending expenses vary by company. If the average fixed expenses and average premium are changing at the same rate, then the fixed expense ratio will be consistent and no trending is necessary. However, some companies trend the fixed expense ratio, which implies that average fixed expenses are changing at a different rate than average premium. For the purpose of this text, the fixed expense provision calculated using that methodology is not trended.

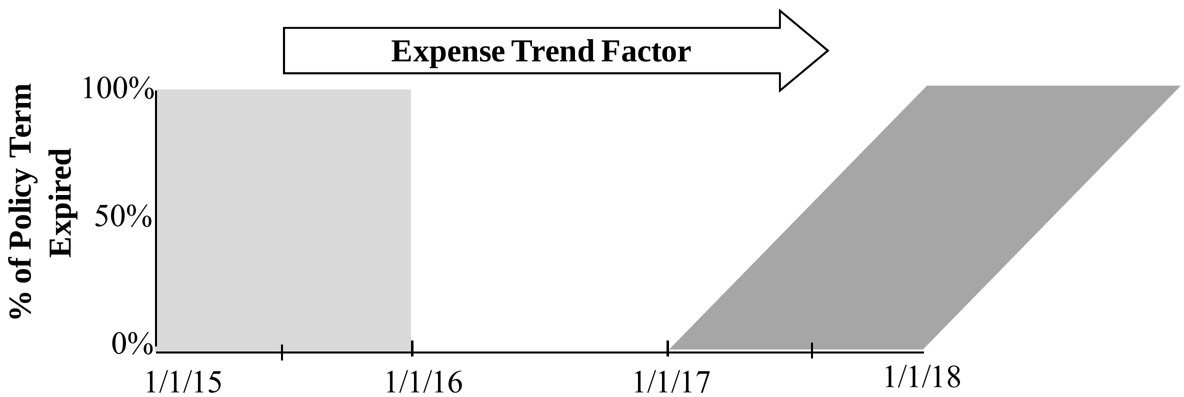
In the Exposure/Policy-based Projection Method, the total fixed expenses are divided by the exposures/policies to calculate the average fixed expense. If an inflation-sensitive exposure base (e.g., payroll per $100) is used, then no trending is necessary if the expenses and exposure base are changing at the same rate. If a non-inflation sensitive base (e.g., car-year or house-year) or policy counts are used, the expectation is that the average fixed expense figure will change over time and trending is appropriate.

Some companies use internal expense data to select an appropriate trend. Similar to the premium and loss trend procedures discussed in earlier chapters, the actuary examines the historical change in average expenses to select an expense trend. Given the volatility of internal data, many companies use government indices (e.g., Consumer Price Index, Employment Cost Index, etc.) and knowledge of anticipated changes in internal company practices to estimate an appropriate trend. One such procedure is shown in Appendix B.

The selected fixed expense ratio will be trended from the average date that expenses were incurred in the historical expense period to the average date that expenses will be incurred in the period that the rates are assumed to be in effect. Thus, the trend period is different for expenses that are incurred at the beginning of the policy and expenses that are incurred throughout the policy.

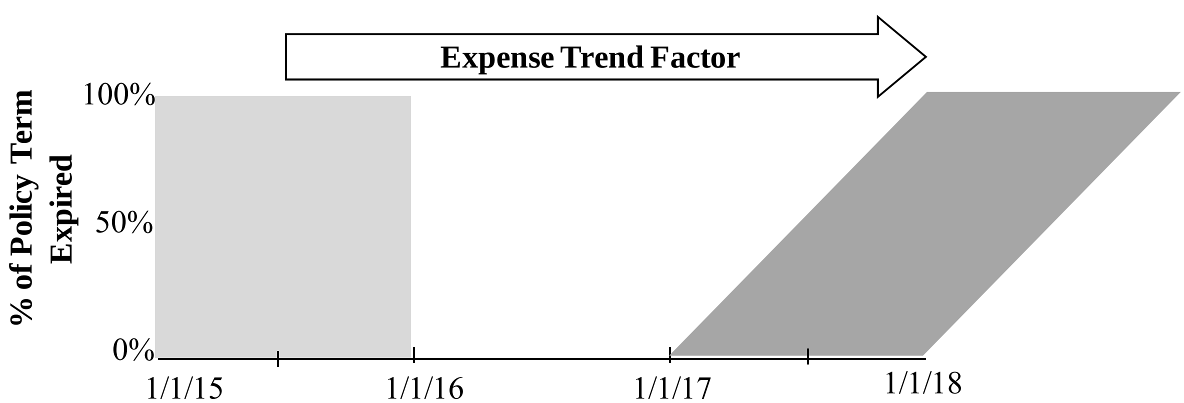
Expenses that are incurred when the policies are written should be trended from the average date that the policies were written in the historical period to the average written date in the projection period. The following figure shows the resulting trend period assuming annual policies are sold, a steady book of business is maintained, and projected rates will be in effect for one year:

7.7 Expenses Incurred at Onset of Policy



In contrast, expenses that are incurred evenly throughout the policy period should be trended from the average date the policies were earned in the historical period to the average earned date in the projection period. The following figure shows the resulting trend period assuming annual policies are sold, a steady book of business is maintained, and the projected rates will be in effect for one year:

7.8 Expenses Incurred Throughout Policy



Since the experience period is a calendar year, the average date the policies are written and earned is the same. However, as demonstrated by the figures, expenses incurred throughout the policy are trended six months longer than expenses incurred at inception. Actuaries may make the simplifying assumption that all expenses are either incurred at the inception of the policy or are incurred evenly throughout the policy period. The materiality of this simplification depends on the magnitude of the expense trend and the percentage of premium that fixed expenses represent.

The explanations and graphics shown above are theoretically correct depictions of the expense trend length for each calendar year in the expense experience period. In practice, however, many actuaries choose to trend historical fixed expenses from a single "trend from" date. For example, if the actuary believes a three-year average expense ratio best represents the historical expense period, the "trend from" date for the average ratio would be the midpoint of the three-year period. This gives approximately the same value as trending each year's expense ratio separately and averaging the results. If the selected trend is based on the latest year only, the "trend from" date would be the midpoint of the latest year. Mathematically this is the same as trending each year's expense ratio separately and choosing only the latest year's trended ratio.

After expenses are trended, the expense ratio or average dollar amount of expense is often called the projected (or trended) fixed expense provision.

REINSURANCE COSTS

As mentioned in Chapter 6, some ratemaking analysis is now performed on a net basis (i.e., with consideration of reinsurance). This practice is becoming more common as reinsurance programs have become more extensive and reinsurance costs have increased substantially.

In proportional reinsurance, the primary carrier transfers or "cedes" the same proportion of premium and losses to the reinsurer; this type of reinsurance may not need to be explicitly considered in ratemaking analysis.

With non-proportional reinsurance, the reinsurer agrees to assume some predefined portion of the losses (which are the reinsurance recoverables). The insurer cedes a portion of the premium (which is the cost of the reinsurance). Common examples of non-proportional reinsurance include catastrophe excess-of-loss (e.g., the reinsurer will cover 50% of the losses that exceed $15,000,000 up to $30,000,000 on their entire property book of business in the event of a catastrophe) and per risk excess-of-loss reinsurance (e.g., the reinsurer will cover for specified risks the portion of any large single event that is between $1,000,000 and $5,000,000).

Typically, the projected losses are reduced for any expected non-proportional reinsurance recoveries. Of course, the cost of purchasing the reinsurance must be included too. That is typically done by reducing the total premium by the amount ceded to the reinsurer. Alternatively, the net cost of the non-proportional reinsurance (i.e., the cost of the reinsurance minus the expected recoveries) may be included as an expense item in the overall rate level indication.

UNDERWRITING PROFIT PROVISION

By writing insurance policies, companies are assuming risk and must maintain capital to support that risk. The cost of this capital entitles companies to include a reasonable profit provision in their rates. For insurance, the **total profit** is the sum of underwriting profit and investment income.

$$\text{Total Profit} = \text{Investment Income} + \text{UW Profit}.$$

Investment Income

There are two major sources of **investment income**: investment income on capital and investment income earned on policyholder-supplied funds.

Capital funds belong to the owners of the insurance company and are referred to as equity on the balance sheet. This has also been called policyholder surplus although the funds may be from investors rather than policyholders. Companies invest these funds and earn investment income. There is substantial disagreement as to whether this source of income should be included in ratemaking or not.

Insurers hold and invest money coming from two types of policyholder-supplied funds: unearned premium reserves and loss reserves. Insureds generally pay their premium at the onset of the policy although coverage is provided continuously throughout the entire policy. The insurer holds and invests that money (i.e., unearned premium) until such time it is earned. The insurer also holds and invests funds to pay for claims that have occurred, but have not yet been settled (i.e., loss reserves). The opportunity for investment income from these funds varies significantly from line to line. For lines of business where claims are reported and settled quickly (i.e., short-tailed lines such as personal auto collision coverage or homeowners insurance), there is only a short time between the payment of premium and the settling of claims; consequently, the investment income will be relatively small. For long-tailed lines (e.g., personal auto bodily injury or workers compensation) there may be years between the time the initial premium is paid and all claims are settled; consequently, the opportunity for investment income is much larger.

The projection of investment income is an advanced topic and is outside of the scope of this text. There is a significant amount of actuarial literature in regards to investment income methodologies.

Underwriting Profit

Underwriting profit is the sum of the profits generated from the individual policies and is akin to the profit as defined in other industries. More specifically, the underwriting profit is defined as follows:

$$\text{UW Profit} = \text{Premium} - \text{Losses} - \text{LAE} - \text{UW Expenses}$$

The actual profit of an insurance policy is not known at the time of sale because the losses, settlement costs, and servicing costs associated with the insurance product are not yet known.

The combination of the underwriting profit and investment income represents the total profit for the company. Typically, the actuary determines the underwriting profit needed to achieve the target total rate of return after consideration of investment income. For some long-tailed lines, the investment income may be large enough that companies can accept an underwriting loss and still achieve the target total rate of return. For short-tailed lines, the investment income potential is lower and the underwriting profit is a larger portion of the total return.

PERMISSIBLE LOSS RATIOS

The expense and profit provisions discussed in this chapter are used to calculate a **variable permissible loss ratio (VPLR)** or the **total permissible loss ratio (PLR)**. These ratios are used directly in the calculation of the overall rate level indications as presented in Chapter 8. The definitions provided below assume that LAE are included with losses in the rate level indication formula.

The variable permissible loss ratio is calculated as follows:

$$\text{VPLR} = 1.0 - \text{Variable Expense\%} - \text{Target Profit\%} = 1.0 - V - Q_T.$$

This can be thought of as the percentage of each premium dollar that is intended to pay for the projected loss and LAE and projected fixed expenses. The remaining portion of each premium dollar is intended to pay for variable expenses and for profit for the company.

The total permissible loss ratio is calculated as follows:

$$\text{PLR} = 1.0 - \text{Total Expense\%} - \text{Target Profit\%} = 1.0 - F - V - Q_T.$$

This can be thought of as the percentage of each premium dollar that is intended to pay for the projected loss and LAE. The remaining portion of each premium dollar is intended to pay for all underwriting expenses and for profit for the company.

If all expenses are treated as variable expenses, the VPLR and PLR are the same. If LAE are not included with historical losses (but maybe included with underwriting expenses) in the rate level indication formula, the definition of VPLR and PLR must be adjusted. An example of this is provided in Appendix C.

SUMMARY

The rate an insurance company charges must be adequate to cover all costs associated with the insurance policy. These costs include underwriting expenses (i.e., general expenses, other acquisition, commissions and brokerage, and taxes, license, and fees). Some of these expenses vary directly with premium and are called variable expenses; other expenses are assumed to be the same for each risk (i.e., exposure or policy) and are called fixed expenses.

There are three common approaches used to project underwriting expenses: the All Variable Method, the Premium-based Projection Method, and the Exposure/Policy-based Projection method. The first two approaches have historical precedence. The latter approach addresses some distortions that can result from the other methods if fixed expenses are a significant portion of total expenses.

In addition to underwriting expenses (and the loss adjustment expenses covered in Chapter 6), companies may also explicitly consider the cost of reinsurance as an expense in a ratemaking analysis.

Companies are entitled to a reasonable expected profit. The two main sources of profit for insurance companies are investment income and underwriting profit. Traditionally, an underwriting profit provision is selected such that there is a reasonable expectation that the underwriting profit and investment income will generate total profit to appropriately compensate the insurer for the risk assumed.

KEY CONCEPTS IN CHAPTER 7

1. Types of underwriting expenses
    a. Commissions and brokerage
    b. Other acquisition costs
    c. Taxes, licenses, and fees
    d. General expenses

2. Fixed and variable expenses

3. Expense projection methods
    a. All Variable Expense Method
    b. Premium-Based Projection Method
    c. Exposure/Policy-Based Projection Method

4. Expense trending

5. Reinsurance costs

6. Underwriting profit provision

7. Permissible loss ratios
    a. Variable permissible loss ratios
    b. Total permissible loss ratios

CHAPTER 8: OVERALL INDICATION

The goal of a ratemaking analysis is to set the rates such that the premium charged will be appropriate to cover the losses and expenses while achieving the targeted profit for policies that will be written during a future time period. As stated in earlier chapters, this relationship is described by the fundamental insurance equation:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

The preceding chapters provided techniques for adjusting historical data to estimate the various components of the fundamental insurance equation for the relevant pricing time period. This chapter will demonstrate how to combine the various estimated components to ascertain whether the current rates are appropriate (i.e., whether the profit target is likely to be met at the current rates). Please note that the techniques in this chapter are focused on whether the rates are appropriate in the aggregate. In other words, the focus is to determine appropriate overall indicated rates or indicated rate level changes. Chapters 9-11 discuss the calculation of indications by subclasses of insureds. Chapter 14 details how to calculate final rates based on the overall indications and indications by subclasses of insureds.

There are two basic approaches for determining an overall rate level need:

1. Pure premium method
2. Loss ratio method

This chapter will discuss each of these in detail, demonstrate the mathematical equivalency of the approaches, and discuss rationale for selecting one over the other.

PURE PREMIUM METHOD

The pure premium method is generally considered the simpler and more direct of the two ratemaking formulae as it determines an indicated average rate, not an indicated change to the current average rate. The pure premium method involves projecting the average loss and loss adjustment expenses per exposure and the average fixed expenses per exposure to the period that the rates will be in effect. The sum of those two is then adjusted for variable expenses and the target profit percentage by dividing by one minus the sum of the variable expense provision and target profit percentage (i.e., the variable permissible loss ratio).

The indicated average rate per exposure can be calculated using the pure premium indication formula:

$$\text{Indicated Average Rate} = \frac{\text{Pure Premium (including LAE)} + \text{Fixed UW Expense Per Exposure}}{1.0 - \text{Variable Expense \%} - \text{Target UW Profit \%}}.$$

This is referred to as the indicated average rate per exposure (or the indicated average premium per exposure). Using the earlier notation, the formula can be rewritten as:

$$\overline{P_{\mathrm{I}}} = \frac{\left[\overline{L + E_{\mathrm{L}}} + \overline{E_{\mathrm{F}}}\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]} = \frac{\left[\left(L + E_{\mathrm{L}}\right)/X + E_{\mathrm{F}}/X\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]}.$$

Derivation of Pure Premium Indicated Rate Formula

To better understand the pure premium indicated rate formula, it is helpful to demonstrate the relationship between the formula and the fundamental insurance equation. Start with the fundamental insurance equation:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

Using the aforementioned notation, the fundamental insurance equation can be rewritten in the following form:

$$P_{\mathrm{I}} = L + E_{\mathrm{L}} + \left(E_{\mathrm{F}} + V \times P_{\mathrm{I}}\right) + (Q_{\mathrm{T}} \times P_{\mathrm{I}}).$$

By simply rearranging the terms, the formula becomes:

$$P_{\mathrm{I}} - V \times P_{\mathrm{I}} - Q_{\mathrm{T}} \times P_{\mathrm{I}} = \left(L + E_{\mathrm{L}}\right) + E_{\mathrm{F}}.$$

Using basic algebra, the preceding formula is transformed as follows:

$$P_{\mathrm{I}} \times \left[1.0 - V - Q_{\mathrm{T}}\right] = \left(L + E_{\mathrm{L}}\right) + E_{\mathrm{F}}.$$

Dividing both sides of the equation by [1-V-Q_{T}], the formula becomes:

$$P_{\mathrm{I}} = \frac{\left(L + E_{\mathrm{L}}\right) + E_{\mathrm{F}}}{\left[1.0 - V - Q_{\mathrm{T}}\right]}.$$

Dividing both sides of the equation by the number of exposures converts each of the component terms into averages per exposure, and the formula becomes the pure premium indication formula:

$$P_{\mathrm{I}}/X = \frac{\left[\left(L + E_{\mathrm{L}}\right)/X + E_{\mathrm{F}}/X\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]} = \frac{\left[\overline{L + E_{\mathrm{L}}} + \overline{E_{\mathrm{F}}}\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]} = \overline{P_{\mathrm{I}}}.$$

Simple Example of Pure Premium Indicated Rate Formula

Given the following information:

- Projected pure premium including LAE = \$300
- Projected fixed UW expense per exposure = \$25
- Variable expense % = 25%
- Target UW profit % = 10%

The indicated average rate per exposure can be calculated as follows:

$$\text{Indicated Average Rate} = \frac{\left[\overline{L+E_{\text{L}}} + \overline{E_{\text{F}}}\right]}{\left[1.0 - V - Q_{\text{T}}\right]} = \frac{[\$300 + \$25]}{[1.0 - 25\% - 10\%]} = \$500.$$

New Company

When the actuary is trying to determine rates for a new company, there will be no internal historical data. In such cases, the actuary can still determine the indicated rate by estimating the expected pure premium and expense provisions and selecting a target profit provision. These estimates may be based on external data or determined judgmentally.

LOSS RATIO METHOD

The loss ratio method is the more widely used of the two rate level indication approaches. This approach compares the estimated percentage of each premium dollar needed to cover future losses, loss adjustment expenses, and other fixed expenses to the amount of each premium dollar that is available to pay for such costs. In other words, this method compares the sum of the projected loss and LAE ratio and the projected fixed expense ratio to the variable permissible loss ratio. That relationship can be written as follows:

$$\text{Indicated Change Factor} = \frac{[\text{Loss \& LAE Ratio} + \text{Fixed Expense Ratio}]}{[1.0 - \text{Variable Expense \%} - \text{Target UW Profit \%}]}.$$

To the extent that the numerator and denominator are not in-balance, the indicated change factor will be something other than 1.0. The resulting factor can be applied to the current premium to bring the formula back in balance.

Using the same notation, the loss ratio indication formula can be rewritten as follows:

$$\text{Indicated Change Factor} = \frac{\left[\left(L + E_{\text{L}}\right)/P_{\text{C}} + F\right]}{\left[1.0 - V - Q_{\text{T}}\right]}.$$

This is commonly rewritten as an indicated change by subtracting 1.0:

$$\text{Indicated Change} = \frac{\left[\left(L + E_{\text{L}}\right)/P_{\text{C}} + F\right]}{\left[1.0 - V - Q_{\text{T}}\right]} - 1.0.$$

Derivation of Loss Ratio Indicated Rate Change Formula

To better understand the loss ratio indicated rate change formula, it is helpful to demonstrate the relationship between the formula and the fundamental insurance equation. Start with the fundamental insurance equation:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

Using the aforementioned notation with respect to premium and profit at current rates, the fundamental insurance equation can be rewritten in the following form:

$$P_C = L + E_L + (E_F + V \times P_C) + Q_C \times P_C.$$

By simply rearranging the terms, the formula becomes:

$$Q_C \times P_C = P_C - (L + E_L) - (E_F + V \times P_C).$$

Dividing each side by the projected premium at current rate level (P_C) yields:

$$Q_C = 1.0 - \frac{(L + E_L) + (E_F + V \times P_C)}{P_C} = 1.0 - \frac{L}{P_C} - \left(\frac{E_L + E_F}{P_C} + V\right).$$

When the terminology introduced in Chapter 1 is substituted for the symbols, the formula becomes more intuitive:

$$\text{Profit \% at Current Rates} = 1.0 - \text{Loss Ratio} - \text{OER} = 1.0 \text{ - Combined Ratio}.$$

Again, the goal of the ratemaking exercise is to determine whether the current rates are appropriate to cover the estimated losses and expenses and produce the target profit. If the expected profit percentage assuming current rates (Q_C) is equivalent to the target profit percentage (Q_T) then the current rates are appropriate. The more likely case is that the expected profit percentage assuming current rates (Q_C) is not equivalent to the target profit percentage (Q_T), and the rates need to be adjusted.

Slightly reordering the prior formula gives:

$$Q_C = 1.0 - \frac{(L + E_L) + E_F}{P_C} - V.$$

The objective is to determine how much the premium at current rates needs to be increased or decreased to achieve the target profit percentage. To do this, it is necessary to substitute the target profit percentage (Q_T) for the expected profit percentage assuming current rates (Q_C) and the indicated premium (P_I) for the projected premium at current rates (P_C). The indicated premium can be represented as the product of the projected premium at current rates and the indicated change factor:

$$Q_T = 1.0 - \frac{(L + E_L) + E_F}{P_C \times \text{Indicated Change Factor}} - V.$$

The terms can be rearranged as follows:

$$1.0 - V - Q_T = \frac{(L + E_L) + E_F}{P_C \times \text{Indicated Change Factor}}.$$

Rearranging the components via cross multiplication and dividing through by P_C yields:

$$\text{Indicated Change Factor} = \frac{L + E_L + E_F}{P_C \times (1.0 - V - Q_T)} = \frac{(L + E_L)/P_C + E_F/P_C}{(1.0 - V - Q_T)},$$

which is equivalent to the loss ratio indication formula derived earlier:

$$\text{Indicated Change Factor} = \frac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]}.$$

A result greater than 1.0 means the current rates are inadequate and need to be adjusted upward; for example, a result of 1.05 means the current rates should be adjusted upward by 5%. Similarly, a result less than 1.0 means the current rates are excessive and need to be reduced; for example, a result of 0.98 means the current rates should be reduced by 2%. Subtracting 1.0 from both sides produces an indicated change as follows:

$$\text{Indicated Change} = \frac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0.$$

Simple Example of Loss Ratio Indicated Rate Change Formula

Assume the following information:

- Projected ultimate loss and LAE ratio = 65%
- Projected fixed expense ratio = 6.5%
- Variable expense % = 25%
- Target UW profit % = 10%

The indicated rate change can be calculated as follows:

$$\text{Indicated Change} = \frac{\left[(L + E_L)/P_C + F\right]}{[1.0 - V - Q_T]} - 1.0 = \frac{[65\% + 6.5\%]}{[1.00 - 25\% - 10\%]} - 1.0 = 10\%.$$

This means that overall average rate level is inadequate and should be increased by 10%.

New Company

Since the loss ratio approach is dependent on current premium, it is only used for ratemaking analysis involving an existing company.

LOSS RATIO VERSUS PURE PREMIUM METHODS

Now that the two different rate level approaches have been discussed, it is important to understand whether the two approaches will produce equivalent results and the relative strengths and weaknesses of each.

Comparison of Approaches

There are two major differences between the two approaches. One major difference is the underlying loss measure used. The loss ratio indication formula relies on the loss ratio (i.e., projected ultimate losses and LAE divided by projected premium at current rate level), and the pure premium indication formula relies on the pure premium statistic (i.e., projected ultimate losses and LAE divided by projected exposures). The significance of this difference is that the loss ratio indication formula requires premium at current rate level and the pure premium indication formula does not. Similarly, the pure premium indication formula requires clearly defined exposures whereas the loss ratio indication formula does not.

Due to this difference, the pure premium approach is preferable if premium is not available or if it is very difficult to accurately calculate premium at current rate level. For example, the rating algorithm for some insurance products (e.g., personal automobile insurance) may include a large number of rating variables. If there were a significant number of changes made to those variables during the historical period, it may be difficult to calculate the premium at current rate level. In contrast, the loss ratio method is preferable if exposure data is not available or if the product being priced does not have clearly defined exposures. For example, commercial general liability (CGL) policies have multiple sub-lines intended to protect policyholders against a broad range of risks; as such, CGL policies can have different exposure bases for the various sub-lines included. Consequently, when pricing CGL, it may be easier to obtain and use premium at current rate level rather than trying to define a consistent exposure.

The other major difference is that the output of the two formulae is different. The result of the loss ratio indication formula is an indicated change to the currently charged rates. In contrast, the result of the pure premium formula is an indicated rate. Because of this difference, the pure premium method must be used with a new line of business for which there are no current rates to adjust.

Some actuaries prefer to express rate need in terms of a percent change to existing rates. This percent change approximates the average impact on existing policyholders if the fully indicated rates are implemented (ignoring any changes in policyholder retention). Consequently, the loss ratio method may be preferred to the pure premium method in this case. If the pure premium approach is used, however, the indicated change is easily calculated by comparing the indicated rate to the current rate.

Equivalency of Methods

Since both formulae can be derived from the fundamental insurance equation, it should be understood that the two approaches are mathematically equivalent. To illustrate the point more clearly, the following shows the reconciliation of the two approaches.

Start with the loss ratio indication formula:

$$\text{Indicated Change Factor} = \frac{\left[{(L + E_{\mathrm{L}})}/{P_{\mathrm{C}}} + F \right]}{\left[1.0 - V - Q_{\mathrm{T}} \right]}.$$

This formula can be restated as follows:

$$\text{Indicated Change Factor} = \frac{\left[\frac{(L+E_{\mathrm{L}})}{P_{\mathrm{C}}} + \frac{E_{\mathrm{F}}}{P_{\mathrm{C}}}\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]}.$$

Recognizing that the indicated adjustment factor is equivalent to the ratio of the indicated premium (P_{I}) to the projected premium assuming current rates (P_{C}) yields the following:

$$\frac{P_{\mathrm{I}}}{P_{\mathrm{C}}} = \frac{\left[\frac{(L+E_{\mathrm{L}})}{P_{\mathrm{C}}} + \frac{E_{\mathrm{F}}}{P_{\mathrm{C}}}\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]}.$$

Multiplying both sides by the projected average premium assuming current rates (P_C/X) results in the pure premium indication formula:

$$\frac{P_{\mathrm{I}}}{X} = \frac{\left[\frac{(L+E_{\mathrm{L}})}{X} + \frac{E_{\mathrm{F}}}{X}\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]} = \frac{\left[\overline{L+E_{\mathrm{L}}} + \overline{E_{\mathrm{F}}}\right]}{\left[1.0 - V - Q_{\mathrm{T}}\right]}.$$

The preceding proof clearly shows the two approaches are equivalent. However, the equivalency of the two formulae depends on consistent data and assumptions being used for both approaches. To the extent that does not happen, it is possible that the approaches will produce different results. For example, if the premium at current rate level is estimated using the parallelogram method rather than the more accurate extension of exposures method, any inaccuracy introduced by the approximation may result in inconsistency between the loss ratio and pure premium methods.

INDICATION EXAMPLES

This and the preceding chapters have provided different techniques that can be used to determine an overall rate level indication. The exact techniques used by the actuary will vary depending on a variety of factors, including unique characteristics of the product being priced, data limitations, historical precedence, and regulatory constraints.

Appendices A-D provide overall rate level indication examples for four different insurance products. Each of these example indications is based on several years of subject experience. Calculating the total loss ratio (or pure premium) can be done in different ways. Many companies sum projected ultimate loss and LAE across all years and divide by projected earned premium at present rates (or projected exposures) across all years. This is equivalent to weighting each year’s loss and LAE ratio (pure premium) by the relevant premium (or exposure). Alternatively, some companies select weights for each accident year’s experience, often giving more weight to the more recent years.

SUMMARY

The preceding chapters show how to adjust historical data to prospective levels. This chapter demonstrates two methods for combining the prospective estimates to determine the appropriate rate level for a future time period: the pure premium method and the loss ratio method.

The pure premium method's main statistic is the pure premium and the outcome of the approach is an indicated average rate. As such, the pure premium approach relies on exposures rather than premium and is most appropriate for pricing new lines of business or situations when the premium at current rate level is difficult to calculate.

The loss ratio method's main statistic is the loss ratio and the outcome of the approach is an indicated adjustment to the current rates. This approach relies on premium rather than exposures, and it is most appropriate for pricing lines of business for which there are not clearly defined exposures or where the indicated rate change is a critically important statistic for the final pricing decision.

Using consistent data and assumptions, the two approaches are mathematically equivalent.

KEY CONCEPTS IN CHAPTER 8

1. Pure premium indication formula

$$\text{Indicated Average Rate} = \frac{\text{Pure Premium (including LAE)} + \text{Fixed UW Expense Per Exposure}}{\text{1.0 - Variable Expense \% - Target UW Profit \%}}$$

$$\text{Indicated Average Rate} = \frac{\left[(L + E_{\text{L}}) / X + E_{\text{F}} / X \right]}{\left[1.0 - V - Q_{\text{T}} \right]} = \frac{\left[\overline{L + E_{\text{L}}} + \overline{E_{\text{F}}} \right]}{\left[1.0 - V - Q_{\text{T}} \right]}.$$

2. Loss ratio indication formula

$$\text{Indicated Change} = \frac{\left[\text{Loss \& LAE Ratio} + \text{Fixed Expense Ratio} \right]}{\left[1.0 - \text{Variable Expense \%} - \text{Target UW Profit \%} \right]} - 1.0$$

$$\text{Indicated Change} = \frac{\left[(L + E_{\text{L}}) / P_{\text{C}} + F \right]}{\left[1.0 - V - Q_{\text{T}} \right]} - 1.0$$

3. Loss ratio versus pure premium method
    a. Strengths and weaknesses of each method
    b. Mathematical equivalency of methods

CHAPTER 9: TRADITIONAL RISK CLASSIFICATION

The preceding chapters focused on making sure the fundamental insurance equation is in balance in the aggregate (i.e., the total premium should cover the total costs and allow for the target underwriting profit). In addition to focusing on the aggregate, it is important for the actuary to be able to develop a balanced indication for individual risks or risk segments, too. Of course, other considerations (e.g., marketing, operational, and regulatory) may cause management to implement a rating algorithm other than what is indicated by the actuary's analysis.

Some very large risks have a significant amount of individual experience. For example, a multi-billion dollar manufacturing corporation may purchase insurance for various plants for property damage, commercial liability, and workers compensation. For these risks, it may be possible for an insurer to use the risk's individual historical experience to reasonably estimate the amount of premium required for a future policy term. Such risks are priced using rating techniques covered in Chapter 15. For most insurance products, however, it is not feasible to set rates for an individual risk using solely the historical experience of that individual risk. In such cases, risks must be analyzed via **classification ratemaking**, which is the process of grouping risks with similar loss potential and charging different manual rates to reflect differences in loss potential among the groups.

The first stage of classification ratemaking involves determining which risk criteria effectively segment risks into groups with similar expected loss experience. For example, a homeowners insurer may recognize that the expected loss for a homeowners policy varies materially based on the age of the home. The characteristic being examined is often referred to as a rating variable. Some companies draw a distinction between underwriting and rating variables. In this text, the term rating variable refers to any variable used to vary rates, even if it is based on a characteristic normally considered an underwriting characteristic. The different values of the rating variable are referred to as levels. In the example given, age of the home is the rating variable, and the different ages or age ranges are the levels.

Once the insured population is subdivided into appropriate levels for each rating variable, the actuary calculates the indicated rate differential relative to the base level for each level being priced. If a rate differential is applied multiplicatively, it is often referred to as a rate relativity. If the rate differential is applied additively, it is generally referred to as an additive. Sometimes actuaries use the term class to refer to a group of insureds that belong to the same level for each of several rating variables. For example, personal lines auto insurers frequently use the term class to refer to a group of insureds with the same age, gender, and marital status.

This chapter discusses:

- The importance of charging equitable rates
- Criteria for evaluating potential rating variables
- Traditional univariate (one-way) techniques used to estimate the appropriate rate differentials for various levels of a given rating variable, including distortions introduced by each

In order to eliminate the distortions inherent in univariate techniques, many actuaries use multivariate classification ratemaking techniques, which are discussed in Chapter 10. Also, Chapter 11 outlines special classification ratemaking techniques used for certain rating variables.

IMPORTANCE OF EQUITABLE RATES

The prior chapters have provided significant detail as to the techniques an actuary should use to calculate rates that give a reasonable expectation of achieving the target profit in total. It may seem like the company should be satisfied as long as the rates are expected to produce the desired aggregate target profit and should not, therefore, be overly concerned with individual rate equity. In reality, a company that fails to charge the right rate for individual risks when other companies are doing so may be subjected to adverse selection, and consequently, deteriorating financial results. Also, a company that differentiates risks using a valid risk characteristic that other companies are not using may achieve favorable selection and gain a competitive advantage.

Adverse Selection

The goal of classification ratemaking is to determine a rate that is commensurate with the individual risk. Consider the situation in which a company (e.g., Simple Company) charges an average rate for all risks when other competing companies have implemented a rating variable that varies rates to recognize the differences in expected costs. In this case, Simple Company will attract and retain the higher-risk insureds and lose the lower-risk insureds to other competing companies where lower rates are available. This results in a distributional shift toward higher-risk insureds that makes Simple Company's previously "average" rate inadequate and causes the company to be unprofitable. Consequently, Simple Company must raise the average rate. The increase in the average rate will encourage more lower-risk insureds to switch to a competing company, which causes the revised average rate to be unprofitable. This downward spiral will continue until Simple Company improves their rate segmentation, becomes insolvent, or decides to narrow their focus solely to higher-risk insureds and raises rates accordingly. This process is referred to as adverse selection. However, the speed and severity of the process depends on various factors, including whether purchasers of insurance have full and accurate knowledge of differences in competitor rates and how much price alone influences their purchasing decisions.

The adverse selection cycle can be demonstrated by expanding the simple pricing example used in prior chapters. For the purpose of demonstrating adverse selection, the assumptions are as follows:

- The average loss ($\bar{L}$) and LAE ($\overline{E_L}$) is \$180. There are no underwriting expenses or profit, so the average total cost is \$180, and rates are set accordingly.
- The insured population consists of 50,000 high-risk insureds (Level H) and 50,000 low-risk insureds (Level L).
- The insurance market consists of two companies (Simple Company and Refined Company) that each currently insure 25,000 of each class of risk.
- H risks have a cost of \$230, and L risks have a cost of \$130.
- Simple Company charges H and L risks the same rate, \$180. Refined Company implements a rating variable to vary the rates according to the cost and, therefore, charges H and L risks \$230 and \$130, respectively.
- 1 out of every 10 insureds shops at renewal and bases the purchasing decision on price.

Originally, the risks are distributed evenly amongst the two companies and the rates are set as follows:

9.1 Original Distribution, Loss Cost, and Rates

Risk	(1) True Expected Cost	(2) Refined Company Insured Risks	(3) Refined Company Charged Rate	(4) Simple Company Insured Risks	(5) Simple Company Charged Rate
H	$ 230.00	25,000	$ 230.00	25,000	$ 180.00
L	$ 130.00	25,000	$ 130.00	25,000	$ 180.00
Total	$ 180.00	50,000	$ 180.00	50,000	$ 180.00

As can be seen on the following table, if the distribution is static (i.e., there is no movement of risks between companies), the aggregate amount of premium collected is the same for both companies. For Refined Company, the premium charged varies by each level of the rating variable and is equitable. For Simple Company, the premium charged is too little for the H risks. There is a shortfall of $1,250,000, which is completely offset by the excess premium collected from L risks. In other words, the L risks are subsidizing the H risks at Simple Company.

9.2 Static Distribution With Results

Risk	(1) True Expected Cost	(2) Refined Company Insured Risks	(3) Refined Company Charged Rate	(4) Refined Company Total $Excess/ ($Shortfall)	(5) Simple Company Insured Risks	(6) Simple Company Charged Rate	(7) Simple Company Total $Excess/ ($Shortfall)
H	$ 230.00	25,000	$ 230.00	$ -	25,000	$ 180.00	$ (1,250,000)
L	$ 130.00	25,000	$ 130.00	$ -	25,000	$ 180.00	$ 1,250,000
Total	$ 180.00	50,000	$ 180.00	$ -	50,000	$ 180.00	$ -

(4)= [(3)-(1)] x (2)
(7)= [(6)-(1)] x (5)

Given the assumption that 1 out of 10 insureds shops at renewal and makes the purchase decision based on price, the distribution will not remain static. The H risks who shop will choose Simple Company, and the L risks who shop will choose Refined Company. This movement results in the following distribution of risks for policy year one:

9.3 Policy Year One Distribution With Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Refined Company			Simple Company		
Risk	True Expected Cost	Insured Risks	Charged Rate	Total $Excess/ ($Shortfall)	Insured Risks	Charged Rate	Total $Excess/ ($Shortfall)
H	$ 230.00	22,500	$ 230.00	$ -	27,500	$ 180.00	$ (1,375,000)
L	$ 130.00	27,500	$ 130.00	$ -	22,500	$ 180.00	$ 1,125,000
Total	$ 180.00	50,000	$ 175.00	$ -	50,000	$ 180.00	$ (250,000)

(4)= [(3)-(1)] x (2)
(7)= [(6)-(1)] x (5)

Because Refined Company charges the right rate for each class, there is still no excess or shortfall (as both their total premium and total costs will be proportionately lower). Because Simple Company's distribution has shifted toward more H risks, the excess premium from the L risks fails to make up for the shortfall from the H risks; therefore, Simple Company loses money in policy year one. In order to correct for the $250,000 shortfall, Simple Company is forced to increase the rate from $180 to $185, the new average cost based on the new distribution.

Unless Simple Company segments its portfolio in a more refined manner, this cycle will continue each year. More specifically, the H risks will continue to shift to Simple Company, and the L risks will continue to shift toward Refined Company. Since Refined Company is charging equitable rates, there will be no excess or shortfall. Conversely, Simple Company continues to charge an average rate based on the prior distribution, and there will be a shortfall each year as the distribution changes. Thus, Simple Company will need to keep taking rate increases. By policy year five, the results will be as follows:

9.4 Policy Year Five Distribution With Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Refined Company			Simple Company		
Risk	True Expected Cost	Insured Risks	Charged Rate	Total $Excess/ ($Shortfall)	Insured Risks	Charged Rate	Total $Excess/ ($Shortfall)
H	$ 230.00	14,762	$ 230.00	$ -	35,238	$ 197.20	$ (1,155,798)
L	$ 130.00	35,238	$ 130.00	$ -	14,762	$ 197.20	$ 992,023
Total	$ 180.00	50,000	$ 159.52	$ -	50,000	$ 197.20	$ (163,775)

(4)= [(3)-(1)] x (2)
(7)= [(6)-(1)] x (5)

This trend will continue until such time that Simple Company begins to segment in a more refined manner, loses too much money to continue, or only insures H risks at the rate of $230. Since Refined Company maintains a rate appropriate for both H and L risks, they are able to write both types of risk competitively and profitably.

Note that this was a very simple example with simple assumptions intended to demonstrate the adverse selection cycle. In reality, there are many factors that will affect the adverse selection cycle. For example, the assumption that Simple Company increased rates to the new true average cost each year may not be entirely feasible. Many jurisdictions require a company to obtain approval to change rates. Any delay in regulatory approval can lead to delays that would only exacerbate the profitability issues for Simple Company.

Favorable Selection

Adverse selection deals with the case where a company fails to segment based on a meaningful characteristic that other companies are using, or fails to charge an appropriate differential for a rating variable that other companies are charging appropriately. Conversely, when a company identifies a characteristic that differentiates risk that other companies are not using, the company has two options for making use of this information:

1. Implement a new rating variable.
2. Use the characteristic for purposes outside of ratemaking (e.g., for risk selection, marketing, agency management).

If the company chooses to implement a new rating variable and prices it appropriately, its new rates will be more equitable. This may allow the company to write a segment of risks that were previously considered uninsurable. If the company is already writing a broad spectrum of risks, then implementation of a new rating variable will have the opposite effect of adverse selection. In other words, the company will attract more lower-risk insureds at a profit. Some of the higher-risk insureds will remain; those who remain will be written at a profit, rather than a loss. Over the long run, the company will be better positioned to profitably write a broader range of risks.

The motorcycle insurance market provides a good example of favorable selection. Originally, motorcycle insurers used very simple rating algorithms that did not include any variation based on the age of the operator. The first companies that recognized that the age of the operator is an important predictor of risk implemented higher rates for youthful operators. In order to keep their overall premium revenue neutral, they lowered rates for non-youthful operators. By doing this, the companies were able to attract a large portion of the profitable adult risks from their competitors. Furthermore, those youthful operators who chose to insure with them were written profitably.

In some cases, the company may not be able to (or may choose not to) implement a new or refined rating variable. If allowed by law, the company may continue to charge the average rate but utilize the characteristic to identify, attract, and select the lower-risk insureds that exist in the insured population; this is called "skimming the cream." If the company can effectively focus on attracting and keeping the lower-risk insureds, the company will be more profitable than the competitors. Ultimately, the company will be able to lower the average rate to reflect the better overall quality of the insured risks.

CRITERIA FOR EVALUATING RATING VARIABLES

The first step in classification ratemaking is to identify the rating variables that will be used to segment the insured population into different groups of similar risks for the purposes of rating. For example, a workers compensation carrier needs to decide whether or not the number, type, and skill level of employees are risk characteristics that will be used as rating variables for workers compensation insurance.

This section explains the various criteria for evaluating the appropriateness of rating variables, as set forth by Robert Finger in “Risk Classification” (Finger 2001, pp. 292-301). The criteria can be grouped into the following categories:

- Statistical
- Operational
- Social
- Legal

Statistical Criteria

The rating variables should reflect the variation in expected costs among different groups of insureds. Ideally, the company will have collected or can obtain data that enables it to test the statistical effectiveness of the rating variable being considered.[28] If so, the company should consider the following statistical criteria to help ensure the accuracy and reliability of the potential rating variable:

- Statistical significance
- Homogeneity
- Credibility

The rating variable should be a statistically significant risk differentiator. In other words, the expected cost estimates should vary for the different levels of the rating variable, the estimated differences should be within an acceptable level of statistical confidence, and the estimated differences should be relatively stable from one year to the next. If all the levels for a given rating variable have no statistical variation in loss experience, then the rating variable may not be useful. If instead the estimates of cost differences are different but the results are volatile, then it is less clear whether the rating variable is improving equity or not.

Second, the levels of a rating variable should represent distinct groups of risks with similar expected costs. In other words, the groups should be defined such that the risk potential is homogeneous within groups and heterogeneous between groups. If a group of insureds contains materially different risks, then the risks should be subdivided further by creating more levels of an existing rating variable or by introducing additional rating variables. When considering homogeneity, it is important to differentiate between expected and actual costs. Even truly identical risks may have different loss experience during a given policy period due to the random nature of the insurance events (i.e., even the highest-risk drivers will not necessarily have a claim every policy period and the lowest-risk driver may have a claim). The key for classification analysis is to identify and group risks for which the magnitude and variability of expected costs are similar; by doing so, the actuary will develop more accurate and equitable rates.

Finally, the number of risks in each group should either be large enough or stable enough or both for the actuary to be able to accurately estimate the costs. Actuaries refer to this as having sufficient credibility and this will be discussed in greater detail in Chapter 12. If a particular level of a rating variable includes too few risks or is not stable over time, then the experience may lack the credibility necessary to

[28] The factors can be tested using the techniques described later in this and the following chapters.

accurately estimate the costs. In such cases, the actuary should consider combining similar levels to increase the credibility or look for additional relevant data.

The science of classification requires balancing two objectives: grouping risks into a sufficient number of levels to ensure the risks within each group are homogeneous while being careful not to create too many granularly defined groups that may lead to instability in the estimated costs.

Operational Criteria

Even if a rating variable effectively segments risk, it may not be practical to use in a rating algorithm due to operational considerations. For a rating variable to be considered practical, it should be

- Objective
- Inexpensive to administer
- Verifiable

First, the levels within a rating variable should have objective definitions. For example, it seems logical that the estimated costs for medical malpractice insurance vary by the skill level of a surgeon. However, the skill level of a surgeon is difficult to determine and somewhat subjective; therefore, it is not a practical choice for a rating variable. Instead, companies can use more objective rating variables like board certification, years of experience, and prior medical malpractice claims that serve as proxies for skill level.

Second, the operational cost to obtain the information necessary to properly classify and rate a given risk should not be too high. For example, there are building techniques and features that improve the ability of a home to withstand high winds. If these items significantly reduce expected losses, statistically speaking the company should implement a rating variable to recognize the differences. Unfortunately, the existence of some of the features cannot be easily identified without a very thorough inspection of the home performed by a trained professional. If the cost of the inspection significantly outweighs the potential benefit, then it may not make sense for a company to use that risk characteristic as a rating variable.

Third, the levels of a rating variable should not be easily manipulated by the insured or distribution channel, and should be easy for the insurer to verify. It is generally accepted that the number of miles driven is a risk differentiator for personal auto insurance. However, many car owners cannot accurately estimate how many miles their car will be driven in the upcoming policy period, and even if they can, the insurance companies may not currently have a cost-effective way to verify the accuracy of the amount estimated by the insured. Since some companies feel the insureds may not supply sufficiently accurate information, they have chosen not to use annual miles driven as a rating variable. Note, as technology evolves and on-board diagnostic devices become standard equipment in cars, the verifiability of this rating variable and how it is used in rating may be substantially different.

Social Criteria

Insurance companies are selling insurance products to a variety of consumers; consequently, companies are affected by public perception. The following items affect the social acceptability of using a particular risk characteristic as a rating variable:

- Affordability
- Causality
- Controllability
- Privacy concerns

First, from a social perspective, it is desirable for insurance to be affordable for all risks. This is especially true when insurance is required by law (e.g., states require “proof of financial responsibility” from owners of vehicles and that is most easily achieved though personal automobile insurance) or required by a third party (e.g., lenders require homeowners insurance), or is merely desirable to facilitate ongoing operation (e.g., stores purchase commercial general liability insurance). In some cases, a particular risk characteristic may identify a small group of insureds whose risk level is extremely high, and if used as a rating variable, the resulting premium may be unaffordable for that high-risk class. To the extent that this occurs, companies may wish to or be required by regulators to combine classes and introduce subsidies. For example, 16-year-old drivers are generally higher risk than 17-year-old drivers. Some companies have chosen to use the same rates for 16- and 17-year-old drivers to minimize the affordability issues that arise when a family adds a 16-year-old to the auto policy. The company may be willing to accept the subsidy in recognition of the fact that the policy will be profitable in the long run as the teenager ages. Alternatively, companies have developed new insurance products that can support a lower rate for high-risk insureds by offering less coverage.

Second, in addition to being correlated with expected losses, some risk characteristics directly impact the amount of expected losses. From a social perspective, it is preferable if rating variables are based on characteristics that are causal in nature. For example, most people understand that the presence of a sump pump in a house has a direct effect on water damage losses to the house (both in propensity to have a claim and the severity of the claim). As such, a corresponding reduction in premium for the presence of a sump pump is likely to be socially acceptable. In recent years, personal lines insurers have introduced insurance credit scores, a measure of the insured’s financial responsibility, into rating algorithms. Despite the strong statistical power in predicting losses, the use of this variable has resulted in a consumer backlash stemming from a belief that there is a lack of obvious causality to losses.

Third, it is preferable if an insured has some ability to control the class to which they belong and, consequently, be able to affect the premium charged.[29] For example, the type and quality of a company’s loss control programs can have a significant effect on workers compensation expected losses. This is a controllable rating variable as insured companies can implement approved loss control programs in an

[29] This may seem to contradict the comment made in the operational criteria section that it is undesirable to have a rating variable that can be manipulated by the insured. The operational criterion refers to insureds or others supplying false information to earn a cheaper rate. The controllability criterion refers to the case where an insured can be motivated to improve his risk characteristic and consequently reduce his rate. The latter often has broader societal benefits (e.g., insureds purchasing cars with safety devices that afford insurance discounts).

effort to reduce expected losses and consequently reduce the charged premium. In contrast, insureds cannot control their age or gender. Interestingly, even though age and gender have been demonstrated to influence personal lines loss costs, some jurisdictions do not allow them as rating variables.

Finally, there can be significant privacy concerns associated with the use of particular rating variables. For example, technology exists that can track where a car is being driven and how safely the driver is driving. When the technology is standard in all vehicles, the information could be used to greatly improve the insurance companies' ability to accurately price a given risk. In order to address the privacy concern, the data is deemed to be protected and the insurance company is only able to use it with the express consent of the insured. Some companies have implemented usage-based insurance programs[30] on a voluntary basis. Of course, any such usage-based programs will be most effective if they can be used on all risks rather than just the ones who volunteer.[31]

Legal Criteria

Most jurisdictions around the world have some level of law and regulation related to property and casualty insurance products. Currently in the United States, property and casualty insurance products are regulated by the states. Each state has laws and regulations concerning the pricing of insurance products, and the details vary greatly from state to state and from product to product. Most states have statutes that require insurance rates to be "not excessive, not inadequate, and not unfairly discriminatory." Additionally, some states' statutes may require certain rates to be "actuarially sound." How a state's executive branch interprets these statutes can vary significantly from state to state and even within a particular state over time.

Some states have promulgated regulations that include details about what is allowed and not allowed in risk classification rating for various property and casualty insurance products. It is imperative that the rate classification system be in compliance with the applicable laws and regulations of each jurisdiction in which a company is writing business.

For example, some states have statutes prohibiting the use of gender in rating insurance while others permit it as a rating variable. As a result, an insurer writing in multiple states may include gender as a rating variable in those states where it is permitted, but not include it in a state that prohibits its use for rating. Some states may allow the use of a rating variable, but may place restrictions on its use. For example, some states allow credit score to be used for rating personal insurance for new business, but do not allow insurers to raise the rates for renewal risks should the insured's credit worsen (although they may allow companies to reduce rates if the insured's credit score improves). Some states also prohibit certain variables from use in the rating algorithm but allow their use in underwriting. Underwriting variables may be used to guide risk selection decisions, but could also guide risk placement decisions.[32]

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[30]Usage-based insurance programs rely on on-board diagnostic devices to track various criteria about how the car is being driven (e.g., mileage by time of day and rapid changes in speed). The insurer adjusts the next policy term premium based on the usage information reported automatically in the prior term.

[31] The issue is one of self-selection. The only insureds who volunteer for the usage-based programs are those who benefit from it in the way of lower rates. Thus, the data cannot really be used to differentiate the high- and low-risk drivers.

[32] In some cases, placing a risk into a different company or tier may affect the rate (though the criteria are not considered "rating variables" by regulators).

An actuary needs to be familiar with the laws and regulations of each jurisdiction in which his or her company writes insurance and assure that the classification rating is in compliance with that jurisdiction's laws and regulations. This usually requires working with other professionals, such as lawyers or regulatory compliance experts, in determining what is acceptable and what is not.

TYPICAL RATING (OR UNDERWRITING) VARIABLES

The following are a few examples of rating variables by line of business:

9.5 Typical Rating Variables

Type of Insurance	Rating Variables
Personal Automobile	Driver Age and Gender, Model Year, Accident History
Homeowners	Amount of Insurance, Age of Home, Construction Type
Workers Compensation	Occupation Class Code
Commercial General Liability	Classification, Territory, Limit of Liability
Medical Malpractice	Specialty, Territory, Limit of Liability
Commercial Automobile	Driver Class, Territory, Limit of Liability

Note that some risk characteristics may be used as both rating variables and underwriting variables.

DETERMINATION OF INDICATED RATE DIFFERENTIALS

In addition to determining the rating variables and the levels within, the actuary must also identify the amount of rate variation among the levels of each rating variable. As discussed in Chapter 2, a rating variable typically has two or more levels with one level designated as the base level. The rate for all non-base levels is expressed relative to the base level, as prescribed in the rating algorithm.

There are many different approaches to determine differentials for a given rating variable. The remainder of this chapter outlines traditional univariate methods that use the historical experience for each level of a rating variable in isolation to determine the differentials. Each of the approaches described assume that the rating algorithm is multiplicative, so differentials are referred to as relativities. Differentials could also be derived in an additive/subtractive fashion, though that is not addressed in this chapter's examples. The following approaches are discussed:

- Pure Premium
- Loss Ratio
- Adjusted Pure Premium

The output of these approaches is a set of indicated rate relativities. If the relativities are changed for some or all of the levels of the rating variables, this can result in more or less premium being collected overall. In most cases, the insurer will alter the base rate to compensate for the expected increase or decrease in premium. This topic, often referred to as base rate offsetting, will not be covered here but will be discussed in depth in Chapter 14.

Assumptions for Simple Example

To demonstrate each of the approaches and to highlight the pros and the cons of each, it is useful to consider a basic example.

The assumptions are as follows:

- All underwriting expenses are variable. The variable expense provision (V) is 30% of premium, and the target profit percentage (Q_T) is 5% of premium; therefore, the permissible loss ratio is 65% (= 1 – 30% - 5%).
- There are only two rating variables, amount of insurance (AOI) and territory, and the exposures are distributed across the two rating variables as follows:

9.6 Exposure Distribution

AOI	Territory 1	2	3	Total
Low	7	130	143	280
Medium	108	126	126	360
High	179	129	40	348
Total	294	385	309	988

AOI	Territory 1	2	3	Total
Low	1%	13%	14%	28%
Medium	11%	13%	13%	37%
High	18%	13%	4%	35%
Total	30%	39%	31%	100%

- The following table summarizes the true underlying loss cost relativities (which is what the actuary is attempting to estimate) as well as the relativities used currently in the company's rating structure (note that the base levels are Medium AOI and Territory 2):

9.7 True and Charged Relativities for Simple Example

AOI	True Relativity	Charged Relativity
Low	0.7300	0.8000
Medium	1.0000	1.0000
High	1.4300	1.3500

Terr	True Relativity	Charged Relativity
1	0.6312	0.6000
2	1.0000	1.0000
3	1.2365	1.3000

- The exposure, premium, and loss data for the classification analyses is summarized as follows:

9.8 Simple Example Info

AOI	Terr	Exposure	Loss & ALAE	Premium @ Current Rate Level
Low	1	7	$ 210.93	$ 335.99
Medium	1	108	$ 4,458.05	$ 6,479.87
High	1	179	$ 10,565.98	$ 14,498.71
Low	2	130	$ 6,206.12	$ 10,399.79
Medium	2	126	$ 8,239.95	$ 12,599.75
High	2	129	$ 12,063.68	$ 17,414.65
Low	3	143	$ 8,441.25	$ 14,871.70
Medium	3	126	$ 10,188.70	$ 16,379.68
High	3	40	$ 4,625.34	$ 7,019.86
TOTAL		988	$ 65,000.00	$ 100,000.00

Pure Premium Approach

Chapter 8 discussed the differences between the pure premium and loss ratio approaches in the context of developing the overall rate level indications. Those comments apply to classification ratemaking as well.

The basic pure premium approach compares the expected pure premiums for each of the levels within a rating variable to determine the indicated relativity. Given a rating variable $R1$ with the rate differential for each level i given by $R1_i$, then the rate applicable to each level of rating variable $R1$ (Rate_i) is determined as the product of the base rate (B) and the rate differential ($R1_i$):

$$\text{Rate}_i = R1_i \times B.$$

Using the subscript I to denote indicated, the indicated differential is calculated as follows:

$$R1_{\text{I},i} = \frac{\text{Rate}_{\text{I},i}}{B_\text{I}}.$$

Recall the formula for the indicated rate according to the pure premium method was given in Chapter 8 as:

$$\text{Indicated Rate} = \frac{\left[\overline{L + E_\text{L}} + \overline{E_\text{F}}\right]}{\left[1.0 - V - Q_\text{T}\right]}.$$

If all underwriting expenses are considered to be variable or if the fixed expenses are handled through a separate fee, then the fixed expense component ($\overline{E_\text{F}}$) is set equal to zero and the formula simplifies to the following:

$$\text{Indicated Rate} = \frac{\left[\overline{L + E_\text{L}}\right]}{\left[1.0 - V - Q_\text{T}\right]}.$$

If the fixed expenses are material and a separate expense fee is not used (i.e., the base rate includes a provision for fixed expenses), the actuary should include the fixed expense loading in the formula. By doing so, the actuary will “flatten” the otherwise indicated relativities to account for the fact that the fixed expenses represent a smaller portion of the risks with higher average premium.

Making the assumption that the fixed component is not necessary and substituting the formula for the indicated rate and base rate, the indicated differential for level i is calculated as follows:

$$R1_{\text{I},i} = \frac{\dfrac{\left[\overline{L + E_\text{L}}\right]_i}{\left[1.0 - V - Q_\text{T}\right]_i}}{\dfrac{\left[\overline{L + E_\text{L}}\right]_B}{\left[1.0 - V - Q_\text{T}\right]_B}}.$$

Based on the assumption that all policies have the same underwriting expenses and profit provisions, the formula becomes:

$$R1_{\mathrm{I},i} = \frac{\left[\overline{L+E_{\mathrm{L}}}\right]_i}{\left[\overline{L+E_{\mathrm{L}}}\right]_B}.$$

Thus, the indicated differential for a given level is equal to the projected ultimate pure premium (including LAE) for that level divided by the projected ultimate pure premium (including LAE) for the base class.

Pure Premium Approach in Practice

In practice, it is not always feasible to allocate ULAE to different classes of business, so the pure premiums used in the classification analysis generally only include loss and ALAE. Also, if the ratemaking actuary chooses to incorporate underwriting expense provisions and target profit provisions that vary by type of risk, the indicated pure premiums for each level can be adjusted by the applicable provisions prior to calculating the indicated relativities.

Depending on the nature of the portfolio, it may not always be necessary to trend and develop the loss and (A)LAE. In stable portfolios for many short-tailed lines of business (e.g., homeowners), it is often acceptable to ignore these adjustments for classification analysis. If the portfolio is growing or shrinking, or the distribution of loss and (A)LAE by class is changing over time, a multi-year pure premium analysis would be improved by applying aggregate trend and development factors to the individual year's loss and (A)LAE before summing. In certain long-tailed lines (e.g., workers compensation), it is quite possible that classes of risk undergo trend and development at materially different rates. For example, workers compensation risks with return-to-work programs may experience less development over time than risks without such a program. If trend and development are believed to be materially different by level, the actuary may want to consider developing and/or trending individual risks or levels prior to classification analysis. In addition, if the classification analysis is undertaken on losses aggregated across multiple claim types (e.g., workers compensation indemnity and medical), the actuary may choose to trend and develop the losses for each claim types separately before combining for classification analysis.

It is common to adjust losses for extraordinary and catastrophic events in classification data as they can have a disproportionate impact on a level or levels for the rating variable being analyzed. For example, a catastrophic event may only affect one territory. Similarly, one extraordinary loss only impacts one level. Consequently, the actuary should consider replacing these actual losses with an average expected figure for each level, if such data is available.

The following table shows the pure premium calculations for the simple example:

9.9 Pure Premium Method

(1) Terr	(2) Exposures	(3) Loss & ALAE	(4) Indicated Pure Premium	(5) Indicated Relativity	(6) Indicated Relativity to Base
1	294	$ 15,234.96	$ 51.82	0.7877	0.7526
2	385	$ 26,509.75	$ 68.86	1.0467	1.0000
3	309	$ 23,255.29	$ 75.26	1.1439	1.0929
Total	988	$ 65,000.00	$ 65.79	1.0000	0.9554

(4)= (3)/(2)
(5)= (4)/(Tot4)
(6)= (5)/(Base5)

Column 4 represents the indicated pure premium for each of the territories as well as overall (i.e., all territories combined). The indicated pure premiums are calculated by dividing the historical losses and ALAE by the exposures for each territory. In this simple example, trend and development have been ignored. Column 5 displays the indicated relativities, which are calculated as the pure premium for each territory divided by the total pure premium. This value represents the indicated relationship between the given territory and the total. Normally, as discussed in Chapter 2, companies select a base level for each rating variable, and all other levels for that rating variable are expressed relative to the base. In this case, the indicated relativities to the base class (assuming Territory 2 is the base territory) are determined by dividing the indicated relativity for each territory by the indicated relativity for Territory 2. This result is displayed in Column 6.

Clearly, Column 6 can be calculated directly from Column 4. The interim step was included as companies will typically compare current, indicated, and competitors' relativities all normalized so that the total average exposure-weighted relativity is 1.00 for each. By doing this, the relativities can be compared on a consistent basis. This consistent basis is also relevant when indicated relativities are credibility-weighted with other experience (as discussed in Chapter 12).

As stated, all expenses were assumed to be variable, and the variable expense and target profit provisions were assumed to apply uniformly to all risks and thereby excluded from the calculations.

Distortion

The true underlying pure premium relativities and the relativities indicated by the pure premium analysis are as follows:

9.10 Result Comparison

Terr	True Relativity	Pure Premium Indication
1	0.6312	0.7526
2	1.0000	1.0000
3	1.2365	1.0929

The indicated territorial relativities do not match the true relativities due to a shortcoming of the univariate pure premium approach. The pure premium for each level is based on the experience of each level, and assumes a uniform distribution of exposures across all other rating variables. To the extent that one territory may have a disproportionate number of exposures of high or low amount of insurance homes, this assumption is violated. By ignoring this exposure correlation between territory and amount of insurance, the loss experience of high or low amount of insurance homes can distort the indicated territorial relativities resulting in a "double counting" effect.

In the simple example, the Territory 1 indicated pure premium relativity is higher than the true relativity due to a disproportionate share of high-value homes in Territory 1. Similarly, the Territory 3 indicated pure premium relativity is lower than the true relativity due to a disproportionate share of low-value homes in Territory 3. If amount of insurance were distributed in the same way within each territory, the resulting indicated relativities from the pure premium method would not have been affected. This does not mean that each of the three amount of insurance levels needs to represent one-third of the exposures within each territory; it merely implies that the distribution of amount of insurance must be the same within every territory.

This example only has two rating variables. In reality, there are many different characteristics that affect the risk potential for each insured. To the extent there is a distributional bias in some or all of the other characteristics, the resulting pure premiums can be materially biased.

Loss Ratio Approach

The major difference between the pure premium and loss ratio approaches is that the loss ratio approach uses premium as opposed to exposure. The basic loss ratio approach compares the loss ratios for each of the levels to the total loss ratio in order to determine the appropriate adjustment to the current relativities.

Start with the pure premium indicated differential formula (which assumes all policies have the same underwriting expenses and profit provisions):

$$R1_{\mathrm{I},i} = \frac{\left[\overline{L+E_{\mathrm{L}}}\right]_i}{\left[\overline{L+E_{\mathrm{L}}}\right]_B} = \frac{\dfrac{(L+E_{\mathrm{L}})_i}{X_i}}{\dfrac{(L+E_{\mathrm{L}})_B}{X_B}}.$$

Multiplying both sides of the equation by the ratio of the average premium at current rates for the base level ($\overline{P_{\mathrm{C},B}}$) to the average premium at current rates for level *i* of the rating variable being reviewed ($\overline{P_{\mathrm{C},i}}$):

$$R1_{\mathrm{I},i} \times \frac{\overline{P_{\mathrm{C},B}}}{\overline{P_{\mathrm{C},i}}} = \frac{\left[\overline{L+E_{\mathrm{L}}}\right]_i}{\left[\overline{L+E_{\mathrm{L}}}\right]_B} \times \frac{\overline{P_{\mathrm{C},B}}}{\overline{P_{\mathrm{C},i}}}.$$

Recognizing that average premium is equal to total premium divided by total exposures and that the pure premium is equal to the total losses and LAE divided by total exposures:

$$\overline{P} = \frac{P}{X} \quad \text{and} \quad \overline{L + E_{\mathrm{L}}} = \frac{L + E_{\mathrm{L}}}{X},$$

and that the current differential for level i ($R1_{C,i}$) is equal to the ratio of the current average premium for level i divided by the current average premium at the base level:

$$R1_{\mathrm{C},i} = \frac{\overline{P_{\mathrm{C},i}}}{\overline{P_{\mathrm{C},B}}},$$

the above formula can be transformed:

$$\text{Indicated Differential Change} = \frac{R1_{\mathrm{I},i}}{R1_{\mathrm{C},i}} = \frac{\dfrac{(L + E_{\mathrm{L}})_i}{P_{\mathrm{C},i}}}{\dfrac{(L + E_{\mathrm{L}})_B}{P_{\mathrm{C},B}}} = \frac{\text{Loss \& LAE Ratio for } i}{\text{Loss \& LAE Ratio for } B}.$$

Loss Ratio Approach in Practice

Similar to the pure premium approach, many of the same data limitations and assumptions regarding losses apply (e.g., ULAE cannot be allocated by class). In the loss ratio approach, however, it is important to bring earned premium to the current rate level of each class. This is most accurately done via extension of exposures, though the parallelogram method can be performed at the class level if data limitations preclude use of extension of exposures.

The following table shows the calculations for the simple example:

9.11 Loss Ratio Method

(1) Terr	(2) Premium @ Current Rate Level	(3) Loss & ALAE	(4) Loss & ALAE Ratio	(5) Indicated Relativity Change Factor	(6) Current Relativity	(7) Indicated Relativity	(8) Indicated Relativity @Base
1	$ 21,314.57	$ 15,234.96	71.5%	1.1000	0.6000	0.6600	0.6540
2	$ 40,414.19	$ 26,509.75	65.6%	1.0092	1.0000	1.0092	1.0000
3	$ 38,271.24	$ 23,255.29	60.8%	0.9354	1.3000	1.2160	1.2049
Total	$ 100,000.00	$ 65,000.00	65.0%	1.0000			

(4)= (3)/(2)
(5)= (4)/(Tot4)
(7)= (5)x(6)
(8)= (7)/(Base7)

Column 4 displays the loss and ALAE ratio for each territory and in total, which is simply the losses and ALAE divided by the premium at current rate level. Column 5 is the indicated relativity change factor, which is the loss and ALAE ratio for each territory divided by the total loss and ALAE ratio. This figure represents the amount the territory relativities should be changed to make the loss and ALAE ratios for every territory equivalent. Column 7 displays the indicated relativity for each territory, which is the product of the current relativity and the indicated change factor. The relativities in this column have the same overall weighted average as the current relativities. As discussed in the pure premium approach, it is sometimes useful to compare the current, indicated, and competitors' relativities for a variable. In such cases, each set of relativities should be adjusted so that the overall weighted-average relativity is the same. The proper weight for making this adjustment is the premium adjusted to the base class for the variable being analyzed (i.e., the premium divided by the current relativity for that variable). Column 8 adjusts the relativities to the base level by dividing the indicated relativity for each level by the indicated relativity at the base level.

Distortion

The true underlying relativities and the indicated relativities from both the pure premium and loss ratio methods are as follows:

9.12 Result Comparison

Terr	True Relativity	Pure Premium Indication	Loss Ratio Indication
1	0.6312	0.7526	0.6540
2	1.0000	1.0000	1.0000
3	1.2365	1.0929	1.2049

While the indicated territorial relativities from the loss ratio method do not match the true relativities, they are closer than those calculated using the pure premium approach. Since the pure premium approach relies on exposures (i.e., one exposure for each house year), the risks in each territory are treated the same regardless of the amount of insurance. In contrast, the use of premium in the denominator of the loss ratio reflects the fact that the insurer collects more premium for homes with higher amounts of insurance. Using the current premium helps adjust for the distributional bias. Even so, the loss ratio method still did not produce the correct relativities. The remaining distortion reflects the variation for the amount of insurance relativities being charged rather than the true variation. If the current amount of insurance relativities are equivalent to the true amount of insurance relativities, then the loss ratio method will produce the true territorial relativities.

An important yet subtle point is that the indicated relativities for a given rating variable produced using the loss ratio method "adjust" for the inequity present in the other rating variables. In the example, the rate relativity for Territory 1 developed using the loss ratio method is higher than the true relativity because the process by which it takes into account the high proportion of high-valued homes relies on the current amount of insurance relativities that are under-priced. The downside to this adjustment is that all homes in Territory 1, not just the high-value homes, are being charged an extra amount to correct for the inequity in amount of insurance relativities.

Adjusted Pure Premium Approach

The loss ratio approach requires the actuary to obtain premium at current rate level for each level of the variable being analyzed. In some cases it may not be practical to obtain premium at that level of refinement; consequently, it will be necessary to use the pure premium approach rather than the loss ratio approach. In such cases, it is possible to make an adjustment to the pure premium approach to minimize the impact of any distributional bias.

As discussed in the previous section, using premium in the loss ratio approach helps adjust for the distributional bias that distorts the pure premium approach. To make the results of the two approaches more consistent, the pure premium approach can be performed using exposures adjusted by the exposure-weighted average relativity of all other variables.

The following table shows the calculation of the current exposure-weighted average amount of insurance relativities by territory.

9.13 Weighted AOI Relativity

AOI	Charged AOI Factor	Exposures by Territory 1	2	3
Low	0.8000	7	130	143
Medium	1.0000	108	126	126
High	1.3500	179	129	40
Total		294	385	309
Wtd Avg AOI Relativity by Terr		1.2083	1.0497	0.9528

If there are multiple rating variables, then the table above needs to be expanded so that the exposure-weighted average relativity is based on all rating variables. Often, a rating algorithm can include too many variables to make this a practical exercise. In such cases, the actuary may focus only on rating variables suspected to have a distributional bias across the levels of the rating variable being analyzed.

The following shows the pure premium calculation using the adjusted exposures.

9.14 Adjusted Pure Premium Method

(1) Terr	(2) Earned Exposures	(3) Wtd Avg AOI Relativity	(4) Adjusted Exposures	(5) Loss & ALAE	(6) Indicated Adjusted Pure Premium	(7) Indicated Relativity	(8) Indicated Relativity @Base
1	294	1.2083	355.24	$ 15,234.96	$ 42.89	0.6954	0.6538
2	385	1.0497	404.13	$ 26,509.75	$ 65.60	1.0636	1.0000
3	309	0.9528	294.42	$ 23,255.29	$ 78.99	1.2806	1.2040
Total	988		1,053.79	$ 65,000.00	$ 61.68	1.0000	0.9402

(3)= from Table 9.13
(4)= (2)x(3)
(6)= (5)/(4)
(7)= (6)/(Tot6)
(8)= (7)/(Base7)

Distortion

Since the current amount of insurance relativities were used for the adjustment, the resulting indicated relativities are equivalent to those calculated using the loss ratio approach (except for rounding), and the same comments made about the distortion associated with the loss ratio approach apply.

If the true amount of insurance relativities are used to determine the exposure-weighted average relativity, then the indicated territorial relativities will be correct. Of course, the true relativities are not known for each rating variable. If they were, no analysis would be necessary.

WORKSHEET EXAMPLE

Appendix E shows a full set of example calculations for the pure premium and loss ratio classification approaches.

SUMMARY

If companies want to compete effectively over the long term, it is critical that their rates are appropriate in the aggregate and at the individual risk level. If a company fails to charge appropriate rates at the individual risk level when other companies are doing so, their lower-risk insureds are likely to leave and insure with other companies that are charging lower rates. If not addressed, the company can be subjected to adverse selection.

For most lines of business, it is not feasible to set rates on a risk-by-risk basis, so companies attempt to identify characteristics that can be used as rating variables to subdivide the insured population into more homogeneous, but still credible, groups for the purposes of rating. Companies should consider statistical, operational, and social criteria, and review applicable laws and statutes when deciding whether or not to use a certain characteristic as a rating variable.

Once the company determines the risk characteristics that will be used as rating variables, the company can perform univariate pure premium, loss ratio, or adjusted pure premium analysis to determine the indicated differentials for each level of each rating variable. These techniques often cause distortions; consequently, many companies have moved to multivariate techniques, which are feasible with today's technology. The fundamental principles of multivariate techniques are covered in the next chapter. Some companies still use these univariate techniques and make adjustments to account for the known distortions.

KEY CONCEPTS IN CHAPTER 9

1. Definitions used in classification ratemaking
    a. Rating variable
    b. Level of a rating variable
    c. Rate differentials

2. Importance of equitable rates
    a. Adverse selection
    b. Favorable selection

3. Considerations for evaluating rating variables
    a. Statistical criteria
    b. Operational criteria
    c. Social criteria
    d. Legal criteria

4. Calculating indicated rate differentials
    a. Pure premium approach
    b. Loss ratio approach
    c. Adjusted pure premium approach

CHAPTER 10: MULTIVARIATE CLASSIFICATION

As discussed in the previous chapter, classification ratemaking allows the insurer to price individual risks more equitably by analyzing the loss experience of groups of similar risks. This protects the insurer against adverse selection, which can lead to unsatisfactory profits and loss in market share. Effective classification ratemaking may provide insurers with a competitive advantage and may help expand the profile of risks the insurer is willing and able to write profitably.

This chapter begins with a review of the shortcomings of the one-way classification ratemaking approaches outlined in the previous chapter. It then discusses the advancement of iteratively standardized one-way approaches, such as the minimum bias procedures, which address some of the shortcomings of one-way approaches. Much of this chapter is dedicated to the use of multivariate approaches, including:

- Circumstances that led to their adoption in classification ratemaking
- The overall benefits of multivariate approaches
- A basic explanation of the mathematical foundation of one particular multivariate method, generalized linear models (GLMs)
- A sample of GLM output
- Examples of statistical diagnostics associated with GLMs

Finally, this chapter concludes with a brief discussion of practical considerations and two developments that have augmented multivariate analysis in the context of classification ratemaking: data mining techniques and the use of external data sources.

A REVIEW OF THE SHORTCOMINGS OF UNIVARIATE METHODS

The previous chapter reviewed one-way, or univariate, approaches to classification ratemaking whereby the loss experience (either pure premium or loss ratio) of the levels within each rating variable is examined and compared in order to establish rate differentials to the base level.

The shortcomings of univariate approaches were also discussed—the primary one being that they do not accurately take into account the effect of other rating variables. The pure premium approach does not consider exposure correlations with other rating variables. If the rating algorithm only contained a handful of rating variables, this shortcoming could be mitigated with two-way analysis or some manual adjustments. Today, however, actuaries working on many lines of business are analyzing tens or hundreds of variables that make manual adjustment inefficient if not impossible.

As an illustrative example of the distortion created with univariate methods, a one-way pure premium analysis may show for a personal auto insurance book of business that older cars have high claims experience relative to newer cars. In reality, however, this analysis is distorted by the fact that older cars tend to be driven by younger drivers—who tend to have high claims experience. The experience for both young drivers and old cars looks unfavorable despite the fact that this may be driven primarily by the youthful driver effect.

Conducting a loss ratio analysis adjusts for an uneven mix of business to the extent the premium varies with risk, but current premium is only an approximation as it most often deviates from true loss cost differentials. Similarly, the adjusted pure premium approach attempts to standardize data for the uneven mix of business by multiplying exposures by the exposure-weighted average of all other rating variables' relativities before calculating the one-way relativities. Again, this is merely an approximation to a proper reflection of all exposure correlations.

MINIMUM BIAS PROCEDURES

Another classification ratemaking approach that was popular during the latter half of the 20th century is the family of minimum bias procedures. Essentially these are iteratively standardized univariate approaches. Each procedure involves the selection of a rating structure (e.g., additive, multiplicative or combined) and the selection of a bias function (e.g., balance principle, least squares, χ^2, and maximum likelihood bias functions). The bias function is a means of comparing the procedure's observed loss statistics (e.g., loss costs) to indicated loss statistics and measuring the mismatch. Both sides of this equation must be weighted by the exposures in each cell to adjust for an uneven mix of business. The term "minimum bias" refers to the commonly used balance principle that requires that the sum of the indicated weighted pure premiums equals the sum of the weighted observed loss costs for every level of every rating variable. This is referred to as "minimizing the bias" along the dimensions of the classification system.

A simple example of the balance principle applied to a multiplicative personal auto rating structure is outlined below. This example assumes only two rating variables: gender and territory. Gender has values male (with a rate relativity expressed as g_1) and female (g_2). Territory has values urban (t_1) and rural (t_2). The base levels, relative to which all multiplicative indications will be expressed, are female and rural (hence $g_2 = 1.00$ and $t_2 = 1.00$). The actual loss costs (or pure premiums) are as follows:

	Urban	Rural	Total
Male	\$650	\$300	\$528
Female	\$250	\$240	\$244
Total	\$497	\$267	\$400

The exposure distribution is as follows:

	Urban	Rural	Total
Male	170	90	260
Female	105	110	215
Total	275	200	475

As stated previously, the balance principle requires that the exposure-weighted observed loss costs equal the indicated exposure-weighted loss cost across every dimension of each rating variable (i.e., each gender and each territory). The following four equations show the observed weighted loss costs on the left and the indicated weighted loss costs (represented as the product of the base rate, the exposure, and the indicated relativities) on the right. The base rate is assumed to be $100.

Males $170 \times \$650 + 90 \times \$300 = \$100 \times 170 \times g_1 \times t_1 + \$100 \times 90 \times g_1 \times t_2.$

Females $105 \times \$250 + 110 \times \$240 = \$100 \times 105 \times g_2 \times t_1 + \$100 \times 110 \times g_2 \times t_2.$

Urban $170 \times \$650 + 105 \times \$250 = \$100 \times 170 \times g_1 \times t_1 + \$100 \times 105 \times g_2 \times t_1.$

Rural $90 \times \$300 + 110 \times \$240 = \$100 \times 90 \times g_1 \times t_2 + \$100 \times 110 \times g_2 \times t_2.$

These equations are not linearly independent; consequently, there is no closed form solution. In order to solve for one variable's unknowns, initial (seed) relativities for the other rating variable are chosen. Generally a sensible seed is the univariate pure premium relativities. Hence, the urban relativity is the total urban loss costs divided by the total rural loss costs:

$t_1 = 1.86 = (\$497 / \$267)$

$t_2 = 1.00.$

Substituting these seed values into the first two equations above, we are able to solve for the first values of g_1 and g_2:

$170 \times \$650 + 90 \times \$300 = (\$100 \times 170 \times g_1 \times 1.86) + (\$100 \times 90 \times g_1 \times 1.00)$

$\$137,500 = (\$31,620 \times g_1) + (\$9,000 \times g_1)$

$\$137,500 = \$40,620 \times g_1$

$g_1 = 3.39.$

$105 \times \$250 + 110 \times \$240 = (\$100 \times 105 \times g_2 \times 1.86) + (\$100 \times 110 \times g_2 \times 1.00)$

$\$52,650 = (\$19,530 \times g_2) + (\$11,000 \times g_2)$

$\$52,650 = \$30,530 \times g_2$

$g_2 = 1.72.$

We can now use these seed values for gender, g_1 and g_2, and set up equations to solve for the new intermediate values of t_1 and t_2:

$170 \times \$650 + 105 \times \$250 = (\$100 \times 170 \times 3.39 \times t_1) + (\$100 \times 105 \times 1.72 \times t_1)$

$\$136,750 = (\$57,630 \times t_1) + (18,060 \times t_1)$

$\$136,750 = \$75,690 \times t_1$

$t_1 = 1.81.$

$90 \times \$300 + 110 \times \$240 = (\$100 \times 90 \times 3.39 \times t_2) + (\$100 \times 110 \times 1.72 \times t_2)$

$\$53{,}400 = (\$30{,}510 \times t_2) + (\$18{,}920 \times t_2)$

$\$53{,}400 = \$49{,}430 \times t_2$

$t_2 = 1.08.$

This same procedure is repeated, each time discarding the previous relativities and solving for new ones. The procedure is iterated until there is no material change in any of the values of g_1, g_2, t_1, and t_2. Upon such convergence, it is common practice to normalize the base class relativities to 1.00. For example, assume the relativities derived above represent the final iteration. Normalizing the base class relativities to 1.00 would result in:

$g_1 = 3.39 / 1.72 = 1.97$

$g_2 = 1.72 / 1.72 = 1.00$

$t_1 = 1.81 / 1.08 = 1.68$

$t_2 = 1.08 / 1.08 = 1.00.$

Recall from above that the univariate relativity for t_1 was 1.86 (this was used to seed the initial value of t_1 in the minimum bias equations). After one iteration of the minimum bias method, the replacement value for t_1 is 1.68. The minimum bias result reflects the fact that the cell for urban males has considerably more exposure than the other cells; consequently, the experience in that cell is given more weight.

Finally, the base loss cost also needs to be adjusted to reflect the normalization:

Base loss cost = $100 x 1.72 x 1.08 = $185.76.

Now the reader should better understand the phrase iteratively standardized one-ways. The method outlined above involves performing several iterations of univariate analysis on rating variables, each time adjusting for the exposure weight and the indication of the previous variable in the sequence. Note that the simple example outlined above only considers one of the minimum bias methods (multiplicative structure with balance principle) using the pure premium statistic. In addition, it considers only two rating variables each with two levels. The computation required to incorporate several rating variables requires at the very least some spreadsheet programming. Several papers have been authored on the various minimum bias procedures. Detailed, intuitive explanations with simple illustrative examples are contained in "The Minimum Bias Procedures: A Practitioner's Guide" (Feldblum and Brosius 2002, pp. 591-684). Sequential analysis, a method related to minimum bias, may also be of interest to the ratemaking actuary. It is currently mandated as the only classification ratemaking method allowed for pricing voluntary private passenger automobile insurance in the state of California. In sequential analysis, the actuary performs a standard one-way analysis on the first variable selected to determine the indicated relativities. The exposures are adjusted for the results of the first variable's analysis (i.e., the adjusted one-way pure premium approach), and the indicated relativities are calculated for the second variable. This continues until the actuary has calculated the indicated relativities for every variable. Sequential analysis involves making only one pass through the sequence of chosen rating variables (rather than iterating until convergence is achieved). The main criticism of the non-iterative sequential approach is that it does not have a closed form solution; the results vary depending on the order of the rating variables in the sequence. There is considerably more detail to the sequential analysis mandated in California, and the ratemaking actuary should seek additional references if working in that market.

THE ADOPTION OF MULTIVARIATE METHODS

The minimum bias procedures are not technically multivariate methods, and they were not necessarily based directly on statistical theory. However, many of the minimum bias procedures are actually a subset of the statistical method, generalized linear models (GLMs). In fact, iterating the minimum bias procedure a sufficient number of times may result in convergence with GLM results, though many would argue the minimum bias procedures involve less computational efficiency. Stephen Mildenhall's paper, "A Systematic Relationship between Minimum Bias and Generalized Linear Models" (Mildenhall 1999) demonstrates that many of the minimum bias procedures correspond directly to generalized linear models.

Several things happened around the late 20th century and start of the 21st century that led to the adoption of statistical techniques, particularly generalized linear models, for classification ratemaking. First, computing power greatly increased. Data no longer had to be aggregated in order to be analyzed. What previously was only achievable by large mainframe machines was now being accomplished by desktop PCs in a fraction of the time. Second, insurers were instituting data warehouse initiatives that greatly improved the granularity and accessibility of data that could be analyzed for ratemaking purposes. So despite the fact that sophisticated statistical techniques existed much earlier than this, it was the circumstances of enhanced computing power and better data that enabled their usage in classification ratemaking. A final and perhaps the most important trigger in the widespread adoption of multivariate methods was competitive pressure. As explained in the last chapter, when one or more companies implement improved classification ratemaking, they gain a competitive advantage and put the rest of the industry in a position of adverse selection and decreased profitability. This occurred in the U.K. personal lines markets in the 1990s and in the U.S. personal auto markets in the early 2000s.

THE BENEFITS OF MULTIVARIATE METHODS

The main benefit of multivariate methods is that they consider all rating variables simultaneously and automatically adjust for exposure correlations between rating variables, which should now be understood as the primary shortcoming of univariate approaches. Later in this chapter a graphical example (Figure 10.1) shows a disparity in results between the univariate method and a particular multivariate method, when rating variables are correlated.

Secondly, multivariate methods attempt to remove unsystematic effects in the data (also known as noise) and capture only the systematic effects (also known as signal) as much as possible. This is not the case with univariate methods, which include both signal and noise in the results.

Third, many multivariate methods produce model diagnostics, additional information about the certainty of results and the appropriateness of the model fitted. Statistical assumptions and model diagnostics will be discussed in more detail later in this chapter.

A fourth benefit of multivariate methods is that they allow consideration of the interaction, or interdependency, between two or more rating variables. Interactions occur when the effect of one variable varies according to the levels of another (e.g., the effect of square footage varies across different levels of amount of insurance). Interactions are an important refinement to multivariate models that can improve the predictive value. They also complicate the model and should therefore be analyzed with an eye for business considerations (e.g., ease of understanding and monitoring results).

As a side note, it is important not to confuse interaction (sometimes referred to as response correlation) with exposure correlation, which describes a relationship between the exposures of one rating variable and another. Gender exposures may be uniformly distributed across age (meaning at any age there is an identical distribution of men and women and no exposure correlation exists), but the two variables may interact if the loss experience for men relative to women is distinctly different at the youthful ages than at the middle and senior ages. Conversely, a variable's exposures may be unevenly distributed across the levels of another rating variable (i.e., exposure correlation exists), yet no interaction is present. The other scenarios of both exposure correlation and interaction being present or neither being present are less confusing.

Other potential benefits vary considerably among the different types of multivariate methods. For example, GLMs, which will be discussed later in this chapter, are widely accepted as a classification ratemaking method. One of the main advantages of GLMs is that they are transparent; the model output includes parameter estimates for each level of each explanatory variable in the model, as well as a range of statistical diagnostics. Other multivariate techniques, such as neural networks (also discussed briefly later in this chapter) are often criticized for a lack of transparency. No matter how sophisticated the mathematics underlying a method, it is important for practitioners to be able to follow and communicate how the results were developed and be able to translate the results into something that can be implemented in the insurance company's operations.

So how do the methods mentioned thus far stack up to this list of benefits? As discussed, the results of univariate approaches are distorted by distributional biases. The results can also be heavily distorted by unsystematic effects (noise). The result is a set of answers with no additional information about the certainty of the results. Interactions can be incorporated but only by expanding the analysis into two-way or three-way tables. Perhaps it scores high only in terms of transparency, but this is overshadowed by the inaccuracies of the method.

In contrast, the minimum bias methods account for an uneven mix of business but, as stated previously, the iterative calculations are considered computationally inefficient. As with one-way analysis, no diagnostics are included. This method scores high on transparency and outperforms univariate analysis in terms of accuracy, but does not provide all of the benefits of full multivariate methods.

GLMs

The multivariate statistical technique that has quickly become the standard for classification ratemaking in many countries and for many lines of business is the generalized linear model, GLM. This technique achieves each of the benefits of multivariate methods listed above. Though less transparent than the cruder and less accurate univariate results, it still scores favorably in comparison to other multivariate methods such as neural networks. Not only can the iterations of a GLM be tracked, but the output of a multiplicative GLM is a series of multipliers—much like the insurance industry is accustomed to using in rating algorithms and rating manuals.

A Mathematical Foundation for GLMs: Linear Models

Though touted above as a relatively transparent method, many practitioners familiar with the traditional univariate approaches may not understand the statistical underpinnings of GLMs. A good foundation for understanding GLMs is to first review linear models (LMs), something many actuaries may have studied in college coursework. Both LMs and GLMs aim to express the relationship between an observed response variable (Y) and a number of explanatory variables, referred to as predictor variables. For example, the response variable may be claim frequency for homeowners insurance, and the predictor variables may include amount of insurance, age of home, and deductible. The observations in the data (e.g., claims on individual exposures) are considered a realization of the response variable.

Linear models express the response variable (Y) as the sum of its mean (μ) and a random variable (ε), also known as the error term:

$$Y = \mu + \varepsilon.$$

They assume that the mean can be written as a linear combination of the predictor variables. For example,

$$Y = (\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4) + \varepsilon,$$

where X_1, X_2, X_3, and X_4 are each predictor variables, and β_1, β_2, β_3, and β_4 are the parameter estimates to be derived by the LM.

Linear models also assume that the random variable, ε, is normally distributed with a mean of zero and constant variance, σ^2.

The aim of the linear model is to find the parameter estimates, which, when applied to the chosen model form, produce the observed data with the highest probability. The function used to achieve this aim is usually the likelihood function (or equivalently the log-likelihood). Maximum likelihood relies on linear algebra to solve a system of equations. In practice, due to the high volume of observations in classification ratemaking datasets, numerical techniques such as multi-dimensional Newton-Raphson algorithms are employed. These techniques find the maximum of a function by finding a zero in the function's first derivative. Also note that in the specific case of linear models, the likelihood function is equivalent to minimizing the sum of squared error between actual and indicated.

Generalized Linear Models: Loosening the Restrictions

GLMs are a generalized version of linear models that remove the restrictions of the normality assumption and the constant variance. They also allow a function, called the link function, to define the relationship between the expected response variable (e.g., claim severity) and the linear combination of the predictor variables (e.g., age of home, amount of insurance, etc.). The choice of various link functions means the predictor variables do not have to relate strictly in an additive fashion (as they do with LMs). For example, GLMs fit to insurance claims experience for ratemaking purposes often specify a log link function, which assumes the rating variables relate multiplicatively to one another. There are other components of the GLM formularization (offset terms, prior weights) that are beyond the scope of this text.

In order to solve a GLM, the modeler must:

- Supply a modeling dataset with a suitable number of observations of the response variable and associated predictor variables to be considered for modeling.
- Select a link function to define the relationship between the systematic and random components.
- Specify the distribution of the underlying random process, typically a member of the exponential family of distributions (e.g., normal, Poisson, gamma, binomial, inverse Gaussian[33]); this is done by specifying the mean and the variance of the distribution, the latter being a function of the mean.

The maximum likelihood approach then maximizes the logarithm of the likelihood function and computes the predicted values for each variable.

More comprehensive detail on the theory of GLMs is beyond the scope of this text, but may be found in Section 1 of "The Practitioner's Guide to Generalized Linear Models" (Anderson , D. et al. 2005).

SAMPLE GLM OUTPUT

Unlike univariate analysis of claims experience that is typically performed on either loss ratios or loss costs, GLM analysis is typically performed on loss cost data (or preferably frequency and severity separately). There are statistical and practical reasons supporting this practice:

- Modeling loss ratios requires premiums to be adjusted to current rate level at the granular level and that can be practically difficult.
- Experienced actuaries have an a priori expectation of frequency and severity patterns (e.g., youthful drivers have higher frequencies). In contrast, the loss ratio patterns are dependent on the current rates. Thus, the actuary can better distinguish the signal from the noise when building models.
- Loss ratio models become obsolete when rates and rating structures are changed.
- There is no commonly accepted distribution for modeling loss ratios.

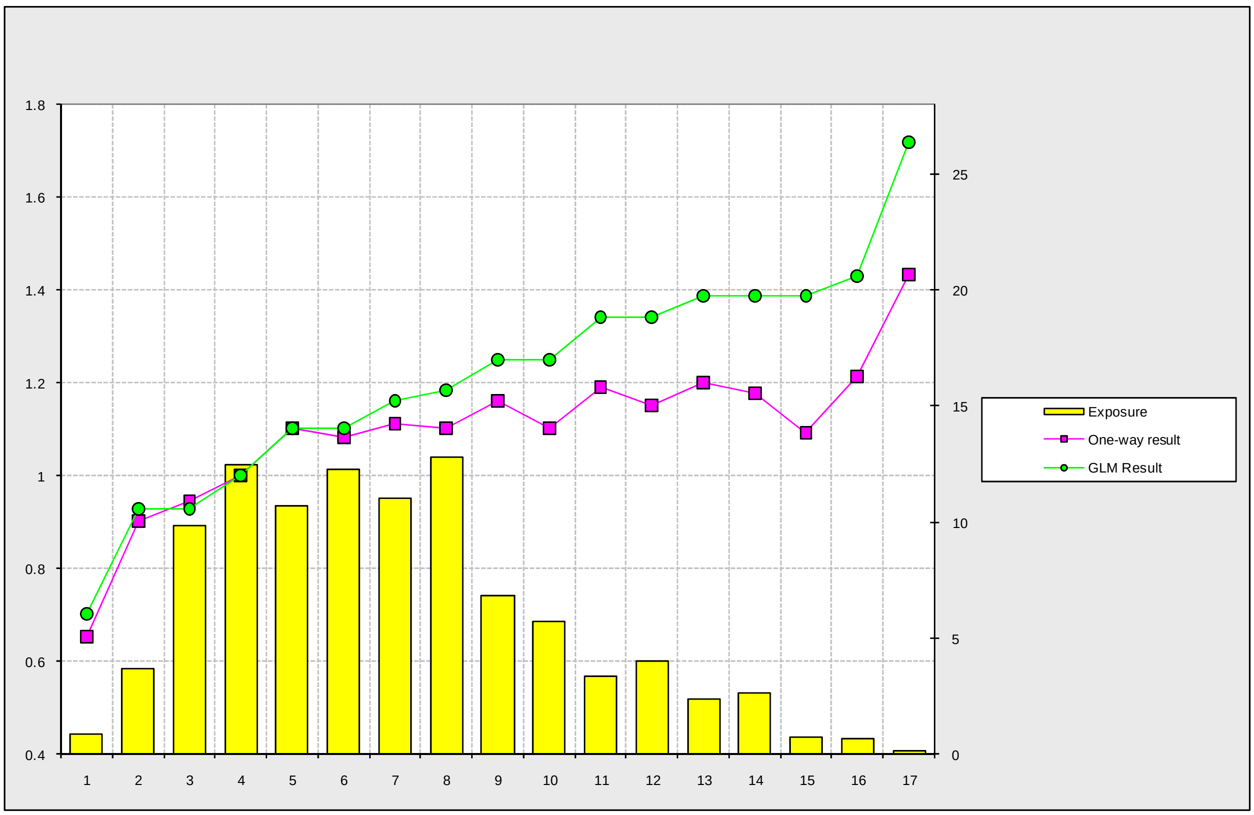
More details can be found about this in "GLM Basic Modeling: Avoiding Predictive Modeling Pitfalls" (Werner and Guven 2007, pp. 263-264). Best practice also dictates that modeling be performed on a homogeneous body of claims. For example, personal automobile models are generally performed at the

[33] The Tweedie family of distributions is considered a special extension of the exponential family.

coverage level but could even be more granular (e.g., subdividing comprehensive claims into theft and non-theft).

A useful way to strengthen an understanding of GLMs is to view illustrative graphical output. The following graph shows the effect of the rating variable vehicle symbol on claim frequency for the claim type personal auto collision. This rating variable has seventeen discrete levels, and each level's exposure count is represented by the yellow bars (the right y-axis). Each symbol represents a group of vehicles that have been combined based on common characteristics (e.g., weight, number of cylinders, horsepower, cost). Note that in addition to discrete variables (also known as categorical factors), GLMs can also accommodate numeric fields as continuous variables (referred to as variates). Variates can take the form of polynomials or splines[34] within GLMs.

10.1 Effect of Vehicle Symbol on Automobile Collision Frequency



This output is from a multiplicative model. The base level, to which all other levels' parameter estimates will be expressed relative, is vehicle symbol 4. Consequently, its multiplicative differential is 1.00. The base level is typically chosen as one with a fairly large, if not the largest, volume of exposure. This ensures statistical diagnostics are expressed relative to something large and presumably stable. The GLM output is shown as the green line with circle markers. The GLM gives the statistical effect of vehicle symbol on collision frequency, all other variables being considered. For example, the GLM indicates that vehicle symbol 10 has a 25% higher indicated collision frequency than vehicle symbol 4, all other

[34] Splines are a series of polynomial functions with each function defined over a short interval.

variables being considered. The pink line with the square markers on the graph represents the results of a univariate analysis. The disparity suggests vehicle symbol is strongly correlated with another variable in the model (perhaps age of driver, prior accident experience, or some other variable), and the univariate results are distorted as discussed earlier.

In a multivariate analysis, it is important to understand the phrase "all other variables being considered."[35] The GLM results of one variable are only meaningful if the results for all other variables are considered at the same time. So for example, the indicated relativity for vehicle symbol 10 discussed above will not be valid if the model is manipulated to remove or change other key predictor variables in the model. Consequently, the results of one variable are only valid if the results for all other key variables are also being used. In other words, that indicated relativity for vehicle symbol 10 is dependent on the other relativities being considered. Chapter 13 discusses how the company's final rate relativities often deviate from the actuary's indicated relativities for business reasons, but for now it is important to understand the statistical relevance of the comments above.

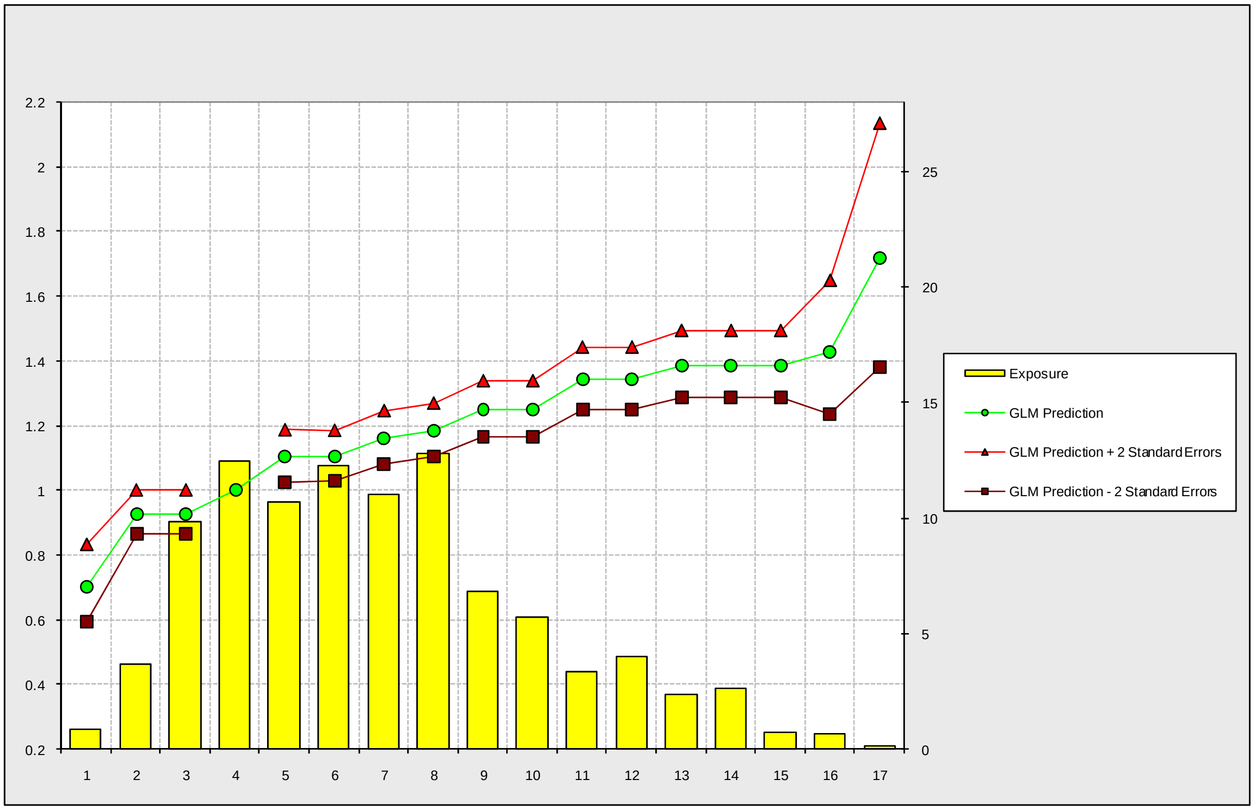
A SAMPLE OF GLM DIAGNOSTICS

Chapter 9 listed statistical significance as an important criterion for evaluating the appropriateness of rating variables. A previous section of this chapter listed the statistical diagnostics to be a major benefit of GLMs. These are tools that aid the modeler in understanding the certainty of the results and the appropriateness of the model. Certain diagnostics can help determine if a predictive variable has a systematic effect on insurance losses (and should therefore be retained in the model). Models should be refined until only such significant variables remain. Other diagnostics assess the modeler's assumptions around the link function and error term. Diagnostics can be grounded in statistical theory or can be more practical in nature. Examples of each will be given.

One of the most common statistical diagnostics for deciding whether a variable has a systematic effect on losses is the standard errors calculation. The mathematical concept is beyond the scope of this text, but "The Practitioner's Guide to Generalized Linear Models" supplies a nice intuitive explanation: "standard errors are an indicator of the speed with which the log-likelihood falls from the maximum given a change in parameter." Two standard errors from the parameter estimates are akin to a 95% confidence interval. This means the GLM parameter estimate is a point estimate, and the standard errors show the range in which the modeler can be 95% confident the true answer lies within. The following graph is identical to the graph shown previously for vehicle symbol but now includes standard error lines for the non-base levels (i.e., +/- two standard errors from the differentials indicated by the GLM). In this particular case, the upward pattern and narrow standard errors suggest this variable is statistically significant. Wide standard errors, often straddling unity, might suggest the factor is detecting mostly noise and is worthy of elimination from the model. In this example, symbol 17 shows wide standard errors, but that is mainly a function of the small volume present in that level. It does not invalidate the strong results for symbols 1-16, where most of the business volume exists.

[35] This caveat may also be written as "all other variables being constant" or "all other variables at the base level."

10.2 Standard Errors for Effect of Vehicle Symbol on Automobile Collision Frequency

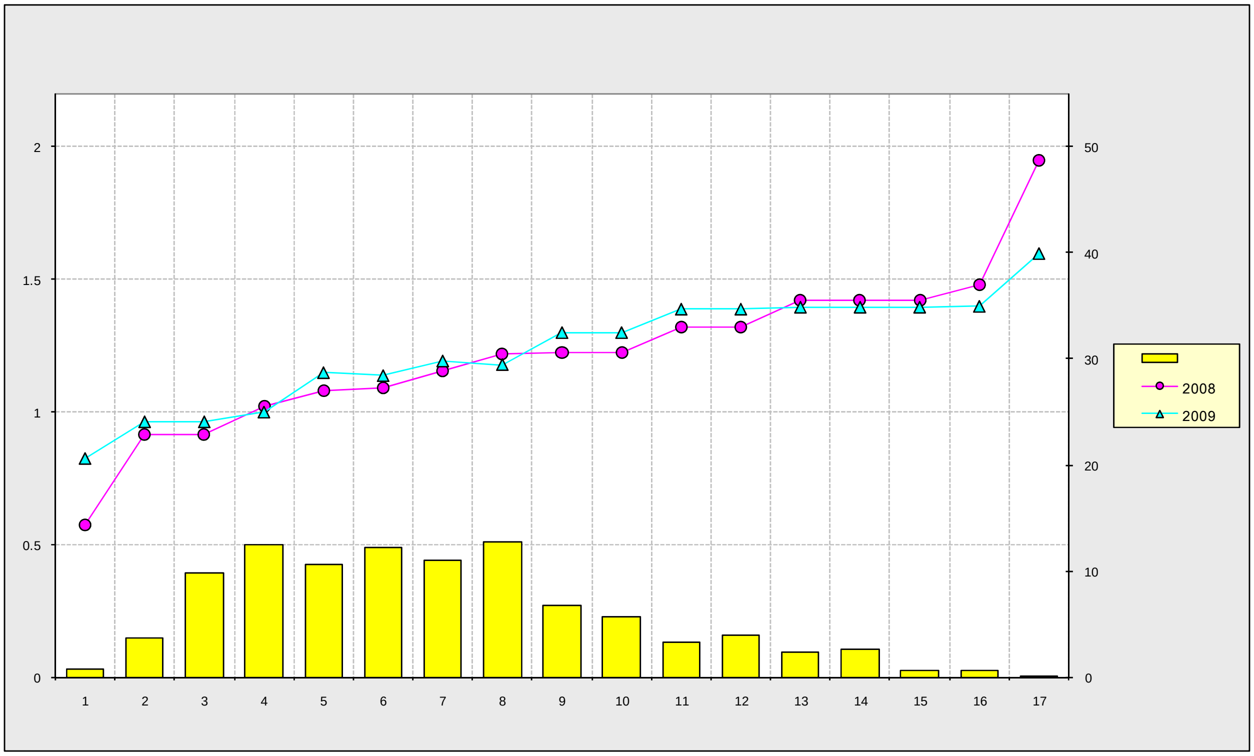


Measures of deviance are an additional diagnostic to assess the statistical significance of a predictor variable. Generally speaking, a deviance is a single figure measure of how much the fitted values differ from the observations. Deviance tests are often used when comparing nested models (one is a subset of the other) to assess whether the additional variable(s) in the broader model are worth including. The deviance of each model is scaled and the results are compared. Statistical tests such as Chi-Square or F-test are used to gauge the theoretical trade-off between the gain in accuracy by adding the variables versus the loss of parsimony in adding more parameter estimates to be solved. Similarly, deviance tests such as Akaike Information Criteria (AIC) and BIC (Bayesian Information Criteria) can be applied to non-nested models.

An example of a practical diagnostic in the modeling process is comparing the GLM results for individual years (assuming a multi-year dataset) to gauge consistency of results from one year to the next.[36] The following graph shows the effect of vehicle symbol on automobile collision frequency separately for the two years present in the experience period. The two lines show some random differences but in general the patterns are the same.

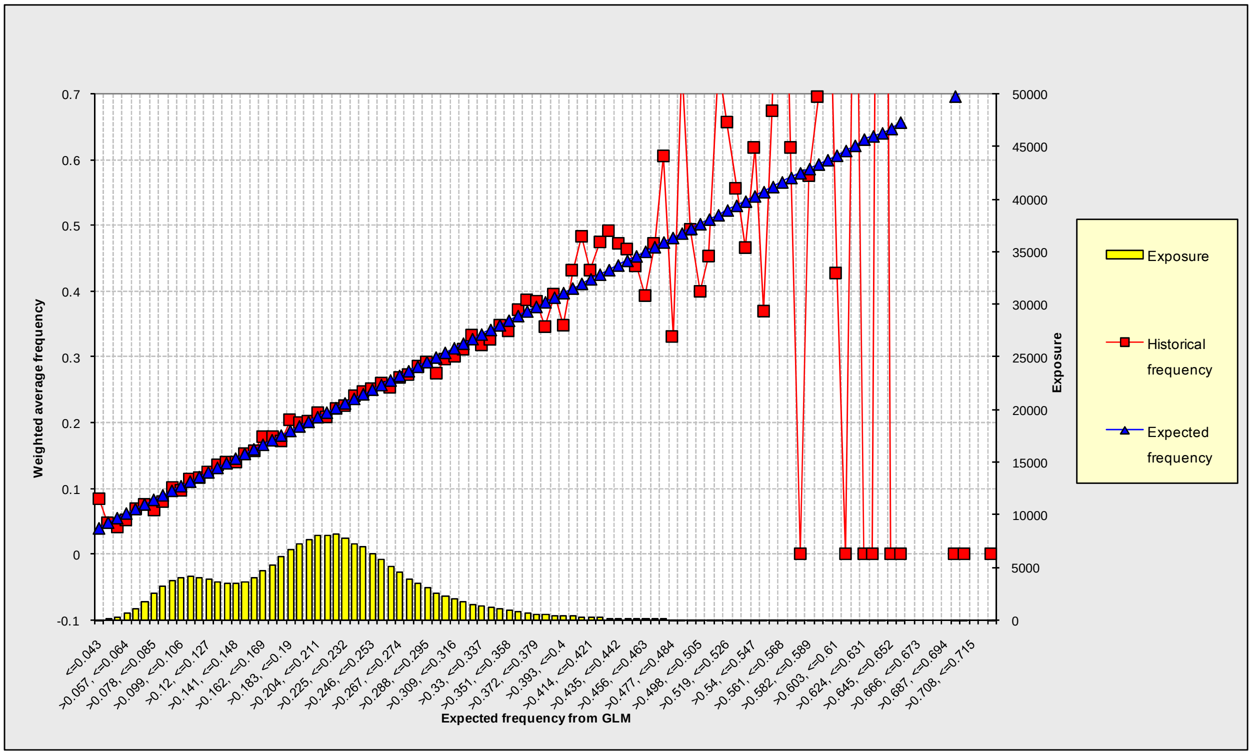
[36] Consistency can also be tested on random subsets of data rather than individual years.

10.3 Consistency of Time for Vehicle Symbol



In addition to reviewing these diagnostics for each factor, another best practice is to perform model validation techniques. One such technique compares the expected outcome of the model with historical results on a hold-out sample of data (i.e., data that was not used in the development of the model so that it could be used to test the effectiveness of the model). The extent to which the model results track closely to historical results for a large part of the portfolio is an indication of how well the model validates. The following example output is a validation of a frequency model. For most of the sample, the bands of expected frequencies from the GLM (ordered from lowest to highest) track very closely to the actual weighted frequency of each band in the hold-out sample of data. The volatile results for the high expected frequency bands are a result of low volume of data.

10.4 Model Validation



Considerable disparity between actual and expected results on the hold-out sample may indicate that the model is over or under-fitting. If the modeler retains variables in the model that reflect a non-systematic effect on the response variable (i.e., noise) or over-specifies the model with high order polynomials, the result is over-fitting. Such a model will replicate the historical data very well (including the noise) but is not going to predict future outcomes reliably (as the future experience will most likely not have the same noise). Conversely, if the model is missing important statistical effects (the extreme being a model that contains no explanatory variables and fits to the overall mean), the result is under-fitting. This model will predict future outcomes (e.g., in the extreme case mentioned above, the future mean) reliably but hardly help the modeler explain what is driving the result.

Appendix F includes additional examples and more details.

PRACTICAL CONSIDERATIONS

In practice, GLM routines are included in various commercial software packages, alleviating the burden of programming the underlying formulae and diagnostics. This does not imply, however, that the ratemaking actuary's role is at all diminished. In fact, the use of such methods means the actuary should focus attention on areas such as:

- ensuring data is adequate for the level of detail of the classification ratemaking analysis (avoiding what is known as the GIGO principle: Garbage In, Garbage Out)
- identifying when anomalous results dictate additional exploratory analysis
- reviewing model results in consideration of both statistical theory and business application
- developing appropriate methods to communicate model results in light of a company's ratemaking objectives (e.g., policyholder dislocation, competitive position)

This list is hardly exhaustive. The nature of statistical modeling for classification ratemaking is such that more work can always be done. The retrieval of data alone requires careful consideration of necessary volume of data; definition of homogeneous claim types; method of organization (e.g., policy year versus calendar-accident year); the treatment of midterm policy changes, large losses, underwriting changes during the experience period, and the effect of inflation and loss development. Actuaries always have to balance stability and responsiveness as it relates to choice of experience period as well as to geographies to be included in the analysis (e.g., countrywide versus individual state analysis). Most importantly, commercial considerations such as IT constraints, marketing objectives, and regulatory requirements have to be carefully incorporated into the statistical analysis before any results are implemented in practice.

The ratemaking actuary is best served to have a solid background in the company's data warehouses, to develop some understanding of statistical methods and diagnostics, and to work collaboratively with other professionals who have a solid understanding of the portfolio being analyzed. The ratemaking actuary should also communicate effectively with various stakeholders and ensure that technical results are ultimately expressed in relation to the company's business objectives.

DATA MINING TECHNIQUES

In addition to GLMs, many actuaries have become more familiar with various data mining techniques. The following is a brief, non-exhaustive survey of some methods used in practice. Though these techniques might not necessarily be used directly for producing rate differentials, they are often used to enhance the underlying classification analysis in various ways as described below.

Factor Analysis

Factor analysis, of which principle components analysis may be the most commonly used, is a technique to reduce the number of parameter estimates in a classification analysis (such as a GLM). This can imply a reduction in the number of variables or a reduction in the levels within a variable.

An example may best illustrate how factor analysis works. If one can summarize the exposure correlation between two variables in a scatter plot, a regression line can then be fit that summarizes the linear relationship between the two variables. A variable can then be defined that approximates this regression line. This combination variable essentially replaces the original variables and thereby reduces the parameter estimates of the model.

This technique might be used in ratemaking to compress a long list of highly correlated variables into a score variable (or a small number of uncorrelated score variables) that represents linear combinations of the original variables. For example, the vehicle symbols discussed earlier in this chapter may have been derived as a linear combination of correlated variables such as vehicle weight, vehicle height, number of cylinders, horsepower, cost when new, etc.. Another example is combining various geo-demographic variables, which are variables describing average characteristics of an area (e.g., population density, average proportion of home-ownership, average age of home, median number of rooms in the home, etc.)

Cluster Analysis

Cluster analysis is an exploratory data analysis tool that seeks to combine small groups of similar risks into larger homogeneous categories or "clusters." It generally aims to minimize the differences within a category and maximize the difference between categories.

In practice, cluster analysis is most commonly used in rating for geography. Actuaries generally start with small geographic units (such as postal code or zip code) that are often quite granular. Cluster analysis applies a collection of different algorithms to group these units into clusters based on historical experience, modeled experience, or well-defined similarity rules. This allows easier incorporation into GLMs.

CART

The purpose of CART (Classification and Regression Trees) is to develop tree-building algorithms to determine a set of if-then logical conditions that help improve classification.

In personal automobile insurance, a resulting tree may start with an if-then condition around gender. If the risk is male, the tree then continues to another if-then condition around age. If the risk is male and youthful, the tree may then continue to an if-then condition involving prior accident experience. The tree "branch" for females may involve a different order or in fact, a completely different set of conditions.

Examination of the tree may help ratemaking actuaries identify the strongest list of initial variables (i.e., whittle down a long list of potential variables to a more manageable yet meaningful list) and determine how to categorize each variable. CART can also help detect interactions between variables.

MARS

The Multivariate Adaptive Regression Spline (MARS) algorithm operates as a multiple piecewise linear regression where each breakpoint defines a region for a particular linear regression equation. This technique is generally used to select breakpoints for categorizing continuous variables. For example, in homeowners insurance, amount of insurance may be treated as a categorical factor despite being continuous in nature. MARS can help select the breakpoints used to categorize the amount of insurance factor before using it in a GLM. MARS can also help detect interactions between variables.

Neural Networks

Neural networks are very sophisticated modeling techniques though they are often criticized for their lack of transparency. The neural network user gathers test data and invokes training algorithms designed to automatically learn the structure of the data. This technique has been described as a recursion applied to a GLM.

In practice, the results of a neural network can be fed into a GLM (or vice versa). This process helps highlight areas of improvement in the GLM (e.g., a missing interaction).

In general the data mining techniques listed above can enhance a ratemaking exercise by:

- whittling down a long list of potential explanatory variables to a more manageable list for use within a GLM;
- providing guidance in how to categorize discrete variables;
- reducing the dimension of multi-level discrete variables (i.e., condensing 100 levels, many of which have few or no claims, into 20 homogenous levels);
- identifying candidates for interaction variables within GLMs by detecting patterns of inter-dependency between variables.

A full survey of these and other methods is beyond the scope of this text. For more information, readers can reference “The Elements of Statistical Learning: Data Mining, Inference and Prediction” (Hastie et al. 2009).

AUGMENTING MULTIVARIATE ANALYSIS WITH EXTERNAL DATA

The adoption of GLMs also resulted in many companies seeking external data sources to augment what had already been collected and analyzed about their own policies. This includes but is not limited to information about:

- geo-demographics (e.g., population density of an area, average length of home ownership of an area);
- weather (e.g., average rainfall or number of days below freezing of a given area);
- property characteristics (e.g., square footage of a home or business, quality of the responding fire department);
- information about insured individuals or business (e.g., credit information, occupation).

This additional data can help actuaries further improve the granularity and accuracy of classification ratemaking. Almost certainly there will continue to be more and more reliable data available publically for actuaries to analyze and use in classification ratemaking.

SUMMARY

Much of the early history of classification ratemaking was based on rudimentary methods such as univariate analysis and later iteratively standardized univariate methods such as the minimum bias procedures. As computing power and data capabilities evolved, pioneering insurance companies employed multivariate methods in their classification ratemaking and moved the entire industry forward.

Grounded in statistical theory, multivariate methods adjust for an uneven mix of business and reflect the nature of the random process of insurance. They provide valuable diagnostics that aid in understanding the certainty and reasonableness of results. They can be refined to incorporate interaction variables. The litmus test of practicality is when multivariate methods are transparent and results can be incorporated in insurance company rating algorithms.

Generalized linear models have become the standard for classification ratemaking in most developed insurance markets—particularly because of the benefit of transparency. Understanding the mathematical underpinnings is an important responsibility of the ratemaking actuary who intends to use such a method. Linear models are a good place to start as GLMs are essentially a generalized form of such a model. As with many techniques, visualizing the GLM results is an intuitive way to connect the theory with the practical use.

GLMs do not stand alone as the only multivariate classification method. Other methods such as CART, factor analysis, and neural networks are often used to augment GLM analysis. Finally, the adoption of GLMs and data mining techniques influenced classification ratemaking in other ways as well—particularly in the incorporation of external data to enhance analysis.

KEY CONCEPTS IN CHAPTER 10

1. Shortcomings of univariate approach

2. Minimum bias techniques

3. Circumstances that led to the adoption of multivariate techniques
    a. Computing power
    b. Data warehouse initiatives
    c. Early adopters attaining competitive advantage

4. Overall benefits of multivariate methods
    a. Adjust for exposure correlations
    b. Allow for nature of random process
    c. Provide diagnostics
    d. Allow interaction variables
    e. Considered transparent

5. Mathematical foundation of generalized linear models (GLMs)

6. Sample GLM output

7. Statistical diagnostics, practical tests, and validation techniques
    a. Standard errors
    b. Deviance tests
    c. Consistency with time
    d. Comparison of model results and historical results on hold-out sample

8. Practical considerations

9. Data mining techniques
    a. Factor analysis
    b. Cluster analysis
    c. CART
    d. MARS
    e. Neural networks

10. Incorporation of external data in multivariate classification analysis

CHAPTER 11: SPECIAL CLASSIFICATION

As discussed in Chapters 9 and 10, companies that can determine and implement equitable rates are able to insure a broader range of risk profitably and, therefore, have a competitive advantage. Companies that choose not to do so may face adverse selection.

The past two chapters discussed traditional (univariate) and multivariate techniques that determine the indicated relativities between different levels of a given rating variable. Certain rating variables and risk characteristics have unique qualities that led actuaries to develop special ratemaking procedures.

This chapter discusses alternate ratemaking procedures to address the following items:

- Territorial boundary analysis
- Increased limits factors
- Deductibles
- Workers compensation size of risk
- Insurance to value/Coinsurance

TERRITORIAL RATEMAKING

Geography is considered one of the primary drivers of claims experience. Consequently, it is one of the most well-established and widely used rating variables. Companies typically define territories as a collection of small geographic units (e.g., postal/zip codes, counties, census blocks) and have rate relativities for each territory. The territorial boundaries and associated rate relativities can vary significantly from insurer to insurer.

Territorial ratemaking poses some interesting challenges. First, location tends to be heavily correlated with other rating variables (e.g., high-value homes tend to be located in the same area), which makes traditional univariate analysis of location very susceptible to distortions. Second, as companies often analyze territory as a collection of small units, the data in each individual territory is sparse. This is referred to as high-dimensionality, and special multivariate techniques are required to circumvent the problem.

Territorial ratemaking generally involves two phases:

- Establishing territorial boundaries
- Determining rate relativities for the territories

Establishing Territorial Boundaries

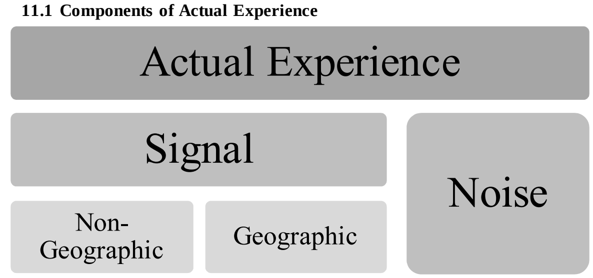
In the past, companies had few rating territories and, for many lines, most companies used the same or very similar territorial boundaries. Often these territories were developed by a third-party (e.g., ISO or NCCI) using industry data. Over time, companies began to subdivide (or modify) the territories to try to gain a competitive advantage. In many cases, the refinement was based on operational knowledge of the area and judgment. Recently, actuaries are applying more advanced methods such as geo-spatial techniques to develop or refine territorial boundaries. Actuaries are also using both internal and external data in their analyses.

Determining Geographic Unit

The first step in establishing territorial boundaries is to determine the basic geographic unit. The unit should be refined enough to be relatively homogenous with respect to geographic differences while still having some observations in most units. Typical units are postal codes (zip codes in the U.S.), census blocks, counties, or some combination of these. Each of these options has practical advantages and disadvantages. For example, while zip codes have the advantage of being the most readily available, they have the disadvantage of changing over time. Counties have the advantage of being static and readily available; however, due to the large size of most counties, they tend to contain very heterogeneous risks. Census blocks are relatively static over time, but require a process to map insurance policies to the census blocks.

Once the basic geographic unit is determined, the actuary's objective is to estimate the geographic risk associated with each unit. Actual experience reflects both signal and random noise. The signal is driven by non-geographic elements (e.g., age, amount of insurance, number of employees) and geographic elements (e.g., density, weather indices, crime rates). The different components are shown in Figure 11.1; the key to accurately estimating the geographic risk is isolating the geographic signal in the data.

11.1 Components of Actual Experience



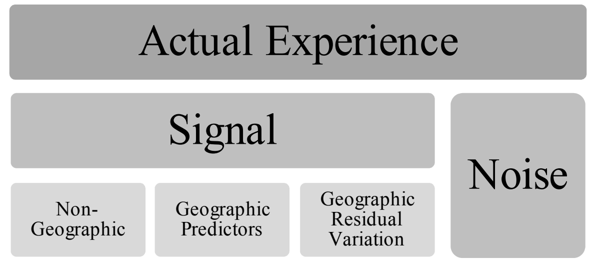
Calculating the Geographic Estimator

Traditionally, the actuary used univariate techniques (e.g., pure premium approach) to develop an estimator for each geographic unit. There are two major issues with this approach. First, the geographic estimator in this approach reflects both the signal and the noise. Since geographic units tend to be small, the data is often sparse and either the resulting loss ratios or pure premiums or both will typically be too volatile to distinguish the noise from the signal. Second, since location tends to be highly correlated with other non-geographic factors, the resulting estimator is biased.[37]

A more sophisticated approach involves building a multivariate model (e.g., a GLM) on loss cost data using a variety of non-geographic and geographic explanatory variables. The non-geographic variables include many traditional rating variables (e.g., age of insured, claim history) as well as other explanatory variables that may not currently be used in rating. The geographic variables can include geo-demographic variables (e.g., population density) and geo-physical variables (e.g., average rainfall). The geo-demographic and geo-physical variables are often obtained from third-party sources and merged with the insurance company database via some geographic unit, although it does not have to be the same as the selected basic geographic unit.

[37] The same comments made in Chapter 9 regarding this bias apply. In other words, actuaries using the loss ratio approach generally assume the rates are equitable and make no adjustments. Actuaries using the pure premium approach may adjust the exposures to account for distributional bias.

11.2 Components of Actual Experience Further Refined



The very nature of the multivariate modeling process enables the actuary to isolate the signal from the noise in the data. Since the variables and interactions included in the model are only a subset of the universe of predictive variables, there may be unexplained signal in the model residuals. Given that geography is a useful basis for examining patterns in the residuals, actuaries often examine the geographic residual variation. The parameters from each of the various geographic predictors, including a predictor variable for the geographic residual variation, can be combined to form one composite risk index or score that represents the geographic signal for each geographic unit.

Smoothing

Geographic risk tends to be similar for units that are close in proximity. Consequently, actuaries may use spatial smoothing techniques to improve the estimate of any individual unit by using information from nearby units. There are two basic types of spatial smoothing: **distance-based** and **adjacency-based**.

The **distance-based** approach smoothes by weighting the information from one geographic unit with the information from all nearby geographic units based on the distance from the primary unit and some measure of credibility. The influence of nearby areas is deemed to diminish with increasing distance.

Distance-based smoothing has the advantage of being easy to understand and implement. A disadvantage to this approach is the assumption that a certain distance (e.g., a mile) has the same impact on similarity of risk regardless of whether it is an urban or rural area. Additionally, the presence of a natural or artificial boundary (e.g., river or highway) between two geographic units is not taken into consideration when determining distance. This assumption tends to be most appropriate for weather-related perils.

Adjacency-based smoothing weights the information from one geographic unit with the information estimators of rings of adjacent units (i.e., immediately adjacent units get more weight than the units adjacent to adjacent units, etc). Adjacency-based smoothing handles urban/rural differences more appropriately, and accounts for natural or artificial boundaries better than the distance-based smoothing. For these reasons, adjacency-based smoothing tends to be most appropriate for perils driven heavily by socio-demographic characteristics (e.g., theft).

Whether distance or adjacency-based smoothing is used, the actuary needs to balance over- and under-smoothing. If the actuary smoothes too much (e.g., uses data from dissimilar units in another part of the state), the actuary may be masking the real spatial variation among the risks. If the actuary does not smooth enough, the actuary may be leaving considerable noise in the estimator.

The exact mechanics of the various spatial smoothing techniques are beyond the scope of this text.

Smoothing techniques are generally applied in one of two ways. First, smoothing techniques can be applied to the geographic estimators themselves. This is most commonly done when the geographic estimator is based on the univariate approaches as the estimators generally still contain a significant amount of noise. Second, these techniques can be applied within a more sophisticated framework to improve the predictive power of a multivariate analysis of geographical effects. In this case, the actuary applies smoothing techniques to the geographic residuals to see if there are any patterns in the residuals;

in other words, the actuary tries to detect any systematic geographic patterns that are not explained by the geographical factors in the multivariate model. Any pattern in the residuals (i.e., the residuals are all positive or negative in a certain region) indicates the existence of geographic residual variation. Once identified, the spatially smoothed residuals can be used to adjust the geographic estimators to improve the overall predictive power of the model.

Clustering

Once the geographic estimators are calculated for each unit, the units can be grouped into territories. When combining units, the goal is to minimize within group heterogeneity and maximize between group heterogeneity. As with smoothing techniques, there are a variety of clustering techniques that can achieve this. The following are basic categories of clustering routines:

- Quantile methods create clusters based on either equal numbers of observations (such as geographic units) or equal weights (such as exposure).
- Similarity methods create clusters based on how close the estimators are to one another. The definition of closeness can be based on a few different statistics:
    - The average linkage similarity method creates boundaries based on the overall average difference between the estimators from one cluster to the next. This tends to join clusters with smaller variances.
    - The centroid similarity method creates boundaries based on the overall average difference in estimators squared. This tends to be more responsive to outliers.
    - Ward's clustering method creates boundaries that lead to the smallest within cluster sum of squares difference. This tends to produce clusters that have the same number of observations.

It is important to note that these types of clustering routines do not naturally produce contiguous groupings (i.e., groupings that only include geographic units that are adjacent to each other). If the actuary desires contiguous territorial boundaries, then a contiguity constraint needs to be added to the clustering routine.

In the absence of some natural or man-made "boundary," the level of geographic risk generally changes gradually. By creating distinct boundaries, there will be a discontinuity at the boundary. If there are too few clusters, there may be a significant jump in estimated risk between two adjacent clusters, which is undesirable. Thus, the actuary should select the number of clusters that minimizes noise without creating significant discontinuities. Interestingly, many companies have eliminated the grouping of units into territories and simply derive rate relativities for each geographic unit; practically speaking, that is no different than creating a significant number of small territories. If done properly, this minimizes extreme discontinuities between units. Ultimately, rather than having rating territories, many companies will geo-code every risk, and the latitude and longitude of the insured item will create a unique rate relativity that changes gradually from one location to a neighboring location.

Calculating Territorial Relativities

Once the boundary definitions have been determined, the actuary determines the associated rate relativities or differentials. This can be accomplished using the techniques described in the prior two chapters. Since location tends to be highly correlated with other variables (e.g., low- or high-valued homes tend to be concentrated in certain areas), it is prudent to perform this analysis using multivariate classification techniques. For example, the new territorial boundaries could be modeled along with various other explanatory variables in a GLM.

INCREASED LIMITS RATEMAKING

Insurance products that provide protection against third-party liability claims usually offer the insured different amounts of insurance coverage, referred to as limits of insurance. Typically, the lowest level of insurance offered is referred to as the basic limit, and higher limits are referred to as increased limits.

Establishing appropriate rate differentials for each limit (referred to as increased limits ratemaking) is growing in importance for several reasons. First, as personal wealth continues to grow, individuals have more assets to protect and need more insurance coverage. Second, general inflation drives up costs and, as discussed in Chapter 6, trends in costs have a greater impact on increased limits losses than on basic limits losses. Third, the propensity for lawsuits and the amount of jury awards have increased significantly (i.e., social inflation). Like general inflation, this has a disproportionate impact on the increased limits losses.

Particular lines of insurance where increased limits are of extreme importance include private passenger and commercial auto liability, umbrella, and any commercial product offering liability coverage such as contractor's liability, professional liability, etc. There are two types of policy limits offered: single limits and compound limits. A single limit refers to the total amount the insurer will pay for a single claim. For example, if an umbrella policy has a limit of $1,000,000, then the policy will only pay up to $1,000,000 for any one claim.

A compound limit applies two or more limits to the covered losses. A compound limit that includes both a per claimant and a per occurrence limit is commonly referred to as a split limit. For example, in personal automobile insurance, a split limit for bodily injury liability of $15,000/$30,000 means that in the event the insured causes an accident, the policy will pay each injured party up to $15,000 with the total payment to all injured parties not to exceed $30,000. Another common compound limit is an occurrence/aggregate limit; it limits the amount payable for any one occurrence and for all occurrences incurred during the policy period. For example, assume an annual professional liability policy has a limit of $1,000,000/$3,000,000. The policy will not pay more than $1,000,000 for any single occurrence and will not pay more than $3,000,000 for all occurrences incurred during the policy period.

The focus of this section will be on determining indicated increased limit factors (ILFs) for a single limit. Compound and split limits are more complex in that both limits must be considered.

Standard ILF Approach

It is possible to aggregate policies based on the limit purchased and to use univariate (e.g., loss ratio or pure premium) analysis or multivariate techniques (e.g., GLMs) to calculate indicated rate differentials for the various limits (commonly referred to as "increased limits factors"). However, since increased limits offer protection for larger, less common liability claims, the data per limit tends to be very sparse and the results can be very volatile. Consequently, actuaries often use special techniques for increased limits ratemaking.

Similar to other rating variables, the increased limit factor (ILF) is used to modify the base rate (*B*, which assumes the basic limit) if the insured selects a limit of liability (*H*) that is different than the basic limit.

$$\text{Rate at Limit } H = \text{ILF for Limit } H \times B.$$

Making the assumption that all underwriting expenses are variable and that the variable expense and profit provisions do not vary by limit, the formula for the indicated ILF is derived in the same way as Chapter 9:

$$\text{Indicated ILF}(H) = \frac{(\overline{L + E_{\mathrm{L}}})_H}{(\overline{L + E_{\mathrm{L}}})_B}.$$

Actuaries may elect to vary the profit provision by limit, which violates the assumption in the previous paragraph. Because higher limits offer additional coverage for claims that are less frequent and very severe, the experience for these limits can be volatile. The greater variability adds uncertainty that makes these limits challenging to price and risky for insurers; consequently, insurers may alter the profit provision in the rates to reflect the higher cost of capital needed to support the additional risk. The actuary also typically makes the simplifying assumption that frequency and severity are independent so that:

$$\text{Indicated ILF}(H) = \frac{\text{Frequency}_H \times \text{Severity}_H}{\text{Frequency}_B \times \text{Severity}_B}.$$

Making the final assumption that the frequency is the same regardless of the limit chosen, the formula simplifies to:

$$\text{Indicated ILF}(H) = \frac{\text{Severity}_H}{\text{Severity}_B}.$$

For some lines of business, data suggests that the frequency of losses may vary by the limit chosen. For example, personal automobile insureds who select a very high limit tend to have lower accident frequencies than insureds who select low limits. One common explanation for this is that the selection of a higher limit tends to be a sign of risk aversion and a higher degree of overall responsibility that applies to driving behavior, too.

If the actuary is willing to accept all of these simplifying assumptions, the indicated ILF for a given limit *H* is equal to the severity of losses limited at *H* divided by the severity of losses limited at *B*. A severity limited at *H* is often referred to as the limited average severity at *H* or LAS (*H*). Using this notation:

$$\text{Indicated ILF}(H) = \frac{\text{LAS}(H)}{\text{LAS}(B)}.$$

LAS (*H*) is the severity assuming every loss is capped at limit *H* (regardless of the actual policy limit), and LAS (*B*) is the severity assuming every loss is capped at the basic limit. If the actuary knows the full amount of each loss assuming no policy limits, then this calculation is straightforward.

To illustrate this, assume the following 5,000 reported uncensored claims categorized by the size of the loss (i.e., a \$150,000 loss is slotted in the \$100,000<*X*<=\$250,000 range):

11.3 Size of Loss Distribution

Size of Loss			Reported Claims	Reported Losses
	X <=	\$ 100,000	2,324	\$ 117,629,223
\$ 100,000	< *X* <=	\$ 250,000	1,923	\$ 307,599,929
\$ 250,000	< *X* <=	\$ 500,000	680	\$ 222,793,514
\$ 500,000	< *X* <=	\$ 1,000,000	73	\$ 43,047,470
	Total		5,000	\$ 691,070,136

The average severity limited to \$100,000, or LAS (\$100,000), is calculated by capping every claim at \$100,000 and dividing by the total number of claims. All 2,324 claims in the first interval have individual sizes of loss less than \$100,000, so these losses are uncapped. The other 2,676 claims in the other three intervals have individual sizes of loss that exceed \$100,000 and are, therefore, capped at \$100,000; the resulting capped losses for these claims are \$267,600,000 (= 2,676 x \$100,000). The sum of those amounts (\$385,229,223 = \$117,629,223 + \$267,600,000) is divided by the total claim count.

Using this technique, the increased limit factor for \$250,000 is calculated as follows:

$$\text{LAS}(\$100\text{K}) = \frac{\$117{,}629{,}223 + (1{,}923 + 680 + 73) \times \$100{,}000}{5{,}000} = \$77{,}046,$$

$$\text{LAS}(\$250\text{K}) = \frac{\$117{,}629{,}223 + \$307{,}599{,}929 + (680 + 73) \times \$250{,}000}{5{,}000} = \$122{,}696,$$

$$\text{Indicated ILF}(\$250\text{K}) = \frac{\text{LAS}(\$250\text{K})}{\text{LAS}(\$100\text{K})} = \frac{\$122{,}696}{\$77{,}046} = 1.59.$$

Censored Losses

The losses used in the example above are uncensored losses. In other words, the loss data reflected the full amount of the loss assuming no policy limits. Unfortunately, the data available to the actuary is typically censored at the policy limit; consequently, the actuary does not know the full amount of the loss. For example, assume an insured with a \$50,000 policy limit has an at-fault accident in which the injured third party has \$150,000 worth of medical costs. The claims database will likely only reflect the amount paid by the insurer (i.e., \$50,000) rather than the amount the claim would be in the absence of any limit (\$150,000).

To further illustrate this point, consider the case that 2,019 of the 5,000 claims in the example above came from policies with a \$100,000 limit. The uncensored losses for these policies are as follows:

11.4 Uncensored Loss Distribution of Policies with $100,000 Limit

Size of Loss			Reported Claims	Reported Losses
	X <=	$ 100,000	922	$ 46,957,898
$ 100,000	< X <=	$ 250,000	787	$ 127,573,028
$ 250,000	< X <=	$ 500,000	282	$ 92,665,855
$ 500,000	< X <=	$ 1,000,000	28	$ 16,640,606
	Total		2,019	$ 283,837,387

Assuming the insurer's data contains only the censored losses, the loss distribution available to the actuary is represented in the right-hand portion of the table below:

11.5 Censored Loss Distribution of Policies with $100,000 Limit

Size of Loss			Uncensored Claims	Uncensored Losses	Censored Claims	Censored Losses
	X <=	$ 100,000	922	$ 46,957,898	2,019	$ 156,657,898
$ 100,000	< X <=	$ 250,000	787	$ 127,573,028		
$ 250,000	< X <=	$ 500,000	282	$ 92,665,855		
$ 500,000	< X <=	$ 1,000,000	28	$ 16,640,606		
	Total		2,019	$ 283,837,387	2,019	$ 156,657,898

Assuming the insurer writes three policy limits ($100,000, $250,000, and $500,000) and the historical database contains only censored losses, the 5,000 losses censored at the applicable policy limit appear in the data as follows:

11.6 Censored Loss Distribution by Policy Limit

Size of Loss			$100,000 Limit Claims	$100,000 Limit Losses	$250,000 Limit Claims	$250,000 Limit Losses	$500,000 Limit Claims	$500,000 Limit Losses
	X <=	$ 100,000	2,019	$ 156,657,898	690	$ 34,903,214	712	$ 35,768,111
$ 100,000	< X <=	$ 250,000			773	$ 142,767,479	574	$ 90,009,422
$ 250,000	< X <=	$ 500,000					232	$ 81,092,725
$ 500,000	< X <=	$ 1,000,000						
	Total		2,019	$ 156,657,898	1,463	$ 177,670,693	1,518	$ 206,870,258

When calculating the limited average severity for each limit, the actuary should use as much data as possible without allowing any bias due to censorship. The general approach is to calculate a limited average severity for each layer of loss and combine the estimates for each layer taking into consideration the probability of a claim occurring in the layer. The limited average severity of each layer is based solely on loss data from policies with limits as high as or higher than the upper limit of the layer.

For example, when calculating the LAS ($100K), the actuary can use the experience from all policies (even those with limits above $100,000) and censor at $100,000:

$$\text{LAS(\$100K)} = \frac{\$156{,}657{,}898 + \$34{,}903{,}214 + \$35{,}768{,}111 + \$100{,}000 \times (773 + 574 + 232)}{5{,}000},$$

$$\text{LAS(\$100K)} = \frac{\$385{,}229{,}223}{5{,}000} = \$77{,}046.$$

When calculating the LAS ($250,000), the actuary cannot use the policies that have a $100,000 limit as there is no way to know what the claim amounts would be if each of those policies had a limit of

$250,000. Instead, the actuary can combine the LAS ($100K) with a limited average severity for the layer between $100,000 and $250,000. To do this, the actuary first needs to determine the losses in that second layer.

By definition, policies with a limit of $100,000 do not contribute any losses to that layer and the data is not used.

Of the 1,463 claims associated with policies having a limit of $250,000, there are 773 claims with sizes of loss in that layer. The total censored losses for those 773 claims are $142,767,479. Eliminating the first $100,000 of each of those losses results in $65,467,479 of losses in the layer between $100,000 and $250,000:

$$\$65{,}467{,}479 = \$142{,}767{,}479 - 773 \times \$100{,}000.$$

Policies with a limit of $500,000 also contribute loss dollars to the layer between $100,000 and $250,000. Of the 1,518 claims associated with a limit of $500,000, there are 574 claims that have losses in the $100,000 to $250,000 layer. These claims contribute $32,609,422 of losses to the layer:

$$\$32{,}609{,}422 = \$90{,}009{,}422 - 574 \times \$100{,}000.$$

Another 232 claims exceed $250,000, and each contributes $150,000 to the layer for a total of $34,800,000:

$$\$34{,}800{,}000 = 232 \times (\$250{,}000 - \$100{,}000).$$

Combining all of those figures yields the following loss dollars in the layer $100,000 to $250,000:

$$\$132{,}876{,}901 = \$65{,}467{,}479 + \$32{,}609{,}422 + \$34{,}800{,}000.$$

Given that those loss dollars were derived from 1,579 (=773+574+232) claims, the limited average severity for the layer between $100,000 and $250,000 is:

$$\$84{,}153 = \frac{\$132{,}876{,}901}{1{,}579}.$$

Before combining this with the LAS ($100K), the actuary needs to adjust for the fact that these losses are based on a subset of the claims used to calculate the LAS ($100K). The adjustment involves calculating the probability that the loss will exceed $100,000, given that a claim occurs. Since the actuary cannot know whether or not the claims from the policies with a $100,000 limit would have exceeded $100,000, that data is not used for this calculation. To adjust this, the limited average severity for the layer between $100,000 and $250,000 can be multiplied by the following probability:

$$\Pr(X >= \$100K) = \frac{773 + 574 + 232}{1{,}463 + 1{,}518} = \frac{1{,}579}{2{,}981}.$$

This is equivalent to dividing the losses in the layer by the total claim count for those policies:

$$\$44{,}575 = \$84{,}153 \ x \ \frac{1{,}579}{2{,}981} = \frac{\$132{,}876{,}901}{2{,}981}.$$

Given these calculations,

$$\text{LAS}(\$250\text{K}) = \$77{,}046 + \$44{,}575 = \$121{,}621.$$

These same techniques can be applied to calculate LAS ($500K). Only the policies with a limit of $500,000 or greater can be used to determine the contribution from the layer between $250,000 and $500,000:

$$\$15{,}213 = \frac{\$81{,}092{,}725 - 232 \times \$250{,}000}{1{,}518}.$$

Given this,

$$\text{LAS}(\$500\text{K}) = \$77{,}046 + \$44{,}575 + \$15{,}213 = \$136{,}834.$$

Other Considerations

The increased limits ratemaking analyses outlined above are intended to produce rate relativities for future policies; therefore, historical losses used in the analysis should be adjusted for any expected trend. This is especially relevant with increased limits losses. Recall from Chapter 6 that loss trends have a leveraged effect on increased limits losses. More specifically, assuming a constant positive percentage trend in total losses, the following relationship holds:

$$\text{Basic Limits Trend} \leq \text{Total Limits Trend} \leq \text{Increased Limits Trend}.$$

See Table 6.15 in Chapter 6 for a numeric example that demonstrates this relationship.

Also, depending on how recent the empirical data is, the claims may not be settled. Since larger claims often develop differently than smaller claims, this can have an impact on the calculation of the increased limit factors. Ideally, all claims should be developed to ultimate before the application of these techniques.

In addition to censoring through policy limits, losses may also be truncated from below if there is a deductible applied to the policy. While it is possible to "add back" the amount of dollars eliminated due to the deductible on known claims, it may not be possible to know how many claims were completely eliminated due to the deductible.

Fitted Data Approach

The prior approach used historical loss data to calculate the indicated increased limit factors. That approach depends heavily on the existence and nature of the claims in the layers of loss being studied. Given the relatively rare nature of large claims, the results using that approach may be volatile.

Consequently, actuaries may fit curves to empirical data to smooth out the random fluctuations in the data. Common distributions include lognormal, Pareto, and the truncated Pareto.

Assuming $f(x)$ represents a continuous distribution of losses of size x, and H is the limit being priced, then the formula for the limited average severity is given by:

$$\text{LAS}(H) = \int_0^H xf(x)dx + H\int_H^\infty f(x)dx.$$

The severity is based on claims that are less than the limit and claims that are censored by the limit. The first term is the loss amount for all claims less than the limit multiplied by the probability of those claims occurring. The second term represents the limit multiplied by the probability that the loss exceeds the limit. The sum of the two terms equals the limited average severity.

Thus, the increased limit factor for the limit H is represented as follows:

$$\text{ILF}(H) = \frac{\int_0^H xf(x)dx + H\int_H^\infty f(x)dx}{\int_0^B xf(x)dx + B\int_B^\infty f(x)dx}.$$

The major challenge with this approach is determining a distribution that is representative of the expected losses.

ISO Mixed Exponential Methodology

The ISO Mixed Exponential Methodology is an advanced approach designed to address some of the issues with the empirical data (trend, censoring by policy limits, etc.). This is an advanced topic and is outside the scope of this text. For more information on this approach, refer to "Increased Limits Ratemaking for Liability Insurance" (Palmer 2006, pp. 19-25).

Multivariate Approach

As discussed in Chapter 10, many actuaries analyze increased limits factors within a multivariate framework. Techniques such as generalized linear models can cope more effectively with sparse data, but this is still an issue for the very high, thinly populated limits. A major difference between a GLM approach and the univariate approaches using limited average severities is that the GLM does not assume the frequency is the same for all risks. Therefore, the GLM results are influenced by both the limiting of losses and the behavioral differences among insureds at different limits. This may produce counter-intuitive results (e.g., expected losses decrease as limit increases). Consequently, actuaries may use both approaches to guide the selection of increased limit factors.

DEDUCTIBLE PRICING

Many early insurance policies were written on a full coverage basis (i.e., the policy covered the entire loss amount). Over time, insurance companies introduced deductible clauses in which the insured is responsible for the first dollars of loss up to the deductible amount, and the insurer pays the amount greater than the deductible, up to applicable policy limits.

There are two basic types of deductibles: flat dollar deductibles and percentage deductibles.[38] Flat dollar deductibles are the most prevalent. As the name suggest, a flat dollar deductible (e.g., $250 deductible) specifies a dollar amount below which losses are not covered by the policy. Flat dollar deductibles may range from very small amounts (e.g., $100 or $250) on personal lines policies to very large deductibles (e.g., $100,000 or more) on large commercial policies. Percentage deductibles state the deductible as a percentage of the coverage amount. For example, a 5% deductible on a home insured for $500,000 is equivalent to a flat dollar deductible of $25,000. These types of deductibles are most prevalent on property policies, and are often applied specifically to perils that are susceptible to catastrophic losses (e.g. earthquake or hurricane).

There are several reasons why deductibles are popular among both insureds and insurers, some of which are listed below:

- **Premium reduction:** The application of a deductible reduces the rate as the insured is responsible for a portion of the losses. Often the insured (whether an individual or company) may be willing to cover the amount under the deductible in exchange for a lower premium.
- **Eliminates small nuisance claims:** Under a full coverage policy, insureds have an incentive to file every claim. Insurance companies incur loss adjustment expenses in the process of settling reported claims. The expense associated with investigating and handling small claims frequently costs more than the actual claim amount. Deductibles minimize the occurrence of these small nuisance claims. By doing this, insurers can better control LAE and keep the rates lower than would otherwise be possible.
- **Provides incentive for loss control:** Since the insured is responsible for the first layer of loss, the insured has a financial incentive to avoid losses.
- **Controls catastrophic exposure:** When an insurer writes a significant number of policies in a given area, the insurer may be susceptible to very large aggregate losses in the case of a catastrophic event. By including large catastrophe deductibles, the insurer can significantly reduce overall exposure to such losses and reduce the overall risk of insolvency.

Loss Elimination Ratio (LER) Approach

It is possible to group data by deductible and use the techniques described in Chapters 9 and 10 to determine rate relativities for each deductible amount. Alternatively, actuaries have determined deductible relativities using a loss elimination ratio (LER) approach.

[38] A third type of deductible, used in a small number of insurance products (e.g., crop hail insurance) is the disappearing deductible. With a disappearing deductible, the insured is still responsible for the first dollars of loss. However, this amount decreases, or disappears, as the size of the claim increases until at a certain point the insured's retained losses are zero. Since this type of deductible is not commonly used in practice today, this text will not further address disappearing deductibles.

Using the assumptions that all expenses are variable and that the variable expenses and profit are a constant percentage of premium, the indicated deductible relativity for deductible *D* is given by the following formula (where the base level in this example assumes no deductible):

$$\text{Indicated Deductible Relativity} = \frac{(\overline{L+E_{\text{L}}})_D}{(\overline{L+E_{\text{L}}})_B}.$$

In other words, the indicated deductible relativity is equivalent to the ultimate losses and LAE after application of the deductible divided by the ground-up ultimate losses and LAE (i.e., no deductible). In the LER approach, the actuary calculates the amount of losses that are eliminated going from full coverage to a deductible, or by going from one deductible to a higher deductible:

$$\text{LER}(D) = \frac{\text{Losses and LAE Eliminated by Deductible}}{\text{Total Ground-up Losses and LAE}} = \frac{(L+E_{\text{L}})_B - (L+E_{\text{L}})_D}{(L+E_{\text{L}})_B}.$$

That formula can be re-written as follows:

$$(L+E_{\text{L}})_D = (L+E_{\text{L}})_B \times (1.0 - \text{LER}(D)).$$

The indicated deductible relativity can be restated as:

$$\text{Indicated Deductible Relativity} = \frac{(\overline{L+E_{\text{L}}})_B \times (1.0 - \text{LER}(D))}{(\overline{L+E_{\text{L}}})_B} = (1.0 - \text{LER}(D)).$$

Empirical Distribution (Discrete Case)

If the ground-up loss is known for every claim, the LER can be calculated as follows:

$$\text{LER}(D) = (1 - \frac{\sum_{\text{All Losses}} \text{Maximum}[0, (\text{Loss Amount} - D)]}{\sum_{\text{All Losses}} \text{Loss Amount}}).$$

To demonstrate the discrete approach for determining loss elimination ratios, consider the following table of ground-up homeowners losses:

11.7 Size of Loss Distribution

(1) Size of Loss	(2) Reported Claims	(3) Ground-Up Reported Losses
\$ - <=*X*< \$ 100	3,200	\$240,365
\$ 100 <=*X*< \$ 250	1,225	\$207,588
\$ 250 <=*X*< \$ 500	1,187	\$463,954
\$ 500 <=*X*< \$1,000	1,845	\$1,551,938
\$ 1,000 <=*X*<	2,543	\$11,140,545
TOTAL	10,000	\$13,604,390

To calculate the loss elimination ratio for a \$250 deductible denoted as LER (\$250), the actuary determines the amount of losses in each layer that will be eliminated by the deductible. The first two rows of data only contain losses that are less than \$250, which will be completely eliminated by the deductible. The remaining rows contain individual losses that are at least \$250; therefore, \$250 will be eliminated for each of the 5,575 claims (or \$1,393,750 in total). The LER is calculated as losses eliminated divided by the total losses:

$$\text{LER}(\$250) = \frac{(\$240{,}365 + \$207{,}588) + \$250 \times (1{,}187 + 1{,}845 + 2{,}543)}{\$13{,}604{,}390} = 0.135.$$

Thus without any further adjustments, the rate credit for going from full coverage to a \$250 deductible is 13.5%; alternatively, this can be restated as a deductible relativity by subtracting 0.135 from 1.0 (i.e., 0.865).

The following table shows the calculations discussed above:

11.8 LER Calculation for \$250 Deductible

(1) Size of Loss	(2) Reported Claims	(3) Ground-Up Reported Losses	(4) Losses Eliminated by \$250 deductible
\$ - <=X< \$ 100	3,200	\$240,365	\$240,365
\$ 100 <=X< \$ 250	1,225	\$207,588	\$207,588
\$ 250 <=X< \$ 500	1,187	\$463,954	\$296,750
\$ 500 <=X< \$1,000	1,845	\$1,551,938	\$461,250
\$ 1,000 <=X<	2,543	\$11,140,545	\$635,750
TOTAL	10,000	\$13,604,390	\$1,841,703
	(5) LER		0.135

$(4)_{\text{Losses}<250}$ = (3)
$(4)_{\text{Losses}>=250}$ = (2) x \$250
(5) = (Tot4) / (Tot3)

Other Considerations

The aforementioned calculations were possible because the ground-up losses were known. The company may not know the ground-up losses for every claim. For example, insureds may not report claims that are obviously less than the deductible on their policy. In this case, the database may only include censored losses (i.e., the portion of reported losses that exceed the deductible); these losses are commonly referred to as net losses. When this is the case, data from policies with deductibles greater than the deductible being priced cannot be used to calculate the loss elimination ratio. For example, data from policies with a \$500 deductible cannot be used to determine loss elimination ratios for a \$250 or \$100 deductible. However, data from policies with deductibles less than the deductible being priced can be used to determine loss elimination ratios (e.g., data from policies with a \$500 deductible can be used to determine the loss elimination ratio associated with moving from a \$750 deductible to a \$1,000 deductible). It is common for the actuary to aggregate the data from all policies with a lower deductible to increase the volume of data used in the loss elimination ratio analysis.

The following example shows the calculation of the credit to change from a $250 to a $500 deductible. Each row contains data for policies with different deductible amounts. Since the goal is to determine the losses eliminated when changing from a $250 to a $500 deductible, the analysis can only use policies with deductibles of $250 or less. Columns 4 and 5 contain the net reported losses in Column 3 restated to $500 and $250 deductible levels, respectively.[39] The losses eliminated by moving from a $250 to a $500 deductible are the difference between the two columns. The LER equals the eliminated losses divided by the total losses at the $250 level.

11.9 LER Calculation to Move from a $250 to $500 Deductible

(1) Deductible	(2) Reported Claims	(3) Net Reported Losses	(4) Net Reported Losses Assuming $500 Ded	(5) Net Reported Losses Assuming $250 Ded	(6) Losses Eliminated
Full Cov	500	$680,220	$524,924	$588,134	$63,210
$100	680	$1,268,403	$1,049,848	$1,176,269	$126,421
$250	1,394	$2,940,672	$2,624,621	$2,940,672	$316,051
$500	2,194	$5,249,242	$5,249,242	Unknown	Unknown
$1,000	254	$859,755	Unknown	Unknown	Unknown
TOTAL	5,022	$10,998,292			

(7) Net Reported Losses for Ded <=$250	$4,705,075
(8) Losses Eliminated <=$250 Ded	$505,682
(9) LER	0.107

(3)= Net of the deductible
(4)= (3) Adjusted to a $500 deductible
(5)= (3) Adjusted to a $250 deductible
(6)= (5) - (4)
(7)= Sum of (5) for $0, $100, $250 Deductibles
(8)= Sum of (6) for $0, $100, $250 Deductibles
(9)= (8) / (7)

The same comments made earlier with respect to trend and development in the Increased Limit Factors section apply to deductible pricing, too.

[39] Columns 4 and 5 are not simply Column 3 minus the product of Column 2 and the assumed deductible. This is because not every reported loss exceeds the assumed deductible. The losses in Columns 4 and 5 are based on an assumed distribution of losses by deductible and size of loss, and cannot be recreated given the data shown.

Fitted Data Approach

The LER can be calculated given a continuous distribution of losses. Assume $f(x)$ represents a continuous distribution of losses of size x, and D is the size of the deductible. The eliminated losses equal the sum of all losses less than the deductible D and the deductible amount for every loss that exceeds D.

This formula is very similar to the formula used in the increased limit factor section and calculates the expected loss eliminated through the application of a deductible, D.

$$\int_0^D xf(x)dx + D\int_D^\infty f(x)dx.$$

The LER is calculated by dividing this formula by the unlimited expected loss:

$$\text{LER}(D) = \frac{\int_0^D xf(x)dx + D\int_D^\infty f(x)dx}{\int_0^\infty xf(x)dx}.$$

Practical Considerations

Like the ILF pricing, the LER approach assumes claiming behavior will be the same for each deductible. This may not be the case. The LER approach assumes an insured with a $250 deductible and an insured with a $1,000 deductible will both report a $1,100 loss. In reality, the same insured who reports the claim under a $250 deductible policy may choose not to report the claim under a $1,000 deductible policy for fear of an increase in premium from the insurer applying a claim surcharge (i.e., the small net payment of $100 is not worth the increase in premium). This difference in behavior is ignored in loss elimination ratio calculations.

Furthermore, when insureds are allowed to freely choose their policy deductible, lower-risk insureds tend to choose higher deductibles. Presumably, those insureds realize they are unlikely to have a claim and are willing to accept the risk associated with a higher deductible. Since the LER approach does not recognize these behavioral differences, higher deductible policies may end up being more profitable than lower deductible policies.

If insureds are not allowed to self-select and are forced to purchase higher deductibles, this phenomena will not be present. In fact, it is possible that the insureds who wanted a lower deductible may try to artificially inflate claims to make up the additional deductible amount.

An analysis using the techniques described in Chapters 9 and 10 will reflect behavioral differences among deductible options inherent in the historical data. The actuary may wish to view both sets of indications before selecting a final set of deductible rate relativities.

Another consideration is that the LER approach determines an average percentage credit that is applied to all policies with a certain deductible amount. In the earlier example, the credit for a $250 deductible is 13.5%. If the total policy premium is $3,000, then the credit for moving from full coverage to a $250 deductible is $405. Since the premium savings exceeds the amount of the deductible, the insured will be better off to select the deductible unless he or she expects to have multiple losses. A company may handle this circumstance in different ways. First, an insurer may implement a cap on the amount of dollar credit from the deductible; for example, the maximum dollar credit for moving from full coverage to a $250 deductible might be $200. Second, companies may calculate a different set of credits for different policies. For example, a homeowners insurer may have different deductible credits for low-, medium-, and high-valued homes. By segregating risks in this fashion, the chance of such reversals is minimized. Finally, percentage deductibles address this issue since the amount of the deductible increases with the amount of insurance.

The examples did not address expenses, profit, etc. These issues are especially important for large deductible commercial policies and will be discussed in depth in Chapter 15.

SIZE OF RISK FOR WORKERS COMPENSATION

Many commercial lines products have relatively simple rating algorithms. Historically, workers compensation rating algorithms did not include a rating variable accounting for the size of the insured company. To account for expected differences in expense and loss levels for larger insureds, some workers compensation insurers vary the expense component for large risks, incorporate premium discounts or loss constants, or all of these.

Expense Component

As discussed in Chapter 7, commercial lines insurers typically use the All Variable Approach to determine the applicable expense provisions. The basic assumption of that approach is that underwriting expenses are a constant percentage of the premium charged. Since some expenses are fixed or nearly fixed, they do not vary greatly by the size of the policy. Consequently, policies with small average premium (i.e., small risks) will be undercharged and policies with large average premium (i.e., large risks) will be overcharged. Insurers may adjust for this in a few different ways.

First, workers compensation insurers may calculate a variable expense provision that only applies to the first $5,000 of standard premium.[40] Thus, the expenses on policies with standard premium greater than the $5,000 limit represent a smaller percentage of the total premium.

Second, insurers may charge an expense constant to all risks, which accounts for costs that are the same no matter the size of the policy, such as many underwriting and administrative expenses. Since the expense constant is a flat dollar amount, it is a decreasing percentage of written premium as the size of the policy increases.

Finally, workers compensation insurers apply a premium discount to policies with premium above a specified amount. The following table shows the calculation of the premium discount for a policy with standard premium of $400,000.

[40] Standard premium is a term defined by the National Council of Compensation Insurers (NCCI). In general, it is premium before application of premium discounts and expense constants, but the exact NCCI definition is beyond the scope of this text.

11.10 Workers Compensation Premium Discount Example

(1) Premium Range		(2)	(3) Premium in Range	(4) Prod	(5) General	(6) Taxes	(7) Profit	(8) Total	(9) Expense Reduction	(10) Discount %	(11) Premium Discount
$ -	-	$ 5,000	$ 5,000	15.0%	10.0%	3.0%	5.0%	33.0%	0.0%	0.0%	$ -
$ 5,000	-	$ 100,000	$ 95,000	12.0%	8.0%	3.0%	5.0%	28.0%	5.0%	5.4%	$ 5,130
$ 100,000	-	$ 500,000	$ 300,000	9.0%	6.0%	3.0%	5.0%	23.0%	10.0%	10.9%	$ 32,700
$ 500,000	-	above	-	6.0%	4.0%	3.0%	5.0%	18.0%	15.0%	16.3%	-
Standard Premium:			$ 400,000								$ 37,830

(3)= Min of [(2) - (1), Standard Premium-SumPrior(3)]
(9)= ($8_{\text{Row 1}}$)-(8)
(10)= (9) / [1.0 -(6) - (7)]
(11)= (3) x (10)

In this procedure, the premium discount is calculated using a graduated expense discount scale and applying it to the premium in different layers. Column 3 shows the premium of $400,000 split into the premium ranges. Columns 4 through 7 show the applicable expense percentage for each type of expense. In the example, percentages for production and general expenses decrease for the larger premium ranges recognizing that some of the expenses do not vary by premium. Taxes and profit are assumed to be a constant percentage of premium and no reduction is applicable. Column 8 is the total expense and profit percentage by premium range, and Column 9 calculates the incremental change in the expense ratio for each premium range. The applicable premium discount is calculated by dividing the percentage reduction by 1.0 minus the expense percentages for taxes and profit; the division reflects the fact that the when the fixed expenses are reduced, the variable items associated with those expenses (i.e., taxes and profit) are reduced, too. The dollar discount is calculated by multiplying the premium in the range by the applicable discount percentage.

Loss Constants

Small workers compensation risks tend to have less favorable loss experience (as a percentage of premium) than large risks. There are several theories for this phenomenon. First, small companies generally have less sophisticated safety programs since they require a large amount of capital to implement and maintain. Second, small companies may also lack programs to help injured workers return to work. Finally, the premium for small insureds are either unaffected or only slightly impacted by experience rating, which results in lower rates for insureds with better than average loss experience and higher rates for insureds with worse than average loss experience.[41] Thus, small insureds may have less incentive to prevent or control injuries than large insureds.

When workers compensation insurers charge the same rate per exposure for small and large insureds, the premium will be inadequate for small companies and excessive for large companies. Historically, a loss constant has been added to the premium to equalize the final expected loss ratios between small and large insureds. The following table shows an example of the calculation.

[41]Experience rating is discussed in detail in Chapter 15. Very small companies either may not be eligible for experience rating or the effect of experience rating may be limited through the use of credibility, or both.

11.11 Workers Compensation Loss Constant Example

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Premium Range		Policies	Premium	Reported Loss	Initial Loss Ratio	Target Loss Ratio	Premium Shortfall	Loss Constant
$ 1	- $ 2,500	1,000	$ 1,000,000	$ 750,000	75.0%	70.0%	$ 71,429	$ 71.43
$ 2,501	- above	1,000	$ 5,000,000	$ 3,500,000	70.0%	70.0%	$ -	$ -

(6)= (5) / (4)
(7)= Given
(8)= [(5) / (7)] -(4)
(9)= (8) / (3)

In the example, the unadjusted expected loss ratios for small (premium less than or equal to $2,500) and large (premium greater than $2,500) risks are 75% and 70%, respectively. Assuming the insurer wants to achieve an expected loss ratio of 70% for both types of risks, an adjustment to the rate is necessary. Column 8 shows the amount of premium needed to decrease the small risk expected loss ratio to 70%, and is calculated by dividing the reported loss by the target loss ratio (to get the needed premium) and subtracting the premium without the loss constant. The loss constant is calculated by dividing the premium shortfall by the number of small risk policies.

With more sophisticated multivariate techniques, some insurers are adding a rating variable to account for the size of the risk. In such cases, the loss constant is no longer necessary.

INSURANCE TO VALUE (ITV)

For many property policies (e.g., homeowners), the policy limit corresponds to the value or replacement cost of the insured item, and the rates vary based on the policy limit chosen. The term insurance to value (ITV) is used to indicate how the level of insurance chosen relates to the overall value or replacement cost of the item. For example, if an item is insured to full value, then the amount of insurance equals the total value or replacement cost of the insured item. This section discusses the importance of ITV and addresses actions companies may take to ensure policies are insured to the appropriate level assumed in the rates.

Insurance to Value Example

To help understand the concept and the issues associated with ITV, consider the following example:

- Two homes worth $250,000 and $200,000 are each insured for the full amount.
- Expected claim frequency is assumed to be 1% for both homes.
- Expected losses are uniformly distributed.

That information yields the following expected size of loss distributions and rates for each home:

11.12 Calculations for a $250,000 Home

Size of Loss ($000s)	(1) Loss Distribution	(2) Average Reported Loss ($000s)
$ - <X<= $ 25	10.0%	$ 12.5
$ 25 <X<= $ 50	10.0%	$ 37.5
$ 50 <X<= $ 75	10.0%	$ 62.5
$ 75 <X<= $ 100	10.0%	$ 87.5
$ 100 <X<= $ 125	10.0%	$ 112.5
$ 125 <X<= $ 150	10.0%	$ 137.5
$ 150 <X<= $ 175	10.0%	$ 162.5
$ 175 <X<= $ 200	10.0%	$ 187.5
$ 200 <X<= $ 225	10.0%	$ 212.5
$ 225 <X<= $ 250	10.0%	$ 237.5
Total	100.0%	$ 125.0
(3) Frequency		1%
(4) Pure Premium ($000s)		$ 1.25
(5) Amount of Insurance ($000s)		$ 250.00
(6) Rate per $1,000		$ 5.00

11.13 Calculations for a $200,000 Home

Size of Loss ($000s)	(1) Loss Distribution	(2) Average Reported Loss ($000s)
$ - <X<= $ 25	12.5%	$ 12.5
$ 25 <X<= $ 50	12.5%	$ 37.5
$ 50 <X<= $ 75	12.5%	$ 62.5
$ 75 <X<= $ 100	12.5%	$ 87.5
$ 100 <X<= $ 125	12.5%	$ 112.5
$ 125 <X<= $ 150	12.5%	$ 137.5
$ 150 <X<= $ 175	12.5%	$ 162.5
$ 175 <X<= $ 200	12.5%	$ 187.5
Total	100.0%	$ 100.0
(3) Frequency		1%
(4) Pure Premium ($000s)		$ 1.00
(5) Amount of Insurance ($000s)		$ 200.00
(6) Rate per $1,000		$ 5.00

(Tot2)= (2) weighted by (1)
(4)= (Tot2) x (3)
(6)= [(4) / (5)] x $1,000

Based on this information, the expected pure premium for the $250,000 home is $1,250 (=$125,000 x 0.01). Assuming no expenses or profit, the appropriate premium is $1,250. More specifically, the rate is $5 per $1,000 of amount of insurance ($= (\$1{,}250/\$250{,}000) \times \$1{,}000$). Similarly, the expected pure premium for a $200,000 home insured to full value is $1,000 (=$100,000 x 0.01), and the appropriate rate is $5 per $1,000 of amount of insurance.

Now consider the case in which the $250,000 home is only insured for $200,000. The expected loss distribution remains unchanged, but the expected claim payment is limited to the amount of insurance for the policy (i.e., $200,000):

11.14 Calculations for a $250,000 Home Insured for $200,000

Size of Loss ($000s)	(1) Loss Distribution	(2) Reported Loss ($000s)	(3) Average Payment ($000s)
$ - <X<= $ 25	10.0%	$ 12.5	$ 12.5
$ 25 <X<= $ 50	10.0%	$ 37.5	$ 37.5
$ 50 <X<= $ 75	10.0%	$ 62.5	$ 62.5
$ 75 <X<= $ 100	10.0%	$ 87.5	$ 87.5
$ 100 <X<= $ 125	10.0%	$ 112.5	$ 112.5
$ 125 <X<= $ 150	10.0%	$ 137.5	$ 137.5
$ 150 <X<= $ 175	10.0%	$ 162.5	$ 162.5
$ 175 <X<= $ 200	10.0%	$ 187.5	$ 187.5
$ 200 <X<= $ 225	10.0%	$ 212.5	$ 200.0
$ 225 <X<= $ 250	10.0%	$ 237.5	$ 200.0
Total	100.0%	$ 125.0	$ 120.0
(4) Frequency			1%
(5) Pure Premium ($000s)			$ 1.20
(6) Amount of Insurance ($000s)			$ 200.00
(7) Rate per $1,000			$ 6.00

(Tot2)= (2) weighted by (1)
(Tot3)= (3) weighted by (1)
(5)= (Tot3) x (4)
(7)= [(5) / (6)] x $1,000

This demonstrates two problems associated with underinsurance. First, the insurance payment will not be sufficient to cover the full loss amount 20% of the time. Thus, the insured will not be returned to the pre-loss condition. Second, if the insurer assumes all homes are insured to full value and uses a rate of $5 per $1,000, then the premium will not be sufficient to cover the expected payments for a home that is underinsured. Therefore, the rates are not equitable.

It is important to note that the inequity in the rates is caused by the fact that the homes are not insured to the same level. If all homes are underinsured by the same percentage amount, then the resulting premium may not be adequate to cover all the losses, but the premium will be equitable. Over time, the base rate will adjust so that aggregate premium covers the aggregate losses at the actual level of ITV present in the book of business.

A key point is that the inequity and adequacy issues only exist because partial losses are possible. The following table shows a comparison if all claims are total losses:

11.15 Three Policies-Total Losses Only

		(1)		(2)		(3)
Full Value of Item ($000s)	$	500	$	500	$	400
Amount of Insurance ($000s)	$	500	$	400	$	400
Frequency		1%		1%		1%
Severity ($000s)*	$	500	$	400	$	400
Pure Premium ($000s)	$	5	$	4	$	4
Rate per $1,000	$	10	$	10	$	10
Premium ($000s)	$	5	$	4	$	4

*All losses are total losses.

In this case, the home that is underinsured (2) still results in a claim payment that is less than the full value of the item. However, the total premium collected is adequate and the rates are equitable.

Coinsurance Clause

Coinsurance implies that two or more parties are jointly participating in the insurance arrangement. In property insurance, an insurer may implement a coinsurance clause in which the two parties are the insurer and the insured. Basically, the insurer may require a minimum insurance to value (e.g., 80% of full value) or else payment on covered losses will be reduced proportionately by the amount of underinsurance.[42] The intent of the coinsurance requirement is to achieve greater equity among risks, though more so through the payment of losses than the adequacy of rates.

The following notation is used in the coinsurance calculations:

- I = indemnity received after loss
- L = amount of loss after deductible
- F = face value of policy (i.e., amount of insurance selected)
- V = value of property
- c = required coinsurance percentage
- a = apportionment ratio
- e = coinsurance penalty

Using this notation, the coinsurance requirement (cV) is the amount of coverage required such that no penalty is applied. The coinsurance apportionment ratio (a) is the relationship of the amount of insurance selected (F) to the coinsurance requirement (cV), and is the factor applied to the loss amount to calculate the indemnity payment:

$$a = \min\left[\frac{F}{cV},\ 1.0\right].$$

[42] In some countries (e.g., the U.K.), this is known as the Principle of Averages.

The indemnity payment is given by the following basic formula:

$$I = L \times \frac{F}{cV}, \text{ where } I \le F \text{ and } I \le L.$$

The coinsurance penalty (e) is the amount that the indemnity payment is reduced by the application of the coinsurance clause. A reduction occurs when the following three conditions apply:

1. A non-zero loss has occurred (i.e., $L > 0$).
2. The face amount of insurance is less than the coinsurance requirement (i.e., $F < cV$).
3. The loss is less than the coinsurance requirement (i.e., $L < cV$).

The amount of the penalty is given by the following:

$$e = \begin{cases} L - I, & \text{if } L \le F \\ F - I, & \text{if } F < L < cV. \\ 0, & \text{if } cV \le L \end{cases}$$

To illustrate these points, consider a home valued at \$500,000 that is only insured for \$300,000 despite a coinsurance requirement of 80% (or \$400,000 in this case). Since the face value is \$300,000 a coinsurance deficiency exists and the apportionment ratio is 0.75 (=\$300,000 / \$400,000).

The following are the indemnity payments and coinsurance penalties for a \$200,000 loss:

$$I = L \times \frac{F}{cV} = \$200{,}000 \times \frac{\$300{,}000}{\$400{,}000} = \$150{,}000,$$

$$e = L\text{-}I = \$200{,}000\text{-}\$150{,}000 = \$50{,}000.$$

The following are the indemnity payments and coinsurance penalties for a \$300,000 loss:

$$I = L \times \frac{F}{cV} = \$300{,}000 \times \frac{\$300{,}000}{\$400{,}000} = \$225{,}000,$$

$$e = L\text{-}I = \$300{,}000\text{-}\$225{,}000 = \$75{,}000.$$

The following are the indemnity payments and coinsurance penalties for a \$350,000 loss:

$$I = L \times \frac{F}{cV} = \$350{,}000 \times \frac{\$300{,}000}{\$400{,}000} = \$262{,}500,$$

$$e = F\text{-}I = \$300{,}000\text{-}\$262{,}500 = \$37{,}500.$$

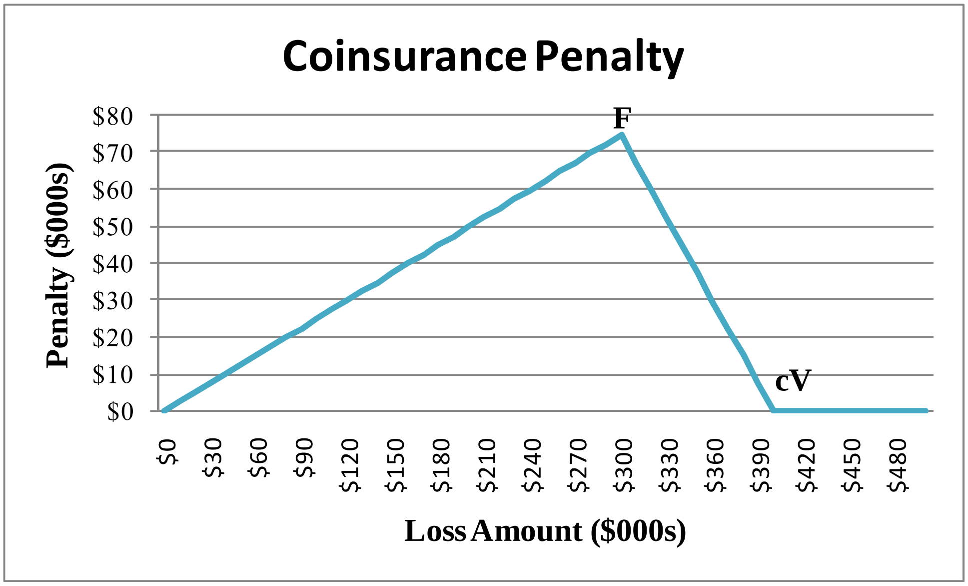
The following are the indemnity payments and coinsurance penalties for a $450,000 loss:

$$I = L \times \frac{F}{cV} = \$450{,}000 \times \frac{\$300{,}000}{\$400{,}000} = \$337{,}500, \text{ but } \$337{,}500 > F, \text{ so } I = F = \$300{,}000,$$

$$e = F\text{-}I = \$300{,}000\text{-}\$300{,}000 = \$0.$$

The following chart illustrates the magnitude of the coinsurance penalty for all loss values between $0 and $500,000 (i.e., the full value of the home):

11.16 Coinsurance Penalty by Loss Amount



This chart shows that the dollar coinsurance penalty increases linearly between $0 and the face amount, which is where the penalty is the largest. The penalty decreases for loss sizes between the face amount and the coinsurance requirement. There is no coinsurance penalty for losses larger than the coinsurance requirement, but the insured suffers a penalty in that the payment does not cover the total loss.

For the coinsurance mechanism to work appropriately in the event of a loss, it is important that the value of the insured property can be established so that the coinsurance penalty can be accurately calculated.

Varying Rates Based on ITV Level

A coinsurance penalty clause corrects for inequity caused by two homes being insured to different levels of ITV by adjusting the indemnity payment in the event of a loss. Another way to achieve equity is to calculate and use rates based on the level of ITV. Returning to Tables 11.12 through 11.14, the indicated rate per $1,000 of insurance was the same for the two homes insured to full value (i.e., $5 per $1,000 of insurance) and higher for the underinsured home (i.e., $6 per $1,000 of insurance). If those indicated rates were used, the premium would have been equitable and no coinsurance penalty would have been necessary.

A rate can be calculated for any face amount of insurance given the expected frequency, the size of loss distribution, and the full value of the property. Use the following notation:

- f = frequency of loss
- $s(L)$ = probability of loss of a given size
- V = maximum possible loss (which may be unlimited for some insurance)
- F = face value of policy

The formula to determine the rate is the expected indemnity payment divided by the face value of the policy.[43] Given a set of empirical losses, the rate is as follows:

$$\text{Rate} = \frac{f \times \left[\sum_{L=1}^{F} Ls(L) + F \times (1.0 - \sum_{L=1}^{F} s(L)) \right]}{F}.$$

Given a distribution of losses, the rate is as follows:

$$\text{Rate} = \frac{f \times \left[\int_{0}^{F} Ls(L)dL + F \times (1.0 - \int_{0}^{F} s(L)dL) \right]}{F}.$$

Assuming partial losses are possible, the rate per amount of insurance decreases as the face value gets closer to the value of the insured item. The rate of change of that decrease will vary depending on the shape of the loss distribution:

- Right-skewed distribution (i.e., small losses predominate): the rate will decrease at a decreasing rate as the policy face value increases.
- Uniform distribution (i.e., all losses equally likely): the rate will decrease at a constant rate as the policy face value increases.
- Left-skewed distribution (i.e., large losses predominate): the rate will decrease at an increasing rate as the policy face value increases.

Under the rate approach (as opposed to the coinsurance penalty), the coinsurance is really thought to be any portion of the loss that exceeds the face value should the insured choose a face value less than the full value of the property. The major difficulty with the rate approach is determining the loss distribution.

Insurance to Value Initiatives

The homeowners policy in the U.S. typically settles losses based on replacement cost, subject to the policy limit. One feature of the policy that encourages insurance to full value is guaranteed replacement cost (GRC). This policy feature allows replacement cost to exceed the policy limit if the property is 100% insured to value and, in some cases, subject to annual indexation. In the 1990s, large catastrophes such as Hurricane Andrew and the Oakland fires changed the dynamics of the construction industry and

[43] The amount of insurance is frequently shown in $100 or $1,000 increments.

insurers were faced with replacement costs far in excess of insured values. The industry responded by changing the policy feature to cap the replacement cost (e.g., 125% of policy limit).

In more recent years, the property insurance industry has implemented other means to encourage insurance to full value. For example, insurers are using more sophisticated property estimation tools. Previously these tools were crude estimators that considered a limited number of inputs when calculating value (e.g., square footage and number of rooms) and updated the value at renewal according to broad geographic indices. Today's component indicator tools consider customized features of the home (e.g., granite countertops, hardwood floors, age of plumbing and electricity); moreover, these same tools are used to estimate insured value at renewal as well.

By increasing the amount of insurance on underinsured homes to the level of ITV assumed in the rates, companies are able to generate additional premium without increasing rates. Since homeowners loss distributions tend to be left-skewed (i.e., small losses predominate), the increased premium is more than the additional losses generated from this action. As the insureds receive increased coverage, they are generally more accepting of the increased premium than if rate increases were implemented.

In addition to property estimation tools, the industry has made better use of property inspections, indexation clauses, and education of insureds. As with any major change to insurance company operations, the actuaries need to estimate the effect of any ITV initiative on overall results.

SUMMARY

The preceding two chapters outlined basic classification ratemaking techniques designed to achieve equity among insureds. This chapter outlined some other methods used by actuaries to determine equitable rates based on a few important risk characteristics.

Territorial ratemaking involves establishing territorial boundaries and then deriving rate relativities for those territories. Because location tends to be heavily correlated with other factors and many locations have very sparse data, special techniques are required to estimate the risk for each geographic unit. Once a geographic estimator is calculated for each unit, additional techniques are applied in order to combine the units into territories. Rate relativities for the territories can be derived using the methods described in the previous rate classification chapters.

Increased limit factors are difficult to price as large losses tend to be rare. Actuaries can price increased limit factors for a given limit of insurance as the severity of losses at that limit divided by the severity of losses at the basic limit. Actuaries may use empirical data or fitted data for these calculations. In some cases, actuaries may use multivariate analysis or other advanced techniques (e.g., ISO Mixed Exponential).

Pricing deductibles is similar to increased limits except that the loss is censored below the deductible rather than above the policy limit. Actuaries generally calculate loss elimination ratios, which represent the portion of the loss eliminated by the deductible. This approach does not account for the varying behavior of insureds that self-select different amounts of insurance; consequently, actuaries may supplement their loss elimination ratio analysis with multivariate analysis that does capture behavioral differences.

Workers compensation rating algorithms have not traditionally considered size of risk as a rating variable yet insurers generally agree that the loss experience between small and large risks is different. To incorporate this difference in the rates, insurers use expense adjustments and loss constants in the rating algorithms.

For many property lines of business, such as homeowners, it is important that the property be insured to the value assumed in the rates. When insureds underinsure their properties, they risk not being fully covered in the event of a loss; moreover, this condition creates inequity compared to policies that are insured to full value. Insurers address this inequity by either reducing covered losses through a coinsurance clause or by adjusting rates according to the degree of underinsurance. Insurers have also implemented various initiatives to ensure that individual risks are insured to the appropriate value.

KEY CONCEPTS FOR CHAPTER 11

1. Territorial ratemaking
   a. Establishing territorial boundaries
      i. Defining basic geographic units
      ii. Creating geographic estimators
      iii. Smoothing geographic estimators
      iv. Combining units based on clustering techniques
   b. Calculating territorial rate relativities

2. Increased limit factors
   a. Limited Average Severity
      i. Uncensored losses
      ii. Censored losses
   b. Fitted data approach
   c. Other considerations
   d. Multivariate approach
   e. ISO mixed exponential approach

3. Deductible LER approach
   a. Discrete approach
   b. Fitted data approach
   c. Practical considerations

4. Workers compensation size of risk
   a. Expense component
   b. Loss constants

5. Insurance to Value (ITV)
   a. Importance of ITV
   b. Coinsurance
      i. Penalty
      ii. Varying rates based on ITV level
   c. ITV initiatives

CHAPTER 12: CREDIBILITY

Prior chapters covered ratemaking techniques that use historical data to develop actuarial estimates of future loss experience. According to the Law of Large Numbers, as the volume of similar, independent exposure units increases, the observed experience will approach the "true" experience, and for a sufficiently large number, the observed experience will equal the "true" experience. The experience of any one insured can vary significantly from year to year. By insuring a large number of independent risks, the experience of the entire group becomes more stable and can be more accurately predicted. Unfortunately, the volume of data used for overall ratemaking or classification ratemaking may not always be fully sufficient to produce accurate and stable rates, and the actuary can consider supplementing the data with additional information. The science of credibility in ratemaking addresses how to blend the actuarial estimate based on observed experience with one or more sets of related experience in order to improve the estimate of expected values.

This chapter covers:

- Methods for measuring credibility in an actuarial estimate[44]
- Desirable qualities for the complement of credibility
- Methods (and examples) for determining the complement of credibility in both first dollar and excess ratemaking
- A brief commentary on credibility when using statistical multivariate ratemaking techniques

NECESSARY CRITERIA FOR MEASURES OF CREDIBILITY

The first step in utilizing credibility is to determine the reliability of the actuarial estimate based on observed experience. Assuming homogenous risks, the amount of credibility given to the observed experience, commonly denoted by Z, should meet the following three basic criteria:

1. Z must be greater than or equal to zero (i.e., no negative credibility) and less than or equal to 1.00 (i.e., capped at fully credible).
2. Z should increase as the size of the risk underlying the actuarial estimate increases (all else being equal).
3. As the size of the risk increases (all else being equal), Z should increase at a decreasing rate.

METHODS FOR MEASURING CREDIBILITY IN AN ACTUARIAL ESTIMATE

As defined in Actuarial Standard of Practice (ASOP) Number 25 "Credibility Procedures Applicable to Accident and Health, Group Term Life, and Property/Casualty Coverages" (ASOP No. 25, 1996, p. 1), credibility is "a measure of the predictive value in a given application that the actuary attaches to a particular body of data."

The actuary should be familiar with and consider various methods for determining the credibility of a particular body of data. Two commonly discussed credibility methods are classical credibility and Bühlmann credibility. Both methods involve explicit calculation of a measure of credibility used to blend

[44] This chapter will not cover the application of credibility within experience rating calculations.

subject experience and related experience. A third method, Bayesian analysis, introduces related experience into the actuarial estimate in a probabilistic measure. In other words, the method does not explicitly calculate a measure of credibility.

These three methods are covered extensively in other actuarial texts; this chapter is meant to provide an overview.

Classical Credibility Approach

The classical credibility approach, commonly called limited fluctuation credibility, is the most frequently used method in insurance ratemaking. The goal of classical credibility is to limit the effect that random fluctuations in the observations have on the risk estimate.

In this approach, a value of credibility (Z) is calculated and used to assign weights to the observed experience (also known as subject experience or base statistic) and to some related experience in the following linear expression:

$$\text{Estimate} = \text{Z x Observed Experience} + (1.0 - \text{Z}) \text{ x Related Experience.}$$

Let Y represent the total number of claims, and S represent the total amount of losses. The actuary first determines the expected number of claims, ($E(Y)$, required for the observed experience to be considered fully credible (Z=1.00).

The observed experience is considered fully credible when the probability (p) is high that the observed experience will not differ significantly from the expected experience by more than some arbitrary amount (k). Stated in probabilistic terms:

$$\Pr\left[(1-k)E(S) \le S \le (1+k)E(S)\right] = p.$$

According to the Central Limit Theorem,

$$\frac{S\text{-}E(S)}{\sqrt{Var(S)}} \sim N(0,1).$$

Therefore, the probabilistic expression above can be transformed as follows:

$$\Pr\left[\frac{(1\text{-}k)E(S) - E(S)}{\sqrt{Var(S)}} \le \frac{S\text{-}E(S)}{\sqrt{Var(S)}} \le \frac{(1+k)E(S) - E(S)}{\sqrt{Var(S)}}\right] = p.$$

Since the normal distribution is symmetric about its mean, this is equivalent to:

$$\left[\frac{(1+k)E(S) - E(S)}{\sqrt{Var(S)}}\right] = z_{(p+1)/2},$$

where $z_{(p+1)/2}$ is the value in the Standard Normal table for specified values $(p+1)/2$.

Consider the following simplifying assumptions about the observed experience:

- Exposures are homogeneous (i.e., each exposure has the same expected number of claims).
- Claim occurrence is assumed to follow a Poisson distribution; therefore, it follows that the expected number of claims, $E(Y)$, equals the variance, $\text{Var}(Y)$.
- There is no variation in the size of loss (i.e., constant severity).

Given those assumptions, the expression above can be simplified to:

$$\left[\frac{kE(Y)}{\sqrt{E(Y)}}\right] = z_{(p+1)/2}.$$

By squaring both sides of the equation and rearranging the terms, the expected number of claims needed for full credibility can be expressed as:

$$E(Y) = \left(\frac{z_{(p+1)/2}}{k}\right)^2.$$

For example, an actuary may regard the loss experience as fully credible if there is a 90% probability that the observed experience is within 5% of its expected value. This is equivalent to saying there is a 95% probability that the observed losses are no more than 5% above the mean. In the Standard Normal table, the 95th percentile is 1.645 standard deviations above the mean; therefore, the expected number of claims needed for full credibility is:

$$E(Y)=\left(\frac{1.645}{0.05}\right)^2 = 1{,}082.$$

If the number of observed claims is equal to or greater than the standard for full credibility (1,082 in the example above), the measure of credibility (Z) is 1.00:

$$Z = 1.00 \text{ where } Y \geq E(Y).$$

If the number of observed claims is less than the standard for full credibility, the square root rule is applied to calculate Z:

$$Z = \sqrt{\frac{Y}{E(Y)}} \text{ where } Y < E(Y).$$

In the example above, if the observed number of claims is 100, Z is calculated as:

$$Z = \sqrt{\frac{100}{1{,}082}} = 0.30.$$

The square root formula, with the inclusion of the maximum of 1.0, does meet the three criteria discussed earlier.

In some cases, the actuary may prefer to have a full credibility standard based on the number of exposures rather than the number of claims. The exposure standard is calculated by dividing the number of claims needed for full credibility by the expected frequency.

The following table shows the number of claims and exposures needed for full credibility using example values for k and p:

12.1 Example Full Credibility Standards

(1) *k*	(2) *p*	(3) $z_{(p+1)/2}$	(4) Number of Claims for Full Credibilty	(5) Projected Frequency	(6) Number of Exposures for Full Credibility
5%	90%	1.645	1,082	5.0%	21,640
10%	90%	1.645	271	5.0%	5,420
5%	95%	1.960	1,537	5.0%	30,740
10%	95%	1.960	384	5.0%	7,680
5%	99%	2.575	2,652	5.0%	53,040
10%	99%	2.575	663	5.0%	13,260

(3)= From Normal Distribution Table
(4)= [(3) / (1)] ^ 2
(6)= (4) / (5)

If the actuary rejects the assumption that there is no variation in the size of losses, the number of claims needed for observed data to be considered fully credible is as follows:

$$E(Y) = \left(\frac{z_{(p+1)/2}}{k}\right)^2 x \left(1 + \frac{\sigma_s^2}{\mu_s^2}\right),$$

where $\frac{\sigma_s^2}{\mu_s^2}$ is the coefficient of variation squared, assuming Poisson frequency.

Removing the other simplifying assumptions will also alter the calculation for the full credibility standard; appropriate derivations and formulae are beyond the scope of this text. More in-depth discussion can be found in “Credibility” (Mahler and Dean 2001).

Simple Example

Calculate the credibility-weighted pure premium estimate assuming the following:

- The standard for full credibility is set so that the observed value is to be within +/-5% of the true value 90% of the time.
- The actuary assumes exposures are homogeneous, claim occurrence follows a Poisson distribution, and there is no variation in claim costs.
- The observed pure premium of $200 is based on 100 claims.
- The pure premium of the related experience is $300.

Based on the specified values of *k* and *p*, the corresponding value on the Standard Normal table is 1.645. The claim count standard for full credibility is therefore:

$$E(Y) = \left(\frac{1.645}{0.05}\right)^2 = 1{,}082.$$

Z is calculated by the square root rule as:

$$Z = \text{Min}\left[\sqrt{\frac{100}{1{,}082}}, 1.00\right] = 0.30.$$

The credibility-weighted pure premium estimate is $270 (=0.30 x $200 + (1-0.30) x $300).

Comments on Approach

This approach has three main advantages. First, it is the most commonly used and is therefore generally accepted. Second, the data required for this approach is readily available. Finally, the computations are very straightforward.

The main disadvantage of this approach is that the derivation involves making several simplifying assumptions that may not be true in practice (e.g., no variation in the size of losses). Another disadvantage of the classical credibility approach is that while it uses a selected complement, it does not take into account the quality of the estimator compared to the latest observation and therefore judgment is required.

The actuary should consider the advantages and disadvantages above and determine whether this approach is appropriate for the particular ratemaking analysis.

Bühlmann Credibility

Bühlmann credibility is commonly referred to as least squares credibility since the goal of this approach is to minimize the square of the error between the estimate and the true expected value of the quantity being estimated. When using least squares credibility, the credibility-weighted estimate is defined as:

$$\text{Estimate} = Z \text{ x Observed Experience} + (1.0 - Z) \text{ x Prior Mean.}$$

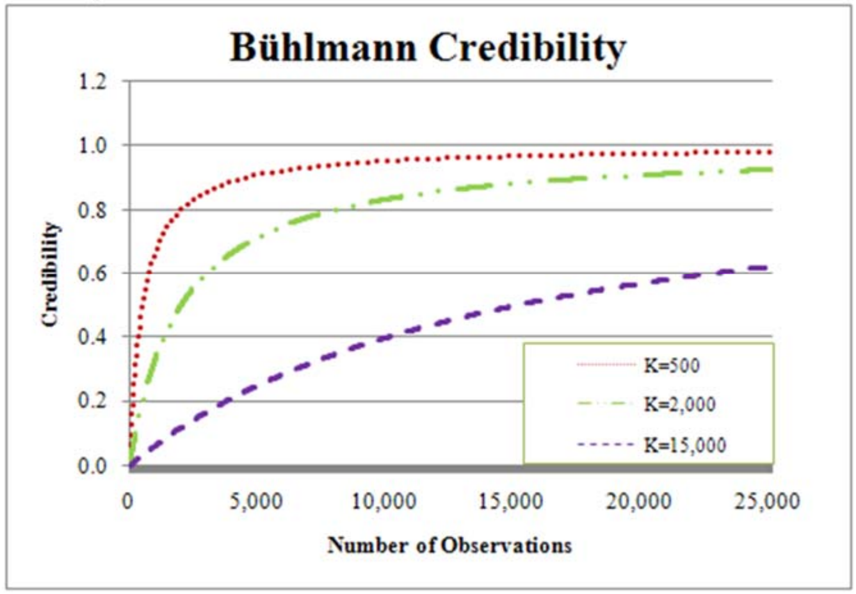
Whereas classical credibility considered related experience, this formula considers a prior mean, which reflects the actuary's a priori assumption of the risk estimate.

In least squares credibility, Z is defined as follows:

$$Z = \frac{N}{N + K}.$$

N represents the number of observations, and K is the expected value of the process variance (EVPV) divided by the variance of the hypothetical means (VHM). The ratio K can be described more simply as the ratio of the average risk variance and the variance between risks. In practice, K can be difficult to calculate. The EVPV and VHM can be derived from a model or estimated based on data. The former case is subject to model error, while the latter case is subject to random fluctuation. Further commentary on the calculation of K is beyond the scope of this text. Chart 12.2 shows the sensitivity of the derived credibility for three different values of K.

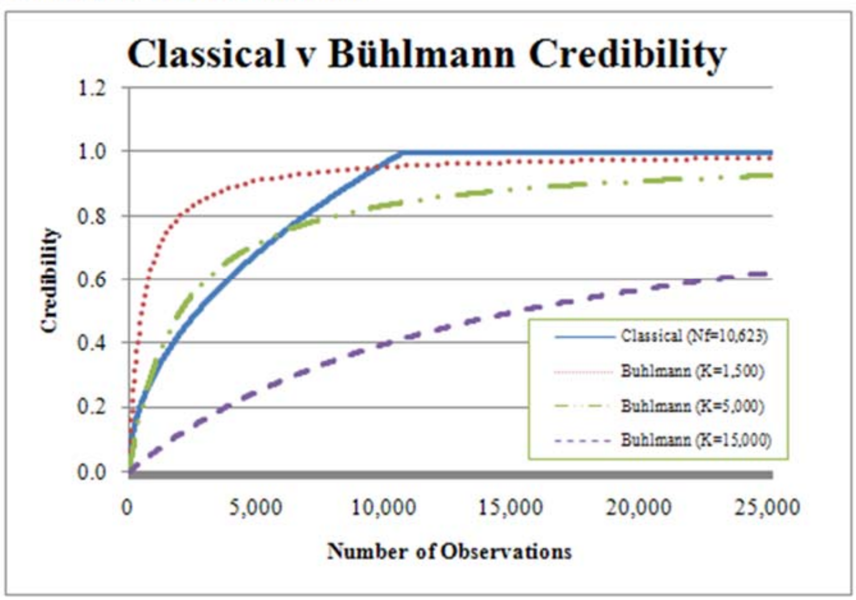
12.2 Comparison of Z for Different Values of K



Since K is a constant for a given situation, the credibility will meet the criteria listed earlier in the chapter. The chart demonstrates this visually.

For Bühlmann credibility, Z approaches 1.0 asymptotically as N gets larger, whereas the classical credibility measure equals 1.0 at the point the number of claims or exposures equals the full credibility standard (denoted N_f) and thereafter. Chart 12.3 shows a comparison of the credibility at different numbers of observations (N) under classical and Bühlmann approaches.

12.3 Comparison of Credibility Values



For these specific values of N_f and K and for a relatively small number of observations, the Bühlmann credibility estimate is closest to the classical credibility estimate when K equals 5,000 (i.e., the line with dashes and dots is close to the solid line). As the number of observations gets larger, the Bühlmann credibility estimate is closest to the classical credibility estimate when K equals 1,500 (i.e., the dotted line). Many practitioners using classical credibility make simplifying assumptions—for example, they ignore the variation in the size of losses and assume that the risks in the subject experience are homogeneous. If these same assumptions are made with least squares credibility, then VHM = 0 (this is because all of the exposures have exactly the same claim distribution). When VHM = 0, then $Z = 0$ and no credibility is assigned to the observed experience.

The Bühlmann credibility formula has a number of assumptions, summarized as follows:

- (1.0-Z) is applied to the prior mean.
- The risk parameters and risk process do not shift over time.
- The expected value of the process variance (EVPV) of the sum of N observations increases with N.
- The variance of the hypothetical means (VHM) of the sum of N observations increases with N.

Simple Example

Calculate the Bühlmann credibility-weighted estimate assuming the following:

- The observed pure premium is \$200 based on 21 observations.
- The expected value of the process variance (EVPV) is 2.00.
- The variance of the hypothetical means (VHM) is 0.50.
- The prior mean is \$225.

Given that information,

$$K = \frac{\text{EVPV}}{\text{VHM}} = \frac{2.00}{0.50} = 4.00,$$

and

$$Z = \frac{21}{21 + 4.00} = 0.84;$$

consequently,

$$\text{Credibility-weighted Pure Premium} = 0.84 \text{ x } \$200 + (1 - 0.84) \text{ x } \$225 = \$204.$$

Comments on Approach

While not as common as classical credibility, least squares credibility is used within the insurance industry and is generally accepted. The major challenge of this approach is the determination of the expected value of the process variance and the variance of the hypothetical means. Like classical credibility, least squares credibility is also based on a set of simplifying assumptions that need to be evaluated to confirm that this approach is suitable for the given situation.

Bayesian Analysis

The third class of credibility analysis is based on Bayesian theory. In Bayesian analysis there is no specific calculation of the Z parameter, but a distributional assumption must be made. Bayesian analysis is based on the fundamental notion that the prior estimate is adjusted to reflect the new information. The new information is introduced into the prior estimate in a probabilistic manner, via Bayes Theorem. This differs from least squares credibility where the new information is introduced into the prior estimate via the credibility weighting. Note that due to the greater complexities of its probabilistic nature, Bayesian analysis is not used as commonly in practice as Bühlmann credibility.

It is interesting to note that Bühlmann or least squares credibility is the weighted least squares line associated with the Bayesian estimate. In certain special mathematical situations, the Bayesian analysis estimate is equivalent to the least squares credibility estimate.

DESIRABLE QUALITIES OF A COMPLEMENT OF CREDIBILITY

As discussed earlier, the basic formula for calculating the credibility-weighted actuarial estimate using classical credibility is:[45]

$$\text{Estimate} = Z \text{ x Observed Experience} + (1 - Z) \text{ x Related Experience}$$

Once the credibility of the observed data is determined, the next step is to select the related experience. This is commonly referred to as the "complement of credibility." According to ASOP 25:

> The actuary should use care in selecting the related experience that is to be blended with the subject experience. Such related experience should have frequency, severity, or other determinable characteristics that may reasonably be expected to be similar to the subject experience. If the proposed related experience does not or cannot be adjusted to meet such criteria, it should not be used. The actuary should apply credibility procedures that appropriately reflect the characteristics of both the subject experience and the related experience.

The complement of credibility can often be more important than the observed data. For example, if the observed experience varies around the true experience with a standard deviation equal to its mean, it will probably receive a very low credibility. Therefore, the majority of the rate (in this context, expected loss estimate) will be driven by the complement of credibility.

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[45] Theoretically when an actuary determines credibility based on the Bühlmann approach, the complement of credibility should be the prior mean. Even so, actuaries have used other related experience when Bühlmann credibility is used.

In "Complement of Credibility" (Boor 2004, pp. 7-8), Boor gives desirable qualities for a complement of credibility:

1. Accurate
2. Unbiased
3. Statistically independent from the base statistic
4. Available
5. Easy to compute
6. Logical relationship to base statistic.

Rates should have as low an error variance as possible around the future expected losses being estimated. A complement of credibility that helps achieve this is considered accurate.

The complement should not be routinely higher or lower than the observed experience. Said another way, the differences between the complement and the observed experience should average to zero over time. If this is not the case, the complement is biased and the actuary needs to determine whether or not the bias is material.

The distinction between accurate and unbiased is important. An unbiased statistic varies randomly around the following year's losses over many successive years, but it may not be close. An accurate statistic may be consistently higher or lower than the following year's losses, but it is always close.

The complement should also be statistically independent from the base statistic. If it is not independent, then any error in the base statistic can be compounded.

The data required to compute the complement should be readily available. If it is not, then the complement of credibility is not practical. The calculations should also be relatively easy to perform and understand. This is particularly important when the actuary must provide justification to a third party (e.g., regulator) for approval.

Finally, the complement should have an explainable relationship to the observed experience. If there is a logical relationship, it is much easier to support the use of the complement to any third party reviewing the actuarial justification.

METHODS FOR DEVELOPING COMPLEMENTS OF CREDIBILITY

There are a variety of complements used in practice. The remainder of this chapter describes and evaluates different methods for developing complements of credibility for both first dollar ratemaking and excess ratemaking. First dollar ratemaking is performed on products that cover claims from the first dollar of loss (or after some small deductible) up to some limit. Personal automobile, homeowners, workers compensation, and professional liability insurance are good examples of first dollar products. In first dollar ratemaking, historical losses are used for the base statistic, and they are generally the same magnitude as the true expected losses. In contrast to first dollar products, excess insurance products cover claims that exceed some high attachment point. Personal umbrella policies, large deductible commercial policies, and excess reinsurance are good examples of excess products.

First Dollar Ratemaking

Boor describes six commonly used methods for developing complements for first dollar ratemaking:

- Loss costs of a larger group that includes the group being rated
- Loss costs of a larger related group
- Rate change from the larger group applied to present rates
- Harwayne's method
- Trended present rates
- Competitor's rates

The complements are discussed in terms of pure premium ratemaking. Several of the methods can be used with loss ratio methods by replacing the exposure units with earned premium.

Loss Costs of a Larger Group that Include the Group being Rated

This complement considers the experience of a larger group to which the subject experience belongs. The following are a few examples that may apply:

- A multi-state insurer may use data from all states in the region to supplement the experience of the state being reviewed.
- A medical malpractice insurer may use the experience of all primary care physicians to supplement the experience of primary care pediatricians.
- An auto insurer may use the data of all insureds ages 16-19 to supplement the experience of 16-year-olds.
- An insurer may use data from a longer-term period to credibility-weight observed experience that is short-term.

Consider the following data (adapted from Boor 2004, p 11) and the possibilities for a complement of credibility to the observed experience, the latest year pure premium from Rate Group A, Class 1 (= $50).

12.4 Data from a Larger Group

		Latest Year		Latest 3 Years	
Rate Group	Class	Exposures	Pure Premium	Exposures	Pure Premium
A	1	100	$ 50	250	$ 64
	2	300	$ 67	850	$ 65
	3	400	$ 48	1,100	$ 50
	Subtotal	800	$ 55	2,200	$ 57
B	Subtotal	600	$ 48	1,700	$ 32
C	Subtotal	1,000	$ 72	2,800	$ 86
D	Subtotal	1,600	$ 94	5,600	$ 87
Total	Total	4,000	$ 74	12,300	$ 74

Some of the obvious candidates for complement of credibility are the three-year pure premium for Rate Group A, Class 1; the one- or three-year pure premium for Rate Group A; and the one- or three-year pure premium for the total of all experience. While not shown, another option is the total of all Class 1 experience across all rate groups.

The following comments summarize the advantages and disadvantages of complement of credibility candidates.

- Using the three-year pure premium of Rate Group A, Class 1 experience (i.e., $64) is problematic. The one-year subject experience comprises over one-third the exposures of the three-year complement experience, thus it is most likely not independent. Additionally, the large difference between the one-year pure premium ($50) and the three-year pure premium ($64) suggests the three-year data may be biased (i.e., changes in loss costs may have occurred that makes the older data less relevant).
- Using the total of all experience combined ranks better with respect to independence as the latest year of Rate Group A, Class 1 is only a small portion of the total experience (100 out of 4,000 exposures). A comparison of the total one and three-year pure premiums suggests the total experience has low process variance; however, the difference between the one-year Rate Group A, Class 1 pure premium ($50) and the one-year total pure premium ($74) implies a bias may be present.
- Using the one-year Rate Group A experience appears to be the best of the given options. The Rate Group A data should reflect risks that are more similar to Class 1. Comparing the one-year pure premium ($55) and three-year pure premium ($57) suggests it has a low process variance. Also, the one-year result is not significantly different than the one-year Rate Group A, Class 1 result ($50), which suggests little bias.
- The data is not readily available to use the Class 1 data from all rate groups combined. Otherwise, it is possible that would be a reasonable option.

Evaluation

Because the complement is based on a greater volume of data, it is likely to have a lower process variance than the subject experience. However, as discussed in the classification ratemaking chapters, the actuary tries to subdivide data into homogenous groups. The fact that the subject experience has been split out of the larger group suggests that the actuary believes the subject experience is different than the larger group. If this is the case, then the larger group is likely a biased estimator of the subject experience. The actuary may be able to make an adjustment to reduce this bias.

The complement can be constructed to include or exclude the subject experience. If the complement excludes the subject experience, then it is likely to be independent. If the subject experience is included, the key is to ensure it does not dominate the group. For example, regional data, including the state, should not be used as a complement if the state represents a large portion of the regional data.

The loss cost data of the larger group is typically available and the loss cost is easy to compute. As long as all the risks in the larger group have something in common, there is a logical connection between the complement and the subject experience.

Loss Costs of a Larger Related Group

Instead of using the loss cost of the larger group to which the subject experience belongs, the actuary may use the loss costs of a separate but similar, large group. For example, a homeowners insurer may use the contents loss experience from the owners forms to supplement the contents experience for the condos form.

Evaluation

This method is similar to the large group complement. It is generally biased though the magnitude and direction of bias are unknown. If the actuary can adjust the related experience to match the exposure to loss in the subject experience, the bias can be reduced. In the example mentioned above, the actuary needs to consider how the exposure to loss for condos differs from owned homes and adjust the experience accordingly.

Since the complement does not contain the subject experience, this lack of dependence may make it a better choice than the first method described.

The data for this method is likely readily available and the calculations should be the same as those used to derive the base statistic. Adjustments made to the related experience to correct for bias may be difficult to explain. If the groups are closely related, then the complement will have a logical relationship to the base statistic.

Rate Change from the Larger Group Applied to Present Rates

The loss costs of a larger related group may be a biased complement of credibility. This third approach mitigates this problem by using the rate change indicated for a larger group applied to the current loss cost of the subject experience, rather than using the larger group's loss costs directly.

The complement (C) can be expressed as:

$$C = \text{Current Loss Cost of Subject Experience} \times \left(\frac{\text{Larger Group Indicated Loss Cost}}{\text{Larger Group Current Average Loss Cost}} \right).$$

As way of example, assume the following:

- Current loss cost of subject experience is \$200.
- Indicated loss cost of larger group is \$330.
- Current average loss cost of larger group is \$300.

Then the complement of credibility, to be blended with the subject experience loss cost, is calculated as follows:

$$C = \$200 \times \frac{\$330}{\$300} = \$220.$$

Evaluation

Even when the overall loss costs for the subject experience and the larger group are different, this complement is largely unbiased. Assuming the rate changes are relatively small, this complement is likely to be accurate over the long term. The level of independence depends on the size of the subject experience relative to the larger group. The data for this method is most likely readily available, and the calculations are very straightforward. In many instances it is logical that the rate change indicated for a larger related group is indicative of the rate change for the subject experience.

Harwayne's Method

Harwayne's Method is used when the subject experience and related experience have significantly different distributions, and the related experience requires adjustment before it can be blended with the subject experience. A prime application of Harwayne's method is when the subject experience is within a specific geographical area (e.g., a state), and the desired complement of credibility considers related experience in other geographical areas. The other geographical areas (e.g., other states) have distinctly different cost levels than the subject experience due to circumstances such as legal environment and population density. For example, the pure premium may be 10% higher for every risk in a complement state compared to the otherwise identical risks in the subject state; in this case, the actuary should adjust the loss costs from that state prior to using them as a complement of credibility.

In this application of Harwayne's method, the complement of credibility is determined using countrywide data (excluding the base state being reviewed), but the countrywide data is adjusted to remove overall differences between states. The following example illustrates the steps necessary to calculate the complement for class 1 of state A.

12.5 Harwayne Method

State	Class	Exposure		Losses	Pure Premium
A	1	100	$	250	2.50
	2	125	$	500	4.00
	Subtotal	225	$	750	3.33
B	1	190	$	600	3.16
	2	325	$	1,500	4.62
	Subtotal	515	$	2,100	4.08
C	1	180	$	500	2.78
	2	450	$	1,800	4.00
	Subtotal	630	$	2,300	3.65
All	1	470	$	1,350	2.87
	2	900	$	3,800	4.22
	Total	1,370	$	5,150	3.76

The first step is to calculate the average pure premium for state A:

$$\overline{L_{\text{A}}} = \frac{100 \times 2.50 + 125 \times 4.00}{100 + 125} = 3.33.$$

The next step is to calculate the average pure premium for states B and C based on the state A exposure distribution by class:

$$\hat{L}_{\text{B}} = \frac{100 \times 3.16 + 125 \times 4.62}{100 + 125} = 3.97,$$

$$\hat{L}_{\text{C}} = \frac{100 \times 2.78 + 125 \times 4.00}{100 + 125} = 3.46.$$

Adjustment factors are calculated by dividing the average pure premium for state A by the reweighted average pure premium for B and C:

$$F_{\text{B}} = \frac{\overline{L}_{\text{A}}}{\hat{L}_{\text{B}}} = \frac{3.33}{3.97} = 0.84,$$

$$F_{\text{C}} = \frac{\overline{L}_{\text{A}}}{\hat{L}_{\text{C}}} = \frac{3.33}{3.46} = 0.96.$$

These adjustment factors are applied to the class 1 pure premium in states B and C, respectively, to adjust for the difference in loss costs by state A. The adjusted loss costs for class 1 in states B and C, respectively, are:

$$\hat{L}_{1,\text{B}} = \overline{L_{1,\text{B}}} \times F_{\text{B}} = 3.16 \times 0.84 = 2.65,$$
$$\hat{L}_{1,\text{C}} = \overline{L_{1,\text{C}}} \times F_{\text{C}} = 2.78 \times 0.96 = 2.67.$$

The complement of credibility (C) is then calculated by combining the adjusted Class 1 loss costs by state into a single Class 1 loss cost according to the proportion of class 1 risks in each state:

$$C = \frac{\hat{L}_{1,\text{B}} \times X_{1,\text{B}} + \hat{L}_{1,\text{C}} \times X_{1,\text{C}}}{X_{1,\text{B}} + X_{1,\text{C}}} = \frac{2.65 \times 190 + 2.67 \times 180}{190 + 180} = 2.66.$$

Evaluation

The complement derived from this method is unbiased as it adjusts for the distributional differences. The use of multi-state data generally implies the complement is reasonably accurate as long as there is sufficient countrywide data to minimize the process variance. Also, since the subject experience and related experience consider data from different states, the complement is considered mostly independent.

The data for the complement is usually available but the computations can be time-consuming and complicated. While the complement bears a logical relationship to the subject experience, the complement may be harder to explain because of the computational complexity.

Trended Present Rates

In cases where there is no larger group to use for the complement, actuaries may rely on the current rates as the best available proxy for the indicated rate. Typically, two adjustments are made before using the current rates to make this a suitable alternative.

First, insurers do not always implement the rate that is indicated (reasons for this are discussed in Chapter 13). Thus, the current rates should be adjusted to what was previously indicated rather than what was implemented.

Second, changes in loss cost level may have occurred between the time the current rates were implemented and the time of the review. Sources of such changes may be monetary inflation, distributional shifts, safety advances, etc. The current rate therefore should be adjusted for any applicable trends. The actuary should select an appropriate annual loss trend, often consistent with the trend used in the latest rate level indication, and apply it from the original target effective date of the current rates to the target effective date of the new rates. The original target effective date of the current rates is used as the "trend from" date rather than the actual effective date to account for the fact that changes are not always implemented when planned and rates may remain in effect for shorter or longer than planned. By using the target effective date, the actuary is trending from the date assumed in the prior actuarial analysis.

Combining these two adjustments, the complement of credibility (C) that is used to supplement the indicated rate is calculated as follows:

$$C = \text{Present Rate} \times \text{Loss Trend Factor} \times \frac{\text{Prior Indicated Loss Cost}}{\text{Loss Cost Implemented with Last Review}}.$$

By way of example, assume the following:

- Present average rate is \$200.
- The selected annual loss trend is 5%.
- The rate change indicated in the last review was 10%, and the target effective date was January 1, 2011.
- The rate change implemented with the last review was 6%, and the actual effective date was February 1, 2011.
- The proposed effective date of the next rate change is January 1, 2013.

Before calculating the complement of credibility, the loss trend length must be measured. This is the length from the target effective date of the last rate review (January 1, 2011) to the target effective date of the next rate change (January 1, 2013), or two years.

Then the complement of credibility is calculated as follows:

$$C = \$200 \times (1.05)^2 x \frac{1.10}{1.06} = \$229.$$

This procedure can also be used to calculate a complement for an indicated rate change factor when using the loss ratio approach:

$$C = \frac{\text{Loss Trend Factor}}{\text{Premium Trend Factor}} \times \frac{\text{Prior Indicated Rate Change Factor}}{\text{Prior Implemented Rate Change Factor}}.$$

Evaluation

The accuracy of this complement depends largely on the process variance of the historical loss costs. That is why it is used primarily for indications with voluminous data. This complement is unbiased since pure trended loss costs (i.e., no updating for more recent experience) are unbiased. This complement may or may not be independent depending on the historical experience used to determine the subject experience and complement. For example, if the complement comes from a review that used data from years 2007 through 2010, and the subject experience is based on data from 2008 through 2011, then the two are not independent.

The data required is readily available, the calculations are very straightforward, and the approach is easily explainable.

Competitors' Rates

New or small companies with small volumes of data often find their own data too unreliable for ratemaking. In such cases the actuary may use the competitors' rates as a complement. The rationalization is that if the competitors have a much larger number of exposures, the competitors' statistics have less process error.

Evaluation

An actuary must consider that competitors' manual rates are not only based on the competitors' loss costs but also reflect marketing considerations, judgment, and the effects of the regulatory process—all of which can introduce inaccuracy to the rates. Competitors may also have different underwriting and claim practices than the subject company, which creates bias that may be difficult to quantify. The competitors' rates will be independent of the company data.

While the calculations may be straightforward, the data needed for this complement may be difficult or time-consuming to obtain. Even with the potential differences between competitors, the rates of a similar competitor bear a logical relationship and are generally accepted as a complement by regulators. This complement is often considered the only viable alternative.

Excess Ratemaking

Excess ratemaking usually deals with volatile and low volumes of data so the complement chosen is often more important than the subject experience. Complements for excess ratemaking are structured around the special problems of excess ratemaking. Typically there are very few claims in the excess layers; consequently, actuaries try to predict the volume of excess loss costs using loss costs below the attachment point. Losses for some lines of business (e.g., liability) may also be slow to develop, and inflation inherent in excess layers is different (usually higher) than that of the total limits experience.

Boor describes four methods that can be used to determine the complement of credibility for excess ratemaking analyses:

- Increased limits analysis
- Lower limits analysis
- Limits analysis
- Fitted curves

The first three methods use available loss data and increased limits factors to calculate the complement of credibility. The last method relies on historical data to fit curves, and the complement is calculated from the distribution.

Increased Limits Factors (ILFs)

Actuaries use this first method when data is available for ground-up losses through the attachment point (i.e., losses have not been truncated at any point below the bottom of the excess layer being priced). Increased limits factors are used to adjust losses capped at the attachment point to produce an estimate of losses in the specific excess layer.

The complement is defined as follows:

$$C = L_A \times \left(\frac{\text{ILF}_{A+L} - \text{ILF}_A}{\text{ILF}_A} \right) = L_A \times \left(\frac{\text{ILF}_{A+L}}{\text{ILF}_A} - 1.0 \right),$$

where

- L_A are the losses capped at the attachment point A;
- ILF_A is the increased limits factor for the attachment point A;
- ILF_{A+L} is the increased limits factor for the sum of the attachment point A and the excess insurer's limit of liability L.

For example, calculate the complement of credibility for the excess layer between $500,000 and $750,000 (i.e., $250,000 of coverage in excess of $500,000). Assume the losses capped at $500,000 are $2,000,000 and the following increased limits factors apply:

12.6 ILFs

Limit of Liability	Increased Limits Factor
$ 100,000	1.00
$ 250,000	1.75
$ 500,000	2.50
$ 750,000	3.00
$ 1,000,000	3.40

The complement of credibility is calculated as follows:

$$C = \$2{,}000{,}000 \times \left(\frac{3.00}{2.50} - 1.0 \right) = 400{,}000.$$

Evaluation

If the subject experience has a different size of loss distribution than that used to develop the increased limits factors, then the results of this procedure will be biased. This is particularly relevant as the increased limits factors may be based on industry data rather than the insurer's own data. Despite the issues with the accuracy, this is often the best available estimate.

The error with this approach is not the process error but rather the parameter error associated with the selection of the increased limits factors. Thus, the error associated with this estimate tends to be independent of the error associated with the base statistic.

This procedure requires increased limits factors—preferably industry factors—and ground-up losses that have not been truncated below the attachment point. To the extent that information is available, the procedure is practical. In terms of acceptability, however, this estimate is more logically related to the data below the attachment point (which is used for the projection) than to the data in the layer, and this may be controversial.

Lower Limits Analysis

The complement discussed above uses losses capped at the attachment point to estimate the losses in the excess layer being priced. If those losses are too sparse to be reliable, the actuary may prefer to use losses capped at a limit lower than the attachment point. This lower limit can often be the basic limit.

The formula for this complement is:

$$C = L_d \times \left(\frac{\text{ILF}_{A+L} - \text{ILF}_A}{\text{ILF}_d} \right),$$

where

- L_d are the losses capped at the lower limit, *d;*
- ILF_A is the increased limits factor for the attachment point *A;*
- ILF_d is the increased limits factor for the lower limit, *d*.
- ILF_{A+L} is the increased limits factor for the sum of the attachment point *A* and the excess insurer's limit of liability *L* (i.e., this sum represents the top of the excess layer being priced).

Note that the first excess procedure is a special case of this procedure where the lower limit, *d*, is equal to the attachment point.

For example, calculate the complement of credibility for the layer between \$500,000 and \$750,000. Assume the losses capped at \$250,000 are \$1,500,000, and the increased limits factors from Table 12.6 apply. The complement of credibility is calculated as follows:

$$C = \$1{,}500{,}000 \times \left(\frac{3.00 - 2.50}{1.75} \right) = \$428{,}571.$$

Evaluation

It is difficult to determine whether this is more or less accurate than the previously discussed complement. Intuitively, this complement will be more biased as the differences in size of loss distributions will be exacerbated when using losses truncated at lower levels. On the other hand, using losses capped at lower limits may increase the stability of the estimate. Like the previous complement, the error associated with this complement is generally independent of the error of the base statistic.

Insurers generally code losses capped at basic limits for statistical reporting purposes. Losses capped at the attachment point are generally important for accounting, too. If some other lower limit is chosen, the data may not be as available. The calculations are no more difficult than the previously discussed complement, and this complement suffers the criticism of being more logically related to the lower limits losses rather than the losses in the layer being priced.

Limits Analysis

The previous approaches work well when losses capped at a single point are available, but sometimes they are not. Primary insurers generally sell policies with a wide variety of policy limits. Some of the individual policy limits fall below the attachment point, and some extend beyond the top of the excess layer. The implication is that each policy's limit and increased limit factor needs to be considered in the calculation of the complement.

For this approach the actuary analyzes the policies at each limit of coverage separately. The actuary calculates the estimated losses in a given layer using the premium volume and expected loss ratio in that layer. Then the actuary performs an increased limits factor analysis on each first dollar limit's loss costs separately. The formula for the complement of credibility is as follows:

$$C = \mathrm{LR} \times \sum_{\mathrm{d} \geq \mathrm{A}} P_d \times \frac{\left(\mathrm{ILF}_{\min(d,A+L)} - \mathrm{ILF}_A\right)}{\mathrm{ILF}_d},$$

where

- LR= Total limits loss ratio,
- P_d= Total premium for policies with limit d.
- The ILFs have the same meaning as previously discussed.

The following shows an example of the calculation of the expected loss for the layer between \$500,000 and \$750,000 assuming a total limits loss ratio of 60%.

12.7 Example Calculation for Limits Approach

(1) Limit of Liability (d)	(2) Premium	(3) Expected Loss Ratio	(4) Expected Total Losses	(5) ILF @ d	(6) ILF @ A	(7) ILF @ $A+L$	(8) % Loss In Layer	(9) Expected Loss in Layer
$ 100,000	$ 1,000,000	60.0%	$ 600,000	1.00	2.50	3.00	0.0%	$ -
$ 250,000	$ 500,000	60.0%	$ 300,000	1.75	2.50	3.00	0.0%	$ -
$ 500,000	$ 200,000	60.0%	$ 120,000	2.50	2.50	3.00	0.0%	$ -
$ 750,000	$ 200,000	60.0%	$ 120,000	3.00	2.50	3.00	16.7%	$ 20,040
$ 1,000,000	$ 75,000	60.0%	$ 45,000	3.40	2.50	3.00	14.7%	$ 6,615
Total	$ 1,975,000		$ 1,185,000					$ 26,655

(4)= (2) x (3)

(8)= if d <= A then 0.0%
if A < d <= $A+L$ then [(5)- (6)]/(5)
if d > $A+L$ then [(7)- (6)]/(5)

(9)= (4) x (8)

Evaluation

This complement is biased and inaccurate to the same extent as the prior two complements, and it involves relying on the additional assumption that the expected loss ratio does not vary by limit.

Because this type of excess loss analysis is typically undertaken by reinsurers that do not have access to the full loss distribution, this may be the only method available. It is more time-consuming to compute, but the calculations are straightforward. It generates the same criticism as the other methods because it is not based on actual data from the layer being priced.

Fitted Curves

As discussed in the increased limits section in Chapter 11, actual loss distributions can be very volatile, especially in the tail of the distribution (i.e., the higher losses). As such, any estimates based directly on actual data are subject to inaccuracy due to the volatility. Actuaries may fit curves to the actual data to smooth out the volatility and to extrapolate the distribution to higher limits.

Once the curve is fitted, the techniques described in Chapter 11 can be used to determine the expected losses in the layer being priced. The following formula is used to determine the percentage of the curve's total losses that are expected in the excess layer:

$$\%\text{ Losses in Layer }(A,\ A+L) = \frac{\int_{A}^{A+L}(x-A)f(x)dx + \int_{A+L}^{\infty}Lf(x)dx}{\int_{-\infty}^{\infty}xf(x)dx}.$$

This percentage can be applied to the total limits loss costs to determine the expected losses in the layer.

Evaluation

This complement tends to be less biased and more stable than the other excess methods, assuming that the fitted curve replicates the general shape of the actual data. This approach tends to be significantly more accurate than the others when there are relatively few claims in the higher layers.

Because the curve-fitting process involves the underlying data, it can be heavily dependent on the existence or non-existence of larger claims. Thus, the error associated with a complement developed using this approach will tend to be less independent than complements determined from the other approaches.

This approach tends to be the most computationally complex and requires data that may not be readily available. The complement developed using this approach tends to be the most logically related to the losses in the layer than the others as the data is more fully used. However, the computational complexity may make it difficult to communicate.

CREDIBILITY EXAMPLES

This chapter provided different techniques that can be used to blend an actuarial estimate based on observed experience with related experience in order to improve the estimate of expected values. The actuarial estimate and the complement can take many forms, as demonstrated in the appendices. The actuarial estimate in Appendix A is the indicated rate change from the subject experience. It is credibility weighted with the trended present rates indicated rate change. Appendix B credibility weights the statewide ex-catastrophe pure premium with a regional ex-catastrophe pure premium. The actuarial estimate in Appendix C is the indicated rate change from the subject experience. It is credibility-weighted with the countrywide indicated rate change. Appendix E, a univariate classification analysis, credibility weights the indicated pure premium relativities with the current pure premium relativities. Before blending these two sets of relativities, each is normalized such that the weighted average relativity is 1.00.

CREDIBILITY WHEN USING STATISTICAL METHODS

When performing a multivariate classification analysis using statistical techniques such as generalized linear models (as discussed in Chapter 10), statistical diagnostics provided with the model results are used to gauge to what extent the model results are meaningful given the data provided. Examples of statistical diagnostics include standard errors of the parameter estimates and standardized deviance tests (e.g., Chi-Square or F-test), as well as practical tests such as consistency of model results over time. The modeler considers this information when selecting the final model structure and the final rate differentials. Statistical methods also provide diagnostics that inform the modeler of the overall appropriateness of the model assumptions (e.g., the link function or error term selected). Examples of such diagnostics include deviance residual plots and leverage plots.

Typically, the results of a multivariate classification analysis are not credibility-weighted with traditional (univariate) actuarial estimates. Some research has been conducted around incorporating Bayesian analysis into the statistical modeling process (for example, the use of hierarchical models), but this is beyond the scope of this text.

SUMMARY

The purpose of this chapter was to provide a broad overview of the credibility procedures used in ratemaking. As discussed, the credibility-weighted actuarial estimate is expressed by the following formula:

$$\text{Estimate} = Z \text{ x Observed Experience} + (1 - Z) \text{ x Related Experience}$$

The classical credibility method and least squares credibility method prescribe different procedures for developing the credibility measure, Z. Classical credibility is effective in developing results that minimize the fluctuation from the related experience. Least squares credibility is used to generate accurate rates. In Bayesian analysis, there is no specific calculation of Z; it is based on the fundamental notion that the prior estimate is adjusted to reflect the new information, which is introduced into the prior estimate in a probabilistic manner. Once the method for developing the credibility measure is selected, the actuary should be careful to understand and appropriately document any simplifying assumptions that are made.

The chapter also provided desirable qualities for the selection of the related experience, referred to as the complement of credibility. Finally, the chapter outlined several methods for developing the complement of credibility for both first dollar and excess ratemaking, and evaluated each method within the context of specified evaluation criteria.

KEY CONCEPTS IN CHAPTER 12

1. Criteria for measures of credibility

2. Methods for determining credibility
    a. Classical credibility
    b. Bühlmann credibility
    c. Bayesian analysis

3. Desirable qualities for the complement of credibility
    a. Accurate
    b. Unbiased
    c. Independent
    d. Available
    e. Easy to calculate
    f. Logical relationship to the base statistic

4. Methods for determining the complement of credibility
    a. First dollar ratemaking
        i. Loss costs of a larger group that includes the group being rated
        ii. Loss costs of a larger related group
        iii. Rate change from the larger group applied to present rates
        iv. Harwayne's method
        v. Trended present rates
        vi. Competitors' rates

    b. Excess ratemaking
        i. Increased limits analysis
        ii. Lower limits analysis
        iii. Limits analysis
        iv. Fitted curves

5. Credibility when using statistical modeling methods

CHAPTER 13: OTHER CONSIDERATIONS

Recall that the fundamental insurance equation is:

$$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}.$$

The preceding chapters have focused on techniques to calculate a set of indicated rates or indicated changes to current rates to produce premium that is expected to cover all costs (i.e., the loss, loss adjustment expense, and underwriting expense) and achieve the targeted underwriting profit. These indications represent the actuary's best cost-based estimate of rates to charge, given the available information. Even when the company is very confident in the analysis, the company may elect to implement rates and rating variable differentials other than those indicated.

This chapter explores other considerations company management should make, along with the cost-based rate indications, to determine what rates to charge in practice. More specifically, the following considerations are covered in this chapter:

- Regulatory constraints
- Operational constraints
- Marketing considerations

REGULATORY CONSTRAINTS

The U.S. property/casualty insurance industry is highly regulated, and for the most part, the regulation is executed by the individual states both through state law and state regulatory agencies. The amount of regulatory scrutiny can vary significantly by jurisdiction and by insurance product. For example, the amount of scrutiny tends to be high for personal automobile insurance since the majority of car owners have to meet state-mandated financial responsibility requirements by purchasing this type of coverage. Similarly, workers compensation insurance is required for most U.S. employers to indemnify employees injured on the job. Because employee welfare is so important, workers compensation is a heavily regulated line of business in every state. In contrast, the amount of oversight tends to be lower for other types of commercial insurance (e.g., directors and officers insurance), which may not be compulsory and are generally purchased by more sophisticated buyers.

U.S. insurance rate regulation generally requires that insurers file proposed manual rates with the appropriate state insurance department or similar regulatory body. The filing requirements vary considerably by jurisdiction and product. Some regulation requires the regulator's approval of the new rates before the company can use them. Other regulation merely requires a copy of the manual rates to be on file with the regulator. In some extreme cases, the regulator may promulgate the rates to be used by the carriers but allow a specified range of deviation from these rates.

In Canada, insurance rate regulation is executed by the individual provinces. Similar to the U.S., the type of regulation varies considerably among the jurisdictions and by insurance product. For the personal automobile product, some provinces require approval of filed rates and others operate more on open competition. A few provinces have a government insurer for compulsory liability coverages, but allow open competition for other coverages.

The United Kingdom has much less rigid insurance rate regulation than the U.S., relying more on competitive pressures to “regulate” the market. Even so, the U.K. also places some pricing restrictions on what insurers can and cannot do. For example, European Union (E.U.) legislation regarding personal automobile insurance requires that, in the U.K., insurers must be prepared to demonstrate that the gender relativities in their rates be proportionate to underlying risk relativities (i.e., insurers should not deviate considerably from actuarial indications regarding gender relativities). Currently, there is also a debate in the E.U. and U.K. about potential legislation that might restrict the treatment of age as a rating variable in a similar way to gender.

In many of the Latin American markets, the regulation of insurance rates is focused more on rate adequacy (i.e., ensuring that insurers collect the minimum premium necessary to meet their obligations) than equity among classifications. Generally, Latin American rating plans are unsophisticated. One exception is Brazil, in which carriers utilize a wider range of rating variables on some products (e.g., personal automobile) and rates are required to be filed with the regulators for approval.

In many developing markets like India, rate regulation is heavier on compulsory coverages (e.g., personal automobile liability), but other insurance products are deregulated and operate more on open competition. Despite the rate deregulation, the rating plans are still relatively simple because of the lack of credible data collected.

Examples of U.S. Regulatory Constraints

In some jurisdictions around the world, insurance regulation may preclude the use of certain actuarially indicated rates or rate differentials. The following are U.S. examples of regulatory constraints that may cause a company to implement rates that are different from those indicated by its ratemaking analyses.

Some jurisdictions have regulations that limit the amount of an insurer’s rate change. These limitations may pertain to either the overall average rate change for the jurisdiction or to the change in premium for any individual customer or group of customers, or both. For example, a jurisdiction may prohibit a rate change that generates an overall premium increase greater than 25% and/or a rate change that results in a significant number of existing customers getting an increase greater than 30%. In fact, the limitation could apply to any insureds seeing an increase larger than 30%. To the extent that the indicated rates exceed either of these thresholds, the proposed rate change will not comply with regulation and will not be approved by the regulator.

While some jurisdictions may not specifically limit the amount of the rate change, they may have different regulatory requirements depending on the magnitude of the requested change. For example, the regulatory authority may require a company to provide written notice to all insureds or hold a public hearing in the event a proposed rate change exceeds some specified threshold. In such cases, a company may decide to implement a rate change that is less than the threshold to avoid the extra requirements.

Some regulations prohibit the use of particular characteristics for rating, even though the characteristics may be demonstrated to be statistically strong predictors of risk. The use of insurance credit score for underwriting or rating personal lines insurance (e.g., personal automobile or homeowners) is a good example. It is widely accepted that an individual’s insurance credit score is a strong predictor of risk in personal lines. Where allowed, many companies charge higher premium for individuals with poor credit scores than for individuals with good credit scores. However, because credit score is often perceived to be correlated with certain socio-demographic variables, some jurisdictions have placed limitations on the use of credit and some have banned the use of credit altogether.

Some regulations prescribe the use of certain ratemaking techniques. For example, the state of Washington currently requires that multivariate classification analysis be used to develop rate relativities if insurance credit score is used to differentiate premium in personal automobile insurance. Other states prescribe the use of a certain method for incorporating investment income in the derivation of the target underwriting provision (further discussion of this is beyond the scope of this text).

In addition, there are times when the company actuary and the regulator have differing views on certain ratemaking assumptions, which often leads to a different set of indicated rates. For example, a regulator may disagree with the method the actuary used to calculate loss trend, or may disagree with the trend selected. There are numerous examples of differences of opinion, and these differences have to be recognized when finalizing what rates are to be charged in practice. In particular, there may be a cost (e.g., delayed implementation of new rates, requirement of specialized staff resources) associated with negotiating with the regulator to resolve such differences.

Regardless of the company's rate indications, a company must charge rates that comply with the applicable state regulations. Fortunately, the regulations typically apply uniformly to all companies; therefore, all companies face the same limitations. A company can take a variety of actions with respect to regulatory restrictions:

- A company can take legal action to challenge the regulation.
- A company may decide to revise underwriting guidelines in order to limit the amount of business written at what it considers to be inadequate rate levels, although some locations require insurers to "take all comers" for personal lines.
- A company may change marketing directives to try to minimize new applicants whose rates are thought to be inadequate. For instance, an insurer might concentrate its advertising on areas in which it believes the rate levels to be adequate.
- In the case of banned or restricted usage of a particular variable (e.g., insurance credit scores), a company can use a different allowable rating variable (e.g., payment history with the company) that it believes can explain some or all of the effect associated with the restricted variable.

OPERATIONAL CONSTRAINTS

Operational constraints can make it difficult or undesirable for a company to implement the actuarially indicated rate change. Operational constraints can include items like systems limitations and resource constraints.

In order for premium quotes to be generated automatically when a customer's information is collected, rating algorithms, rates, and rate differentials need to be programmed. Base rates and rate differentials (e.g., relativities or addends) can usually be changed easily. For many companies, however, modifying the structure of the rating algorithm can require significant systems changes. The complexity of the change depends largely on two factors:

- The extent of the structural changes (e.g., the number of rating variables, the number of levels within each rating variable, how the rating variables are applied in the rating algorithm)

- The number of systems (e.g., quotation, claims, monitoring, etc.) impacted by the rate change

For example, prior to the 1990s many U.S. personal automobile carriers charged the same rate for all adults over the age of 30. Even after analysis clearly indicated that the risk varied significantly within the adult class (e.g., drivers over the age of 65 are relatively higher risk drivers than adult drivers under the age of 65), many companies did not immediately implement a more refined classification plan because the change required significant systems changes.

In addition, the implementation of a new rating variable may require data that has not been previously captured. While it may be possible to obtain this data from a third-party vendor, it is often necessary to get this data directly, either through a questionnaire sent to insureds or by visually inspecting the insured item. These approaches can necessitate additional insurance company staff with unique skills. For example, new building techniques (e.g., tie-down roofs) have enabled homes to better withstand strong winds. Because companies were not previously offering lower rates for such features, the information was not tracked by most companies. As a result, trained inspectors were necessary to ascertain the existence of these features. If such inspectors are not readily available, implementation may not be feasible immediately.

When an operational constraint arises, a cost-benefit analysis can be performed to help determine the appropriate course of action. Consider the example of a systems constraint that prohibits the introduction of a new or refined rating variable. The cost of implementing the change is the tangible cost associated with modifying the system. The benefit of implementing the change is the incremental profit that can be generated by charging more accurate rates, and presumably attracting more appropriately priced customers (i.e., the calculation of incremental profit should consider any estimated change in the distribution of business caused by the change). If the cost outweighs the benefit, then it may not be wise to pursue the change unless there are additional intangible benefits that could not be quantified.

The following is an example of a very simple cost-benefit analysis. Assume a ratemaking analysis identifies that a risk characteristic accounts for a 10% difference in projected ultimate losses and expenses between Class A and Class B. The characteristic is not currently reflected in the rates; consequently, both classes are charged a rate of $1,050. (Note that this average rate reflects a target profit provision of 5.2%.) Using the current average rate, Class A risks will be more profitable than Class B risks. Table 13.1 depicts the number of risks for each class, as well as the projected costs, current rates, and achieved profit for each class.

13.1 Calculation of Profit (Current Rates)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						Actual Profit	
Class	# Risks	Projected Losses & Expenses	Projected Losses & Expenses per Risk	Current Rate per Risk	Target Profit %	$	%
A	50,000	$ 45,000,000	$ 900	$ 1,050		$ 7,500,000	14.3%
B	1,000,000	$ 1,000,000,000	$ 1,000	$ 1,050		$ 50,000,000	4.8%
Total	1,050,000	$ 1,045,000,000	$ 995	$ 1,050	5.2%	$ 57,500,000	5.2%

(3) = (2) / (1)
(6) = [(4) - (3)] x (1)
(7) = (6) / [(4) x (1)]

If the rating variable is implemented, the company can decrease the rate for Class A and increase the rate for Class B in line with the difference in expected costs. In other words, instead of charging $1,050 for all risks, Refined Company can charge Class A risks $950 and Class B risks $1,055. Assuming no change in the risks insured, there will be no change in the total profit but the cross-subsidy will be eliminated. This can be seen in Table 13.2.

13.2 Calculation of Profit (After Rate Change)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						Actual Profit	
Class	# Risks	Projected Losses & Expenses	Projected Losses & Expenses per Risk	Current Rate per Risk	Target Profit %	$	%
A	50,000	$ 45,000,000	$ 900	$ 950		$ 2,500,000	5.3%
B	1,000,000	$ 1,000,000,000	$ 1,000	$ 1,055		$ 55,000,000	5.2%
Total	1,050,000	$ 1,045,000,000	$ 995	$ 1,050	5.2%	$ 57,500,000	5.2%

(3) = (2) / (1)
(6) = [(4) - (3)] x (1)
(7) = (6) / [(4) x (1)]

If this action is taken, the company will likely write more Class A risks and possibly fewer Class B risks. Assuming the change results in 25% more Class A business and no change in Class B business, the profit projections are as follows:

13.3 Calculation of Profit (After Rate Change and Distributional Shift)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Projected			Actual Profit	
		Projected	Losses &	Current	Target		
		Losses &	Expenses	Rate per	Profit		
Class	# Risks	Expenses	per Risk	Risk	%	$	%
A	62,500	$ 56,250,000	$ 900	$ 950		$ 3,125,000	5.3%
B	1,000,000	$ 1,000,000,000	$ 1,000	$ 1,055		$ 55,000,000	5.2%
Total	1,062,500	$ 1,056,250,000	$ 994	$ 1,049	5.2%	$ 58,125,000	5.2%

(3) = (2) / (1)
(6) = [(4) - (3)] x (1)
(7) = (6) / [(4) x (1)]

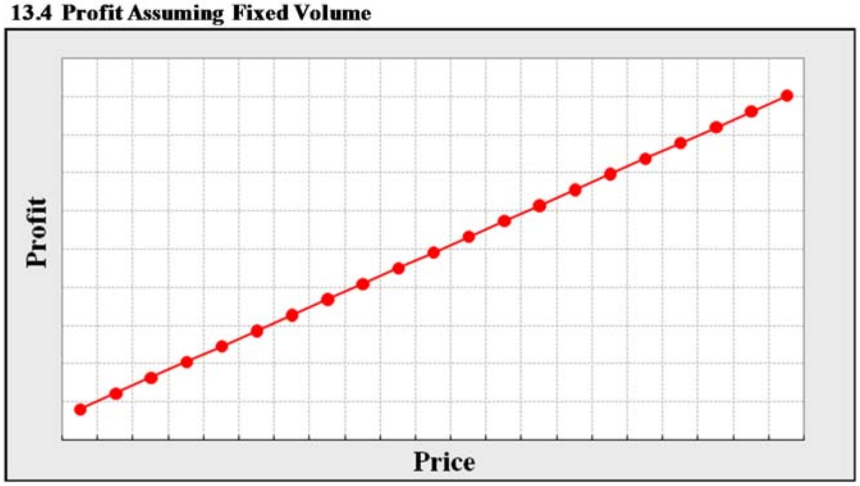
Based on this simple analysis and the assumptions inherent in it, implementation of the rating variable will generate an additional $625,000 (= $58,125,000 - $57,500,000) in profits over the time horizon estimated. This figure should be compared to the cost of making the change to help determine the appropriate course of action.

The standard ratemaking analysis used to develop the indicated rate differentials generally does not account for costs necessary to implement systems changes. When such costs are considered, the indicated rates may be different. There may also be other costs associated with this change (e.g., changes in staffing for the underwriting department to handle the increased number of Class A insureds). This is a crude example of a cost-benefit analysis and is based solely on tangible benefits (e.g., profit) and costs (e.g., system costs). Some projects may require significantly more complex calculations and may include intangible benefits (e.g., goodwill). The amount of rigor necessary for any cost-benefit analysis should vary depending on the relative costs, benefits, and uncertainty associated with the project.

MARKETING CONSIDERATIONS

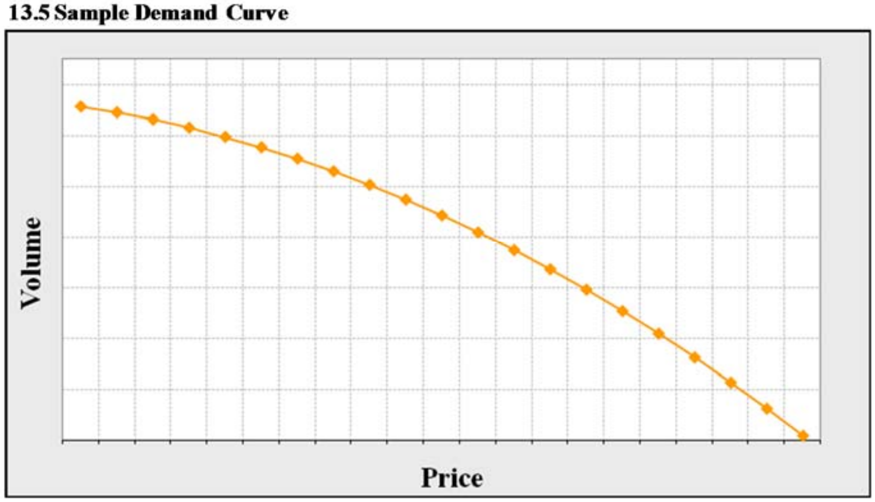
Prior to this chapter, the focus has been on using traditional actuarial techniques to determine the premium at which a company is able to cover costs and earn the target underwriting profit without any regard to the company's ability to sell the product. When assuming the number of policies is fixed, the relationship between price and profit can be illustrated as follows:

13.4 Profit Assuming Fixed Volume



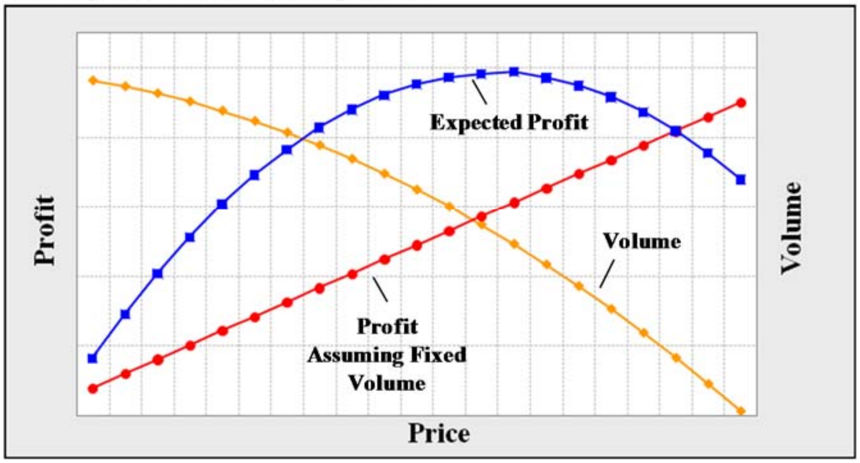
In other words, profit increases as price increases. Of course, profit is only achieved if the product is actually sold. Additionally, there is a certain amount of fixed cost (e.g., building costs) that does not vary significantly regardless of the number of policies sold. For these reasons, companies should consider the demand for the product being priced. The following figure depicts a typical demand curve, demonstrating that the demand for a product decreases as the price increases.

13.5 Sample Demand Curve



To determine the true expected profitability, the two curves should be considered simultaneously. As shown in Figure 13.6, expected profit as a function of price is an arc-shaped curve.

13.6 Expected Profit Considering Demand



Total profit increases as price increases until the price at which the impact of lost business outweighs the benefit associated with higher prices on the business that remains. In other words, overall profitability will suffer if the prices are set too high. This does not mean that the traditional actuarial rate indication is incorrect. The traditional actuarial techniques described thus far determine rates without regard to whether or not the product will be purchased. Prior to finalizing a rate change, the insurance company should consider both the cost-based rate indication and the marketing conditions.

When contemplating marketing considerations, companies often categorize insureds into new and renewal business. New business comprises potential customers who are currently uninsured or insured with another carrier. Renewal business refers to existing customers of the insurance product being analyzed. These groups are generally analyzed separately as the purchasing behavior and expected profitability of each group can be quite different. Some factors that commonly affect an insured's propensity to renew an existing product or purchase a new product are:

- **Price of competing products**: If insureds know another company offers the same product at a substantially lower price, they are likely to purchase the competing product.
- **Overall cost of the product**: If the insurance product is relatively cheap in general (e.g., as a percent of disposable income), then insureds are less likely to spend time shopping for a cheaper product. On the other hand, if the product is costly, insureds are more likely to compare prices to determine any potential savings.
- **Rate changes:** Significant increases (or decreases) in premium for an existing policy can cause existing insureds to believe there may be better options available.
- **Characteristics of the insured**: A large established law firm may be less sensitive to the price of its commercial package policy than a sole practitioner. A young policyholder may shop (and subsequently change insurers) more frequently than an older policyholder.
- **Customer satisfaction and brand loyalty:** Poor claims handling or a bad customer service experience may cause existing insureds to be dissatisfied and explore other options.

It should be noted that these factors may be more relevant for personal lines insureds than for larger commercial lines insurance purchasers. Commercial entities generally have less access to competitive price information and may have a vested interest to stay with an existing carrier based on service.

Traditional Techniques for Incorporating Marketing Considerations

Traditionally, marketing considerations have been incorporated judgmentally in the ratemaking process. Using this approach, the decision-maker considers the traditional actuarial rate indication along with marketing information to judgmentally determine the set of rates that should be implemented. The marketing information may include:

- Competitive comparisons
- Close ratios, retention ratios, growth
- Distributional analysis
- Dislocation analysis

Competitive Comparisons

One way for an insurer to study its competitive position is to compare its premium to the premium charged by one or more competitors. The availability and accuracy of competitor premium information varies by jurisdiction and by product. Even in the U.S. where companies are routinely required to file rating manuals, all the information necessary to accurately determine the premium charged by competitors can be difficult to obtain. For example, U.S. commercial lines companies typically adjust the manual rate via schedule and experience rating (which will be discussed in more detail in Chapter 15). In U.S. personal lines, estimating a competitor's premium can be difficult if the competitor makes extensive use of risk placement to vary the rate charged. For example, U.S. personal lines companies utilize underwriting tiers that essentially function as an additional rating variable, but the guidelines or algorithms that allocate risks into tiers are not always publicly available.

In more sophisticated, less regulated markets (e.g., the U.K.), rate manuals may not be readily available, and rates may be changed as frequently as daily. Companies in these markets may rely on obtaining competitive price information from brokers, questioning potential or existing customers about price information, or surveying Web-based quoting engines.

In spite of the challenges in obtaining accurate competitor price information, it is still a valuable endeavor for companies to compare their own premium to their best estimate of their main competitors' premium.

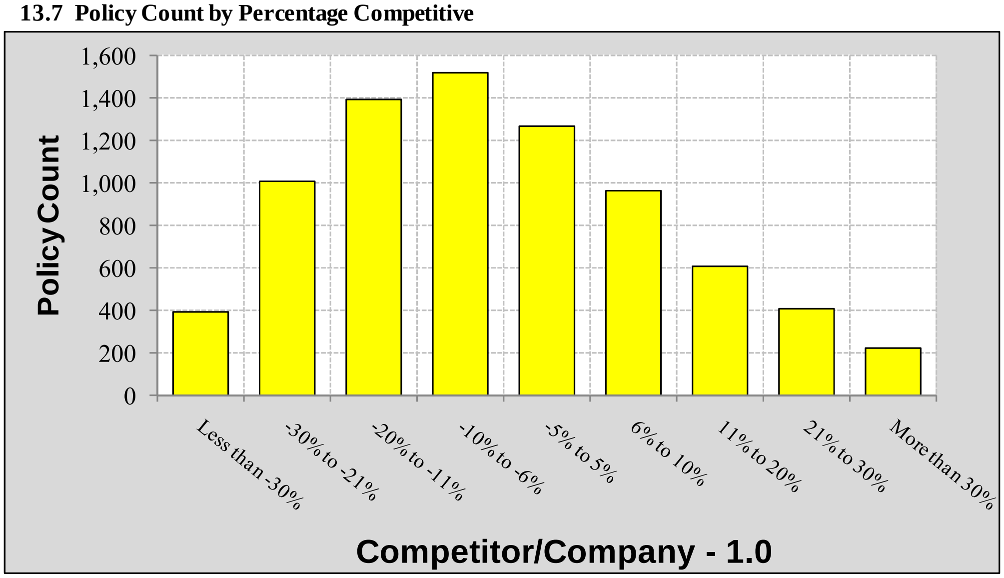
Companies are generally interested in two levels of competitiveness. First, companies want to understand how competitive their rates are on average (i.e., for all risks combined); this is sometimes referred to as a base rate advantage. Second, companies want to understand how competitive they are for individual risks or groups of risks (e.g., new homes or claims-free drivers).

Companies generally determine overall competitive position by comparing premiums for a set of sample risks,[46] for all quoted risks (for new business), or for all existing insureds (for renewal competitiveness). When doing so, companies typically focus on one or more of the following metrics:

- $\%\text{Competitive Position} = \dfrac{\text{Competitor Premium}}{\text{Company Premium}}(\text{or the reciprocal}) - 1.0.$
- $\$\text{Competitive Position} = \text{Competitor Premium} - \text{Company Premium}(\text{or the reverse})$
- $\%\text{Win} = \dfrac{\text{Number of Risks Meeting Criteria (e.g., Premium Lower than Competitor)}}{\text{Total Number of Risks}}$
- $\text{Rank} = \text{Rank of Company Premium when compared to the premium from several competitors}$

The following chart shows a distribution of policies for different ranges of the percentage competitive measure:

13.7 Policy Count by Percentage Competitive



In this graph, the x-axis represents different ranges of the percent competitive position. If the two companies being compared charge exactly the same premium, then all policies will be in the range containing 0% (i.e., -5% to 5%). On the other hand, if the competitor has a very different premium structure, the bars will be dispersed across the different ranges. In the example, the overall average competitive position is -7% (i.e., on average, the competitor's premium is 7% lower than the company's premium), but the competitiveness ranges from a low of -60% to a high of over 100%. This variation in the competitive index highlights significant differences in the rating algorithms and rate relativities between the two companies. Similar charts can be produced for the other metrics.

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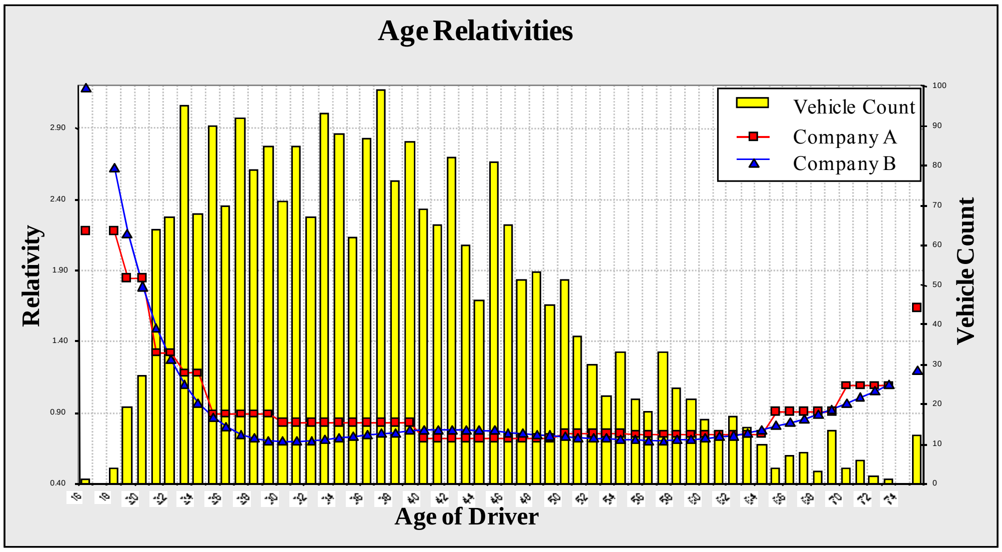
[46] This is also referred to as a market basket of risks.

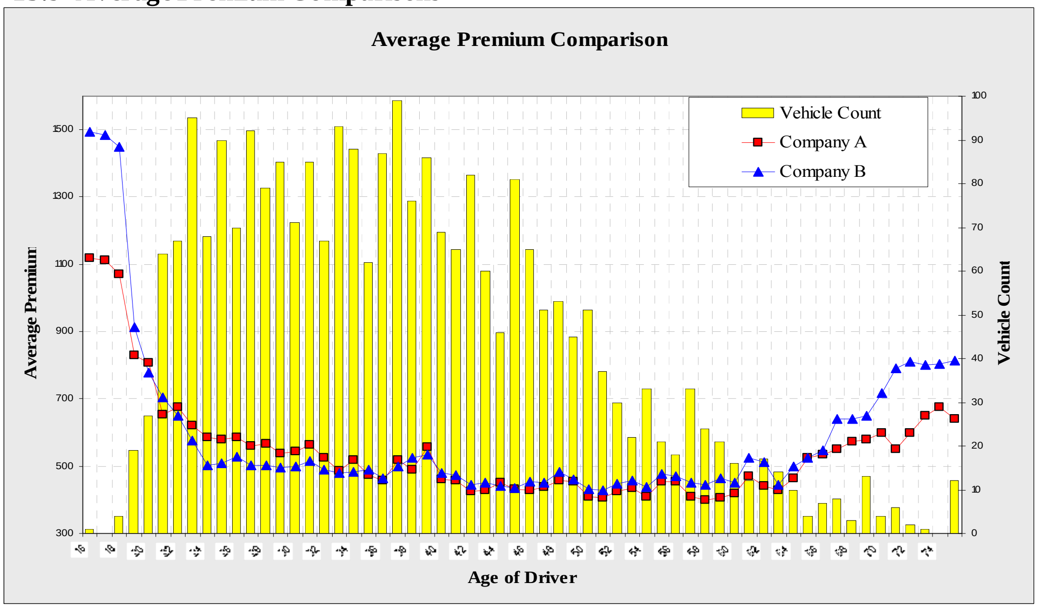
The competitiveness of different segments is often studied via rate relativity comparisons. For example, Chart 13.8 shows a typical comparison of age relativities for personal automobile coverage. In this graph, the x-axis shows the different levels of the variable being studied (i.e., ages), the bars represent the number of vehicles for each level of age (right y-axis), and the lines represent the rate relativities by company (left y-axis).

13.8 Relativity Comparison



This type of competitive analysis can be very effective when the rating algorithms are similar between companies. In recent years, rating algorithms have become much more complex, often including many more risk characteristics than previously. Consequently, individual rate relativity comparisons may be less meaningful. For example, the above comparison of age relativities may not be useful if one company also includes other age-related factors in its rating algorithm (e.g., retiree discounts, inexperienced operator surcharges) that the other company does not. Additionally, rating variables may be additive for one company and multiplicative for another company. Because of this, companies have begun to use total premium comparisons for groups of risks sharing the rating characteristic of interest. Chart 13.9 shows the average premium by age rather than the rate relativities by age.

13.9 Average Premium Comparisons



While this does not account entirely for carriers having different sets of rating variables, it does provide an indication of where competitive threats and opportunities may exist for the company's existing rating variables. Care must be taken when using this type of analysis, however, as a change in one variable's rate relativities can have an unintended impact on the average premium of a certain level of another variable. For example, if square footage is introduced as a rating variable in homeowners insurance, it may significantly change the average premium of certain territories or amount of insurance levels (as those characteristics tend to be highly correlated with square footage).

Close Ratios, Retention Ratios, Growth

Close ratio (also known as hit ratio, quote-to-close ratio, or conversion rate) is a measure of the rate at which prospective insureds accept a new business quote and is defined as follows:

$$\text{Close Ratio} = \frac{\text{Number of Accepted Quotes}}{\text{Total Number of Quotes}}.$$

Thus if the company issues 25,000 quotes in a particular month and generates 6,000 new policies from those quotes, then the close ratio is 24% (= 6,000 / 25,000). Care should be taken to understand the data used to calculate the ratio, especially when comparing to another carrier's ratio. For example, Company A may include in the denominator all quotes issued, and Company B may only include one quote per applicant. If this is the case, Company A will have a lower close ratio, all else being equal, if applicants routinely request more than one quote before making a decision (e.g., if an applicant gets several quotes with different limits).

Retention ratio (also known as persistency ratio) is a measure of the rate at which existing insureds renew their policies upon expiration and is defined as follows:

$$\text{Retention Ratio} = \frac{\text{Number of Policies Renewed}}{\text{Total Number of Potential Renewal Policies}}.$$

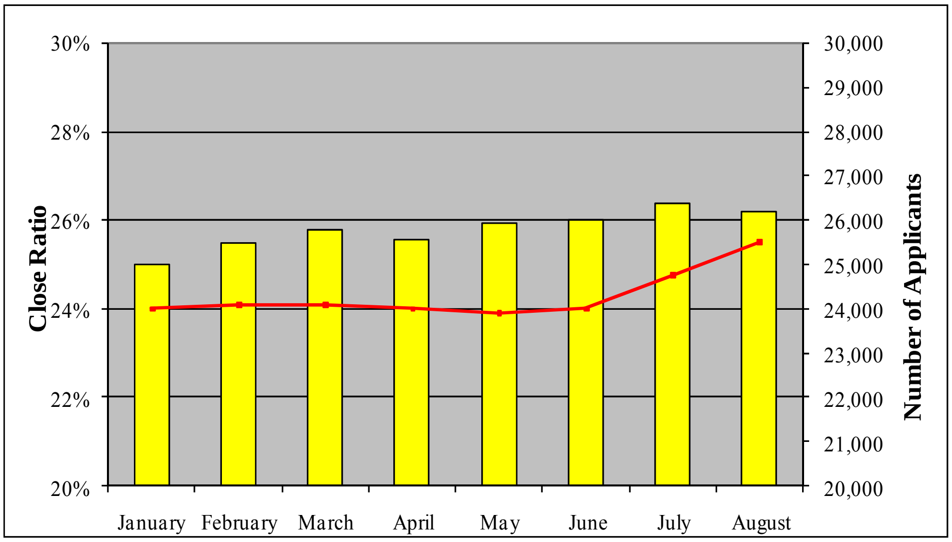
If 30,000 policies are up for renewal in a particular month and 24,000 of the insureds choose to renew, then the retention ratio is 80% (= 24,000 / 30,000). All else being equal, renewal customers tend to be less expensive to service and generate fewer losses on average than new business customers. Consequently, retention ratios and changes in the retention rate are monitored closely by marketing departments as companies generally want to retain as many profitable customers as possible.

Care should be taken to understand the data used to calculate the retention ratio. For example, if Company A excludes from the calculation all policies that were non-renewed by the company (i.e., the company canceled the policy as it no longer met the eligibility criteria), and Company B includes them, then Company A will have a better retention ratio than Company B, all else being equal.

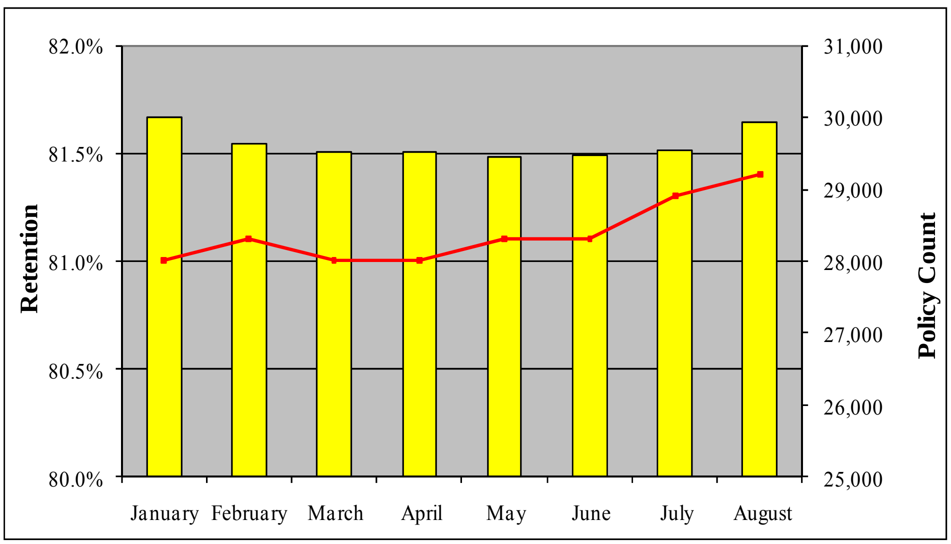
Analysts study both the absolute ratios and changes in the close and retention ratios. As price is a major determinant of customer buying decisions, companies frequently rely on close ratios and retention ratios as primary signals of the competitiveness of rates for new business and renewal customers, respectively. Changes in these ratios are often used to gauge changes in competitiveness. Companies also scrutinize close ratios and retention ratios when rate changes are implemented. Rate changes affect renewal business directly, and any change from the status quo can motivate existing customers to shop for insurance elsewhere. Rate changes also influence the company's competitive position, which is considered heavily by the price-sensitive new business prospects. If a company takes a rate decrease, the expectation is that the close and retention ratios will improve; similarly, a rate increase will generally lead to reductions in these ratios. (Note these changes may be neutralized if competitors are making similar changes.)

Charts 13.10 and 13.11 are typical charts comparing close ratios and retention by month (x-axis). The bars represent the number of applicants or renewals (right y-axis) for each month. The line represents the close or retention ratio (left y-axis) for each month. The increase in each ratio over the last couple months coincides with a rate decrease implemented in July.

13.10 Close Ratios by Month



13.11 Retention Ratios by Month

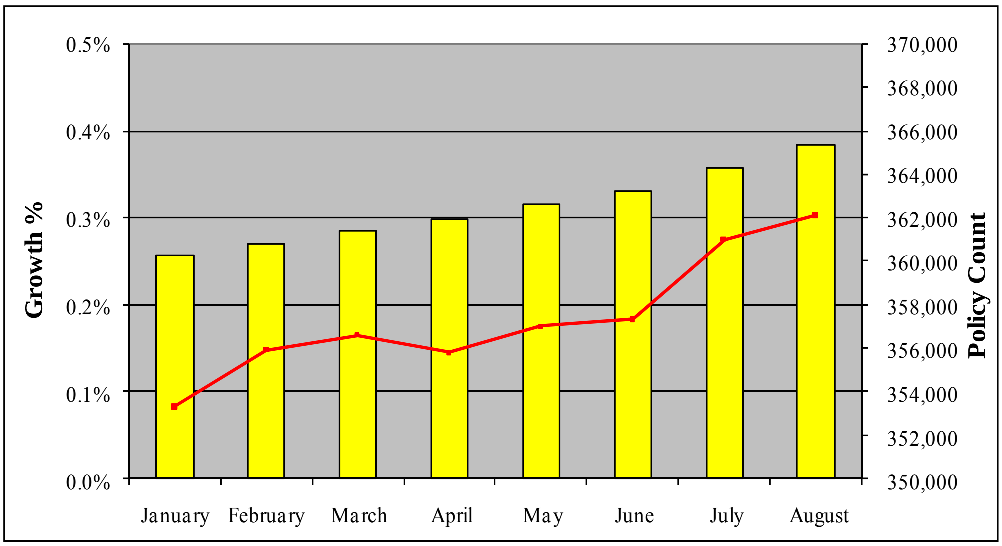


Growth is a function of attracting new business and retaining existing customers. More specifically, policy growth rate is defined as:

$$\%\ \text{Policy Growth} = \frac{(\text{New Policies Written} - \text{Lost Policies})}{\text{Policies at Onset of Period}} = \frac{\text{Policies at End of Period}}{\text{Policies at Onset of Period}} - 1.0,$$

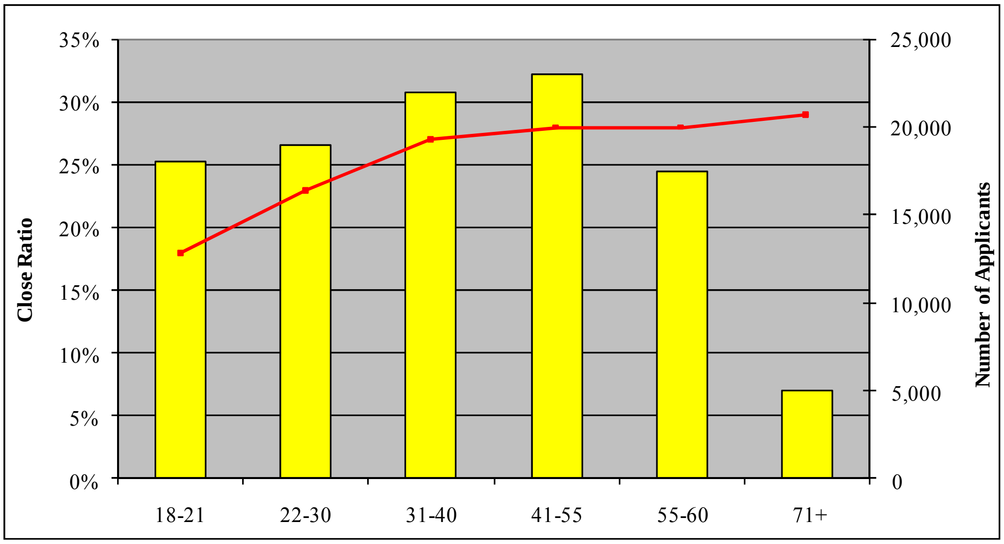
where a "lost policy" can either be a cancelled or non-renewed policy. Assume there were 360,000 policies at the beginning of the month. If 9,600 new policies were added and 6,000 policies were lost during the month, then the monthly policy growth is 1.0% (= [9,600 - 6,000] / 360,000). As with retention and close ratios, growth percentages are tracked over time. Low or negative growth can indicate uncompetitive rates and vice versa. Of course, changes in growth can also be significantly impacted by items other than price. For example, if a company tightens or loosens the underwriting standards, growth can be affected. In general, companies want to be aware of rapid changes in the volume of insureds and monitor the effect on profitability. Chart 13.12 shows monthly policy growth.

13.12 Policy Growth by Month



The close, retention, and growth ratios described above were calculated at the aggregate level. Companies may also track these for specific groups of insureds. If any of the ratios look significantly worse for a particular segment despite having similar competitiveness as other segments, then it may be an indication that the particular segment is more price sensitive, that the competitive rate comparisons are not valid, or that something other than price is driving the purchasing decision. Chart 13.13 shows an example of close ratios by age of named insured. The bars represent the number of applicants (right y-axis) and the line represents the close ratio (left y-axis) by age of applicant (x-axis).

13.13 Close Rates by Age of Named Insured



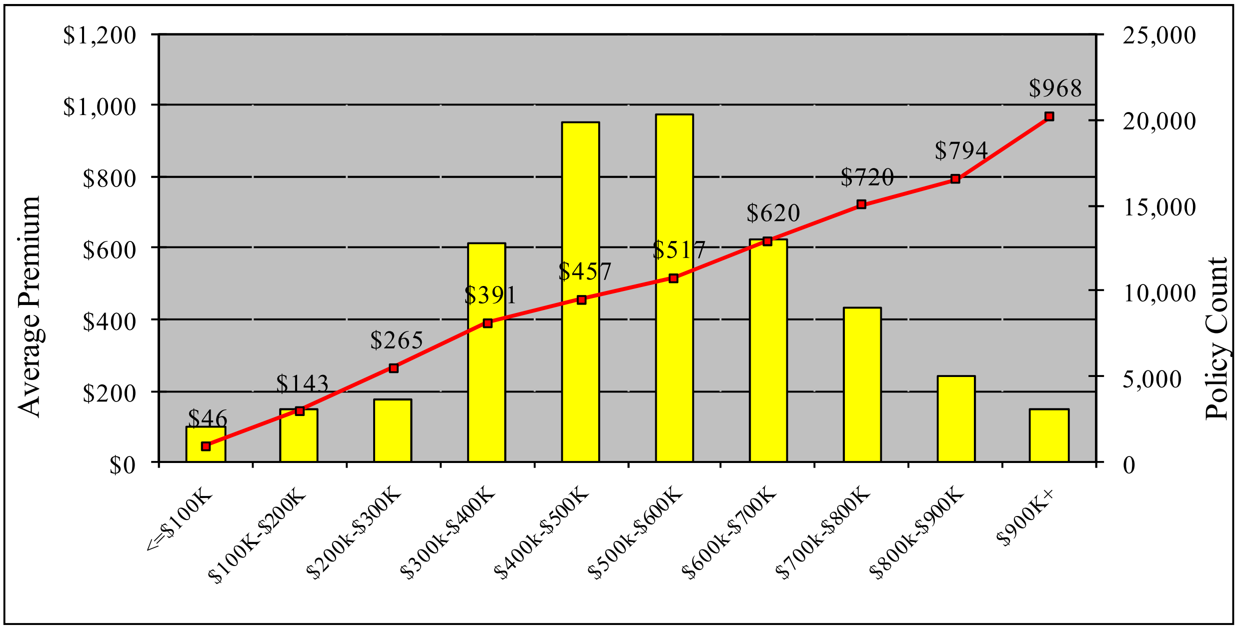
It is interesting to note that the close rate is the lowest for the younger insureds. Even if the competitive position is similar across all age groups, this result is not surprising as younger insureds tend to be more price-sensitive. Similar information can be examined for retention and growth.

Distributional Analysis

Companies may also examine distributions of new and renewal business by customer segment. A distributional analysis normally includes both the distribution by segment at a given point of time and changes in distributions over time.

For example, a company may examine the distribution of policies by various amounts of insurance (AOI) categories for homeowners. For additional information, the average premium for each category is included. Chart 13.14 shows the number of policies (right y-axis) and average premium (left y-axis) for each AOI category (x-axis).

13.14 Policies and Average Premium by AOI Range



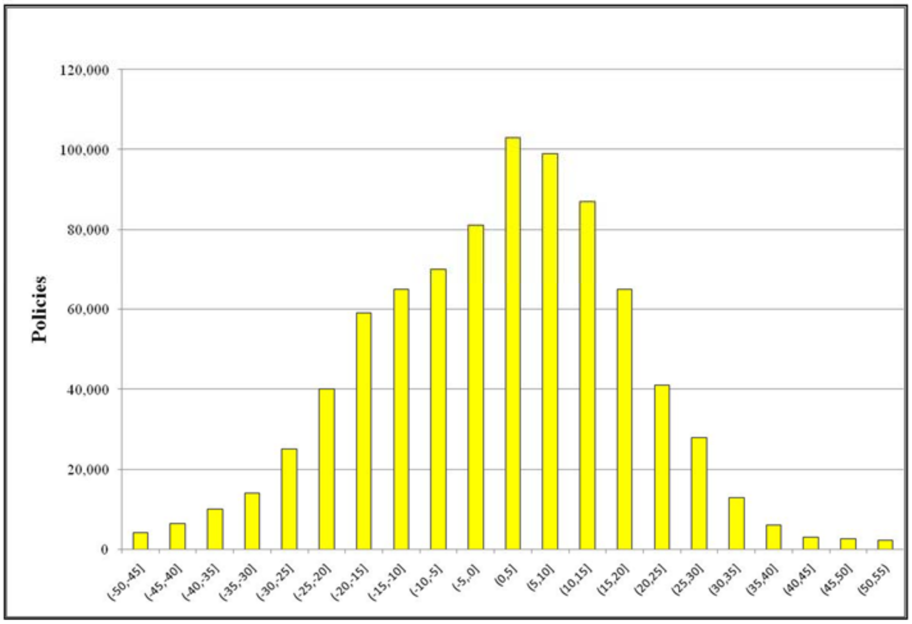
This distributional information should be considered in the context of the general population of insureds and the target distribution for the company. For example, the distributional analysis may uncover that while 15% of homes in a market are valued under $200,000, only 5% of the homes in the company's portfolio have an amount of insurance in that range. Assuming the company wants to insure those homes, this may be an indication that the rates for homes in this range are uncompetitive. It could also indicate other issues such as poor marketing or inadequate agent placement. A comparison of distributions over time can reveal whether this low penetration has been consistent or if it is a recent development. If it is a recent development, it could also indicate that a major competitor recently began targeting homes valued less than $200,000 (via marketing strategy, price strategy, etc).

Policyholder Dislocation Analysis

Existing customers are directly impacted when rates are changed; consequently, the amount of any rate change can be a major influence on whether or not an existing insured decides to renew the policy. The purpose of dislocation analysis is to quantify the number of existing customers that will receive specific amounts of rate change. The company often uses this information to extrapolate how the rate change may affect retention. In the absence of sophisticated retention modeling techniques (discussed briefly in the next section), companies typically have a threshold defining the magnitude and dispersion of rate changes that the company believes will produce an unacceptable effect on retention (in total or by customer segment). If the dislocation analysis highlights the effects are outside the tolerance level, the company may revise the proposed rate change. In addition, knowledge of the expected dislocation can be shared with the sales channel and customer support units (e.g., call centers) in advance of the implementation to help them prepare for the potential customer response (e.g., a customer calling an agent about a large premium increase).

When a simple base rate change is implemented, the amount of dislocation is nearly uniform across all insureds. If rate relativities are also changed, the amount of dislocation can vary significantly for different insureds or classes of insureds. Typically, companies look at the distribution of rate changes across the entire book of business, summarized by key segments, and by each level of rating variables being specifically adjusted. Chart 13.15 shows the distribution of policies across various rate change ranges.

13.15 Rate Change Distribution



Assimilating the Information

Once the traditional actuarial indications and marketing considerations are known, the decision-maker needs to weigh all information and select the rates that best meet the goals of the company. Typically, this is done judgmentally.

For example, assume the following about a particular class of business:

- Current average premium = \$1,000
- Indicated average premium = \$1,200 (or 20% increase)
- Competitor's average premium = \$1,000
- Close ratio, retention ratio, and growth are all significantly below target

The company may conclude that implementation of a 20% increase will cause significant loss of renewal customers and prohibit new business growth. In this situation, the company should consider the ramifications of implementing the change versus not implementing the change. If the company decides the full increase should not be implemented, it can consider other non-pricing solutions to improve profitability (e.g., revise underwriting guidelines or marketing strategies). Along the same lines, in markets where rates are promulgated by regulation or rate changes are difficult to obtain, companies often perform ratemaking analysis but rely on the information to improve profitability through these non-pricing solutions.

Systematic Techniques for Incorporating Marketing Considerations

Some companies use techniques to more systematically incorporate both marketing information and actuarial indications when proposing rates. A couple of these techniques will be discussed here briefly, but an in-depth review is outside the scope of this text.

Lifetime Value Analysis

Standard actuarial ratemaking techniques develop the cost-based indicated rate required to achieve the targeted underwriting profit over a short period of time (i.e., one year) assuming all insureds will renew. Lifetime value analysis tries to improve upon this by examining the profitability of an insured over a longer period of time taking into account that not all insureds will renew. To do this, assumptions are made regarding the propensity of the insured to renew and the expected profitability of the insured over the time period being projected.

Tables 13.16 and 13.17 show an example of a personal automobile lifetime value calculation for analyzing the longer term profitability of a 22-year-old and a 70-year-old. The first row of each table represents the first policy year for the 22-year-old and 70-year-old, respectively. The subsequent rows of each table show subsequent policy years, as each individual ages. The premium, losses, expense, and persistency (i.e., the probability the risk will not cancel) are given for each year. Premium varies by year reflecting any expected rate and relativity changes; losses vary by year reflecting overall loss trends and changes in expected costs as the insured ages; and expenses vary reflecting different costs for new and renewal business. Columns 2 through 4 are used to calculate the profit in Column 5. Column 6 shows the probability that the risk will renew that year, and Column 7 converts the renewal probability of each year into a cumulative persistency. The profit in Column 5 is reduced to reflect the cumulative persistency in Column 7, and the result is shown in Column 8. This value is essentially profit adjusted to reflect that not all customers will renew. Column 9 is the present value of the adjusted profit from Column 8, reflecting the time value of money. Column 10 is the present value of the premium, taking cumulative persistency into account as well. Column 11 is the ratio of Column 9 to Column 10; profit as a percentage of premium is a commonly used profit measure.

Based on the percentage profit over a one-year time horizon (i.e., the first row in each table), a 70-year-old is more profitable to insure than a 22-year-old. However, over a four-year time horizon, the 22-year-old (who is age 25 at the end of the time period) is more profitable than the 70-year-old (who is age 73 by the end of the time period).

13.16 Four-Year Time Horizon for 22-Year-Old

Year	(1) Age	(2) Prem	(3) Losses	(4) Expense	(5) Profit	(6) Renewal Prob	(7) Cumulative Persistency	(8) Adj Profit	(9) PV of Adj Profit	(10) PV of Premium	(11) Profit %
1	22	$ 810	$ 800	$ 35	$ (25)	100.0%	100.0%	$ (25.00)	$ (25.00)	$ 810.00	-3.1%
2	23	$ 800	$ 750	$ 15	$ 35	75.0%	75.0%	$ 26.25	$ 25.00	$ 571.43	4.4%
3	24	$ 790	$ 700	$ 15	$ 75	75.0%	56.3%	$ 42.23	$ 38.30	$ 403.42	9.5%
4	25	$ 780	$ 650	$ 15	$ 115	80.0%	45.0%	$ 51.75	$ 44.70	$ 303.21	14.7%
Total		$3,180	$2,900	$ 80	$ 200			$ 95.23	$ 83.01	$ 2,088.06	4.0%

13.17 Four-Year Time Horizon for 70-Year-Old

Year	(1) Age	(2) Prem	(3) Losses	(4) Expense	(5) Profit	(6) Renewal Prob	(7) Cumulative Persistency	(8) Adj Profit	(9) PV of Adj Profit	(10) PV of Premium	(11) Profit %
1	70	$ 600	$ 550	$ 35	$ 15	100%	100.0%	$ 15.00	$ 15.00	$ 600.00	2.5%
2	71	$ 600	$ 578	$ 15	$ 7	95%	95.0%	$ 6.65	$ 6.33	$ 542.86	1.2%
3	72	$ 600	$ 606	$ 15	$ (21)	96%	91.2%	$ (19.15)	$ (17.37)	$ 496.33	-3.5%
4	73	$ 600	$ 640	$ 15	$ (55)	97%	88.5%	$ (48.68)	$ (42.05)	$ 458.70	-9.2%
Total		$2,400	$2,374	$ 80	$ (54)			$ (46.18)	$ (38.09)	$ 2,097.88	-1.8%

(5)= (2) - (3) - (4)
(7)= (6) x (Prior7)
(8)= (5) x (7)
(9)= (8) discounted by 5% per annum
(10)= (2) x (7) discounted by 5% per annum
(11)= (9) / (10)

Improvements to this type of analysis may include refining the assumptions, increasing the time horizon, and incorporating results from other products the customer may also purchase. More information on this type of analysis can be found in "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/Casualty Insurance" (Feldblum 1996).

Optimized Pricing

Originally, multivariate statistical modeling techniques were used primarily to determine better estimates of loss costs for insureds with different characteristics. More recently, these same techniques are being applied to develop renewal and conversion models (i.e., customer demand models). These models are used to estimate the probability that an applicant will accept a quote (i.e., conversion model) or that an existing customer will accept the renewal offer (i.e., retention model).

The historical data used to develop these models includes a series of observations and a corresponding response for each observation. For example, a conversion model dataset contains a series of new business quotes and whether each quote was accepted or rejected. A retention model dataset contains a series of renewal offers and whether each offer was accepted or rejected. Each dataset should also include relevant information about each observation, including risk characteristics, amount of premium quoted, rate change information (for retention models), and an indicator of the competitiveness of the premium. The resulting models can help predict the change in close rate or retention rate in response to a proposed rate change, given a set of observations and associated characteristics.

13.18 Retention Model Output

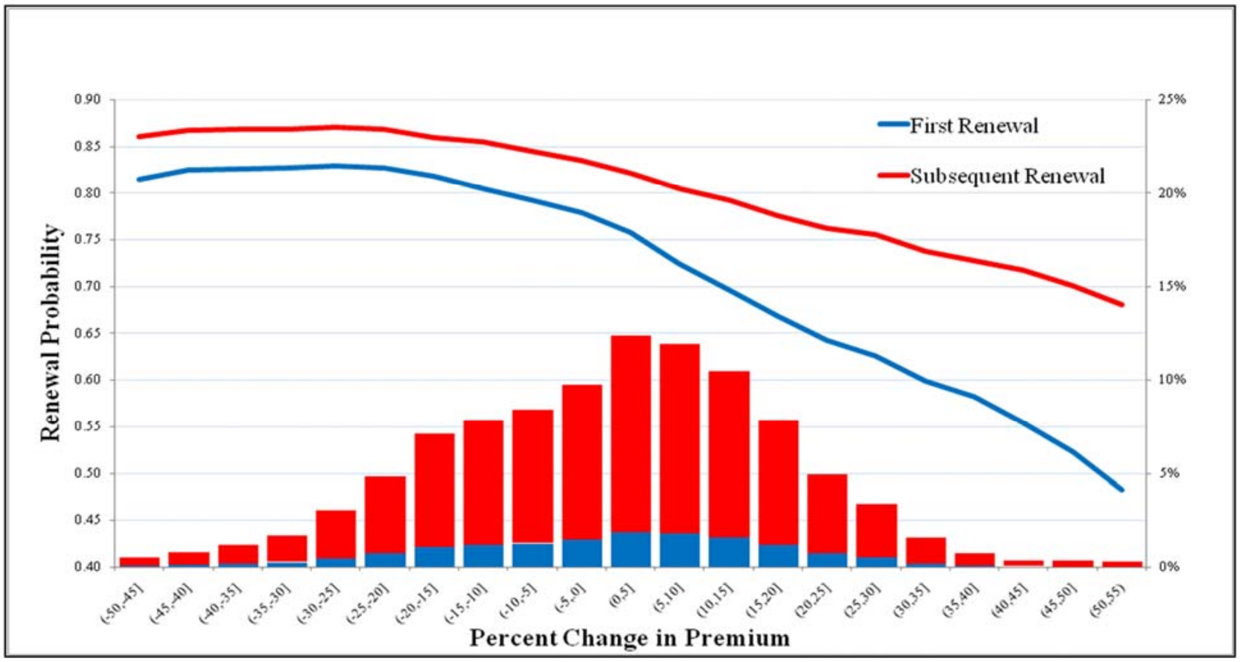


Chart 13.18 shows example output from a retention model. The bars represent the percentage of policies (right y-axis) getting different percentage change in premium (x-axis). The lines illustrate the insured's propensity to renew (left y-axis) depending on whether it is the first or subsequent renewal for the insured. As the premium changes increase, the blue line drops more steeply than the red line, highlighting that the longer the insured is with the carrier, the less sensitive he or she is to premium increases.

A loss cost model and a customer demand model can be used together to estimate expected premium volume, losses, and total profits for a given rate proposal. For renewal business, the loss cost and retention models project the expected profitability and probability of renewal for each existing risk at a given price. Given these models, a company can test several rate change scenarios on the in-force distribution to determine the expected volume, premium, losses, and profit of each scenario. The objective is to identify the rate change that best achieves the company's profitability and volume goals on the renewal portfolio. This same process can also test multiple rate scenarios on new business by applying the results of loss cost models and conversion models on a portfolio of quotes.

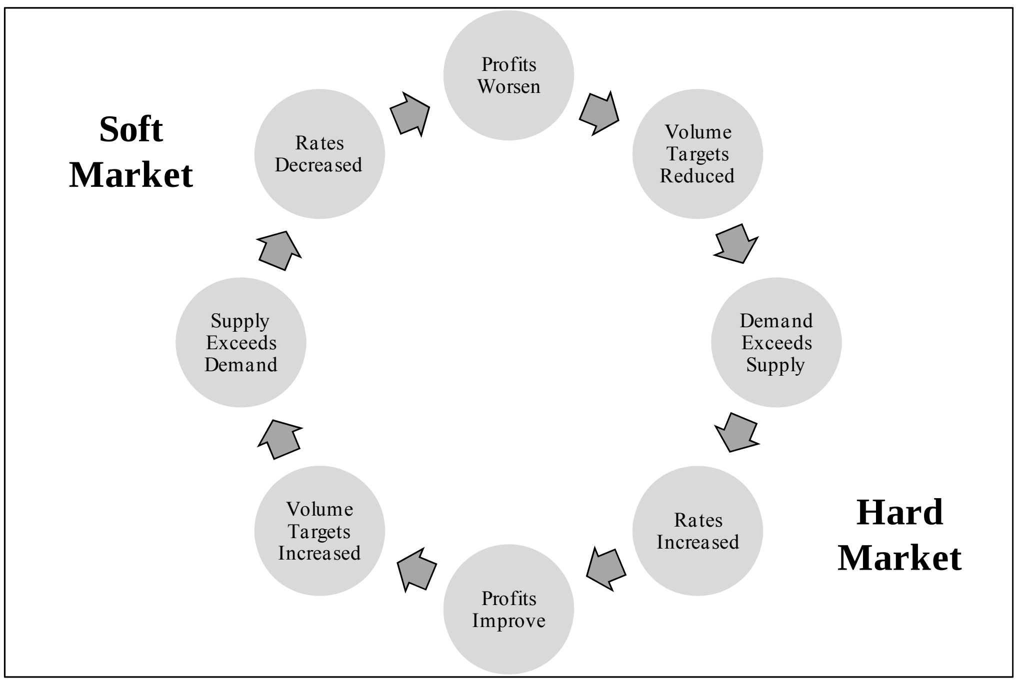
Scenario testing rate changes is a precursor to full price optimization. Optimization algorithms incorporate loss cost models, demand models, and other assumptions as inputs, and generate hundreds of thousands of scenarios to determine the premium for each individual risk that optimizes overall profit while achieving a company's overall volume goals (or optimize volume while achieving a company's overall profitability goals). The algorithms can be as simple or complex as desired. Complex algorithms may take into account several per policy constraints (e.g., minimum premium or profit per policy), include models on the propensity to cross-sell, and consider time horizons longer than one year. Regardless of the complexity of the optimization routine, the ratemaking actuary may still have the challenge of determining how to translate individually optimized premium into a manual rate structure, depending on the product being priced. (This is outside the scope of this text.) In addition, the considerations covered earlier in this chapter (regulatory and operational) still apply.

In summary, actuaries have always considered both expected loss costs and customer demand when setting rates, although the customer demand aspect was often incorporated judgmentally. Optimized pricing more systematically combines knowledge of loss costs and customer demand to develop rates that meet the particular volume and profitability objectives of the company, and represents an improvement over traditional techniques.

Underwriting Cycles

When determining which rates to implement, it is important to understand that the insurance industry historically has cyclical results. In other words, the overall profitability of the industry tends to oscillate systematically. The industry uses the terms “hard market” and “soft market” to identify the peaks and valleys of this cycle. The hard market refers to periods of higher price levels and increased profitability. Normally, companies respond to this profitability by trying to expand their market share. To do this, some companies become more aggressive in their pricing (often deviating from actuarial indications), which puts pressure on other companies to respond by reducing prices. This generally leads to a soft market, during which profits are lower. In response to the low profits generated during a soft market, companies again begin to focus more on the actuarial indications and take appropriate rate increases. Thus, competitive pressures ease and the cycle begins again. The cycle is demonstrated pictorially in Figure 13.19.

13.19 Underwriting Cycle



When making pricing decisions, it is important that the actuary understands the existence of underwriting cycles and considers the current cycle stage of the industry. By understanding this, the company can better respond to changes in the market conditions.

For more detailed information on underwriting cycles, refer to “The Impact of the Insurance Economic Cycle on Insurance Pricing” (Boor 2004).

SUMMARY

Insurance companies invest considerable resources to perform ratemaking analysis, but do not always implement the actuarially indicated rates. Two reasons that a company may implement something other than the indicated rates are regulatory constraints and operational constraints. In addition, marketing considerations such as competitive position, customer demand, and underwriting cycle may lead the company to deviate from indicated rates. Traditional pricing strategy incorporates these market considerations judgmentally, but advanced techniques such as lifetime customer value and optimized pricing can accomplish this more systematically.

KEY CONCEPTS IN CHAPTER 13

1. Regulatory constraints

2. Operational constraints
    a. Types of operational constraints
    b. Cost-benefit analysis

3. Market considerations
    a. Traditional analysis
        i. Competitive comparisons
        ii. Close ratios
        iii. Retention ratios
        iv. Distributional analysis
        v. Policyholder dislocation analysis
    b. Systematic analysis
        i. Lifetime customer value
        ii. Optimized pricing
    c. Underwriting cycles

CHAPTER 14: IMPLEMENTATION

As discussed throughout the paper, the fundamental insurance equation is:

Premium= Losses + LAE + UW Expenses + UW Profit.

Prior chapters provide techniques to project the individual components of the equation in order to determine whether or not the equation will be in balance for a given set of rates. This chapter discusses potential actions a company can take if its current rates do not produce an average premium that is equivalent to the sum of the expected costs and target underwriting profit. In particular, this chapter discusses:

- Non-pricing solutions to an imbalanced fundamental insurance equation
- Rate change solutions, including detailed discussion of how to calculate final rates for existing products and products being introduced
- Communicating the expected effect of rate changes to key stakeholders (e.g., regulators and company management) and monitoring results after implementation.

EXAMPLE IMBALANCE

This chapter uses the notation introduced in the Foreword to this text, and considers the same pricing example and assumptions presented in prior chapters (referred to as the "simple example"):

- The average expected loss and LAE ($\overline{L} + \overline{E_L}$) for each exposure is $180.
- Each time the company writes an exposure, the company incurs $20 in fixed expenses ($\overline{E_F}$).
- 15% of each dollar of premium collected covers expenses (V) that vary with the amount of premium, such as premium taxes.
- Company management has determined that the target profit provision (Q_T) is 5% of premium.

Based on the expected losses, expenses, and target underwriting profit in the future policy period, the indicated average premium per exposure is $250 (= ($180 + $20) / (1.0 – 15% – 5%)).

If the projected average premium assuming the company's current rates is $235, then the fundamental insurance equation is not in balance. The company can bring the equation into balance by reducing its costs (non-pricing solutions) or increasing its rates or both.

NON-PRICING SOLUTIONS

A company may try to achieve balance through expense reductions (i.e., reduction in UW or LAE expenses). For example, the company may try to reduce the marketing budget or reduce the staffing levels. In the simple example, the equation will be brought into balance if the fixed expenses per exposure are reduced from $20 to $8, or the variable expenses are reduced from 15% to 10%. If the company actuary projects a reduction in expenses, the overall rate level indication should be updated accordingly.

A company can also achieve balance by reducing the average expected loss. One way to do this is to change the make-up of the portfolio of insureds. For example, a company may tighten the underwriting criteria or non-renew policies that have grossly inadequate premium relative to expected costs. It is important to note that when the portfolio changes, both the expected losses and expected premium may change; however, if the loss reduction is greater than the premium reduction, the underwriting action could move the fundamental equation to the balanced position. If a company does this, then the actuary should adjust the premium and loss projections and recalculate the overall rate level indication.

Another way to reduce average expected loss is to reduce the coverage provided by the policy. A reduction or expansion of coverage is referred to as a coverage level change. For example, a homeowners insurer may adjust the policy to exclude coverage for mold losses. If this action eliminates previously covered losses and rates are not decreased accordingly, then this coverage level change is equivalent to a rate level increase. In the simple example, the company needs to reduce the average expected loss and LAE from \$180 to \$168 to bring the fundamental insurance equation into equilibrium. If a company accomplishes such a change, then the actuary should adjust the projected losses and LAE and recalculate the overall rate level indication.

These two methods above are not the only approaches to reduce average expected loss. Companies may also institute better loss control procedures. For example, a workers compensation carrier may be able to reduce average severity by applying proactive medical management procedures and return-to-work programs for disability claims that are likely to escalate.

PRICING SOLUTIONS

The typical company response to an unbalanced fundamental equation is to adjust the rates or expect an underwriting profit below the target underwriting profit until adjustments can be made. In the simple example, the overall rate level analysis indicates a need to increase the average rate from \$235 to \$250, but the company may choose not to do this. Chapter 13 addressed reasons a company may implement rates different from those indicated. If the company decides that \$235 is the most that can be charged in the short run, then the company is, in effect, forced to accept the resulting target underwriting profit provision of -0.1% (= (\$235 - \$180 - \$20 – (15% x \$235)) / \$235) until rates can be increased.

Since achieving the target underwriting profit is important, most companies choose to change the current rates (i.e., implement a rate change) to achieve or at least get closer to the desired equilibrium. The next section covers the process that the actuary may use to revise the rates of an existing product to the desired level. Calculating rates for a new product will be covered later in the chapter.

CALCULATING NEW RATES FOR AN EXISTING PRODUCT

In order to calculate a final set of rates for an existing product, the company must:

- Select an overall average premium target for the future policy period
- Finalize the structure of the rating algorithm
- Select the final rate differentials for each of the rating variables
- Calculate proposed fixed expense fees and other dollar additives, if applicable
- Derive the base rate necessary to achieve the overall average premium target

Chapter 8 discusses the calculation of the overall rate level indication, and Chapters 9 through 11 discuss calculation of the proposed rate differentials. Chapter 13 discusses conditions that may cause selections of overall rate levels or rate differentials to deviate from indicated.

The next sections of this chapter use a simple example to illustrate the calculation of the fixed expense fees and the derivation of the base rate.

Example Rating Algorithm

As discussed in Chapter 2, the rating algorithm describes in detail how to combine the various rate components (e.g., base rates, rate differentials, expense fees, and other additive premium) to calculate the overall premium charged for any risk. Rating algorithms vary considerably by company and by product, and the determination of the most appropriate rating algorithm[47] is outside the scope of this text. When using any of the formulae described in this chapter, consider the specific rating algorithm of the product being priced, and modify as necessary.

The portion of the total premium that varies by risk characteristics (i.e., is a function of the base rate and rate differentials) is often referred to as **variable premium**. The portion of the premium derived from expense fees and other dollar additives is often referred to as **flat or additive premium**. These terms will be used throughout the remainder of the chapter.

For the purpose of explaining the expense fee and base rate derivation formulae, assume a simple rating algorithm that includes a base rate (B), two multiplicative rating variables ($R1$ and $R2$), two discounts ($D1$ and $D2$) that are subtracted from one and applied multiplicatively in the rating algorithm, and an additive per exposure expense fee (A). As before, P and X are used to denote premium and exposures, respectively. Using a subscript of P to refer to proposed and the subscripts of i, j, k, m to refer to different levels for the different rating variables/discounts, the proposed premium for a given risk can be defined as follows:[48]

$$P_{\mathrm{P},ijkm} = [[B_{\mathrm{P}} \text{ x } R1_{\mathrm{P},i} \times R2_{\mathrm{P},j} \times (1.0 - D1_{\mathrm{P},k} - D2_{\mathrm{P},m})] + A_{\mathrm{p}}] \times X_{ijkm}.$$

Example Rating Variable Differentials

The rating algorithm in the example contains two multiplicative rating variables ($R1$ and $R2$) and two discounts ($D1$ and $D2$). Assume the company relied on the following information to select proposed rate differentials for each rating variable:

[47] For example, the extent to which the formula should be multiplicative or additive.
[48] For some lines of business (e.g., homeowners insurance), the X_{ijkm} can be 1.0.

14.1 Differentials and Discounts

R1	Current Differential	Indicated Differential	Competitor Differential	Proposed Differential
1	0.8000	0.9000	0.9200	0.9000
2	1.0000	1.0000	1.0000	1.0000
3	1.2000	1.2500	1.2500	1.2500

R2	Current Differential	Indicated Differential	Competitor Differential	Proposed Differential
A	1.0000	1.0000	1.0000	1.0000
B	1.0500	0.9000	0.9500	0.9500
C	1.2000	1.3000	1.3500	1.3000

D1	Current Discount	Indicated Discount	Competitor Discount	Proposed Discount
Y	5.0%	4.0%	5.0%	5.0%
N	0.0%	0.0%	0.0%	0.0%

D2	Current Discount	Indicated Discount	Competitor Discount	Proposed Discount
Y	10.0%	2.5%	7.5%	5.0%
N	0.0%	0.0%	0.0%	0.0%

Calculation of Fixed Expense Fees and Other Additive Premium

If the rating algorithm incorporates fixed expenses through an additive per exposure expense fee, that fee is typically based on the average fixed expense per exposure. In addition, the fee must be adjusted to account for variable underwriting expenses and underwriting profit in the same way that losses and LAE per exposure are adjusted for these items in the rate level indication formulae. In other words, the company incurs variable expenses and expects target profit on all premium, including that which comes from fixed expense fees.

The adjustment to the expense fee to account for variable expense and profit is accomplished by dividing the average fixed underwriting expense by the variable permissible loss ratio:

$$A_{\mathrm{P}} = \frac{\overline{E_{\mathrm{F}}}}{(1.0 - V - Q_{\mathrm{T}})}.$$

The following shows the calculation of the proposed expense fee in the simple example:

14.2 Calculation of Fee

(1)	Average Fixed Expense per Exposure	$20.00
(2)	Variable Expense %	15.0%
(3)	Target Profit %	5.0%
(4)	Variable Permissible Loss Ratio	80.0%
(5)	Proposed Expense Fee	$25.00

(4)= 1.0 - (2) - (3)
(5)= (1) / (4)

In this example, the proposed $25 additive fee includes $20 to cover the fixed expenses and $5 to cover the variable expense (e.g., premium tax) and profit associated with the $20.

Some companies use a fixed per policy expense fee rather than a fixed per exposure expense fee in the rating algorithm. It is important that base rate derivation formulae discussed in the next section combine average variable premium and average flat premium on a consistent basis (i.e., per policy or per exposure). A per policy expense fee can be converted to a per exposure expense fee by dividing by the average number of exposures per policy.

Also, it is possible that the variable expense provision (V) used to adjust the fixed expense fee differs from that used in calculating the overall rate level indication. This can occur when companies elect not to apply certain aspects of the variable expenses to the flat fee. For example, some companies do not make the flat fee subject to agent commissions.

If the premium-based expense projection method is used (as discussed in Chapter 7), a fixed expense ratio is calculated rather than a fixed expense dollar amount. The ratio can be converted to a dollar amount by multiplying it by the projected average premium per exposure, as shown in the following table.

14.3 Calculation of Fee (Fixed Expense Ratio)

(1) Fixed Expense Ratio		8.0%
(2) Projected Average Premium per Exposure	$	250.00
(3) Average Fixed Expense per Exposure	$	20.00
(4) Variable Expense %		15.0%
(5) Target Profit %		5.0%
(6) Variable Permissible Loss Ratio		80.0%
(7) Proposed Expense Fee	$	25.00

(3) = (1) x (2)
(6) =1.0 - (4) - (5)
(7) = (3) / (6)

In addition to fixed expense fees, some rating algorithms have other additive premium components. For example, in the homeowners line of business, many endorsements that add or extend coverage are priced separately and added to the variable premium of the standard policy. The same adjustment as described above for fixed expense fees applies to other additive premium as well.

Derivation of Base Rate: No Rate Differential Changes

Once the actuary selects the proposed average premium (or proposed change in average premium), proposed rate differentials, and proposed fixed expense fees and other additive premium, the remaining task is to determine the proposed base rate. Essentially, the base rate is derived such that proposed average premium (or change in average premium) is expected to be achieved. Regardless of whether the pure premium method is used to calculate a target average premium, or the loss ratio method is used to calculate a target change in average premium, the goal is the same: to derive a base rate that achieves the target.

First consider the simple scenario when there is only variable premium and rate differentials are not changing. In this case, the proposed base rate is equal to the current base rate times the ratio of the proposed average premium to current average premium:

$$B_P = B_C \times \frac{\overline{P_P}}{\overline{P_C}}.$$

If there are flat premium components (and rate differentials are still not changing), the proposed base rate is equal to the current base rate times the ratio of the proposed average variable premium to the current average variable premium:

$$B_{\text{P}} = B_C \times \frac{(\overline{P_{\text{P}}} - A_{\text{P}})}{(\overline{P_C} - A_{\text{C}})}.$$

To understand this base rate formula when there is a flat premium component, consider the example where a 5.0% overall average premium change is targeted. The 5.0% change can be achieved by increasing the base rate 5.0% and increasing the flat premium 5.0%. Alternatively, if it is undesirable to change flat premium (i.e., keep A_{P} the same as A_{C}), the base rate change needs to be increased such that the total average premium change will be achieved. This is because the base rate change only affects variable premium. If flat premium is assumed to be 10% of the total average premium (and the amount of flat premium is not changing with this rate review), the base rate has to increase by 5.56% in order to achieve the 5.0% overall change (i.e., 5.0% = 90% (5.56%) + 10% (0.0%)).

Derivation of Base Rate: Rate Differential Changes

The next section describes three base rate derivation approaches to use if rate differentials are changing:

- Extension of exposures
- Approximated average rate differential
- Approximated change in average rate differential

The extension of exposures method is the most direct and most accurate, but requires detailed data. The approximated methods are used when application of extension of exposures is not practical for the product being priced.

Extension of Exposures Method

Chapter 5 discussed the extension of exposures technique as a method to rerate individual policies, or unique combinations of rating variables, according to a current set of rates in order to calculate earned premium at current rate level. The same general technique is applied to derive a proposed base rate. Policies are rerated in consideration of the proposed rate differentials, proposed flat premium, and a placeholder value for the unknown proposed base rate (referred to as a seed base rate or B_{S}[49]). If the resulting proposed average premium matches the target average premium, then the placeholder base rate is the correct proposed base rate. If not, the placeholder base rate requires adjustment, as described below.

[49] The seed base rate is an initial approximation of the proposed base rate. It is merely a means to an end. The proposed base rate will be derived from the seed base rate using algebra, as will be discussed. In practice, the seed base rate is often selected as the current base rate or the current base rate adjusted by the selected overall change in average premium.

In the example, the extension of exposures technique is used to rerate individual policies[50] using the proposed rate differentials ($R1_P$, $R2_P$, $D1_P$, $D2_P$), a proposed fixed expense fee per exposure (A_P), and some seed value for the proposed base rate (B_S). Using the notation presented earlier, the proposed premium per policy, assuming the seed base rate, is:

$$P_{S,ijkm} = [[B_S \text{ x } R1_{P,i} \times R2_{P,j} \times (1.0 - D1_{P,k} - D2_{P,m})] + A_p] \times X_{ijkm}.$$

Once each set of policies is rerated, the premium is aggregated across some distribution (e.g., the latest in-force distribution) and divided by the total exposures. The resulting average proposed premium assuming the seed base rate is:

$$\overline{P_S} = \frac{\sum_i \sum_j \sum_k \sum_m [[[B_S \text{ x } R1_{P,i} \times R2_{P,j} \times (1.0 - D1_{P,k} - D2_{P,m})] + A_p] \times X_{ijkm}]}{X},$$

which can be simplified as:

$$\overline{P_S} = B_S \times \frac{\sum_i \sum_j \sum_k \sum_m \left[[R1_{P,i} \times R2_{P,j} \times (1.0 - D1_{P,k} - D2_{P,m})] \times X_{ijkm}\right]}{X} + A_p.$$

Table 14.4 shows the extension of exposures method applied to data from the example. Assuming a seed base rate of \$215, the resulting proposed average premium is \$246.83.

[50] For lines of business that are priced by coverage and/or by individual exposure, the extension of exposures and base rate derivation is calculated at that same level. For example, in personal automobile insurance, the base rate applies to the individual car at the coverage level.

14.4 Extention of Exposures (Assuming Seed Base Rate)

(1) Exposures	(2) $R1$	(3) $R2$	(4) $D1$	(5) $D2$	(6) Proposed Premium (assuming Seed Base Rate = $215)
10,000	1	A	Y	Y	$ 1,991,500.00
7,500	2	A	Y	Y	$ 1,638,750.00
3,000	3	A	Y	Y	$ 800,625.00
9,000	1	B	Y	Y	$ 1,713,982.50
20,000	2	B	Y	Y	$ 4,176,500.00
5,000	3	B	Y	Y	$ 1,273,960.00
1,875	1	C	Y	Y	$ 471,365.63
5,000	2	C	Y	Y	$ 1,382,750.00
2,000	3	C	Y	Y	$ 678,875.00
3,500	1	A	N	Y	$ 730,887.50
7,500	2	A	N	Y	$ 1,719,375.00
3,500	3	A	N	Y	$ 981,093.75
15,000	1	B	N	Y	$ 2,994,667.50
36,000	2	B	N	Y	$ 7,885,350.00
9,000	3	B	N	Y	$ 2,407,873.50
3,750	1	C	N	Y	$ 989,896.88
10,000	2	C	N	Y	$ 2,905,250.00
2,000	3	C	N	Y	$ 713,834.00
3,500	1	A	Y	N	$ 730,887.50
7,500	2	A	Y	N	$ 1,719,375.00
3,500	3	A	Y	N	$ 981,093.75
15,000	1	B	Y	N	$ 2,994,667.50
36,000	2	B	Y	N	$ 7,885,350.00
9,000	3	B	Y	N	$ 2,407,873.50
3,750	1	C	Y	N	$ 989,896.88
10,000	2	C	Y	N	$ 2,905,250.00
5,000	3	C	Y	N	$ 1,784,585.00
48,000	1	A	N	N	$ 10,488,000.00
112,500	2	A	N	N	$ 27,000,000.00
25,000	3	A	N	N	$ 7,343,750.00
11,000	1	B	N	N	$ 2,297,075.00
250,000	2	B	N	N	$ 57,312,500.00
65,000	3	B	N	N	$ 18,220,312.50
28,125	1	C	N	N	$ 7,777,968.75
68,000	2	C	N	N	$ 20,706,000.00
15,000	3	C	N	N	$ 5,615,625.00
869,500					$ 214,616,746.63
(7) Avg Prop Prem (Base Seed = $215)					$ 246.83

(6)= Calculated via extension of exposures with B_S =$215

(7)= (Tot6) / (Tot1)

The proposed average premium assuming a seed base rate is lower than the target average premium of \$250 so the seed base rate needs to be increased. The actuary can derive the proposed base rate via trial and error (i.e., testing various base rates until the target average premium is achieved). Alternatively, the actuary can calculate the amount the seed base rate needs to be adjusted via formula.

Recall that the formula for the proposed average premium assuming a seed base rate is:

$$\overline{P_S} = B_S \times \frac{\sum_i \sum_j \sum_k \sum_m \left[[R1_{\mathrm{P},i} \times R2_{\mathrm{P},j} \times \left(1.0 - D1_{\mathrm{P},k} - D2_{\mathrm{P},m}\right)] \times X_{ijkm} \right]}{X} + A_p,$$

and the formula for the proposed average premium assuming the proposed base rate is:

$$\overline{P_\mathrm{P}} = B_\mathrm{P} \times \frac{\sum_i \sum_j \sum_k \sum_m \left[[R1_{\mathrm{P},i} \times R2_{\mathrm{P},j} \times \left(1.0 - D1_{\mathrm{P},k} - D2_{\mathrm{P},m}\right)] \times X_{ijkm} \right]}{X} + A_p$$

The only difference between these formulae is the base rate used (i.e., the former uses B_S and the latter uses B_P).

Rearranging the terms and dividing one formula by the other yields:

$$\frac{(\overline{P_\mathrm{P}} - A_\mathrm{P})}{(\overline{P_S} - A_\mathrm{P})} = \frac{B_\mathrm{P}}{B_S}.$$

Thus, the proposed base rate in the extension of exposure method is derived by adjusting the seed base rate as follows:

$$B_\mathrm{P} = B_S \times \frac{(\overline{P_\mathrm{P}} - A_\mathrm{P})}{(\overline{P_S} - A_\mathrm{P})}.$$

If no fixed expense fee or other additive premium applies, the calculation of the proposed base rate is simple:

$$B_\mathrm{P} = B_S \times \frac{\overline{P_\mathrm{P}}}{\overline{P_S}}.$$

The table below summarizes the calculation of the proposed base rate in the example, according to the formula provided earlier:

14.5 Proposed Base Rate (Extension of Exposures)

(1) Seed Base Rate	$ 215.00
(2) Average Premium assuming Seed Base Rate	$ 246.83
(3) Proposed Fixed Fee	$ 25.00
(4) Proposed Average Premium	$ 250.00
(5) Proposed Base Rate	$ 218.07

(2)= from Table 14.4, Row (7)
(5)= (1) x [(4) - (3)] /[(2) - (3)]

If the loss ratio method is used to calculate an overall rate level indication, the target is a change in average premium rather than an average premium. In this case, the first step is to calculate the proposed average premium based on the selected change (Δ):

$$\overline{P_{\mathrm{P}}} = (1 + \Delta\%) \times \overline{P_{\mathrm{C}}}.$$

This value can then be used in the same base rate derivation formula:

$$B_{\mathrm{P}} = B_S \times \frac{\overline{P_{\mathrm{P}}} - A_{\mathrm{P}}}{\overline{P_S} - A_{\mathrm{P}}} = B_S \times \frac{(1 + \Delta\%) \times \overline{P_{\mathrm{C}}} - A_{\mathrm{P}}}{\overline{P_S} - A_{\mathrm{P}}}.$$

In our example, assume the current average premium is $242.13. This value was selected for illustrative purposes. If the current base rate and expense fee is known, then extension of exposures could be undertaken in a manner parallel to Table 14.4 in order to determine the current average premium. If the indicated percent change in average premium is 3.25%, the resulting proposed average premium is $250. The table below uses these inputs to calculate the proposed base rate.

14.6 Proposed Base Rate (Extension of Exposures, Loss Ratio Method)

(1) Target % Change in Average Premium	3.25%
(2) Current Average Premium	$ 242.13
(3) Proposed Average Premium	$ 250.00
(4) Seed Base Rate	$ 215.00
(5) Average Premium assuming Seed Base Rate	$ 246.83
(6) Proposed Fixed Fee	$ 25.00
(7) Proposed Base Rate	$ 218.07

(3)= (1.0 + (1)) x (2)
(7)= (4) x [(3) - (6)] /[(5) - (6)]

Approximated Average Rate Differential Method

It may not be feasible for a company to retrieve the detailed data necessary to undertake the extension of exposures method for deriving the proposed base rate. One alternative method involves estimating the weighted average proposed rate differential across all rating variables (referred to as $\overline{S_{\mathrm{P}}}$).

Recall from the prior section that he formula for the proposed average premium in our example is:

$$\overline{P_{\mathrm{P}}} = B_{\mathrm{P}} \times \frac{\sum_i \sum_j \sum_k \sum_m \left[R1_{\mathrm{P},i} \times R2_{\mathrm{P},j} \times \left(1.0 - D1_{\mathrm{P},k} - D2_{\mathrm{P},m}\right) \times X_{ijkm}\right]}{X} + A_{\mathrm{P}}.$$

In order to simplify the notation, $\overline{S_{\mathrm{P}}}$ is substituted for the weighted average proposed rate differential across all rating variables:

$$\overline{S_{\mathrm{P}}} = \frac{\sum_i \sum_j \sum_k \sum_m \left[R1_{\mathrm{P},i} \times R2_{\mathrm{P},j} \times \left(1.0 - D1_{\mathrm{P},k} - D2_{\mathrm{P},m}\right) \times X_{ijkm}\right]}{X}.$$

The terms can then be rearranged to solve for the proposed base rate:

$$B_{\mathrm{p}} = \frac{\overline{P_{\mathrm{P}}} - A_{\mathrm{P}}}{\overline{S_P}}.$$

When a rating algorithm is purely multiplicative, $\overline{S_{\mathrm{P}}}$ is typically approximated as the product of the exposure-weighted average differentials for each of the rating variables. In our example rating algorithm, which has discounts that are additive in nature, the exposure-weighted average discounts are calculated and subtracted from one before being multiplied by the average differentials of the multiplicative rating variables:

$$\overline{S_{\mathrm{P}}} \approx \frac{\sum_i X_i \times R1_{\mathrm{P},i}}{X} \times \frac{\sum_j X_j \times R2_{\mathrm{P},j}}{X} \times \left[1.0 - \left[\frac{\sum_k X_k \times D1_{\mathrm{P},k}}{X} + \frac{\sum_m X_m \times D2_{\mathrm{P},m}}{X}\right]\right].$$

The following tables show the approximation of $\overline{S_{\mathrm{P}}}$ for the example, using exposures as weights:

14.7 Proposed Differentials Wtd by Exposures

(1) $R1$	(2) Exposures	(3) Proposed Differential
1	152,500	0.9000
2	570,000	1.0000
3	147,000	1.2500
Total	869,500	1.0247

(1) $R2$	(2) Exposures	(3) Proposed Differential
A	235,000	1.0000
B	480,000	0.9500
C	154,500	1.3000
Total	869,500	1.0257

(1) $D1$	(2) Exposures	(3) Proposed Discount
Y	156,625	5.00%
N	712,875	0.00%
Total	869,500	0.90%

(1) $D2$	(2) Exposures	(3) Proposed Discount
Y	153,625	5.00%
N	715,875	0.00%
Total	869,500	0.88%

(4)	$\tilde{\tilde{S}}_P$	1.0323

(Tot3) = (3) weighted by (2)
(4) = $(\text{Tot3}_{R1}) \times (\text{Tot3}_{R2}) \times (1.0 - \text{Tot3}_{D1} - \text{Tot3}_{D2})$

The proposed base rate assuming the exposure-weighted average proposed rate differential across all rating variables from Table 14.7 is:

$$B_p = \frac{\overline{P_P} - A_P}{\overline{S_P}} = \frac{\$250 - \$25}{1.0323} = \$217.96.$$

This proposed base rate ($217.96) is different than that which was calculated using the extension of exposures method ($218.07). Exposure-weighting each variable's differentials independently and then combining those averages according to the structure of the rating algorithm ignores the dependence of the exposure distribution by level of one rating variable on the level of another rating variable (i.e., the distributional bias between variables, as discussed in Chapters 9 and 10). The example data was not largely biased, but in practice the bias can drive larger discrepancies in the proposed base rate. One way to mitigate this bias is to use variable premium at current rate level and at base level instead of exposures for weights in the approximation. Recall that variable premium is the premium before addition of any fixed expense fees or other additive premium. The current rate level adjustment for the premium in this analysis should be done at the class level (i.e., applying the parallelogram method to fully aggregated data would not be suitable). The phrase "at base level" means that the variable premium for non-base levels is adjusted to remove the effect of the current rate differential. For multiplicative factors this means dividing the variable premium for each non-base level by the current rate differential for the given variable. Assuming the rating algorithm is entirely multiplicative and the current rate level adjustment is not too time-consuming, calculating variable premium at base level may be a feasible improvement. When the rating algorithm has both multiplicative and additive components, the derivation of variable premium at current rate level and at base level becomes so challenging that the effort to improve the approximation would be better spent compiling data to undertake the extension of exposures technique.

Approximated Change in Average Rate Differential Method

One of the issues with this approximated average rate differential method is that the actuary needs to calculate the weighted average proposed rate relativities for each rating variable. When the variable premium portion of the rating algorithm is entirely multiplicative, the actuary may prefer to estimate the change in the average rate differential; by doing so, the actuary can focus solely on the rating variables that are changing**.**

Recall that the proposed average premium is the current average premium multiplied by the proposed overall change in average premium:

$$\overline{P_{\mathrm{P}}} = (1.0 + \Delta\%) \times \overline{P_{\mathrm{C}}}.$$

The proposed overall change in average premium is comprised of changes to the variable and additive premium components. Using the notation $\Delta_{\mathrm{V}}\%$ and $\Delta_{\mathrm{A}}\%$ to indicate the percentage changes to the variable and additive premium components, respectively, the formula can be transformed:

$$\overline{P_{\mathrm{P}}} = (1.0 + \Delta_{\mathrm{V}}\%) \times (\overline{P_{\mathrm{C}}} - A_{\mathrm{C}}) + (1.0 + \Delta_{\mathrm{A}}\%) \times (A_{\mathrm{C}}).$$

Taking into account that the last term on the right side of the equation is equivalent to the proposed additive premium per exposure, A_{P}, this equation can be rewritten as follows:

$$\overline{P_{\mathrm{P}}} - A_{\mathrm{P}} = (1.0 + \Delta_{\mathrm{V}}\%) \times (\overline{P_{\mathrm{C}}} - A_{\mathrm{C}}).$$

This can be further simplified to show the proposed change in variable premium given the overall change, the current average premium, and the current and proposed additive premium:

$$(1.0 + \Delta_{\mathrm{V}}\%) = \frac{\overline{P_{\mathrm{P}}} - A_{\mathrm{P}}}{\overline{P_{\mathrm{C}}} - A_{\mathrm{C}}} = \frac{(1.0 + \Delta\%) \times \overline{P_{\mathrm{C}}} - A_{\mathrm{P}}}{\overline{P_{\mathrm{C}}} - A_{\mathrm{C}}}.$$

The change in variable premium is comprised of the change in base rate and the change in the average rate differential across all variables:

$$(1.0 + \Delta_{\mathrm{V}}\%) = \frac{B_{\mathrm{P}}}{B_{\mathrm{C}}} \times \frac{\overline{S_{\mathrm{P}}}}{\overline{S_{\mathrm{C}}}}.$$

By substituting and reordering terms, the base rate adjustment is defined as follows:

$$\frac{B_{\mathrm{P}}}{B_{\mathrm{C}}} = \frac{(1.0 + \Delta\%) \times \overline{P_{\mathrm{C}}} - A_{\mathrm{P}}}{\overline{P_{\mathrm{C}}} - A_{\mathrm{C}}} \times \frac{\overline{S_{\mathrm{C}}}}{\overline{S_{\mathrm{P}}}}.$$

Using $\Delta_{\mathrm{B}}\%$ and $\Delta_{\mathrm{S}}\%$ to represent the percentage base rate change and the percentage change in average rate differential, the equation becomes:

$$1.0 + \Delta_{\mathrm{B}}\% = \frac{(1.0 + \Delta\%) \times \overline{P_{\mathrm{C}}} - A_{\mathrm{P}}}{\overline{P_{\mathrm{C}}} - A_{\mathrm{C}}} \times \frac{1.0}{(1.0 + \Delta_{\mathrm{S}}\%)}.$$

The final term of the equation, which is the reciprocal of one plus the change in average rate differential, is commonly referred to as the **off-balance factor**. It is called that as it represents the amount the base rate needs to be adjusted to balance the changes in the rate differentials.

The only component of the formulae above not previously discussed is the calculation of the change in the average rate differential across all variables (Δ_{S}). An exact calculation of Δ_{S} can be made using the extension of exposures method described earlier in this section. When data at that level of detail is not available, the change in average rate differential needs to be approximated.

When the rating algorithm is entirely multiplicative, the formula for the approximated average rate differential across all variables is shown below (the subscript w refers to each rating variable). Only multiplicative variables that are changing need to be considered in the product.

$$1.0 + \Delta_{\mathrm{S}}\% \approx \prod_{w} (1.0 + \Delta_{\mathrm{S},w}\%).$$

The change in average rate differential for each multiplicative rating variable is calculated as the change in the rate differential for each level of the rating variable weighted by the current variable premium. The formula for the change in average rate differential for $R1$ is given below:

$$(1.0 + \Delta_{\mathrm{S},R1}\%) = \frac{\sum_{i} \frac{R1_{\mathrm{P},i}}{R1_{\mathrm{C},i}} \times \left(P_{\mathrm{C},i} - A_{\mathrm{C}}\right)}{\sum_{i} (P_{\mathrm{C},i} - A_{\mathrm{C}})}$$

Said in another way, this formula is simply the change in the current variable premium due to the change in the rate differentials for the given rating variable.

The use of variable premium as weights may be difficult for various reasons. First, it may be difficult to obtain the current variable premium data (particularly at current rate level). Second, weighting by variable premium is challenging when a rating algorithm has additive components. For these reasons, actuaries may choose to measure the average change in rating differentials using exposures as weights.

This method of weighting introduces the same distributional bias as discussed in the previous section, but it may be the most feasible alternative.

In the example rating algorithm, the additive discounts can be combined and restated as a single multiplicative variable (i.e., 1-*D*1-*D*2). The formula for the average rate differential across all variables in the example is as follows:

$$1.0+\Delta_S\%\approx(1.0+\Delta_{S,R1}\%)\ x\ (1.0+\Delta_{S,R2}\%)\ x\ (1.0+\Delta_{S,(1-D1-D2)}\%)$$

Actuaries approximate the average rate differential changes for multiplicative variables (e.g., *R*1) as follows:

$$(1.0+\Delta_{\mathrm{S},R1}\%)\approx\frac{\overline{R1}_{\mathrm{P}}}{\overline{R1}_{\mathrm{C}}},$$

where the current and proposed average differentials are determined using exposures as weights:

$$\overline{R1}_{\mathrm{P}}\approx\frac{\sum_i R1_{\mathrm{P},i}\times X_i}{X}\ \text{and}\ \overline{R1}_{\mathrm{C}}\approx\frac{\sum_i R1_{\mathrm{C},i}\times X_i}{X}.$$

The change in (1-*D*1-*D*2) can be approximated as follows:

$$(1.0+\Delta_{\mathrm{S},(1-D1-D2)}\%)\approx\frac{1-\overline{D1}_{\mathrm{P}}-\overline{D2}_{\mathrm{P}}}{1-\overline{D1}_{\mathrm{C}}-\overline{D2}_{\mathrm{C}}},$$

where the current and proposed average discounts are determined using exposures as weights, as shown below for *D*1:

$$\overline{D1}_{\mathrm{P}}\approx\frac{\sum_i D1_{\mathrm{P},i}\times X_i}{X}\ \text{and}\ \overline{D1}_{\mathrm{C}}\approx\frac{\sum_i D1_{\mathrm{C},i}\times X_i}{X},$$

The following table shows the approximation of the average change in differentials ($(1.0+\Delta_{\mathrm{S}}\%)$ for the example using exposures as weights.

14.8 Proposed Average Change in Differentials

(1) $D1$	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	156,625	5.00%	5.00%
N	712,875	0.00%	0.00%
Total	869,500	0.90%	0.90%

(1) $D2$	(2) Exposures	(3) Current Discount	(4) Proposed Discount
Y	153,625	10.00%	5.00%
N	715,875	0.00%	0.00%
Total	$ 869,500	1.77%	0.88%

(Tot3) = (3) Weighted by (2)
(Tot4) = (4) Weighted by (2)

(5) $R1$	(6) Exposures	(7) Current Differential	(8) Proposed Differential	(9) Proposed / Current
1	152,500	0.8000	0.9000	1.1250
2	570,000	1.0000	1.0000	1.0000
3	147,000	1.2000	1.2500	1.0417
Total	869,500	0.9987	1.0247	1.0260

(5) $R2$	(6) Exposures	(7) Current Differential	(8) Proposed Differential	(9) Proposed / Current
A	235,000	1.0000	1.0000	1.0000
B	480,000	1.0500	0.9500	0.9048
C	154,500	1.2000	1.3000	1.0833
Total	869,500	1.0631	1.0257	0.9648

(10) 1-$D1$-$D2$	(11) Exposures	(12) Current Differential (1-$D1$-$D2$)	(13) Proposed Differential (1-$D1$-$D2$)	(14) Proposed / Current
Total	(8) / (7)	0.9733	0.9822	1.0091
	(15) Average Change in Differential			0.9989

(9)= (8) / (7)
(Tot9)= (Tot8) / (Tot7)
(12)= 1 - (Tot3$_{D1}$) - (Tot3$_{D2}$)
(13)= 1 - (Tot4$_{D1}$) - (Tot4$_{D2}$)
(14)= (13) / (12)
(15) = (Tot9$_{R1}$) x (Tot9$_{R2}$) x (Tot14)

Using the results from Table 14.8 and the previously derived formula:

$$1.0 + \Delta_B\% = \frac{(1.0 + \Delta\%) \times \overline{P_C} - A_P}{\overline{P_C} - A_C} \times \frac{1.0}{(1.0 + \Delta_S\%)},$$

the proposed base rate can be calculated as shown in the following table.

14.9 Proposed Base Rate (Approximated Method)

(1)	Current Base Rate	$ 210.00
(2)	Current Average Premium	$ 242.13
(3)	Target Change in Average Premium	3.25%
(4)	Proposed Average Premium	$ 250.00
(5)	Proposed Additive Premium (same as Current)	$ 25.00
(6)	Average Rating Differential Adjustment	0.9989
(7)	Proposed Base Rate Adjustment	1.0374
(8)	Proposed Base Rate	$ 217.85

(4)= (1.0 + (3)) x (2)
(7)= [(4) - (5)] / [(2) - (5)] x [1.0 / (6)]
(8)= (1) x (7)

Other Considerations

Minimum Premium

Some rating algorithms have a minimum premium requirement. The minimum premium requirement is intended to ensure that, on an individual risk basis, premium covers the expected fixed expenses plus some minimum expected loss, as determined by the company. In most cases, companies that use a minimum premium requirement do not have additive fixed expense fees in their rating algorithms. Implementation of a minimum premium requirement can effectively increase total premium. The effect is calculated as follows:

$$\text{Effect} = \frac{\text{Premium With Minimum}}{\text{Premium Without Minimum}} - 1.0.$$

To offset this increase in premium, the otherwise applicable base rate should be multiplied by the following factor:

$$\text{Offset Factor} = \frac{1.0}{1.0 + \text{Effect}}.$$

Limiting the Premium Effect of a Single Variable

In practice, actuaries may decide to limit the premium impact caused by the change in rate differentials for a single rating variable. For example, the actuary may perform a territorial analysis and determine a set of proposed relativities. After taking into account other business considerations (e.g., marketing) as discussed in Chapter 13, the actuary may decide to limit or "cap" the premium impact on any one territory by adjusting the proposed relativities. If the actuary caps the proposed relativity for any one territory, this will reduce the proposed average rate differential across all territories, which will necessitate an offsetting increase in the proposed base rate in order to achieve the target average premium. The extent of the increase will depend on the magnitude of the capping and the number of insureds affected by the cap.

The following example outlines a rate change scenario in which the insurer is targeting an overall rate level change of 15.0%. As part of the rate change, the insurer is revising relativities for a particular rating variable, and management requires that the premium increase for any level of this variable not exceed 20%.

Table 14.10 shows the current and selected relativities (prior to capping) in Columns (3) and (4). These relativity changes would result in an off-balance factor of 0.9749 (= 1 / (1 + 2.57%)). (For simplicity, the example assumes that there is no additive premium.) The total change to each level is the product of the relativity change factor, the off-balance factor, and the target overall change factor, as displayed in Column (8).

14.10 Rate Change Before Capping

(1) Level	(2) Premium	(3) Current	(4) Selected	(5) Relativity Change	(6) Off-Balance Factor	(7) Selected Overall Change	(8) Total Change	(9) Premium on Proposed Rates
1	$ 138,000	0.8000	0.9000	12.50%	0.9749	15.00%	26.13%	$ 174,059
2	$ 659,000	1.0000	1.0000	0.00%	0.9749	15.00%	12.11%	$ 738,805
3	$ 203,000	1.2000	1.2500	4.17%	0.9749	15.00%	16.79%	$ 237,084
Total	$ 1,000,000			2.57%	0.9749	15.00%	14.99%	$ 1,149,948

(5)= (4) / (3) - 1.0
(Tot5)= (5) weighted by (2)
(6)= 1.0 / (1.0 + (Tot5))
(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0
(9)= (2) x (1.0 + (8))

The total change for Level 1 is 26.13%, which exceeds the desired maximum change of 20.0%. The new capped relativity for Level 1 (refer to this as *X*) is determined such that the product of the relativity change factor (new capped relativity for Level 1 / current relativity for Level 1 = *X* / 0.8000), the off-balance factor (0.9749), and the overall change factor (1.1500) results in a 20% total change. The new capped relativity for Level 1 (*X*) that satisfies this equation is 0.8563.

If the total change for Level 1 were limited to 20.0%, the premium achieved would be $165,600 (=$138,000 x 1.20). This presents a shortfall of $8,459 (=$174,059 - $165,600) which will need to be made up by charging the other levels (Levels 2 and 3) higher premium. The premium proposed for Levels 2 and 3 is $975,889 (= $738,805 + $237,084). This premium must be increased to cover the $8,459 shortfall. One way to achieve this is to increase the base rate by 0.87% (=$8,459 / $975,889).

Since all levels are affected by any base rate change, one problem remains. If the base rate is being increased by 0.87%, this means the premium for capped Level 1 will increase beyond the desired 20% limit. Therefore, the capped relativity for Level 1 must be further reduced by 0.87% to essentially undo the effect of the base rate increase on this level. This adjustment results in a relativity for Level 1 of 0.8489 (= 0.8563 / 1.0087).

Table 14.11 summarizes these calculations.

14.11 Rate Change After Capping Non-Base Level at 20%

(1) Level	(2) Premium	(3) Current	(4) Selected	(5) Relativity Change	(6) Off-Balance Factor	(7) Selected Overall Change	(8) Total Change	(9) Premium Shortfall if Total Change Capped to 20%
1	$ 138,000	0.8000	0.9000	12.50%	0.9749	15.00%	26.13%	$ 8,459
2	$ 659,000	1.0000	1.0000	0.00%	0.9749	15.00%	12.11%	$ -
3	$ 203,000	1.2000	1.2500	4.17%	0.9749	15.00%	16.79%	$ -
Total	$ 1,000,000			2.57%	0.9749	15.00%	14.99%	$ 8,459

(10)	**Proposed Premium from Non-capped Levels (2, 3)**	$ 975,889
(11)	**Proposed Level 1 Relativity to Comply with Cap**	0.8563
(12)	**Base Rate Adjustment to Cover Shortfall**	1.0087
(13)	**Proposed Level 1 Relativity Further Adjusted for Base Rate Offset**	0.8489

(5)= (4) / (3) - 1.0
(Tot5)= (5) weighted by (2)
(6)= 1.0 / (1.0 + (Tot5))
(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0
(9)= max of [(2) x ((1.0 + (8))] - [(2) x (1.0 + 20%)] and 0
(10)= (2) x (1+(8)) summed over Levels 2 and 3
(11)= [(1.0 + 20%) / ((6$_{\text{Row 1}}$) x (1.0 + (7$_{\text{Row 1}}$))] x (3$_{\text{Row 1}}$)
(12)= 1.0 + (Tot9) / (10)
(13)= (11) / (12)

The final base rate offset factor would be the original off-balance factor (0.9749) times the base rate adjustment to cover the premium shortfall from capping (1.0087). The revision to the Level 1 relativity achieves the 20% desired cap, and the adjustment to the base rate ensures the overall change is still 15.0%.

The calculations are a little different if capping is necessary for the base class. Table 14.12 shows a rate change scenario (with the same selected overall change and same premium capping requirement) in which the base class exceeds the premium cap.

14.12 Rate Change Before Capping Base Level Impact

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Level	Premium	Current	Selected	Differential Change	Off-balance Factor	Selected Overall Change	Total Change	Premium on Proposed Rates
1	$ 138,000	0.8000	0.6500	-18.75%	1.0541	15.00%	-1.51%	$ 135,916
2	$ 659,000	1.0000	1.0000	0.00%	1.0541	15.00%	21.22%	$ 798,840
3	$ 203,000	1.2000	1.0500	-12.50%	1.0541	15.00%	6.07%	$ 215,322
Total	$ 1,000,000			-5.13%	1.0541	15.00%	15.01%	$ 1,150,078

(5)= (4) / (3) - 1.0
(Tot5)= (5) weighted by (2)
(6)= 1.0 / (1.0 + (Tot5))
(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0
(9)= (2) x (1.0 + (8))

In this case, the base rate is adjusted downward to cap the change for the base level. The non-base relativities are adjusted upward to cover the amount of premium shortfall due to the cap and to offset the effect of the base rate change in the non-base levels. This is explained in detail below.

In order to limit the total change for Level 2 to 20.0%, the base rate is decreased by applying a factor of 0.9899 (= 1.2000 / 1.2122). This results in a shortfall in Level 2 premium of $8,040 (= (21.22% - 20.00%) x $659,000). The premium collected from the non-base levels need to make up for that shortfall. Prior to capping, the premiums from Levels 1 and 3 was $351,238 (=135,916 + 215,322). The relativities for these levels need to increase by 2.29% (=$8,040 / $351,238). Furthermore, the relativities for Level 1 and Level 3 need to be adjusted to negate the effect of the base rate offset. This means the final adjustment factor for these levels' relativities is 1.0333 (=1.0229 / 0.9899).

Table 14.13 summarizes these calculations.

14.13 Rate Change After Capping Base Level at 20%

(1) Level	(2) Premium	(3) Current	(4) Selected	(5) Relativity Change	(6) Off-Balance Factor	(7) Selected Overall Change	(8) Total Change	(9) Premium Shortfall if Total Change Capped to 20%
1	$ 138,000	0.8000	0.6500	-18.75%	1.0541	15.00%	-1.51%	
2	$ 659,000	1.0000	1.0000	0.00%	1.0541	15.00%	21.22%	$ 8,040
3	$ 203,000	1.2000	1.0500	-12.50%	1.0541	15.00%	6.07%	$ -
Total	$ 1,000,000			-5.13%	1.0541	15.00%	15.00%	$ 8,040

(10)	**Base Rate Adjustment to Comply with Cap**	0.9899
(11)	**Premium from Non-capped Levels (1, 3)**	$ 351,238
(12)	**Adjustment to Level 1, 3 Relativities due to Cap**	1.0229
(13)	**Total Adjustment to Level 1, 3 Relativities**	1.0333

(5)= (4) / (3) - 1.0
(Tot5)= (5) weighted by (2)
(6)= 1.0 / (1.0 + (Tot5))
(8)= [1.0 + (5)] x (6) x [1.0 + (7)] - 1.0
(9)= max of [(2) x ((1.0 + (8))] - [(2) x (1.0 + 20%)] and 0
(10)= (1.0 + 20.0%) / (1.0 + ($8_{\text{Row 2}}$))
(11)= (2) x (1+(8)) summed over Levels 1 and 3
(12)= 1.0 + (9) / (11)
(13)= (12) / (10)

Thus, the revised Level 1 differential is 0.6716 (= 0.6500 x 1.0333) and the Level 3 differential is 1.0850 (=1.0500 x 1.0333). The final base rate offset factor would be the original off-balance factor (1.0541) times the base rate adjustment to comply with the cap (0.9899). These changes result in a 15.0% overall change with no level's premium exceeding the 20.0% limit.

Premium Transition Rules

The last section dealt with capping the rate differential change for any one rating variable. Even if caps are used to minimize this effect, the impact on an individual insured's premium can still be quite large if the proposed rate change includes changes to several rating variables. In other words, even if the change for any one rating variable is small, the cumulative effect of the changes to all of the rating variables may be significant.

The company may wish to mitigate the premium impact for any single insured to reduce the probability that the insured shops for a better deal. In addition, a regulation or law may limit the increase an insurance company may offer a renewing insured. The company can try to alter the proposed rates such that no insured's renewal increase exceeds the limit, but that may be practically impossible if the change includes changes to multiple rating variables. Consequently, the company may choose to pursue a premium transition rule.

A premium transition rule dictates the maximum and/or minimum amount of change in premium that an insured can receive at a single renewal. For example, a company may decide to cap the renewal premium increase for each individual insured to 15%. If the company's rate change results in an insured receiving a 20% premium increase, the insured will receive a 15% rate change at the first renewal following the implementation of the rate change, and the remaining 4.3% (= 1.20 / 1.15 - 1.0) at the second renewal.

The following are some key considerations when using a premium transition rule:

- The company needs to determine the maximum and minimum premium change amounts. As discussed in Chapter 13, the company can test various scenarios of minimum and maximum amounts, to determine the optimal selections.
- Typically premium transition rules apply only to premium changes directly resulting from company initiated rate changes. If premium change is affected by a change in risk characteristics (e.g., the insured buys a newer car), the transition rule algorithm must be adjusted to neutralize the effect of the risk characteristics change. For example, the premium change may be calculated as the ratio of new premium on new risk characteristics to old premium on new risk characteristics.
- The length of time necessary to fully transition the renewal portfolio to the manual rates depends on the extent of the proposed rate change and the premium transition rule implemented. The company should try to avoid long transition periods in order to minimize the chances of multiple overlapping transition periods created by multiple rate changes.
- The effect on the average premium level should also be considered and the base rate altered accordingly. The actuary must decide whether the base rate should be set so that the equilibrium is achieved over the whole time the proposed rates are in effect, or by the expected end of the transition period. In other words, if the company is targeting an average premium of $250 and using a premium transition rule that is expected to span two years, then the company needs to decide whether the base rate should be set so that average premium will equal $250 over the two years combined or at the end of the two-year period. If the cap applies equally to premium increases and decreases, and the rate changes are uniformly distributed, this is not an issue. However, that is not normally the case.

Expected Distribution

Whether using extension of exposures or the approximated average rate differential methods to derive base rates, the actuary makes an assumption about the distribution expected during the period the rates will be in effect. Normally, actuaries use the latest in-force distribution as the best estimate of the expected future distribution. If the company intends to non-renew certain policies, this distribution can be adjusted accordingly.

By using the latest in-force distribution to measure the proposed average premium or the proposed average rate differential across all rating variables, the actuary assumes the rate change will not alter the existing portfolio. The validity of that assumption may vary significantly based on the product, market conditions, and the extent of the proposed changes. For example, a small change that applies uniformly to all homeowners insureds will probably have very little impact on the overall distribution. In this case, the actual average premium change will be close to that estimated using the latest in-force distribution. On the other hand, a non-standard auto insurer implementing a significant rate change that varies widely by age of insured may see a significant change in the overall volume and distribution of business (i.e., insureds receiving large rate changes may non-renew their policies). In this case, the actual average premium change realized may be different than proposed using the latest in-force distribution. If all risks are equally profitable, then loss of premium will be offset by a corresponding loss in expected costs, and the overall rate level adequacy will be unaffected. If the risks are not equally profitable, however, then the distributional shift can affect the adequacy of the overall rates.

This is a shortcoming of the standard actuarial techniques. Price optimization techniques, as discussed in Chapter 13, address this issue by taking into consideration how the rate change is expected to affect demand (i.e., volume).

CALCULATING NEW RATES BASED ON BUREAU OR COMPETITOR RATES

Companies writing a brand new insurance product generally do not have the data necessary to project the individual components of the fundamental insurance equation. Consequently, these companies generally rely on information from their other similar products, similar products sold by competitors (if information is publicly available), or information from rating bureaus, and make adjustments accordingly.

If the company has data from a related product or rating bureau, then the pricing actuary may be able to calculate the rates directly using the techniques described under the pure premium approach. The more likely scenario is that the company must use the rates of a competitor or rating bureau as a guide. This requires a copy of the relevant rating manual or rating bureau filing. Even if a competitor's rating manual is publicly available, the underwriting guidelines may not be. To the extent that the competitor varies premium significantly based on underwriting criteria, the rating manual may not describe how these criteria affect the premium. In such cases, the company will need to use judgment to supplement the competitor information.

In addition to the competitor's rating manual, the company should try to obtain information regarding the relative expense levels and profitability of the target competitor. This information can normally be obtained from recent rate filings or from annual statement data. The company can use this information to better estimate the profit expected if it copies the competitor's rates. Since there will be differences in the way the companies operate as well as differences in the distribution of the portfolios, copying a competitor's rates exactly will not guarantee the same results for the company introducing the new product. The company should use judgment to determine a range of outcomes with respect to how much better or worse it expects profit for the new product to be based on the assessment of the company's situation compared to the competitor's situation.

Depending on the situation, the company may simply use the competitor's manual as a starting point and make adjustments based on known or suspected differences. The following are a few examples of potential adjustments.

First, the company may estimate its fixed expenses will be higher or lower than those of the target competitor. In such a case, the company can simply increase or decrease the competitor's expense fee by the appropriate percentage. For example, assume the company estimates its fixed expenses will be 10% lower than the competitor's. If the competitor has an expense fee of $25.00, then the company should implement an expense fee of $22.50, which is equivalent to the target competitor's fee of $25 multiplied by a factor of 0.90 (= 1.0 - 0.10).

Second, the company may estimate its variable expenses will be higher or lower than those of the target competitor. In such a case, the company can adjust the base rate and the expense fee by the ratio of the target competitor's variable permissible loss ratio to the expected variable permissible loss ratio. For example, assume the company plans to use a commission percentage that is 5 percentage points higher than the competitor's but all other variable expenses are expected to be the same. Assuming that the competitor's variable expense ratio is 15% and the target profit percentage for both companies is 5%, then the company should adjust the target competitor's base rate and expense fees by a factor of 1.067 [= (1.0- 0.15 - 0.05) / (1.0 - 0.20 - 0.05)].

Third, the company may believe its expected loss costs will be different than the target competitor's due to operational differences or a lack of experience with the product. In such cases, the company should judgmentally change the base rate to account for the anticipated difference. For example, the company may feel its lack of experience in settling claims for the new product will result in expected costs that are 5% to 10% higher than those of the target competitor's. The company should increase the base rates by 5% to 10% to account for this.

Fourth, the company may want to target a certain segment of the market that the competitor does not seem to be targeting. In such a case, the company may adjust the rate differentials accordingly. For example, if the company aims to write a significant amount of new business in a certain territory, then it may choose to reduce the rate differential in that territory. If any adjustments are made, then the company can adjust the base rate to offset the change in the average territorial differential.

COMMUNICATING AND MONITORING

Prior to implementing a final set of rates, the ratemaking actuary typically communicates the expected rate change effect to key stakeholders such as regulators and company management.

If the proposed rates apply to a brand new product for new insureds, then communication to regulators may be limited to the source of the derivation of rates (e.g., competitor or bureau rates) and some justification for any judgmental adjustments made. Internal decision-makers will likely want to understand the expected profitability and how the proposed rates position the company in the competitive marketplace.

On the other hand, if the company is implementing rate changes that will impact existing policies, then the communications to key stakeholders may be more extensive. Internal management may want to understand some of the assumptions and selections involved in the overall rate level indication or rate differential changes, but more importantly, they will want to understand the impact on competitive position, expected volume, and expected profitability. As discussed in detail in Chapter 13, the actuary will typically prepare competitive comparisons (e.g., percent wins) under the current and final proposed rates, as well as policyholder dislocation analysis for company management (in total as well as by key segments).[51] This information is useful for the marketing, sales, and customer service functions to prepare for any potential repercussions of large policyholder premium impacts or, on the positive side, to focus advertising on customer segments that will be priced more competitively.

[51] Ideally company management will have seen such analysis prior to the rates being considered final. This analysis is merely confirming the effect of the final proposed set of rates.

In addition, some companies use models to estimate the conversion and retention rates (per individual risk and in aggregate) expected after implementation of a rate change. Once individual risk conversion and retention rates are estimated, models and assumptions can be used to estimate future expected loss costs, premium, and expenses on these risks. This allows calculation of expected profitability after the rate change. This information aids in business forecasting.

Depending on the jurisdiction, regulators may require considerable detail about the methods and assumptions underlying the overall rate level and rate differential indications and selections. Moreover, they too may want to understand the expected policyholder dislocation.

In addition to communicating the effect of the rate change, it is important for the ratemaking actuary to establish a strategy to monitor the actual effect of the rate change against the expected effect. This may involve comparing actual and expected close rates, retention rates, distributions, and claim frequencies against those expected. The comparison allows quick identification of any strong differences, and allows the company to investigate the potential source of any differences and act accordingly.

SUMMARY

Preceding chapters explained how to calculate actuarial indications and discussed reasons that companies may implement something other than what was indicated. If the actuarial analysis indicates that a product has an inadequate rate level, the company can respond with non-pricing solutions (e.g., reduce expected expenses or expected losses) or it can implement a rate change. Much of this chapter focused on rate change solutions, and in particular derivation of the base rate. Two approaches for derivation of the base rate were outlined: extension of exposures and an approximation of the average rate differential across all rating variables.

This chapter also discussed options for calculating rates for a new product. The company actuary typically obtains raw data or rate information on related products (from the same company or a competitor) or from a rating bureau, and adjusts judgmentally.

Finally, the actuary's role in communicating the rate change effect to internal and external stakeholders was discussed, as well as the importance of establishing a strategy to monitor the actual rate change effect as compared to what was expected.

KEY CONCEPTS IN CHAPTER 14

1. Non-pricing solutions to an imbalanced fundamental insurance equation
   a. Reduce expenses
   b. Reduce loss costs

2. Pricing solutions for an existing product
   a. Calculation of additive fixed expense fee and other additive premium
   b. Derivation of base rate
      i. Extension of exposures method
      ii. Approximated average rate differentials method
      iii. Approximated change in average rate differentials method
   c. Other considerations
      i. No fixed expense fees or additive premium
      ii. Minimum premium
      iii. Limit on the premium effect of a single variable
      iv. Premium transition rules
      v. Expected distribution

3. Pricing solutions for a new product
   a. Use of related data, competitor's rates, or bureau rates
   b. Consideration of differences in expected loss, expense, and target segments

4. Communicating rate change effect to key stakeholders
   a. New product
   b. Existing product

CHAPTER 15: COMMERCIAL LINES RATING MECHANISMS

Most of the text thus far has concentrated on manual ratemaking—in other words, determining what rate should be charged average members of homogeneous groups based on similar risk characteristics. For many commercial insurance products, the creation of homogenous groups for ratemaking purposes is not feasible, and without adjustment, individual risk experience can be expected to vary widely around the average group rate. In addition, some commercial risks are sufficiently large that their historical experience can be used in whole or in part to derive an individual rate. Consequently, commercial lines ratemaking employs special techniques that address the heterogeneity and credibility of commercial risks.

This chapter covers the following topics:

- Manual rate modification mechanisms: experience rating and schedule rating
- Rating techniques for large commercial risks: large deductible plans, loss-rated composite rating, and retrospective rating plans

Commercial risks may be subject to one or many of these rating mechanisms.

Examples of each type of rating mechanism are provided.

MANUAL RATE MODIFICATION TECHNIQUES

Manual rate modification techniques rely on past experience and/or risk characteristics not adequately reflected in the manual rate or the past experience. There are two basic types of manual rate modification techniques: experience rating and schedule rating.

Experience Rating

Experience rating is used when an individual insured's past experience, with appropriate adjustments, is determined to be predictive of the future experience. This determination is reflected in eligibility criteria, typically based on size of manual premium. The experience rating adjustment for the future policy period manual premium is equal to a credibility weighting of the adjusted past experience (often referred to as the "experience" component) and some expected results (referred to as the "expected" component). Techniques to derive credibility measures as well as various options to develop the complement of credibility are discussed in Chapter 12.

The experience component and the expected component should be defined consistently. For example, ALAE should be included in the experience component if it was included in the expected component.

The comparison of the experience and expected components can be performed in many different ways:

- Actual paid loss (and ALAE) compared to expected paid loss (and ALAE) for the experience period as of a particular date
- Actual reported loss (and ALAE) compared to expected reported loss (and ALAE) for the experience period as of a particular date
- Projected ultimate loss (and ALAE) compared to expected ultimate loss (and ALAE) for the experience period
- Projected ultimate loss (and ALAE) for the experience period that has been adjusted to current exposure and dollar levels compared to expected ultimate loss (and ALAE) based upon the current exposure and dollar levels

Following is a discussion of the key components of the experience rating formula, including necessary adjustments to each.

Experience Component

First, the ratemaking actuary must determine the length of the historical experience period to be used in the experience rating formula. The experience period usually ranges from two to five policy years, ending with the last complete year. A shorter experience period is more responsive to changes, but more subject to large fluctuations, due to its relative loss immaturity and the reduced aggregate exposure of the shorter period. Conversely, a longer experience period is less responsive to changes but less subject to large fluctuations in the experience.

Second, the historical experience may need to be adjusted for extraordinary losses. Many experience rating plans apply per occurrence caps on the losses in order to exclude unusual or catastrophic losses. This is often referred to as the maximum single limit per occurrence or MSL. The caps could apply to losses only, or could apply to loss and ALAE. If the actual losses are subject to a per occurrence cap, then the expected losses need to be on the same basis. In addition, caps may be applied to the aggregate of all losses in the policy period.

If the experience modification is based on projected ultimate losses, then historical losses and ALAE (assuming that ALAE is included) for each year in the experience period need to be developed to an ultimate level. This is commonly done by applying loss development factors to either paid or reported losses and ALAE (discussed in detail in Chapter 6). The expected losses, to which the projected ultimate losses will be compared, also need to reflect an ultimate level. If capped losses are used, then the loss development factors applied should be developed from data that has also been capped.

Further adjustments to the historical losses are needed if the basis of the experience rating formula is projected ultimate losses at current exposure and dollar levels (i.e., the fourth method of comparison listed above). The adjustments should reflect economic and social inflation (e.g., changes in judicial decisions or litigiousness) as well as changes in risk characteristics (e.g., size and type of entity) and changes in policy limits. First, historical losses are developed to ultimate, trended to current cost levels, and summed across the years. This figure is then compared to the sum of historical exposures by year. If the exposure base is sensitive to inflation (e.g., payroll), the historical exposures should be trended to current levels and then summed. The ratio of trended ultimate losses to exposures at current level is then multiplied by a current exposure measure. Following is an illustration of this calculation:

15.1 Trended Projected Ultimate Losses & ALAE at Current Exposure Level

	(1)	(2)	(3)	(4)	(5)
Policy Year	Trended Ultimate Losses & ALAE	Exposures	Pure Premium	Current Exposures	Projected Ultimate Losses & ALAE @ Current Exposures
2006	$ 2,568,325	688			
2007	$ 1,954,725	564			
2008	$ 1,465,741	414			
Total	$ 5,988,791	1,666	$ 3,594.71	400	$ 1,437,885

(3) = (Tot1) / (Tot2)
(4) = Number of Vehicles Currently Insured
(5) = (Tot3) x (Tot4)

Expected Component

As mentioned above, the expected component should relate to the experience component. This includes not only such items as inclusion of ALAE, but also whether the past or current exposure is considered. For the four comparison combinations listed above, the first three consider past exposure and the fourth considers current exposure.

Expected losses are usually estimated as the product of an expected loss rate and an exposure measure. The expected loss rate is the expected loss cost reflected in the manual rates; moreover, it can reflect either the prior or current period. If the loss rates are needed for a prior period, the expected loss rate can be based on the manual rates for the prior period or based on manual rates for the current period, adjusted to the appropriate dollar level (i.e., de-trended). If the two sets of manual rates are considerably different, the actuary should understand the reason and assess which approach is appropriate for the situation.

Other Considerations

The experience rating modification factor (or experience "mod") may be subjected to maximum or minimum changes. Another consideration in the application of experience rating is when the total premium under the experience rating plan does not equal the total expected premium. The necessary adjustment, often referred to as off-balance correction, is discussed in detail in Chapter 14.

Example Experience Rating Plan – Commercial General Liability

The following example is a simplified version of the experience rating portion of the 1997 Insurance Services Office (ISO) Commercial General Liability Experience and Schedule Rating Plan. References to "company" indicate the insurance company using the experience rating plan. Each insurance company may have different premium and expense assumptions for the same exposures.

The formula for computing the experience rating debit/credit is:

$$\mathrm{CD} = \frac{(\mathrm{AER} - \mathrm{EER})}{\mathrm{EER}} \times Z,$$

where

CD	= Credit/debit percentage
AER	= Actual experience ratio (i.e., the experience component)
EER	= Expected experience ratio (i.e., the expected or exposure component)
Z	= Credibility

The following information is pertinent to the example:

- The policy being experience rated is an occurrence policy with an annual term, and the effective date is July 1, 2010.
- The experience period consists of the last three completed policies effective July 1 to June 30 (i.e. annual policies originating in July 2006, 2007, and 2008), evaluated at March 31, 2010.
- Losses are capped at basic limits, and allocated loss adjustment expenses (ALAE) are unlimited.
- A maximum single limit per occurrence (MSL) is applied to the basic limits losses and unlimited ALAE combined.
- The credibility of the company is 0.44.
- The expected experience ratio is 0.888.

Table 15.2 shows the basic calculation of the experience rating debit/credit. Table 15.3 supports the derivation of certain inputs to Table 15.2.

The actual experience is represented by the projected ultimate losses and ALAE for the three-year experience period, which consists of the reported losses and ALAE as of March 31, 2010, [given as 1(a) in Table 15.2] and the expected unreported losses and ALAE at March 31, 2010 (derived in column 8 of Table 15.3). For both the reported and unreported losses and ALAE, losses are capped at basic limits and a maximum single limit per occurrence (MSL) is applied to the basic limited losses and ALAE combined. The company subject basic limit loss and ALAE costs [1(d) in Table 15.2] represent the expected loss and ALAE underlying the current rating manual rates adjusted to the dollar level of the experience period. The adjustment to the dollar level of the experience period is shown in Table 15.3.

The actual experience ratio (AER) is the projected ultimate losses and ALAE (at basic limits and limited by the MSL) divided by the company subject basic limits loss and unlimited ALAE costs. This is a measure of how the company's actual loss experience subject to the experience rating plan limitations was relative to the expected loss experience represented in the current manual rates.

The expected experience ratio (EER) is essentially the complement of an expected deviation of the company's loss costs in the experience rating plan from the loss costs underlying the manual rate. In this example, the deviation is caused by application of the MSL in the experience rating plan.

The experience rating credit/debit is calculated as a credibility weighting of the AER and the EER according to the formula provided earlier:

$$CD = \frac{(\text{AER - EER})}{\text{EER}} \times Z.$$

An experience credit results in a reduction in premium and an experience debit results in an increase in premium. In the example below, the experience debit would result in a 10.7% increase in premium. This particular plan example does not have any minimums, maximums, or an explicit off-balance correction.

15.2 Experience Credit/Debit Calculation

(1)	Experience Components			
	(a)	Reported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL	$	141,500
	(b)	Expected Unreported Losses and ALAE at 3/31/10 Limited by Basic Limits and MSL	$	58,762
	(c)	Projected Ultimate Losses and ALAE Limited by Basic Limits and MSL	$	200,262
	(d)	Company Subject Basic Limit Loss and ALAE Costs	$	181,366
	(e)	Actual Experience Ratio		1.104
(2)	Expected Experience Ratio			0.888
(3)	Credibility			0.44
(4)	Experience (Credit)/Debit			10.7%

(1a)= given
(1b)= Table 15.3
(1c)= (1a) + (1b)
(1d)= Table 15.3
(1e)= (1c) / (1d)
(2), (3)= Given
(4)= [((1e) - (2)) / (2)] x (3)

Table 15.3 shows the derivation of two elements in Table 15.2: the company subject basic limits loss and unlimited ALAE costs and the expected unreported losses and ALAE.

15.3 Calculation of Expected Unreported Losses and ALAE and Subject Loss Costs

(1) Policy Period	(2) Coverage	(3) Current Company B/L Loss & ALAE Costs	(4) Detrend Factors	(5) Company Subject B/L Loss & ALAE Costs	(6) Expected Experience Ratio	(7) Expected Percentage B/L Losses & ALAE Unreported at 3/31/10	(8) Expected B/L Losses & ALAE Unreported at 3/31/10
7/1/06-07	Prem/Ops	$ 51,675	0.804	$ 41,547	0.888	0.192	$ 7,084
	Products	$ 18,850	0.839	$ 15,815	0.888	0.426	$ 5,983
7/1/07-08	Prem/Ops	$ 51,675	0.849	$ 43,872	0.888	0.300	$ 11,688
	Products	$ 18,850	0.876	$ 16,513	0.888	0.545	$ 7,992
7/1/08-09	Prem/Ops	$ 51,675	0.897	$ 46,352	0.888	0.394	$ 16,217
	Products	$ 18,850	0.916	$ 17,267	0.888	0.639	$ 9,798
Total				$ 181,366			$ 58,762

(4)= the reciprocal of the loss and ALAE trend.
(5)= (3) x (4)
(6), (7)= given
(8)= (5) x (6) x (7)

The company subject basic limits losses and unlimited ALAE costs (column 5 above) are the product of:

- the current company basic limits loss and ALAE costs (i.e., the loss costs underlying the current manual rates) and
- the detrend factors, which bring current company basic limits loss and ALAE to the average accident date of each of the policy periods in the experience period, using the loss and ALAE trend underlying the current rates.

  The detrend factor for each policy period in the experience period is the reciprocal of the loss and ALAE trend factor. Chapter 6 explained that the purpose of the trend factor is to project historical losses to a future period. The purpose of the detrend factor is to adjust the current loss costs to a historical experience period. For example, the average accident date of the prospective policy period is January 1, 2011. For the policy period beginning July 1, 2008, the length of the detrend period is two years (the length of time between January 1, 2011, and January 1, 2009). For a loss trend of 4.5%, the detrend factor for the 2008 policy period is the reciprocal of the trend plus 1.0, raised to the length of the detrend period [$=0.916 = (1/1.045)^2$].

The expected basic limits losses and ALAE unreported at March 31, 2010, (column 8 above) are the product of the following:

- The company subject basic limits losses and ALAE
- The expected experience ratio (EER)
- The expected percentage basic limits losses and ALAE unreported at March 31, 2010 (note that these are derived from a separate analysis).

Example Experience Rating Plan – Workers Compensation

The majority of U.S. state insurance departments designate The National Council on Compensation Insurance (NCCI) as the licensed rating and statistical organization of workers compensation insurance. The NCCI Experience Rating Plan has unique features that divide losses into primary and excess components. Consider the generic formula, where primary and excess losses are credibility weighted separately:

$$M = \frac{Z_P \times A_P + (1.0 - Z_P) \times E_P + Z_e \times A_e + (1.0 - Z_e) \times E_e}{E},$$

where
M = Experience Modification Factor
A_p = Actual Primary Losses
A_e = Actual Excess Losses
E_p = Expected Primary Losses
E_e = Expected Excess Losses
$E = E_p + E_e$
Z_p = Primary Credibility
Z_e = Excess Credibility

Although algebraically equivalent, the NCCI uses an alternative expression of this formula by substitution of some terms, which is shown below.

$$M = \frac{A_P + w \times A_e + (1.0 - w) \times E_e + B}{E + B},$$

where
B = Ballast Value, which is based on: $Z_p = E / (E + B)$
w = Weighting Value = Z_e / Z_p.

The primary and excess credibility factors are not expressed directly in the NCCI's formula above. The primary credibility factor is a function of the ballast value (B). The excess credibility factor is a function of both the ballast value (B) and the weighting value for excess losses (w). The ballast value and weighting value are obtained from a table based upon the policy's expected losses and both values increase as expected losses increase. Further detail on the derivation of the NCCI formula is beyond the scope of this text.

The experience period consists of the three most recent complete policy years. The actual losses are the reported losses evaluated at 18 months, 30 months, and 42 months from the beginning of the most recent, second most recent and third most recent policy years, respectively. The actual primary losses are capped at $5,000 per loss.

The expected losses are the actual payroll (in hundreds) by class for the experience period multiplied by the expected loss rates by class for the prospective period. The expected loss rates reflect the losses expected to be reported at the respective evaluations of the experience period policies (18, 30, and 42 months). The expected primary losses are the expected losses multiplied by a D-ratio, which is the loss elimination ratio at the primary loss limit (determined using the same loss elimination ratio techniques described in Chapter 11).

Following is a sample calculation of the NCCI experience modification factor. In this example, the effective date of the policy being rated is September 1, 2010, and the policy is comprised of only one class code. Table 15.4 lists the actual losses from the last three complete policy years. The losses are separated into primary and excess components. The primary losses are capped at $5,000 and the excess losses are calculated as the portion of each individual loss above $5,000.

15.4 Actual Losses as of 3/31/10

Policy Year	Claim #	(1) Reported Losses	(2) Primary Losses	(3) Excess Losses
9/1/06-07	1	$15,000	$5,000	$10,000
	2	$100,000	$5,000	$95,000
	3	$25,000	$5,000	$20,000
9/1/07-08	1	$45,000	$5,000	$40,000
	2	$50,000	$5,000	$45,000
	3	$10,000	$5,000	$5,000
9/1/08-09	1	$20,000	$5,000	$15,000
	2	$55,000	$5,000	$50,000
Total		$320,000	$40,000	$280,000

(2) = Minimum [(1), $5,000]
(3) = (1) - (2)

Table 15.5 shows the calculation of expected losses based upon payroll and the expected loss rate,[52] which reflects the expected loss as of the policy's evaluation date. The expected losses are separated into the primary and excess components based upon a *D*-ratio.

15.5 Expected Losses

Policy Year	(1) Payroll	(2) Expected Loss Rate	(3) Expected Losses	(4) D-Ratio	(5) Expected Primary Losses	(6) Expected Excess Losses
9/1/06-07	$ 1,956,000	3.52	$ 68,851	0.24	$ 16,524	$ 52,327
9/1/07-08	$ 2,128,000	3.52	$ 74,906	0.24	$ 17,977	$ 56,929
9/1/08-09	$ 2,317,000	3.52	$ 81,558	0.24	$ 19,574	$ 61,984
Total	$ 6,401,000		$ 225,315		$ 54,075	$ 171,240

(3) = [(1) / $100] x (2)
(5) = (3) x (4)
(6) = (3) - (5)

[52] For illustrative simplicity, this example assumes the employer has only one class code in the state; hence, there is only one expected loss rate and one D-Ratio. A typical employer would have payrolls assigned to more than one class code.

Assuming a ballast value (B) of \$30,000 and a weighting value (w) of 0.25, the experience rating modification factor is calculated as follows:

$$M = \frac{\$40{,}000 + [0.25 \times \$280{,}000] + [(1.0 - 0.25) \times \$171{,}240] + \$30{,}000}{\$54{,}075 + \$171{,}240 + \$30{,}000} = 1.051.$$

This experience modification factor, 1.051, would be applied multiplicatively to the policy's manual premium.

Schedule Rating

Schedule rating is another mechanism for modifying the manual rate in commercial lines pricing. Schedule rating is used to alter manual rates to reflect characteristics that are expected to have a material effect on the insured's future loss experience but that are not actually reflected in the manual rate, or (if experience rating applies) not adequately reflected in the prior experience. For example, if a company implements a new loss control program, the expectation is that the expected losses will be lower than that indicated by the actual historical experience; consequently, an underwriter can use schedule rating to reflect this.

Schedule rating is typically applied in the form of percentage credits (reductions) and debits (increases) to the manual rate. The characteristics can be objective (e.g., the number of years a physician has been licensed) or subjective (e.g., quality of company management). Objective characteristics are generally easier to quantify and validate. However, schedule rating often requires significant underwriting judgment. In general, state insurance laws and regulations require that the filed schedule rating guidelines are applied consistently, and documentation is often required to support the application of each credit and debit.

If experience rating is used in addition to schedule rating, then it is important to recognize that a new characteristic (e.g., a newly implemented safety program) reflected in the schedule rating adjustment will eventually be reflected in the loss experience. The key is for the underwriter to avoid double-counting the effect of a risk characteristic in both the experience modification and schedule rating.

Schedule credits and debits are typically subject to an overall maximum modification.

Example Schedule Rating Plan

The following example illustrates a schedule rating plan for workers compensation and employers liability. In this plan, the underwriter has some discretion in applying the credits or debits. There are five categories for which an insured can be eligible for a schedule credit or debit with minimums and maximums specific to each category. Overall maximum credit or debit also applies.

15.6 Schedule Rating Worksheet

Category	Available Range of Modification (Credit to Debit)	Credit Applied	Debit Applied	Reason / Basis
Premises - General Housekeeping - Preventative Maintenance - Workplace Design - Physical Condition	-10% to +10%			
Classification - Exposures not contemplated in class - Hazards peculiar to a classification have been eliminated - Exposure variation due to technology	-15% to +15%			
Medical Facilities - First Aid - Medical Assistance on Site	-5% to +5%			
Safety Organization - Written Safety Program - Emergency and Disaster Plans - Loss Control Programs - Ergonomics	-15% to +15%			
Employees - Pre-employment Physicals - Drug-Free Workplace - New Hire Training - Job-Specific Training	-15% to +15%			
Total				Maximum = 25% (Credit) / Debit

RATING MECHANISMS FOR LARGE COMMERCIAL RISKS

The rating mechanisms described above used past experience or risk characteristics to modify the manual rate. The mechanisms in this section do not modify the manual rate but rather develop a premium for the large commercial entity. These mechanisms include loss-rated composite risks, large deductible policies, and retrospective rating plans.

Composite Rating

In general, composite rating is an administrative tool used to facilitate the rating of large, complex commercial risks. It is often used to rate commercial risks when the amount of exposure is difficult to track throughout the policy period. The policy premium is calculated at the beginning of the policy term based on estimates for each coverage's exposure measure along with the relevant rating algorithms for each coverage. Rather than auditing each exposure measure (e.g., sales revenue for general liability, property value for commercial business property) at the end of the term, a proxy exposure measure is used to gauge the overall change in exposure to loss. For example, if property value is chosen as the proxy exposure measure, a 20% increase in property value during the policy term would trigger a premium adjustment of 20% for the whole policy's premium.

Depending on the size of the risk, the composite rate can also be based entirely on the insured's prior experience. This is referred to as composite rating for loss-rated risks, and is the focus of this section of the chapter. Specifically, this section will focus on ISO's Composite Rating Plan for Loss-Rated Risks. It should be noted that some rules specific to ISO's plan have been simplified or omitted because they are beyond the scope of this paper.

Example Composite Rating Plan for Loss-Rated Risks

In ISO's Composite Rating Plan, an insured is eligible for being classified as "loss-rated" if its historical reported losses and allocated loss adjustment expenses over a defined period exceed a specified aggregate dollar amount. The threshold varies based on different combinations of coverage and limits. If eligible, the insured's historical experience is implicitly considered 100% credible for purposes of determining the composite rate.

The process for determining the composite rate for a loss-rated risk is summarized below.

For each type of coverage and for each of the past five completed years of experience, the reported loss and ALAE based on the most recent valuation is developed to ultimate and trended to the average accident date of the proposed policy period:

Trended Ultimate Loss & ALAE by coverage by year =

(Reported Loss & ALAE) x (Development Factor) x (Loss & ALAE Trend Factor).

After the insured selects a composite exposure base to use for rating, the composite exposures for the past five years are measured and, if applicable, trended from the average earned date of the historical policy to the average earned date of the future policy period. It should be noted that the application of a trend depends on the composite exposure base that is selected. Sales and payroll are common commercial lines exposure bases that are inflation-sensitive and are subject to trend; however, the number of vehicle years used in commercial auto does not need to be trended. The trended composite exposure formula is as follows:

Trended Composite Exposure = Composite Exposure x Exposure Trend Factor.

The next step is to estimate the adjusted premium by dividing the trended ultimate loss and ALAE by the expected loss and ALAE ratio for the five-year period. Dividing the loss and ALAE by the expected loss and ALAE ratio incorporates a provision for ULAE, underwriting expenses, and underwriting profit. The formula is as follows:

$$\text{Adjusted Premium} = \frac{\text{Trended Ultimate Loss \& ALAE}}{\text{Expected Loss \& ALAE Ratio}}.$$

The composite rate for the coverage to be written is then determined as follows:

$$\text{Composite Rate} = \frac{\text{Adjusted Premium}}{\text{Trended Composite Exposure}}.$$

It should be noted that for loss-rated risks, the composite rate is not adjusted by any experience rating plan because the insured's own experience has already been reflected in the rate. On the other hand, schedule rating may apply.

Example Calculation

Bob's Rentals is an equipment dealer that sells new and used equipment, operates a repair and service shop, and offers leases and rentals on equipment it owns. The calculation of the commercial general liability (CGL) policy premium for this type of business is generally complex because each of the three operations is rated separately, and the exposure base for each operation is different. The exposure for sales on new and used equipment is receipts (in $000s) attributable only to sales on new and used equipment. The exposure for the repair and service shop is payroll (in $00s) relating to workers in the repair and service shop, and the exposure for leases and rentals is receipts (in $000s) attributable only to leases and rentals.

Bob's Rentals is sufficiently large enough to meet the eligibility requirements for loss rating under ISO's Composite Rating Plan and desires coverage up to $250,000 per occurrence with $500,000 general aggregate for its exposure to commercial general liability.

The following are the last five years of reported losses and ALAE across all three operations, separated into bodily injury and property damage. Amounts are capped at $250,000 per occurrence and evaluated as of December 31, 2008.

15.7 Reported Loss & ALAE a/o 12/31/08

Policy Year	Bodily Injury	Property Damage
7/1/03-04	$ 1,842,705	$ 626,162
7/1/04-05	$ 1,406,353	$ 591,899
7/1/05-06	$ 1,356,511	$ 517,616
7/1/06-07	$ 1,355,545	$ 623,184
7/1/07-08	$ 1,193,012	$ 568,669
Total	$ 7,154,126	$ 2,927,530

Notes:
Amounts are capped at $250,000 per occurrence.
Amounts are valued as of December 31, 2008.
Amounts represent CGL losses from all three operations.

The selected composite exposure base is total receipts (in $000s). Receipts for the last five years for each of the three operations are as follows:

15.8 Receipts

Policy Year	New/Used Equipment	Repair and Service	Lease and Rentals	Total
7/1/03-04	$ 56,498,756	$ 22,599,503	$ 33,899,254	$ 112,997,513
7/1/04-05	$ 58,564,822	$ 23,425,929	$ 35,138,893	$ 117,129,644
7/1/05-06	$ 61,193,878	$ 24,477,551	$ 36,716,327	$ 122,387,756
7/1/06-07	$ 63,245,228	$ 25,298,091	$ 37,947,137	$ 126,490,456
7/1/07-08	$ 65,721,869	$ 26,288,748	$ 39,433,121	$ 131,443,738
Total	$ 305,224,553	$ 122,089,822	$ 183,134,732	$ 610,449,107

Assume the following:

- Loss and ALAE annual trend (for bodily injury and property damage) is 6%.
- Exposure annual trend rate is 4%.
- Expected loss & ALAE ratio is 72%.
- Loss development factors are as follows:

15.9 Development Factors

Age to Ultimate	Bodily Injury	Property Damage
66-Ult	1.10	1.03
54-Ult	1.25	1.10
42-Ult	1.45	1.20
30-Ult	1.70	1.35
18-Ult	1.95	1.50

Using the data and assumptions provided above, calculate the loss-rated composite rate for Bob's Rentals for its upcoming annual policy to be effective July 1, 2009.

The first step is to develop the trend factors to be applied to the loss and ALAE and the exposure base. The average accident date of the proposed policy period is December 31, 2009, and the average accident date of each policy year from the experience period is December 31. Therefore, the length of time between the average accident date of the most recent policy year and the average accident date of the proposed policy period is two years. Based on the assumed trend rates, the trend factors are calculated as follows:

15.10 Trend Factors

Policy Year	(1) Trend Period	(2) Annual Loss & ALAE Trend	(3) Loss & ALAE Trend Factor	(4) Annual Exposure Trend	(5) Exposure Trend Factor
7/1/03-04	6	6.0%	1.4185	4.0%	1.2653
7/1/04-05	5	6.0%	1.3382	4.0%	1.2167
7/1/05-06	4	6.0%	1.2625	4.0%	1.1699
7/1/06-07	3	6.0%	1.1910	4.0%	1.1249
7/1/07-08	2	6.0%	1.1236	4.0%	1.0816

(3) = [1.0 + (2)] ^ (1)
(5) = [1.0 + (4)] ^ (1)

The next step is to estimate the trended ultimate loss and ALAE, which is calculated as follows:

15.11 Trended Ultimate Loss & ALAE

	(1)	(2)	(3)	(4)	(5)	(6)
Policy Year	Incurred Loss and ALAE BI	PD	Development Factors BI	PD	Loss & ALAE Trend Factor	Trended Ultimate Loss & ALAE
7/1/03-04	$ 1,842,705	$ 626,162	1.10	1.03	1.4185	$ 3,790,122
7/1/04-05	$ 1,406,353	$ 591,899	1.25	1.10	1.3382	$ 3,223,764
7/1/05-06	$ 1,356,511	$ 517,616	1.45	1.20	1.2625	$ 3,267,451
7/1/06-07	$ 1,355,545	$ 623,184	1.70	1.35	1.1910	$ 3,746,558
7/1/07-08	$ 1,193,012	$ 568,669	1.95	1.50	1.1236	$ 3,572,348
Total	$ 7,154,126	$ 2,927,530				$ 17,600,243

(6) = [(1) x (3) + (2) x (4)] x (5)

The trended composite exposure is equal to the product of the selected composite exposure and the exposure trend factors.

15.12 Trended Composite Exposure

	(1)	(2)	(3)
Policy Year	Total Receipts ($000's)	Exposure Trend Factor	Trended Exposure
7/1/03-04	$ 112,998	1.2653	$ 142,976
7/1/04-05	$ 117,130	1.2167	$ 142,512
7/1/05-06	$ 122,388	1.1699	$ 143,182
7/1/06-07	$ 126,490	1.1249	$ 142,289
7/1/07-08	$ 131,444	1.0816	$ 142,170
Total	$ 610,450		$ 713,129

(1) = Sum of receipts from 15.8
(3) = (1) x (2)

The final calculation of the composite rate is as follows:

15.13 Composite Rate

(1) Trended Ultimate Loss & ALAE	$ 17,600,243
(2) Expected Loss & ALAE Ratio	72.0%
(3) Adjusted Premium	$ 24,444,782
(4) Trended Composite Exposure	$ 713,129
(5) Composite Rate	$ 34.28

(3) = (1) / (2)
(5) = (3) / (4)

Assuming total receipts for the upcoming policy period are estimated to be $142,500,000, then the deposit premium is $4,884,900 (= $142,500 x 34.28). The final premium is calculated according to the audited exposure; any difference from the deposit premium can be charged or credited to the insured.

Large Deductible Policies

It is not uncommon for commercial entities to purchase insurance with deductible clauses similar to those found in personal insurance. For example, a commercial general liability policy may contain a $500 deductible for property coverage. The main purpose of small deductibles is for the insurer to keep premium low by avoiding expenses associated with the processing and investigation of small nuisance or frivolous claims. At some value, however, a deductible can be set high enough so that the insured is bearing significant risk. For example, a large deductible workers compensation insurance policy may have a deductible of $1 million per occurrence. At that level, the expectation is that a significant proportion of claims will fall entirely within the deductible and thus the insured is bearing a significant portion of the risk.

When the deductible is set to a level where the insured is bearing significant risk, either from the expectation of a large number of small claims or a small number of large claims, the following pricing considerations must be addressed in addition to those associated with small deductible pricing:

- **Claims handling:** It must be determined whether the insured or insurer will assume responsibility for handling claims that fall entirely within the deductible. Large deductible policies will vary in their treatment of this issue; in some cases, the insured assumes responsibility but in most cases, the insurer handles all claims. If the insurer assumes responsibility, the premium must be set to cover the cost for all claim handling expenses, even those expenses associated with claims that do not pierce the deductible. If the insured assumes responsibility, the insurer should evaluate the insured's claim handling expertise to determine the likelihood of claims leakage above the deductible; any material increase in expected costs as a result of the insured's inexperience should be reflected in the pricing.
- **Application of the deductible:** The deductible may apply only to losses or to the sum of losses and allocated loss adjustment expenses (ALAE). The calculation of loss elimination ratios should be based on data consistent with the treatment of ALAE in the policy terms.
- **Deductible processing:** In some large deductible policies the insurer is responsible for paying the entire claim and seeking reimbursement for amounts below the deductible from the insured. In these situations, the premium should reflect the cost of invoicing and monitoring deductible activity as well as a provision associated with the risk that the insured may become bankrupt and be unable to pay for any future deductible invoices (i.e., credit risk). In some instances, collateral is received to cover potentially uncollectible deductible amounts; however, it is rare that this credit risk is fully collateralized.
- **Risk margin:** While the proper treatment and computation of profit is beyond the scope of this paper, it should be noted that losses above a large deductible are expected to be more uncertain than losses below the deductible. As a result, the profit margin may need to be adjusted accordingly to reflect the increased risk being assumed by the insurer.

With the exception of these considerations, pricing for a large deductible policy is otherwise the same as pricing a standard deductible, which is addressed in Chapter 11.

Example Calculation

The following example illustrates how to price a large deductible commercial general liability (CGL) policy based on the following provisions and assumptions:

- The deductible is $500,000 per occurrence.
- The insurer will handle all claims, including those that fall entirely below the deductible.
- The use of a deductible is not expected to reduce ALAE costs. ALAE costs are estimated to be 11% of total losses.
- The deductible applies to losses only. The total ground-up losses without recognition of a deductible are estimated to be $1,000,000.
- The fixed expenses are assumed to be $50,000.
- Variable expenses are assumed to be 13% of premium.
- The insurer will make the payments on all claims and will seek reimbursement for amounts below the deductible from the insured. The cost of processing deductibles is estimated to be 4% of the losses below the deductible.
- Deductible recoveries will not be fully collateralized, and the associated credit risk is estimated to be 1% of the expected deductible payments.
- The desired underwriting profit for a full-coverage (i.e., no deductible) premium is 2%. The insurer includes an additional risk margin of 10% of excess losses for policies with a deductible of $500,000.
- The percent of total losses below the deductible (i.e., Loss Elimination Ratio or LER) and the percent of total losses above the deductible (i.e., excess ratio) are summarized in the table below.

15.14 Loss Elimination Ratios

Loss Limit	LER	Excess Ratio [1.0-LER]
$100,000	60%	40%
$250,000	80%	20%
$500,000	95%	5%

The premium for this policy is developed based on the following formula:

$$\text{Premium} = \frac{\text{Losses above Deductible} + \text{ALAE} + \text{Fixed Expense} + \text{Credit Risk} + \text{Risk Margin}}{(1.0 - \text{Variable Expense Provision} - \text{Profit Provision})}.$$

The first step in deriving the premium is to estimate losses above the $500,000 deductible. This calculation is summarized in the table below.

15.15 Estimated Losses

(1) Expected total ground-up losses	$1,000,000
(2) Excess ratio	5%
(3) Estimated losses above deductible (1) x (2)	$50,000

The premium in this example is computed as follows:

15.16 Computation of Premium

(1) Estimated Losses Above the Deductible	\$50,000
(2) ALAE	\$110,000
(3) Fixed Expenses	
(a) Standard	\$50,000
(b) Deductible Processing	\$38,000
(4) Credit Risk	\$9,500
(5) Risk Margin	\$5,000
(6) Variable Expenses and Profit	15%
(7) Premium	\$308,824

(1) = Table 15.15, Row (3)
(2) = 11% x Table 15.15, Row (1)
(3a) = Provided
(3b) = 4% x Table 15.15, Row (1) x LER in Table 15.14
(4) = 1% x Table 15.15, Row (1) x LER in Table 15.14
(5) = 10% x (1)
(7) = [(1) + (2) + (3a) + (3b) + (4) + (5)] / [1.0 - (6)]

Retrospective Rating

Unlike the rating mechanisms described above, which use past experience to estimate the premium needed for a prospective policy period, a retrospective rating plan uses the insured's actual experience during the policy period as the basis for determining the premium for that same period. Conceptually, retrospectively rated insurance is similar to self-insurance with the exception that retrospectively rated insurance policies contain provisions that cause the insurer to retain some risk and that affect the timing of payments for costs incurred under the policy. For example, the actual losses used to determine the final retrospective premium may be limited to reduce the effect of any single unusual or catastrophic event. Similarly, the total premium charged may be subject to a minimum and maximum amount, which helps stabilize the year-to-year cost and further protects the insured from exceeding an aggregate cost due to a large number of claims incurred in any one year.

The premium for a retrospectively rated policy typically consists of an initial premium derived at the beginning of the policy period and periodic premium adjustments made after the policy period to reflect information about the actual claims experience for a pre-determined number of adjustments or until the insurer and insured agree.[53] The initial premium and premium adjustments can be structured in many different ways. Three such examples are as follows:

- The initial premium for a retrospectively rated policy may be based on the total expected expenses, profit, and costs associated with any caps. At the end of the policy period, the insured will be billed annually for all losses incurred under the policy after consideration of any capping rules contained in the policy. These adjustments will continue each year for a pre-determined length of time. The annual amount billed is referred to as a premium adjustment.
- The initial premium may be based on expenses, profit, and costs associated with any caps but excluding LAE associated with the policy. In this case, the annual premium adjustments associated with reported losses during the policy period will include a provision for LAE costs. The provision is typically based on a pre-determined percentage chosen to reflect LAE costs.
- The initial premium may be based on an estimate of the final premium under the policy, including provision for total expected ultimate losses and expenses. In this case, the periodic premium adjustments are due to changes in the revised estimate of the final premium based on up-to-date loss information.

In theory, all three examples above should produce the same total premium for a given retrospectively rated policy; however, the amount of the initial premium and premium adjustments will vary, resulting in cash flow timing differences.

Example Retrospective Rating Plan – Workers Compensation

The following example is a simplified illustration of a typical U.S. workers compensation retrospective rating plan. It should be noted that retrospective rating plans tend to have numerous rules and additional computations, which in this example have been simplified or omitted because they are beyond the scope of this paper.

Basic Formula

The basic formula for retrospective premium is as follows:

$$\text{Retro Premium} = [\text{Basic Premium} + \text{Converted Losses}] \times \text{Tax Multiplier},$$
$$\text{where the retro premium is subject to a maximum and minimum.}$$

[53] Due to the long-tailed nature of many commercial lines of insurance, it may take years before the actual claims experience is known with relative certainty.

Basic Premium

The basic premium is given by:

$$\text{Basic Premium} = \left[\text{Expense Allowance} - \text{Expense Provided Through LCF} + \text{Net Insurance Charge} \right] \text{x} \text{ Standard Premium,}$$

where

$\text{LCF} = \text{Loss Conversion Factor},$

$\text{Expense Provided Through LCF} = \text{Expected Loss Ratio} \times (\text{LCF} - 1.0),$

$\text{Net Insurance Charge} = [\text{Insurance Charge} - \text{Insurance Savings}] \times \text{Expected Loss Ratio} \times \text{LCF}.$

The Basic Premium is intended to provide for:

1. The insurer's target underwriting profit and expenses excluding expenses provided for by the loss conversion factor (LCF) and the tax multiplier;
2. The cost of limiting the retrospective premium to be between the minimum and maximum premium negotiated under the policy.

Expenses

Expenses are introduced into the retro premium formula through three different components: the tax multiplier, the expense allowance, and the LCF. The tax multiplier reflects the cost of premium taxes and related assessments. The expense allowance in the basic premium formula includes target underwriting profit and underwriting expenses (other than premium taxes and assessments that are paid for via the tax multiplier) and expenses that vary with losses. Since a provision for expenses that vary with losses (e.g., loss adjustment expenses) is incorporated in the retro premium formula through the converted losses term, these expenses are eliminated from the basic premium by subtracting out the product of the Expected Loss Ratio x (LCF -1.0).

Converted Losses

$$\text{Converted Losses} = \text{Reported Losses} \times \text{LCF}.$$

The converted losses are the reported losses limited by the selected accident limit (if any) and multiplied by the LCF. The LCF generally adjusts the losses to include the ALAE that is not already included in the losses plus the ULAE. The LCF is negotiated between the insured and insurer.

Standard Premium

Standard premium is the insurance premium for the risk before consideration of the retrospectively rated plan and any premium discount. It is determined on the basis of the exposure, the insurer's rates, the experience modification, and any premium charges excluding premium discount.

Minimum/Maximum Retrospective Premium

The formulae for deriving the minimum and maximum retrospective premium are as follows:

$$\text{MinimumRetro Premium} = \text{StandardPremium} \times \text{MinimumRetro PremiumRatio},$$
$$\text{MaximumRetro Premium} = \text{StandardPremium} \times \text{MaximumRetro PremiumRatio}.$$

The minimum and maximum retrospective premium ratios are subject to negotiation between the insured and insurer.

Insurance Charge and Insurance Savings

As stated earlier, the retrospective premium may be limited by a minimum and a maximum. The application of a minimum and maximum will affect the total premium collected by the insurer and therefore the cost of doing so needs to be considered as part of the determination of the final premium. The insurance charge is the estimate of the cost associated with limiting the retrospective premium to be no higher than the maximum retrospective premium. The insurance savings is the estimate of the savings associated by requiring the retrospective premium to be no lower than the minimum retrospective premium. The insurance charge and insurance savings are contained in a table of values. The derivation of these tables is beyond the scope of this paper; however, it should be noted that the insurance charge and insurance savings are expressed as a percentage of expected unlimited losses. In this example, the impact of the per occurrence loss limitation is incorporated into the values contained within this table; however, there are some instances where the table represents only the effect of the maximum and minimum premiums, and the effect of the per occurrence loss limitation is computed as a separate additional charge.

Example Calculation

The following simple example is intended to demonstrate the basic computations. Assume the following:

- The first computation of the retrospective premium occurs six months after the end of the policy period and annually thereafter until the insurer and insured agree that the latest computation shall be the final computation.
- The policy is an annual policy and the limited reported losses valued as of 18 months are \$153,000.
- The hypothetical provisions that apply for a workers compensation retrospective rating plan are given in the first 10 rows of Table 15.17.

The calculation of the retrospective premium is as follows:

15.17 Provisions of Plan

(1) Minimum retrospective premium ratio (negotiated)	60.0%
(2) Maximum retrospective premium ratio (negotiated)	140.0%
(3) Loss Conversion Factor (negotiated)	1.10
(4) Per Accident Loss Limitation (negotiated)	$100,000
(5) Expense Allowance (excludes tax multiplier)	20%
(6) Expected Loss Ratio	65%
(7) Tax Multiplier	1.03
(8) Standard Premium	$769,231
(9) Insurance Charge for Maximum Premium	0.42
(10) Insurance Savings for Minimum Premium	0.03
(11) Basic Premium	$318,346
(12) Converted Losses	$168,300
(13) Preliminary Retrospective Premium	$501,245
(14) Minimum Retrospective Premium	$461,539
(15) Maximum Retrospective Premium	$1,076,923
(16) Retrospective Premium	$501,245

(11) = [(5)-(6) x [(3)-1.0]+[(9)-(10)] x (6) x (3)] x (8)
(12) = $153,000 x (3)
(13) = [(11)+(12)] x (7)
(14) = (1) x (8)
(15) = (2) x (8)
(16) = Min [Max[(13),(14)] , (15)]

SUMMARY

Some commercial risks are sufficiently large such that their experience can be used in whole or in part to derive an individual rate. Special commercial lines rating mechanisms can be divided into two categories: those that modify the manual rate and those that derive premium specifically for the large commercial risk. Manual rate modification plans include experience rating and schedule rating. Experience rating is used when the past loss experience is determined to be reliably predictive of future expected losses. The experience modification factor is based upon a comparison of the actual experience to the expected experience with credibility taken into consideration. The actual experience may be evaluated in several ways, and it is critically important that the actual experience and expected experience are evaluated on a consistent basis before comparison. Schedule rating alters the manual rate according to characteristics that are expected to have a material effect on the insured's loss experience relative to that assumed in the manual rate or (if experience rating applies) relative to the manual rate modified by experience rating.

Rating mechanisms for large commercial risks include loss-rated composite plans, large deductible policies, and retrospective rating. Loss-rated composite rating plans facilitate rating of large, complex commercial risks through the use of a single, auditable, composite exposure, and derive a rate based entirely on the insured's prior experience. Large deductible policies are priced similarly to small deductible policies but several special considerations need to be addressed (e.g., how ALAE are treated and whether the profit provision should include a risk margin). Retrospective rating uses the individual entity’s experience during the policy period to establish the final rate (within a pre-determined range of minimum and maximum premium).

KEY CONCEPTS IN CHAPTER 15

1. Manual rate modification plans
    a. Experience rating
        i. Actual experience
        ii. Expected experience
        iii. Other considerations
        iv. Examples for CGL and workers compensation
    b. Schedule rating (with example plan for workers compensation and employer's liability)

2. Rating techniques for large commercial risks
    a. ISO loss-rated composite risks (with example for CGL)
    b. Large deductible policies
    c. Retrospective rating plans (with example for workers compensation)

CHAPTER 16: CLAIMS-MADE RATEMAKING

During the 1960s and 1970s, loss trends for many liability lines increased dramatically due to high economic and social inflation, as well as increases in claim frequency. This was especially the case for professional liability insurance including medical malpractice. As discussed in Chapter 6, claims for long-tailed insurance products can take many years to report and settle. Because of the long-tailed nature of professional liability, it took several years before insurance carriers realized that their products were significantly underpriced. Once companies realized their rates were inadequate, they either reduced coverage or filed for large rate increases or did both to try to improve profitability. This delay in recognizing price inadequacy highlights the significant pricing risk that exists for long-tailed insurance products relative to short-tailed ones.

The long period between the occurrence of a claim and the settlement of a claim can be driven by a reporting lag (i.e., the time between the occurrence date and report date), a settlement lag (i.e., the time between the report date and settlement date), or both. From a loss development perspective, reporting lag relates to pure IBNR (claims that are incurred but not reported), and settlement lag relates to IBNER (claims that are incurred but not enough reported). For a product like medical malpractice, it may be many years before an insured becomes aware of a claim and reports it. For example, it may take several years for the physician's error to cause identifiable symptoms. Even after the claim is reported, it may take many years for the claim to be ultimately settled due to factors such as the need for ongoing treatment and lengthy court proceedings.

In an attempt to reduce the pricing risk inherent in professional liability, the industry introduced an alternative to occurrence coverage that minimizes the time between the coverage inception and claim settlement. This alternative is called claims-made coverage. The major difference between claims-made and occurrence coverage is that the coverage trigger is the date the claim is reported rather than the date the event occurs. Consequently, the difference in pricing these products is not in the coverage provided, but rather in the timing of the pricing decisions. When pricing claims-made policies, the actuary only needs to project claims reported during next year's policy period. When pricing occurrence policies for professional liability and other long tail lines, the actuary must consider claims that will be reported many years into the future.

This chapter covers:

- Aggregation of losses by report year and report year lag
- Coverage triggers for claims-made coverage
- The five principles of claims-made policies
- Issues related to coordinating coverage between claims-made and occurrence policies.

REPORT YEAR AGGREGATION

To better understand the difference between claims-made coverage and occurrence coverage, consider the following diagram that categorizes claims by the year reported and the report lag:

16.1 Report Year Aggregation

		Report Year Lag				
		0	**1**	**2**	**3**	**4**
Report Year	**2010**	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

For example, the first entry, L(2010,0), corresponds to a claim that occurs in 2010 and is reported in year 2010 (i.e., there is 0 time lag between when the claim occurred and when it was reported). The entry for L(2012,2) represents a claim that is reported in 2012 after a report lag of two years (i.e., the claim occurred in 2010). More generally, each row corresponds to claims reported in a given year (i.e., the report year), each column corresponds to claims that share the same reporting lag, and each diagonal (top left to bottom right) represents claims that occurred in the same year (i.e., the same accident year). Since occurrence policies provide compensation for claims that occur during the policy period regardless of when the claim is reported, they are aggregated by accident year (i.e., each diagonal in the table).

For example, an annual occurrence policy written on January 1, 2010, covers claims that are incurred during the policy period but may be reported during the policy period or subsequent to the policy period. Stated in a different way, the occurrence policy covers claims reported in 2010 with no report lag, claims reported in 2011 with a one-year report lag, claims reported in 2012 with a two-year report lag, and so on:

$$\text{Occurrence Policy}(2010) = L(2010,0) + L(2011,1) + L(2012,2) + L(2013,3) + L(2014,4)$$

Assuming a maximum report lag of N, the occurrence policy for year Y can be written more generally:

$$\text{Occurrence Policy}\,(Y) = \sum_{i-0}^{N} L(Y+i,i).$$

Since the coverage trigger for the claims-made policy is the report date, a claims-made policy is represented by the entries in a row. For example, a claims-made policy written on January 1, 2010, covers all claims reported in 2010 regardless of the report lag:

$$\text{Claims-made Policy}\,(2010) = L(2010,0) + L(2010,1) + L(2010,2) + L(2010,3) + L(2010,4)$$

This can be written more generally:

$$\text{Claims - made Policy}\,(Y) = \sum_{i-0}^{N} L(Y,i).$$

The following chart compares a 2010 claims-made policy (enclosed by the dotted box) and a 2010 occurrence policy (enclosed by the solid diagonal box).

16.2 Comparison of 2010 Claims-Made and Occurrence Policies

		Report Year Lag				
		0	**1**	**2**	**3**	**4**
Report Year	**2010**	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = dashed

Occurrence Policy = solid

PRINCIPLES

In "Rating Claims-Made Insurance Policies" (Marker and Mohl 1980), the authors identify five principles of claims-made policies that provide more detail as to how pricing risk is reduced.

1. A claims-made policy should always cost less than an occurrence policy as long as claim costs are increasing.
2. If there is a sudden, unpredictable change in the underlying trends, the claims-made policy priced based on the prior trend will be closer to the correct price than an occurrence policy based on the prior trend.
3. If there is a sudden, unexpected shift in the reporting pattern, the cost of a mature claims-made policy (i.e., a policy that covers claims reported during the policy period regardless of accident date) will be affected relatively little, if at all, relative to the occurrence policy.
4. Claims-made policies incur no liability for IBNR, so the risk of reserve inadequacy is greatly reduced.
5. The investment income earned from claims-made policies is substantially less than under occurrence policies.

To help illustrate these principles, assume the following:

- Exposure levels are constant.
- The average loss cost for Report Year 2010 is $1,000.
- Loss costs increase by 5% each report year.
- An equal number of incurred claims are reported each year and all claims are reported within five years of occurrence (i.e., 20% reported each year).
- Loss costs do not vary by report year lag. Also, any trends affecting settlement lag have been ignored.

The assumptions are simple to help illustrate the principles. Relaxing the assumptions does not change the conclusions; it merely makes the interpretation more difficult.

The data underlying these assumptions is represented in the following table:

16.3 Example

Report Year	Loss Costs by Report Year Lag 0	1	2	3	4	Claims-made Loss Costs
2010	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 1,000.00
2011	$ 210.00	$ 210.00	$ 210.00	$ 210.00	$ 210.00	$ 1,050.00
2012	$ 220.50	$ 220.50	$ 220.50	$ 220.50	$ 220.50	$ 1,102.50
2013	$ 231.53	$ 231.53	$ 231.53	$ 231.53	$ 231.53	$ 1,157.65
2014	$ 243.10	$ 243.10	$ 243.10	$ 243.10	$ 243.10	$ 1,215.50
2015	$ 255.26	$ 255.26	$ 255.26	$ 255.26	$ 255.26	$ 1,276.30
2016	$ 268.02	$ 268.02	$ 268.02	$ 268.02	$ 268.02	$ 1,340.10
2017	$ 281.42	$ 281.42	$ 281.42	$ 281.42	$ 281.42	$ 1,407.10
2018	$ 295.49	$ 295.49	$ 295.49	$ 295.49	$ 295.49	$ 1,477.45

Accident Year	Occurrence Loss Costs
2010	$ 1,105.13
2011	$ 1,160.39
2012	$ 1,218.41
2013	$ 1,279.33
2014	$ 1,343.29

Principle 1

Principle 1 states "A claims-made policy should always cost less than an occurrence policy as long as claim costs are increasing." Note that this holds true when comparing loss costs from the claims-made policies and the occurrence policies for each individual year in the table above.

This supports the fact that occurrence policies require the actuary to make projections about the settlement of claims that occur further out into the future. An actuary pricing a 2011 occurrence policy has to project the ultimate value of claims that occur in 2011 and may not even be reported until 2015. In contrast, an actuary pricing a 2011 claims-made policy only needs to project the ultimate cost of claims that will be reported in that year. For claims-made policies, there is a shorter period of time between coverage trigger and settlement date. Since short-term projections are more accurate than long-term ones, the pricing risk is significantly reduced with the claims-made policy compared to an occurrence policy.

Principle 2

Principle 2 states "If there is a sudden, unpredictable change in the underlying trends, the claims-made policy priced based on the prior trend will be closer to the correct price than an occurrence policy based on the prior trend."[54]

The following table restates the example assuming the actual loss cost trend by report year is 7% instead of 5%:

[54] The example that supports this principle assumes constant trends by report year. Certain scenarios involving variable and offsetting trends by report year (e.g., trend overstated in one report year and understated in the following year) may violate the principle.

16.4 Unexpected Trend

	Loss Costs by Report Year Lag 0	1	2	3	4	Claims-made Loss Costs
Report Year 2010	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 1,000.00
2011	$ 214.00	$ 214.00	$ 214.00	$ 214.00	$ 214.00	$ 1,070.00
2012	$ 228.98	$ 228.98	$ 228.98	$ 228.98	$ 228.98	$ 1,144.90
2013	$ 245.01	$ 245.01	$ 245.01	$ 245.01	$ 245.01	$ 1,225.05
2014	$ 262.16	$ 262.16	$ 262.16	$ 262.16	$ 262.16	$ 1,310.80
2015	$ 280.51	$ 280.51	$ 280.51	$ 280.51	$ 280.51	$ 1,402.55
2016	$ 300.15	$ 300.15	$ 300.15	$ 300.15	$ 300.15	$ 1,500.75
2017	$ 321.16	$ 321.16	$ 321.16	$ 321.16	$ 321.16	$ 1,605.80
2018	$ 343.64	$ 343.64	$ 343.64	$ 343.64	$ 343.64	$ 1,718.20

Accident Year	Occurrence Loss Costs
2010	$ 1,150.15
2011	$ 1,230.66
2012	$ 1,316.81
2013	$ 1,408.99
2014	$ 1,507.62

The unexpected increase in trend resulted in the Report Year 2011 loss cost for the claims-made policy to be 1.9% (=$1,070.00 / $1,050.00 – 1.0) higher than the original estimate in Table 16.3. Compare this to the occurrence policy in which the unexpected trend resulted in an Accident Year 2011 loss cost that is 6.1% (=$1,230.66 / 1,160.39 -1.0) higher than the original estimate. Since occurrence policies cover claims that may be reported much further in the future and such claims are more significantly affected by trend, an error made in the trend selection has more of an impact than for claims-made policies.

Principle 3

Principle 3 states, "If there is a sudden, unexpected shift in the reporting pattern, the cost of a mature claims-made policy will be affected relatively little, if at all, relative to the occurrence policy." Instead of 20% of the claims being reported each year, assume that 5% of the claims are reported one year later than expected, but all claims are reported within five years. As an example, in 2010, $50 of the loss cost shifts from lag 0 to lag 1, $50 of the loss costs from lag 1 shift to lag 2, and so on. Since an equal amount of loss costs are shifting in and out of lag periods 1, 2, and 3, the only impact is on the first and last lag periods.

16.5 Unexpected Reporting Shift

	Loss Costs by Report Year Lag 0	1	2	3	4	Total all lags
Report Year 2010	$ 150.00	$ 200.00	$ 200.00	$ 200.00	$ 250.00	$ 1,000.00
2011	$ 157.50	$ 210.00	$ 210.00	$ 210.00	$ 262.50	$ 1,050.00
2012	$ 165.38	$ 220.50	$ 220.50	$ 220.50	$ 275.63	$ 1,102.51
2013	$ 173.64	$ 231.53	$ 231.53	$ 231.53	$ 289.41	$ 1,157.64
2014	$ 182.33	$ 243.10	$ 243.10	$ 243.10	$ 303.88	$ 1,215.51
2015	$ 191.44	$ 255.26	$ 255.26	$ 255.26	$ 319.07	$ 1,276.29
2016	$ 201.02	$ 268.02	$ 268.02	$ 268.02	$ 335.03	$ 1,340.11
2017	$ 211.07	$ 281.42	$ 281.42	$ 281.42	$ 351.78	$ 1,407.11
2018	$ 221.62	$ 295.49	$ 295.49	$ 295.49	$ 369.37	$ 1,477.46

Accident Year	Occurrence Loss Costs
2010	$ 1,115.91
2011	$ 1,171.70
2012	$ 1,230.30
2013	$ 1,291.80
2014	$ 1,356.40

Examining the results, there is no impact on the loss cost estimates for the claims-made policies, but the estimates for the occurrence policies have changed from the original table (Table 16.3). For example, the Accident Year 2011 loss cost estimate for the occurrence policies has changed by 1% (= ($1,171.70 / $1,160.39) – 1.0).

Principle 4

Principle 4 states, "Claims-made policies incur no liability for IBNR, so the risk of reserve inadequacy is greatly reduced." When pricing occurrence policies, actuaries need to worry about claims that are incurred but not reported (pure IBNR) and claims that are incurred but not enough reported (IBNER). By definition, claims-made policies do not have a pure IBNR component; therefore, the actuary only has to determine an IBNER reserve, and the risk of reserve inadequacy is greatly reduced.

Principle 5

Principle 5 states, "The investment income earned from claims-made policies is substantially less than under occurrence policies." Insurers are required to hold funds (i.e., reserves) to cover expected liabilities. Those reserves include unearned premium reserves, case reserves, IBNR reserves, and IBNER reserves. As discussed in Chapter 7, insurers can invest those funds and earn investment income. Relative to the occurrence policy, the claims-made policy shortens the period of time between collection of premium and payment of claim; consequently, funds invested for a shorter time horizon result in less investment income.

This principle has implications on the pricing risk of claims-made policies. Part of the pricing process is the determination of the underwriting profit that is required to earn a reasonable rate of return after consideration of the investment income earned. When determining the target underwriting profit provision for a claims-made policy, the pricing actuary should take into consideration both the reduced investment income as well as the reduced pricing risk.

DETERMINING RATES

Once the expected loss costs are determined, the rates can be derived using similar techniques to those discussed previously. More detail is beyond the scope of this text, but may be found in "Rating Claims-Made Insurance Policies" (Marker and Mohl, 1980).

COORDINATING POLICIES

Since occurrence and claims-made policies have different coverage triggers, insureds converting from one policy type to the other should be cognizant of coverage overlaps or gaps. As way of example, consider an insured that had an occurrence policy in 2010 and switches to a claims-made policy starting in 2011. As shown in the following diagram, there is overlapping coverage between the occurrence policy and the claims-made policy.

16.6 Comparison of 2010 Claims-Made and Occurrence Policies

	Report Year Lag				
Report Year	0	1	2	3	4
2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = enclosed by dotted rectangle

Occurrence Policy = shaded

There are several important features of claims-made policies that are intended to coordinate with occurrence policies correctly.

Claims-made policies have a retroactive date. The claims-made coverage only covers claims that occur on or after the retroactive date. To provide complete coverage without overlap, the retroactive date should be coordinated with the expiration of the last occurrence policy.

When the retroactive date is applied to Figure 16.6, the result is Figure 16.7. The insured can purchase a first-year claims-made policy in 2011 with a retroactive date of January 1, 2011. The first-year claims-made policy will only provide coverage for claims that occurred on or after January 1, 2011, and were reported in 2011 (i.e., L(2011,0)). A second-year claims-made policy with a retroactive date of January 1, 2011, will cover L(2012,0) and L(2012,1). This continues until a mature claims-made policy is issued in 2015.

16.7 Coordinating the Switch from Occurrence to Claims-Made Policy

	Report Year Lag				
Report Year	0	1	2	3	4
2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = enclosed by dotted rectangle

Occurrence Policy = shaded

The rating of claims-made policies employs a factor to recognize the growth in exposure for each successive claims-made policy during the transition; this factor is known as the step factor. The step factor is a percentage of the mature claims-made rate. Determination of the appropriate step factors requires an evaluation of the expected reporting lag and the various factors affecting claim costs during the lag time. Such an evaluation leads to a distribution of costs to each of the lags of a mature claims-made policy.

As an example, consider the mature claims-made policy from 2015 displayed in Table 16.7 above. Loss estimates for L(2015,0), L(2015,1), L(2015,2), L(2015,3) and L(2015,4) expressed as a ratio to the total losses for Report Year 2015 can be used to determine the step factors. The cumulative values of these ratios by year of lag are used to determine the step structure. The table below shows a potential step factor structure for a claims-made policy.

16.8 Step Factors

Claims-Made Year	Step Factor
First	40%
Second	70%
Third	85%
Fourth	95%
Fifth or More	100%

The table implies that 40% of the costs of a mature claims-made policy come from claims that occurred and were reported during that year, 70% of the costs come from claims that occurred during that year and one year prior, and so on. The progression continues until the mature stage is reached.

There is a similar coordination issue when switching from claims-made coverage to an occurrence policy. Consider the example of an insured switching from a claims-made policy to an occurrence policy in 2011.

16.9 Switch from Claims-Made to Occurrence Policy

		Report Year Lag				
		0	1	2	3	4
Report Year	2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = enclosed by dotted rectangle

Occurrence Policy Coverage = shaded

This situation creates a coverage gap. More specifically, there is no coverage for claims that occurred before 2011, but were not reported until after the expiration of the last claims-made policy. To address this issue, companies offer an extended reporting endorsement (or tail coverage) that covers claims that occurred but were not reported before the expiration of the last claims-made policy.

16.10 Switch from Claims-Made to Occurrence Policy with Tail Coverage

		Report Year Lag				
		0	1	2	3	4
Report Year	2010	L(2010,0)	L(2010,1)	L(2010,2)	L(2010,3)	L(2010,4)
	2011	L(2011,0)	L(2011,1)	L(2011,2)	L(2011,3)	L(2011,4)
	2012	L(2012,0)	L(2012,1)	L(2012,2)	L(2012,3)	L(2012,4)
	2013	L(2013,0)	L(2013,1)	L(2013,2)	L(2013,3)	L(2013,4)
	2014	L(2014,0)	L(2014,1)	L(2014,2)	L(2014,3)	L(2014,4)
	2015	L(2015,0)	L(2015,1)	L(2015,2)	L(2015,3)	L(2015,4)

Claims-made = enclosed by dotted rectangle

Tail Coverage = enclosed by dotted triangle

Occurrence Policy Coverage = shaded

While the example above described the situation of switching from a claims-made policy to an occurrence policy, a gap in coverage can also occur in the case of retirement. If physicians with claims-made policies retire, they need protection against claims that are reported after the expiration of the last claims-made policy. This protection is given by a tail policy that covers losses occurring during the period for which claims-made coverage was in force and that are reported after the insured's last claims-made policy expires.

SUMMARY

In the 1960s and 1970s, professional liability insurers had poor results due to unanticipated inflation and increasing claim frequencies. Because of the long-tailed nature of the product, it took a significant amount of time for insurers to realize and react to the poor results. Insurers introduced claims-made coverage to minimize the likelihood of the same thing happening in the future.

Claims-made policies differ from occurrence policies in that the coverage trigger is the report date as opposed to the accident date. Claims-made policies are able to be priced more accurately because of the shorter forecast period.

As there are different coverage triggers, it is important to carefully consider the interplay of claims-made and occurrence policies when an insured switches from one to the other. Failure to do this can result in overlapping coverage or coverage gaps.

KEY CONCEPTS IN CHAPTER 16

1. Rationale for claims-made coverage

2. Aggregating losses by report year and report lag

3. Coverage triggers for claims-made coverage

4. Five principles of claims-made policies

5. Coordinating coverage
   a. Retroactive date
   b. First- and second-year claims-made policies
   c. Mature claims-made policies
   d. Extended reporting endorsement or tail coverage

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APPENDICES

As mentioned throughout this text, there are a variety of techniques that actuaries employ based on the unique circumstances of the product being priced and the data that is available. The following appendices include real examples taken from various insurance rate filings. As such, some of the procedures may vary from those discussed within the actual text.

The numbers have been color-coded in the documents. Blue font represents inputs, red font represents selections, and black font is used for numbers that are calculated or referenced from another exhibit.

APPENDIX A: AUTO INDICATION

The following exhibits show an example of an overall rate level indication using the loss ratio approach. This example is for the property damage liability coverage of personal automobile insurance in State XX. All policies are semi-annual, and the proposed effective date for the revised rates is January 1, 2017. Rates are expected to be in effect for one year.

The individual exhibits are as follows:

- LR Indication: summarizes the calculation of the overall indicated premium change using the loss ratio method on five accident years of State XX experience evaluated as of March 31, 2016.
- Credibility: derives the credibility measure and complement of credibility to be applied to the experience period indicated rate change using the classical credibility approach and the square-root rule.
- Current Rate Level: details the calculation of the current rate level factors using the parallelogram method.
- Premium Trend: derives premium trend factors using the two-step trending approach.
- Loss Development: displays the selection of the reported loss and ALAE development factors using the chain ladder method.
- Loss Trend: supports the selection of the loss trend factors based on the pattern of historical changes in frequency, severity, and pure premium.
- ULAE Ratio: shows the determination of the ULAE factor based on the historical relationship of paid ULAE to paid losses and ALAE.
- Expense: derives the fixed and variable expense provisions using the premium-based projection method.

LR (LOSS RATIO) INDICATION EXHIBIT

The overall rate level indication on the LR Indication Exhibit is calculated based on the latest five accident years evaluated as of March 31, 2016. A projected loss and LAE ratio is selected and added to the fixed expense provision. This ratio is compared to the variable permissible loss ratio to obtain the overall indicated rate change, which is credibility-weighted with the complement, the trended present rates indication from the prior rate change analysis. Each column of the exhibit is described in detail below. Some inputs are calculated on later exhibits, as noted in the exhibit footnotes.

Columns 1 through 4 show the calculation of the projected earned premium at current rate level. Column 1 includes the earned premium for each of the historical accident years. Column 2 displays the current rate level adjustment factors required to convert the historical earned premium to current rate level. Column 3 includes the premium trend factors used to project the historical earned premium to the levels expected during the period the rates will be in effect. Column 4 is the projected earned premium at current rates, which is calculated as the product of Columns 1 through 3.

Columns 5 through 9 show the calculation of the projected ultimate loss and LAE. Column 5 displays the reported losses and ALAE for each accident year. Column 6 shows the loss development factors used to develop the losses and ALAE to ultimate levels. Column 7 contains the trend factors that will adjust the ultimate losses and ALAE from historical levels to the projected level expected during the period the rates will be in effect. Column 8 contains the ULAE factors used to adjust the reported losses and ALAE for the ULAE. Column 9 shows the ultimate loss and LAE expected during the period the rates will be in effect, which is the product of Columns 5 through 8.

Column 10 is the calculation of the projected loss and LAE ratio for each accident year, and is calculated by dividing the projected ultimate loss and LAE (Column 9) by the projected earned premium at current rate level (Column 4). The 5-year average projected loss ratio is calculated by dividing the sum of Column 9 by the sum of Column 4; this is equivalent to weighting the individual years by the earned premium at current rate level in each year. The selected projected ultimate loss and LAE ratio is based on the five-year average, and is included in Row 11.

Rows 12 through 15 show the underwriting expense and profit items. Row 12 displays the projected fixed expense ratio (as a percentage of premium). Rows 13 through 15 show the calculation of the variable permissible loss ratio. Row 13 contains the variable expense provision (i.e., the variable expenses as a percentage of premium), and Row 14 includes the underwriting profit provision (i.e., target profit as a percentage of premium). Row 15 is the variable permissible loss ratio, which is calculated as 100% minus the sum of Rows 13 and 14; this figure represents the percentage of each premium dollar that is available to pay for losses, LAE, and fixed expenses.

Row 16 is the calculation of the indicated rate change using the formula:

$$\text{Indicated Change} = \frac{\text{Loss \& LAE Ratio} + \text{Fixed Expense Ratio}}{\text{Variable Permissible Loss Ratio}} - 1.0$$

$$= \frac{[\text{Row11} + \text{Row12}]}{[\text{Row15}]} - 1.0.$$

Row 17 shows the credibility to be applied to the indicated rate change. Row 18 shows the trended present rates indication from the prior review, which is used as the complement of credibility. Row 19, the credibility-weighted indication, is the result of weighting the actuarial indication from this review with the complement of credibility based on the trended present rates approach. The selected rate change, shown in Row 20, is the credibility-weighted indicated rate change.

CREDIBILITY EXHIBIT

The credibility measure and the complement of credibility are derived on the Credibility Exhibit. The credibility measure is calculated based on a full credibility standard of 1,082 claims, and the complement of credibility is the residual indication based on the latest rate change and indication (i.e., the “trended present rates” approach to derive complement of credibility, as discussed in Chapter 12).

Rows 1 through 3 show the calculation of the credibility measure. Row 1 displays the number of claims in the experience period. Row 2 shows the full credibility standard for private passenger auto calculated using the classical credibility approach. Row 3 shows the credibility assigned to the historical loss ratio indication. Since the number of claims exceeds the number of claims needed for full credibility, the credibility is 100%.

Rows 4 through 11 display the derivation of the complement of credibility. Rows 4 and 5 show the last indicated rate change and the last rate change taken. Row 6 divides the sum of one plus Row 4 by the sum of one plus Row 5 and then subtracts one; this represents the residual indication. The residual indication is adjusted by the net trend factor. The net trend is calculated by dividing the sum of one and the loss trend (Row 7) by the sum of one and the premium trend (Row 8) and then subtracting one. The trend period is measured from the last rate change effective date (January 1, 2016) to the proposed effective date (January 1, 2017). The trended present rates indication is shown in Row 11 and is used as the complement of credibility.

CURRENT RATE LEVEL EXHIBIT

Historical premium needs to be adjusted to account for any rate changes that have taken place during or after the historical experience period; in other words, the historical premium needs to be adjusted to the rate level currently in effect. The Current Rate Level Exhibit shows the calculation of the current rate level factors using the parallelogram method for each year.

Sheet 1

Sheet 1 shows the derivation of the cumulative rate level indices for each rate level group during or after the historical period. The rate change history is displayed in Columns 1 and 2. The rate level index in Column 3 is the rate change added to one, and the cumulative rate level index in Column 4 is the cumulative product of the indices in Column 3.

Sheet 2

Sheet 2 calculates the current rate level factors. The columns in 1a display the portion of premium earned during each calendar year for each of the individual rate level groups. These figures are calculated based on the assumption that the six-month policies are written uniformly throughout the year. Column 2 shows the average cumulative rate level for each calendar year, which is the cumulative rate level associated with each rate level group weighted by the portion of the calendar year premium represented by the rate level group. Column 3 displays the current rate level index, which is the cumulative rate level in the most recent rate level group. Column 4 is the factor to be applied to earned premium in each calendar year to bring it to current rate level, and is the ratio of Column 3 to Column 2.

PREMIUM TREND EXHIBIT

Historical premium also needs to be adjusted to account for the change in average premium level due to distributional changes in the book of business. The Premium Trend Exhibit shows the calculation of the premium trend factors used in the indication using a two-step trending approach. This exhibit is described in detail below.

Sheets 1-2

Sheet 1 shows the historical annual changes in average written premium at current rate level. Column 3 is the average written premium at current rate level for the 12-month period ending each quarter, and is calculated by dividing the written premium at current rate level (Column 1) by the written exposures (Column 2). It would have been preferable to use the average written premium at current rate level for each quarter (rather than the 12-month rolling quarter), but that data was not readily available. Column 4 calculates an annual trend of average written premium at current rate level (i.e., the percentage change from the prior year). Exponential trends based on various lengths of time are calculated and displayed at the bottom of the sheet. Sheet 2 displays the data in graphical format. The selected projected premium trend is included on Sheet 2. The trend selection is based on the more recent data because this projection is going to be applied to historical premium already trended to the most recent period.

Sheet 3

Sheet 3 shows the derivation of the premium trend factors. Columns 1 and 2 show calendar year earned premium at current rate level and earned exposures, respectively. Average earned premium at current rate level is calculated in Column 3 by dividing Column 1 by Column 2. Column 4 is the most recent average written premium at current rate level from Sheet 1. Column 5 shows the current trend factor, which adjusts the earned premium for each calendar year to the most recent average written premium level; these factors are calculated by dividing Column 4 by Column 3. Column 6 is the selected projected premium trend. Column 7 is the projected trend period, measured from the average written date of the 12 month period ending December 31, 2015 (this is June 30, 2015) to the average written date of PY2017 (June 30, 2017). The projected trend factor is calculated in Column 8 as one plus Column 6, raised to the power of Column 7. Column 9 is the total trend factor that brings historical earned premium at current rate level to the projected level when rates will be in effect, and is calculated as the product of Columns 5 and 8.

LOSS DEVELOPMENT EXHIBIT

Since losses and ALAE in the historical data are not fully mature, they need to be developed. The Loss Development Exhibit shows the calculation of the loss and ALAE development factors using the chain ladder technique. In this exhibit, the historical reported loss and paid ALAE are shown for each accident year at each valuation point. Each row represents the reported loss and paid ALAE for a given accident year with each column representing a specific age of development.

The age-to-age factors, or link ratios, are calculated for each accident year by dividing the reported loss and paid ALAE at one valuation point by the value at the previous valuation point. Rows 1 through 5 show various averages used as guides for selections. The three-, four-, and all-year averages represent straight averages of the link ratios. The average excluding hi-lo represents the straight average of all link ratios after excluding the highest and lowest link ratios. The geometric average is the n^{th} root of the product of the n link ratios used in the average.

Row 6 shows the selected age-to-age factors. Row 7 converts the selected age-to-age factors to age-to-ultimate factors by multiplying each age-to-age factor by all of the subsequent age-to-age factors. For example, the 39-ultimate factor is the product of the selected 39-51, 51-63, and 63-ultimate age-to-age factors.

LOSS TREND EXHIBIT

Because the proposed rates will be in effect in a period later than the historical period, the loss and ALAE need to be adjusted to account for expected trends in the frequency and severity of claims between the two periods. A two-step loss trending approach is used. Regional data is used to determine appropriate trends.

Sheets 1-4

Sheet 1 shows the historical frequencies, severities, and pure premiums. Columns 1 through 3 are the earned exposures, closed claim counts, and paid losses on a rolling 12-month basis (i.e., 12 month period ending each quarter). Changes in paid losses are used as the best estimate of the trend as the use of paid losses eliminates any distortions caused by changes in overall reserve adequacy. LAE are not included with the losses in the trend data, and are therefore assumed to be affected by the same trend. Columns 4 through 6 display the frequency (Column 2 divided by Column 1), severity (Column 3 divided by Column 2), and pure premium (Column 3 divided by Column 1) for each 12-month ending period. Exponential trends are fit to the frequency, severity, and pure premiums columns for various durations. While not displayed, some actuaries may view the *R-squared* statistic to gauge the goodness of fit of the exponential trends, and consider that when making selections.

Sheets 2 through 4 are the graphical representation of this data and the selected trends.

Sheet 5

Sheet 5 shows the derivation of the total loss trend factor. Column 1 shows the selected current loss trend factor, and Column 2 shows the current cost trend period for each accident year, which is the number of years between the average date of loss in the accident year (June 30, 20XX) to the average date of loss for the most recent period used to select the loss trends (June 30, 2015). Column 3 is the sum of one and the selected current pure premium trend from Column 1 trended for the length of time in Column 2. Columns 4 through 6 show a similar calculation to determine the projected pure premium trend factor. In this case, the selected projected pure premium trend is used to trend losses and ALAE from June 30, 2015, to the average date of loss for the projected period (September 30, 2017). Column 7 is the total pure premium loss trend factor and is calculated as the product of Columns 3 and 6.

ULAE RATIO EXHIBIT

In this example, three calendar years of countrywide data are used to determine the factor needed to adjust the State XX reported loss and paid ALAE to include ULAE. Column 1 includes the countrywide calendar year paid loss and ALAE, and Column 2 shows the countrywide calendar year paid ULAE. Calendar year paid information is used as it is readily available accounting data and is not susceptible to changes in reserving practices. Column 3 (Column 2 divided by Column 1) is the paid ULAE as a percentage of paid loss and ALAE. The selection in Row 4 is based on the historical ratios. The selected percentage is converted into a factor in Row 5 by adding one.

EXPENSE EXHIBIT

The underwriting expense ratios are determined using the premium-based projection method. This method assumes that the historical relationship between expenses and premium is expected to continue during the projected period.

The expenses are divided into five categories: general, other acquisition, licenses and fees, commissions and brokerage, and taxes. The calculations and selections are performed for each category separately.

For each of the five categories, Row "a" shows the expense associated with the category for each of the three calendar years. The expense is aggregated either at the state or countrywide level, depending on the category. Row "b" displays the corresponding premium. The premium used in this calculation is either state or countrywide and either written or earned depending on the nature of the expense category. Row "c" is the calculation of the expense ratio for each expense category for each year, as well as the premium-weighted average of the three years; the selected percentage is displayed in the last column. Row "d" contains the percentage selected to split each expense ratio between fixed and variable. Rows "e" and "f' are the resulting fixed and variable expense ratios, respectively, using the selected percentage shown in Row "d."

Rows 6 and 7 at the bottom of the exhibit are the totals of the fixed and variable expense ratios from summing the individual categories. No expense trend is applied to the fixed expense ratio. This assumes the expenses and premium will trend at the same rate and the ratio will remain constant.

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Indicated Rate Change - Loss Ratio Method

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Calendar Accident Year	Earned Premium	Current Rate Level Factor	Premium Trend Factor	Projected Earned Premium at Current Rate Level	Reported Losses and Paid ALAE	Loss Development Factor	Loss Trend Factor	ULAE Factor	Projected Ultimate Losses and LAE	Projected Loss and LAE Ratio
2011	$ 1,122,372	1.2161	1.1342	$ 1,548,088	$ 856,495	1.0000	0.9912	1.143	$ 970,359	62.7%
2012	$ 1,154,508	1.2176	1.1116	$ 1,562,608	$ 867,184	0.9799	0.9962	1.143	$ 967,578	61.9%
2013	$ 1,280,545	1.1311	1.0879	$ 1,575,741	$ 835,120	1.0003	1.0012	1.143	$ 955,974	60.7%
2014	$ 1,369,976	1.0892	1.0663	$ 1,591,109	$ 821,509	1.0282	1.0062	1.143	$ 971,450	61.1%
2015	$ 1,397,750	1.0991	1.0452	$ 1,605,706	$ 797,866	1.0966	1.0113	1.143	$ 1,011,357	63.0%
Total	$ 6,325,151			$ 7,883,252	$ 4,178,174				$ 4,876,718	61.9%

(11)	Selected Projected Loss and LAE Ratio	61.9%
(12)	Fixed Expense Provision	11.3%
(13)	Variable Expense Provision	17.0%
(14)	UW Profit Provision	5.0%
(15)	Variable Permissible Loss Ratio	78.0%
(16)	Indicated Rate Change	-6.2%
(17)	Credibility	100.0%
(18)	Trended Present Rates Indication	6.2%
(19)	Credibility-Weighted Indicated Rate Change	-6.2%
(20)	Selected Rate Change	-6.2%

(2) From Current Rate Level Exhibit - 2
(3) From Premium Trend Exhibit - 3
(4) = (1) x (2) x (3)
(5) Case Incurred Losses and ALAE Evaluated As Of 03/31/2016
(6) From Loss Development Exhibit
(7) From Loss Trend Exhibit - 5
(8) From ULAE Ratio Exhibit
(9) = (5) x (6) x (7) x (8)
(10) = (9) / (4)
(12) From Expense Exhibit
(13) From Expense Exhibit
(14) Selected profit provision
(15) = 100% - (13) - (14)
(16) = { [(11) + (12)] / (15) } - 1.0
(17) From Credibility Exhibit
(18) From Credibility Exhibit
(19) = (16) x (17) + (18) x [1.0 - (17)]

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Credibility Calculations

(1)	Total Number of Claims in Historical Period	3,612
(2)	Number of Claims for Full Credibility	1,082
(3)	Credibility Min{ [(1) / (2)] ^ 0.5, 1.0 }	100.0%
(4)	Latest Indicated Rate Change	13.2%
(5)	Last Rate Change Taken From Current Rate Level Exhibit - 1	5.0%
(6)	Residual Indication { [1.0 + (4)] / [1.0 + (5)] } - 1.0	7.8%
(7)	Projected Loss Trend From Loss Trend Exhibit - 1	0.5%
(8)	Projected Premium Trend From Premium Trend Exhibit - 1	2.0%
(9)	Net Trend { [1.0 + (7)] / [1.0 + (8)] } - 1.0	-1.5%
(10)	Trend Period From Last Rate Change Effective Date (01/01/2016) to Proposed Effective Date (01/01/2017)	1.0
(11)	Trended Present Rates Indication { [1.0 + (6)] x [1.0 + (9)] ^ (10) } - 1.0	6.2%

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Rate Change History

Rate Level Group	(1) Effective Date	(2) Rate Change	(3) Rate Level Index	(4) Cumulative Rate Level Index
A			1.0000	1.0000
B	04/01/2011	-5.0%	0.9500	0.9500
C	07/01/2012	10.0%	1.1000	1.0450
D	10/01/2013	5.0%	1.0500	1.0973
E	07/01/2014	-2.0%	0.9800	1.0754
F	10/01/2015	5.0%	1.0500	1.1292
G	01/01/2016	5.0%	1.0500	1.1857

(3) = 1.0 + (2)
(4) = Cumulative Product of (3)

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Calculation of Current Rate Level Factors

	(1a)							(2)	(3)	(4)
	Portion of Earned Premium Assumed in Each Rate Level Group							Average Cumulative Rate Level	Current Rate Level Index	
Calendar Year	A	B	C	D	E	F	G			CRL Factor
2011	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.9750	1.1857	1.2161
2012	0.00%	75.00%	25.00%	0.00%	0.00%	0.00%	0.00%	0.9738	1.1857	1.2176
2013	0.00%	0.00%	93.75%	6.25%	0.00%	0.00%	0.00%	1.0483	1.1857	1.1311
2014	0.00%	0.00%	6.25%	68.75%	25.00%	0.00%	0.00%	1.0886	1.1857	1.0892
2015	0.00%	0.00%	0.00%	0.00%	93.75%	6.25%	0.00%	1.0788	1.1857	1.0991
(1b) Cumulative Rate Level	1.0000	0.9500	1.0450	1.0973	1.0754	1.1292	1.1857			

(1a) Portion of Each Calendar Year's Earned Premium by Rate Level Group
(1b) Cumulative Rate Level for each Rate Level Group
(2) (1b) Weighted by (1a) Within Each Calendar Year
(4) = (3) / (2)

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Premium Trend Selection

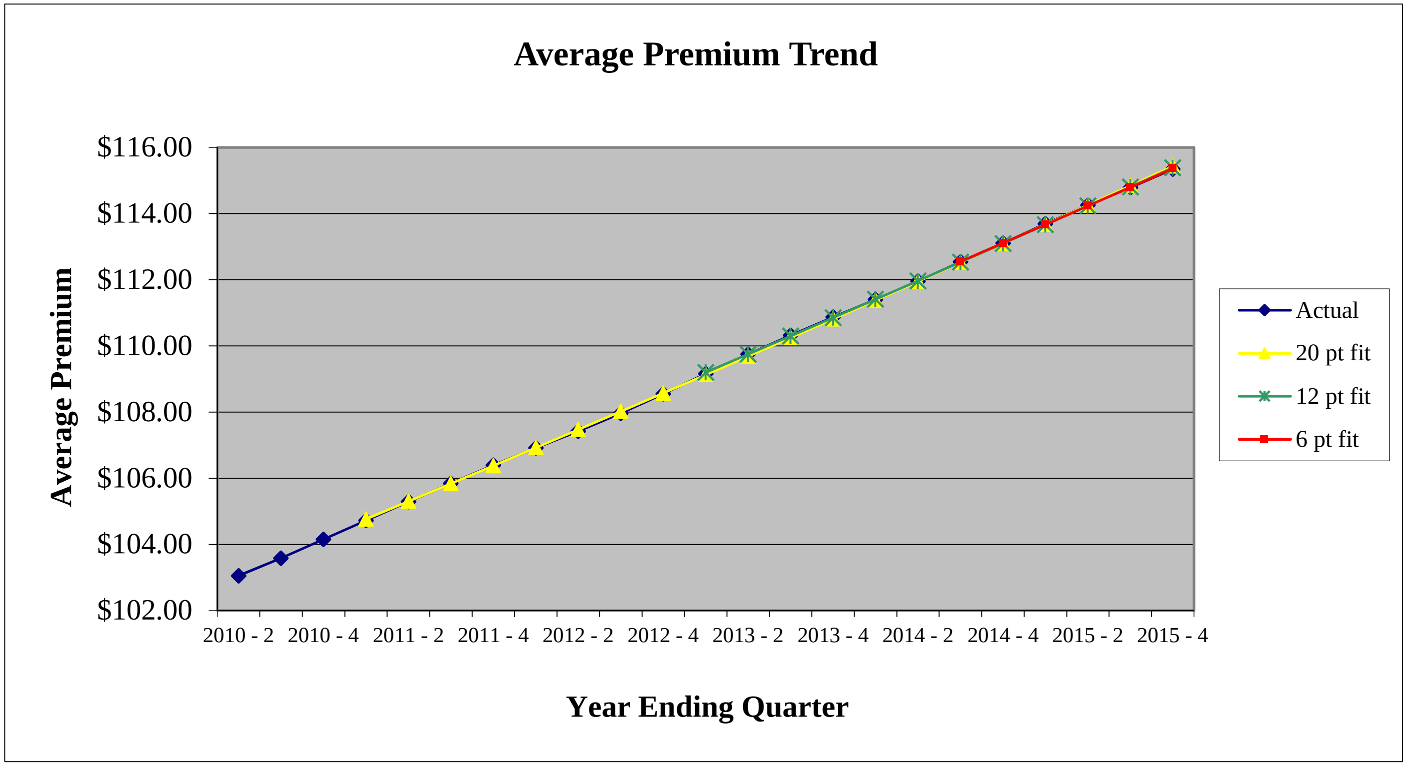
Year Ending Quarter - X	(1) Written Premium at CRL	(2) Written Exposure	(3) Average Written Premium at CRL	(4) Annual Trend
2010 - 2	$1,314,117	12,752	$103.05	
2010 - 3	$1,323,381	12,776	$103.58	
2010 - 4	$1,333,726	12,806	$104.15	
2011 - 1	$1,343,014	12,825	$104.72	
2011 - 2	$1,354,391	12,863	$105.29	2.2%
2011 - 3	$1,364,644	12,893	$105.84	2.2%
2011 - 4	$1,374,283	12,917	$106.39	2.2%
2012 - 1	$1,384,951	12,953	$106.92	2.1%
2012 - 2	$1,393,570	12,973	$107.42	2.0%
2012 - 3	$1,403,987	13,005	$107.96	2.0%
2012 - 4	$1,415,881	13,044	$108.55	2.0%
2013 - 1	$1,428,087	13,082	$109.16	2.1%
2013 - 2	$1,438,647	13,108	$109.75	2.2%
2013 - 3	$1,448,311	13,128	$110.32	2.2%
2013 - 4	$1,458,540	13,155	$110.87	2.1%
2014 - 1	$1,468,617	13,183	$111.40	2.1%
2014 - 2	$1,479,666	13,217	$111.95	2.0%
2014 - 3	$1,492,537	13,262	$112.54	2.0%
2014 - 4	$1,503,294	13,292	$113.10	2.0%
2015 - 1	$1,514,903	13,325	$113.69	2.1%
2015 - 2	$1,524,242	13,341	$114.25	2.1%
2015 - 3	$1,536,215	13,383	$114.79	2.0%
2015 - 4	$1,547,368	13,414	$115.35	2.0%

Exponential Trend	
20 pt	2.1%
16 pt	2.1%
12 pt	2.0%
8 pt	2.0%
6 pt	2.0%
4 pt	1.9%

Selected Projected Premium Trend 2.0%

(3) = (1) / (2)
(4) Percent Change in Avg WP at CRL From Prior Year

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Premium Trend



Exponential Trend		Selection
20 pt	2.1%	2.0%
12 pt	2.0%	
6 pt	2.0%	

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Premium Trend Calculation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Calendar Year	Earned Premium at CRL	Earned Exposure	Average Earned Premium at CRL	Most Recent Average Written Premium at CRL	Current Trend Factor	Selected Projected Premium Trend	Projected Trend Period	Projected Trend Factor	Total Trend Factor
2011	$1,364,916.59	12,900	$105.81	$115.35	1.0902	2.0%	2.0000	1.0404	1.1342
2012	$1,405,728.94	13,020	$107.97	$115.35	1.0684	2.0%	2.0000	1.0404	1.1116
2013	$1,448,424.45	13,130	$110.31	$115.35	1.0457	2.0%	2.0000	1.0404	1.0879
2014	$1,492,177.86	13,258	$112.55	$115.35	1.0249	2.0%	2.0000	1.0404	1.0663
2015	$1,536,267.03	13,380	$114.82	$115.35	1.0046	2.0%	2.0000	1.0404	1.0452

(1) = [LR Indication Exhibit (1)] x [Current Rate Level Exhibit - 2 (4)]
(3) = (1) / (2)
(4) Average Written Premium for Year Ending 2015, Quarter 4
[From Premium Trend Exhibit - 1]
(5) = (4) / (3)
(6) From Premium Trend Exhibit - 1
(7) From 06/30/2017 to 06/30/2017
(8) = [1.0 + (6)] ^ (7)
(9) = (5) x (8)

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Loss Development

Accident Year	15 Months	27 Months	39 Months	51 Months	63 Months
	Reported Losses and Paid ALAE Evaluated As Of				
2009	705,088	725,592	738,686	753,027	732,239
2010	712,475	753,295	782,248	800,258	813,949
2011	714,196	763,913	855,150	874,106	856,495
2012	764,101	861,114	884,498	867,184	
2013	774,384	846,167	835,120		
2014	785,068	821,509			
2015	797,866				

Age-to-Age Factors	15-27	27-39	39-51	51-63	63-Ult
2009	1.0291	1.0180	1.0194	0.9724	
2010	1.0573	1.0384	1.0230	1.0171	
2011	1.0696	1.1194	1.0222	0.9799	
2012	1.1270	1.0272	0.9804		
2013	1.0927	0.9869			
2014	1.0464				
(1) All-Year Average	1.0704	1.0380	1.0113	0.9898	
(2) 3-Year Average	1.0887	1.0445	1.0085	0.9898	
(3) 4-Year Average	1.0839	1.0430	1.0113		
(4) Average Excluding Hi-Lo	1.0665	1.0279	1.0208	0.9799	
(5) Geometric Average	1.0699	1.0371	1.0111	0.9896	
(6) Selected Age-to-Age	1.0665	1.0279	1.0208	0.9799	1.0000
(7) Age-to-Ultimate	1.0966	1.0282	1.0003	0.9799	1.0000

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Straight Average Excluding Highest and Lowest Values
(5) = (Product of Age-to-Age Factors) ^ (1.0 / Number of Age-to-Age Factors)
(7) = Cumulative Product of (6)

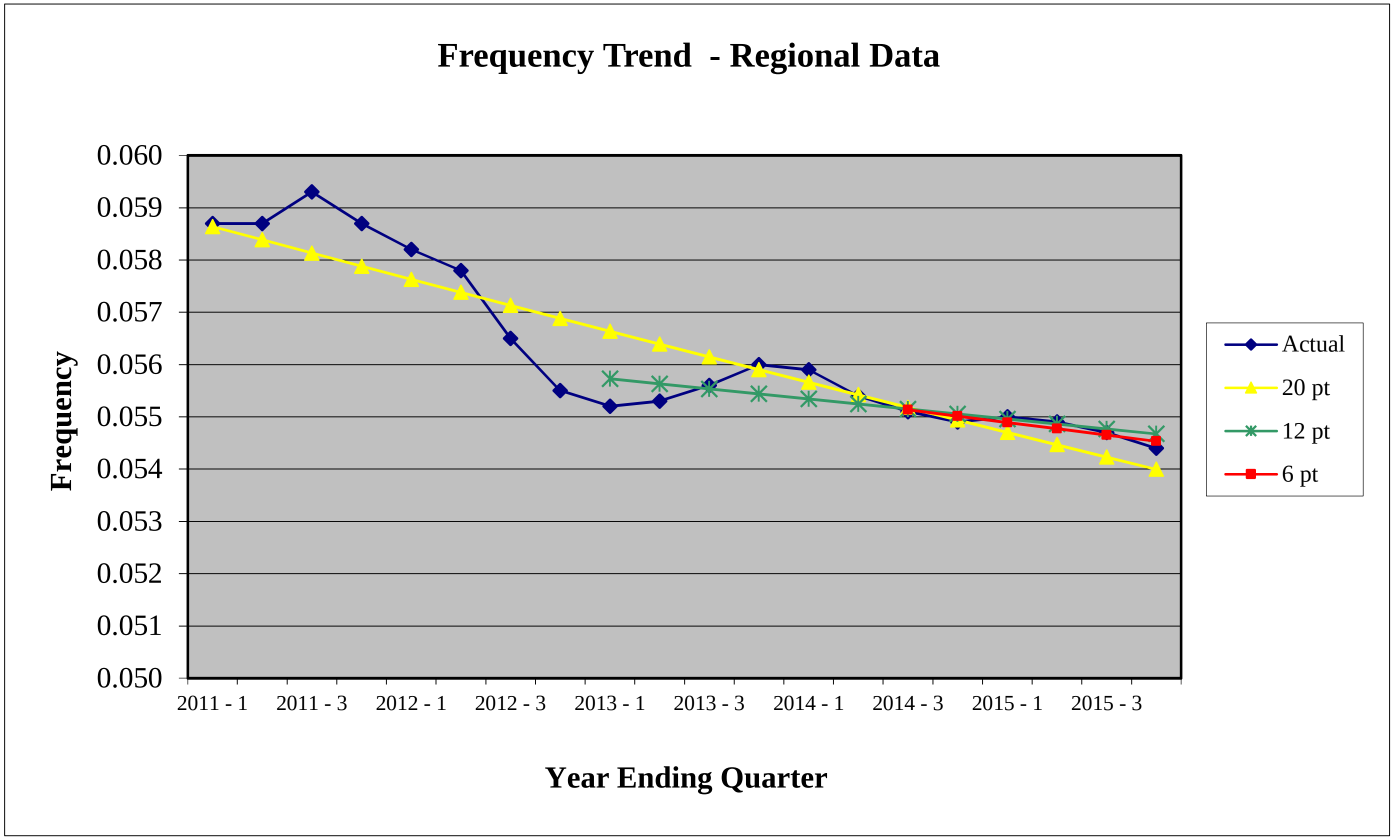
State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Loss Trend Selections - Regional Data

Year Ending Quarter - X	(1) Earned Exposure	(2) Closed Claim Count	(3) Paid Losses	(4) Frequency	(5) Severity	(6) Pure Premium
2011 - 1	131,911	7,745	$8,220,899	0.0587	$1,061.45	$62.32
2011 - 2	132,700	7,785	$8,381,016	0.0587	$1,076.56	$63.16
2011 - 3	133,602	7,917	$8,594,389	0.0593	$1,085.56	$64.33
2011 - 4	135,079	7,928	$8,705,108	0.0587	$1,098.02	$64.44
2012 - 1	137,384	7,997	$8,816,379	0.0582	$1,102.46	$64.17
2012 - 2	138,983	8,037	$8,901,163	0.0578	$1,107.52	$64.04
2012 - 3	140,396	7,939	$8,873,491	0.0565	$1,117.71	$63.20
2012 - 4	140,997	7,831	$8,799,730	0.0555	$1,123.70	$62.41
2013 - 1	140,378	7,748	$8,736,859	0.0552	$1,127.63	$62.24
2013 - 2	139,682	7,719	$8,676,220	0.0553	$1,124.01	$62.11
2013 - 3	138,982	7,730	$8,629,925	0.0556	$1,116.42	$62.09
2013 - 4	138,984	7,790	$8,642,835	0.0560	$1,109.48	$62.19
2014 - 1	139,155	7,782	$8,602,105	0.0559	$1,105.38	$61.82
2014 - 2	139,618	7,741	$8,535,327	0.0554	$1,102.61	$61.13
2014 - 3	139,996	7,720	$8,466,272	0.0551	$1,096.67	$60.48
2014 - 4	140,141	7,691	$8,412,159	0.0549	$1,093.77	$60.03
2015 - 1	140,754	7,735	$8,513,679	0.0550	$1,100.67	$60.49
2015 - 2	141,534	7,769	$8,614,224	0.0549	$1,108.79	$60.86
2015 - 3	141,800	7,755	$8,702,135	0.0547	$1,122.13	$61.37
2015 - 4	142,986	7,778	$8,761,588	0.0544	$1,126.46	$61.28

Exponential Trend	Frequency	Severity	Pure Premium
20 pt	-1.7%	0.5%	-1.2%
16 pt	-1.3%	-0.1%	-1.4%
12 pt	-0.7%	-0.2%	-0.9%
8 pt	-1.2%	1.2%	-0.1%
6 pt	-0.9%	2.5%	1.6%
4 pt	-1.5%	3.3%	1.9%
Selections			
Current	-1.0%	0.5%	-0.5%
Projected	-1.0%	1.5%	0.5%

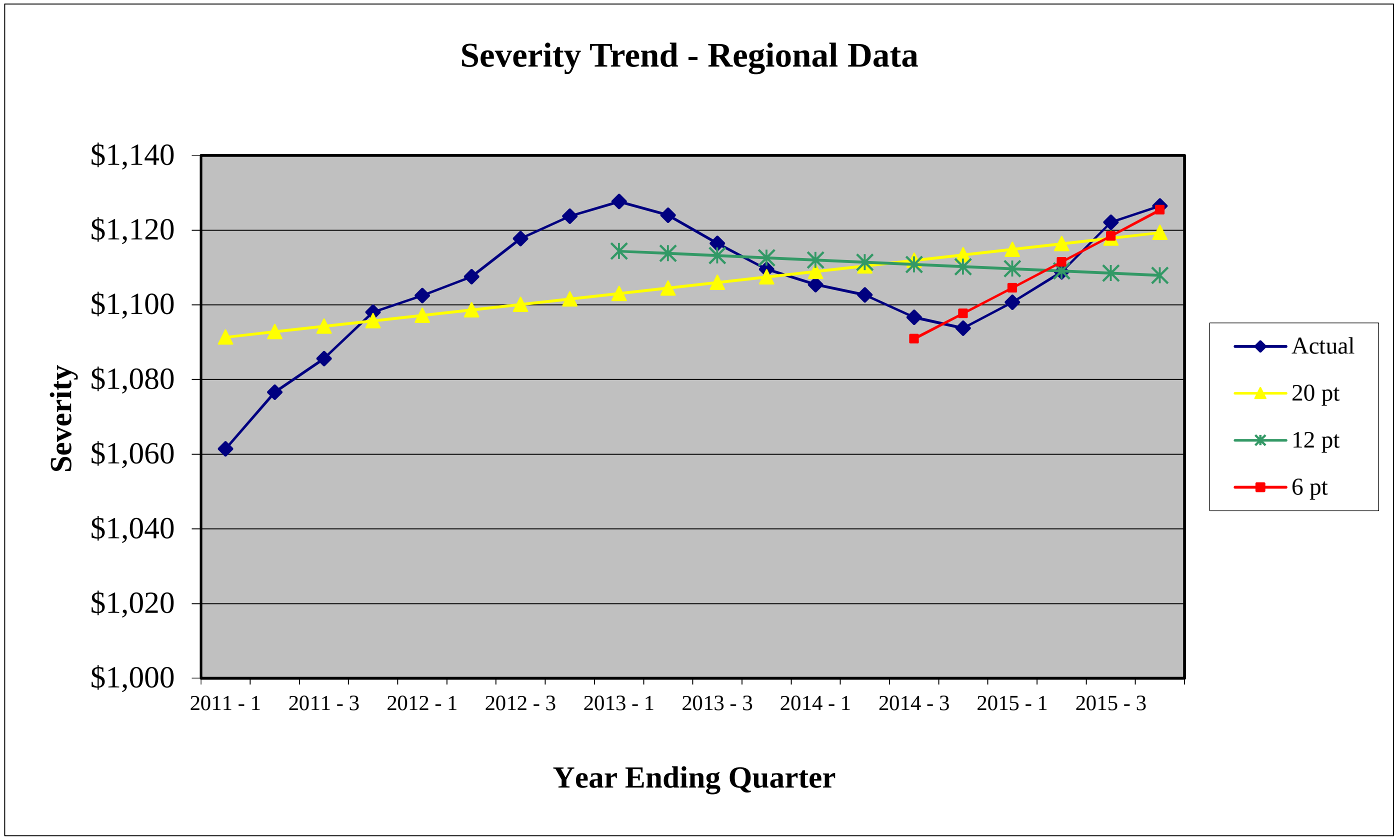
(1) Shown on a 4-Quarter Rolling Total Basis
(2) Shown on a 4-Quarter Rolling Total Basis
(3) Shown on a 4-Quarter Rolling Total Basis
(4) = (2) / (1)
(5) = (3) / (2)
(6) = (3) / (1)

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Frequency Trend - Regional Data



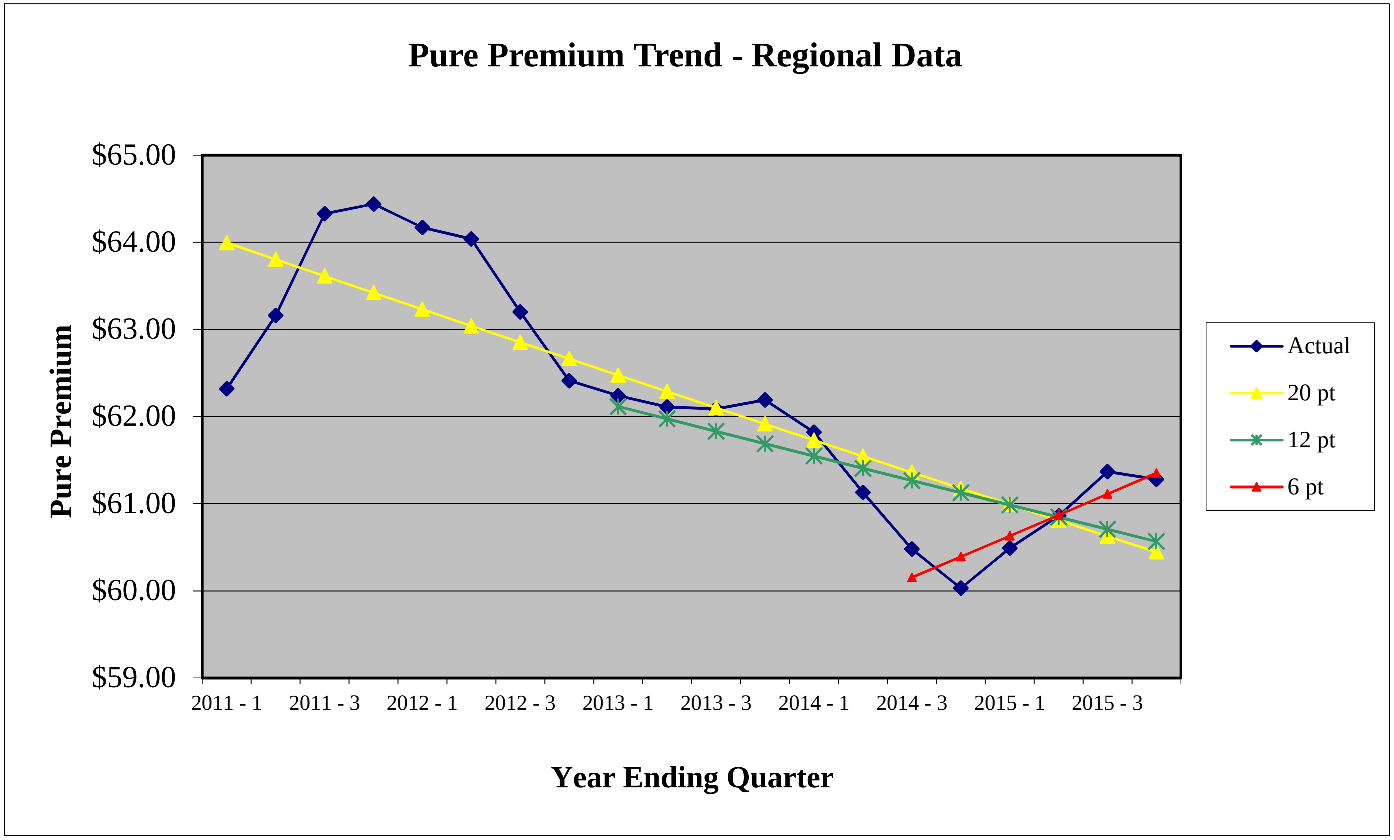
Exponential Trend			Selections	
20 pt	-1.7%		Current	-1.0%
12 pt	-0.7%		Projected	-1.0%
6 pt	-0.9%			

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Severity Trend -Regional Data



Exponential Trend			Selections	
20 pt	0.5%		Current	0.5%
12 pt	-0.2%		Projected	1.5%
6 pt	2.5%			

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Pure Premium Trend - Regional Data



Exponential Trend			Selections*	
20 pt	-1.2%		Current	-0.5%
12 pt	-0.9%		Projected	0.5%
6 pt	1.6%		* Calculated Using Frequency and Severity Trend Selections	

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Loss Trend

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Accident Year	Selected Current Trend	Current Cost Trend Period	Current Trend Factor	Selected Projected Trend	Projected Cost Trend Period	Projected Trend Factor	Loss Trend Factor
2011	-0.5%	4.00	0.9801	0.5%	2.25	1.0113	0.9912
2012	-0.5%	3.00	0.9851	0.5%	2.25	1.0113	0.9962
2013	-0.5%	2.00	0.9900	0.5%	2.25	1.0113	1.0012
2014	-0.5%	1.00	0.9950	0.5%	2.25	1.0113	1.0062
2015	-0.5%	0.00	1.0000	0.5%	2.25	1.0113	1.0113

(1) From Loss Trend Exhibit - 1
(2) From 07/01/20XX to 06/30/2015
(3) = [1.0 + (1)] ^ (2)
(4) From Loss Trend Exhibit - 1
(5) From 07/01/2015 to 09/30/2017
(6) = [1.0 + (4)] ^ (5)
(7) = (3) x (6)

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
ULAE Ratio

Calendar Year	(1) Countrywide Paid Losses and ALAE	(2) Countrywide Paid ULAE	(3) ULAE Ratio
2013	$ 283,299,252	$ 41,170,520	14.5%
2014	$ 290,213,410	$ 41,262,210	14.2%
2015	$ 293,934,810	$ 41,959,671	14.3%
Total	$ 867,447,472	$ 124,392,401	14.3%
		(4) Selected Ratio	14.3%
		(5) ULAE Factor	1.143

(3) = (2) / (1)
(5) = 1.0 + (4)

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Expense Calculation

	2013	2014	2015	3-Year Weighted Average	Selected
(1) General Expenses					
a Countrywide Expenses	$ 29,143,368	$ 29,940,978	$ 30,763,160		
b Countrywide Earned Premium	$ 466,001,205	$ 478,971,842	$ 491,904,082		
c Ratio[(a)/(b)]	6.3%	6.3%	6.3%	6.3%	6.3%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c)x(d)]					4.7%
f Variable Expense % [(c)x(1.0-(d))]					1.6%
(2) Other Acquisition					
a Countrywide Expenses	$ 40,158,296	$ 40,912,479	$ 41,652,543		
b Countrywide Written Premium	$ 468,850,020	$ 482,345,783	$ 495,356,701		
c Ratio[(a)/(b)]	8.6%	8.5%	8.4%	8.5%	8.5%
d % Assumed Fixed					75.0%
e Fixed Expense % [(c)x(d)]					6.4%
f Variable Expense % [(c)x(1.0-(d))]					2.1%
(3) Licenses and Fees					
a State Expenses	$ 3,124	$ 3,190	$ 3,229		
b State Written Premium	$ 1,289,484	$ 1,380,129	$ 1,407,811		
c Ratio[(a)/(b)]	0.2%	0.2%	0.2%	0.2%	0.2%
d % Assumed Fixed					100.0%
e Fixed Expense % [(c)x(d)]					0.2%
f Variable Expense % [(c)x(1.0-(d))]					0.0%
(4) Commission and Brokerage					
a State Expenses	$ 145,073	$ 154,235	$ 158,712		
b State Written Premium	$ 1,289,484	$ 1,380,129	$ 1,407,811		
c Ratio[(a)/(b)]	11.3%	11.2%	11.3%	11.2%	11.2%
d % Assumed Fixed					0.0%
e Fixed Expense % [(c)x(d)]					0.0%
f Variable Expense % [(c)x(1.0-(d))]					11.2%
(5) Taxes					
a State Expenses	$ 27,338	$ 27,549	$ 29,853		
b State Written Premium	$ 1,289,484	$ 1,380,129	$ 1,407,811		
c Ratio[(a)/(b)]	2.1%	2.0%	2.1%	2.1%	2.1%
d % Assumed Fixed					0.0%
e Fixed Expense % [(c)x(d)]					0.0%
f Variable Expense % [(c)x(1.0-(d))]					2.1%
(6) Fixed Expense Provision	(1e) + (2e) + (3e) + (4e) + (5e)				11.3%
(7) Variable Expense Provision	(1f) + (2f) + (3f) + (4f) + (5f)				17.0%

APPENDIX B: HOMEOWNERS INDICATION

Companies use a variety of approaches to produce homeowners overall rate level indications. The following exhibits show an example of a homeowners rate level indication using the pure premium approach. All policies are annual, and the proposed effective date for new rates in State XX is January 1, 2017. Rates are expected to be in effect for one year.

The individual exhibits are as follows:

- PP Indication: summarizes the calculation of the overall indicated rate per exposure using the pure premium method on five accident years of experience evaluated as of March 31, 2016.
- Non-Modeled Cat: details the calculation of the catastrophe provision for non-modeled catastrophes.
- AIY Projection: supports the selection of the projected average amount of insurance years (AIY) in the effective period, as used in the derivation of the non-modeled catastrophe pure premium.
- Reinsurance: derives the projected net reinsurance cost per exposure.
- Loss Development: displays the derivation and selection of the loss and ALAE development factors using the chain ladder method.
- Loss Trend: supports the selection of the loss trend factors based on the historical changes of pure premium.
- ULAE Ratio: shows the determination of the ULAE factor based on the historical relationship of paid ULAE to paid losses and ALAE.
- Expense: derives the fixed and variable expense provisions using the exposure-based projection method.

PP (PURE PREMIUM) INDICATION EXHIBIT

The overall rate level indication is calculated on the Pure Premium Indication Exhibit based on the latest five accident years evaluated as of March 31, 2016. The projected non-catastrophe pure premium for State XX is credibility-weighted with a regional non-catastrophe pure premium, and then added to the sum of the non-modeled catastrophe pure premium and modeled catastrophe pure premium. The total projected pure premium is combined with the projected fixed expense per exposure and the projected net reinsurance cost per exposure. This value is compared to the variable permissible loss ratio to obtain the overall indicated rate. Each column or input of the exhibit is described in detail below. Some inputs are derived on later exhibits, as noted in the exhibit footnotes.

Column 1 is the earned exposure by calendar year. Columns 2 through 7 show the calculation of the projected non-catastrophe pure premium (including LAE). The projected non-catastrophe loss and LAE in Column 6 is calculated by multiplying the non-catastrophe reported loss and paid ALAE (Column 2) by the loss development factor (Column 3), the loss trend factor (Column 4), and the ULAE factor (Column 5). The projected non-catastrophe pure premium in Column 7 is Column 6 divided by the earned exposures in Column 1. Row 8 is the selected non-catastrophe pure premium, which is based on the five-year weighted average non-catastrophe pure premium.

Rows 9 through 13 show the derivation of the credibility-weighted non-catastrophe pure premium. The full credibility standard of 1,082 claims is based on the classical credibility approach; partial credibility is calculated using the square root rule. The complement of credibility is the regional non-catastrophe pure premium.

Rows 14 and 15 display the non-modeled catastrophe pure premium and the modeled catastrophe pure premium, respectively. Row 16 is the total projected pure premium, calculated as the sum of Rows 13, 14, and 15.

Row 17 shows the projected net reinsurance cost per exposure.

The indicated rate per exposure (Row 22) is calculated as the sum of the total pure premium (Row 16), the projected fixed expense per exposure (Row 18), and the projected net reinsurance cost per exposure (Row 17), divided by the variable permissible loss ratio (Row 21).

NON-MODELED CAT EXHIBIT

This exhibit outlines the calculation of the non-modeled catastrophe pure premium, considering a twenty year period. Column 1 shows the amount of insurance years, or AIY, (in $000s) for each calendar year. Amount of insurance years represents the sum total of amount of insurance for all policies in-force during the calendar year. If the non-modeled catastrophe pure premium was based on the ratio of non-modeled catastrophe losses and ALAE to house years, the ratio would increase over time due to the influence of inflation and other factors on the numerator during the twenty year period. Using AIY in the denominator is a simple way to adjust the ratio for inflation. Column 2 displays the non-modeled catastrophe losses and ALAE for each calendar year. Column 3 is the ratio of Column 2 to Column 1, called the Cat-to-AIY Ratio. Row 4 is the arithmetic average of the Cat-to-AIY Ratios. Row 6 is the non-modeled catastrophe provision per $1,000 of AIY, or the average Cat-to-AIY Ratio adjusted by the ULAE factor in Row 5 (calculated in a subsequent exhibit). The non-modeled catastrophe provision per $1,000 of AIY is multiplied by the selected average amount of insurance for the period the rates are to be in effect (Row 7, as calculated in the AIY Projection Exhibit). The resulting non-modeled catastrophe pure premium is displayed in Row 8.

AIY PROJECTION EXHIBIT

The projected average AIY is used to calculate the expected non-modeled catastrophe pure premium. The AIY Projection Exhibit details how the projected average AIY is calculated.

Columns 1 through 3 list the amount of insurance years (in $000s), earned exposures, and the ratio of the two. The annual change in the AIY-to-earned exposure ratio is shown in Column 4. Column 5 is the result of an exponential curve fit to the AIY-to-earned exposure ratios, and projected through the year 2018. Row 6 displays the average AIY for the effective period (Policy Year 2017), or the arithmetic average of Column 5 for 2017 and 2018. Row 7 shows the selected projected average AIY.

REINSURANCE EXHIBIT

A reinsurance contract was purchased with an effective date of January 1, 2017 and a twelve-month term. The Reinsurance Exhibit calculates the net reinsurance cost per exposure, which considers both the expected reinsurance recoveries and the cost of the reinsurance contract.

Row 1 displays the expected reinsurance recoveries associated with the reinsurance contract. This is the output of catastrophe models and is the expected recoveries in an "average year." Row 2 shows the cost of reinsurance, or the expected premium that will be ceded to the reinsurer. The net cost of reinsurance is calculated in Row 3 as Row 2 minus Row 1.

Rows 4 through 7 derive the projected exposures for the effective period of the reinsurance contract. Row 4 contains the latest year's exposures. Row 5 displays an estimate of annual exposure growth based on company goals. The projection period in Row 6 is the length of time between the midpoint of the latest year and the midpoint of the reinsurance contract term. Row 7 shows the projected exposures, which is the product of the latest year exposures and the expected exposure increase, raised to the power of the length of the projection period.

The projected net reinsurance cost per exposure is shown in Row 8, and is the net cost of reinsurance divided by the projected exposures.

LOSS DEVELOPMENT EXHIBIT

This is the same procedure used for the personal automobile example in Appendix A. Thus, the same comments apply.

LOSS TREND EXHIBIT

This is the same procedure used for the personal automobile example, except that the data is at the pure premium level rather than at the frequency and severity level. Thus, the same comments apply.

ULAE RATIO EXHIBIT

This is the same procedure used for the personal automobile example. Thus, the same comments apply.

EXPENSE EXHIBIT

The underwriting expense provisions are determined using the exposure-based projection method. This assumes the historical relationships between variable expenses and premium and between fixed expenses and exposures are expected to continue during the projected period.

Sheet 1

On Sheet 1, the expenses are divided into the following categories: general expense; other acquisition; taxes, licenses, and fees; and commissions and brokerage. The calculations and selections are performed for each category independently.

For each of the expense categories, Row "a" shows the expense associated with each category for each of the three calendar years. The expense is either at the state or countrywide level, depending on the category. Row "b" contains the percentage of the expense assumed to be fixed. Rows "c" through "e" show the derivation of the fixed expense per exposure for each expense category. Row "c" displays the fixed expenses for each year, which is calculated by multiplying the expenses for the category by the selected percentage from Row "b." Row "d" displays the exposure per year; the exposures are state or countrywide and written or earned depending on the expense category. Row “e” includes the average fixed expense per exposure for each of the three years.

Rows “f” through “h” show the derivation of the variable expense ratio for each expense category. Row “f” displays the variable expenses for each year, which are calculated by multiplying the total expenses for the category by one minus the selected fixed percentage from Row “b.” Row “g” displays the premium for each year; the premium is state or countrywide and written or earned depending on the expense category. Row “h” includes the variable expense ratio (i.e., the variable expense divided by the premium) for each of the three years, the average of the three years combined, and the selected variable expense ratio. The selected expense ratio was chosen as the most recent year’s ratio to be responsive to trends.

Row 5 at the bottom of the exhibit is the total of the fixed expense per exposure across all of the categories for each of the three years. Rows 6 through 9 describe the projection of the fixed expenses. Row 6 displays the selected expense trend from Sheet 2. Row 7 is the length of the trend period for each year, which is measured as the number of years from the average written date of each calendar year to the average written date for the time period the rates are to be in effect. Row 8 contains the projected fixed expense trend factor for each year. Row 9 is the projected average fixed expense per exposure that results from the application of the trend factor. The selected projected average fixed expense per exposure is based on the latest year’s projection. This figure is used directly in the pure premium indication formula. Row 10 is the total of the selected variable expense provisions; this is used directly in the indication formula.

Sheet 2

Sheet 2 outlines the procedure for selecting the fixed expense trend. Rows 1 and 3 display the annualized changes over the latest two years in the Employment Cost Index and Consumer Price Index, respectively. These two changes are weighted together based on the portion of the major expense categories assumed to be related to salaries. Row 4 displays the selected expense trend.

State XX
Wicked Good Insurance Company
Homeowners
Pure Premium Indication

Calendar Accident Year	(1) Earned Exposures	(2) Non-Cat Reported Losses and Paid ALAE	(3) Loss Development Factor	(4) Loss Trend Factor	(5) ULAE Factor	(6) Projected Ultimate Non-Cat Losses and LAE	(7) Projected Non-Cat Pure Premium
2011	12,760	$ 5,161,624	1.0000	1.1939	1.012	$6,236,412	$488.75
2012	12,766	$ 4,820,968	1.0012	1.1705	1.012	$5,717,511	$447.87
2013	12,805	$ 4,112,172	1.0055	1.1476	1.012	$4,802,025	$375.01
2014	12,834	$ 5,052,052	1.0186	1.1251	1.012	$5,859,265	$456.54
2015	13,411	$ 6,559,224	1.0555	1.1030	1.012	$7,727,993	$576.24
Total	64,576	$ 25,706,040				$30,343,206	$469.88

(8)	Selected Projected Non-Cat Pure Premium	$469.88
(9)	Number of Claims	683
(10)	Claims Required for Full Crediblity	1,082
(11)	Credibilty	79.5%
(12)	Regional Non-Cat Pure Premium	$585.75
(13)	Credibility-Weighted Non-Cat Pure Premium	$493.63
(14)	Non-Modeled Cat Pure Premium	$29.11
(15)	Modeled Cat Pure Premium	$74.57
(16)	Total Pure Premium	$597.31
(17)	Projected Net Reinsurance Cost Per Exposure	$15.68
(18)	Projected Fixed Expense Per Exposure	$ 77.83
(19)	Variable Expense Provision	13.8%
(20)	Profit and Contingency Provision	5.0%
(21)	Variable Permissible Loss Ratio	81.2%
(22)	Indicated Rate	$850.76
(23)	Selected Rate	$850.76

(2) Reported Losses and Paid ALAE Evaluated As Of 03/31/2016
(3) From Loss Development Exhibit
(4) From Loss Trend Exhibit - 1
(5) From ULAE Ratio Exhibit
(6) = (2) x (3) x (4) x (5)
(7) = (6) / (1)
(11) = Min{ [(9) / (10)] ^ 0.5, 1.0 }
(13) = (8) x (11) + (12) x [1.0 - (11)]
(14) From Non-Modeled Cat Exhibit
(15) From Hurricane Catastrophe Model
(16) = (13) + (14) + (15)
(17) From Cost of Reinsurance Exhibit
(18) From Expense Exhibit - 1
(19) From Expense Exhibit - 1
(21) = 100% - (19) - (20)
(22) = [(16) + (17) + (18)] / (21)

State XX
Wicked Good Insurance Company
Homeowners
Calculation of Non-Modeled Cat Loading

Calendar Year	(1) Amount of Insurance Years ($000s)	(2) Reported Cat Losses and Paid ALAE	(3) Cat-to-AIY Ratio
1996	$ 1,752,020	$ 4,412	0.003
1997	$ 1,911,500	$ 26,236	0.014
1998	$ 2,110,710	$ 155,872	0.074
1999	$ 2,333,580	$ 38,689	0.017
2000	$ 2,494,580	$ 145,490	0.058
2001	$ 2,545,420	$ 227,118	0.089
2002	$ 2,631,470	$ 222,464	0.085
2003	$ 2,738,710	$ 833,316	0.304
2004	$ 2,858,230	$ 173,649	0.061
2005	$ 2,927,850	$ 2,668,809	0.912
2006	$ 2,936,440	$ 96,981	0.033
2007	$ 2,923,330	$ 256,753	0.088
2008	$ 2,910,500	$ 54,333	0.019
2009	$ 2,944,090	$ 475,524	0.162
2010	$ 2,916,440	$ 1,230	-
2011	$ 2,665,300	$ 70,299	0.026
2012	$ 2,771,912	$ 485,029	0.175
2013	$ 2,882,788	$ 29,025	0.010
2014	$ 2,998,100	$ 69,868	0.023
2015	$ 3,208,151	$ 178,200	0.056

(4) All-Year Arithmetic Average	0.110
(5) ULAE Factor	1.012
(6) Non-Modeled Cat Provision Per AIY	0.111
(7) Selected Average AIY Per Exposure	$ 262.21
(8) Non-Modeled Cat Pure Premium	$ 29.11

(3) = (2) / (1)
(4) = Average of (3)
(5) From ULAE Ratio Exhibit
(6) = (4) x (5)
(7) From AIY Projection Exhibit
(8) = (6) x (7)

State XX
Wicked Good Insurance Company
Homeowners
Calculation of Projected Average AIY

	(1)	(2)	(3)	(4)	(5)
Calendar Year	Amount of Insurance Years ($000s)	Earned Exposures	AIY-to-Earned Exposure Ratio	Annual Change	AIY-to-Earned Exposure Exponential Fit
2011	$ 2,665,300	12,760	$ 208.88		$ 209.58
2012	$ 2,771,912	12,766	$ 217.13	3.9%	$ 216.93
2013	$ 2,882,788	12,805	$ 225.13	3.7%	$ 224.53
2014	$ 2,998,100	12,834	$ 233.61	3.8%	$ 232.39
2015	$ 3,208,151	13,411	$ 239.22	2.4%	$ 240.54
2016					$ 248.97
2017					$ 257.69
2018					$ 266.72

(6) Projected Average AIY in Effective Period	$ 262.21
(7) Selected AIY in Effective Period	$ 262.21

(3) = (1) / (2)
(4) = Current Year (3) / Prior Year (3) - 1.0
(5) Exponential Fit of (3) Using Data From Calendar Years 2011 Through 2015
(6) Average of (5) For Latest 2 Years

State XX
Wicked Good Insurance Company
Homeowners
Cost of Reinsurance

(1)	Expected Reinsurance Recoveries	$	458,673
(2)	Cost of Reinsurance (Expected Ceded Premium)	$	673,248
(3)	Net Cost of Reinsurance	$	214,575
(4)	Latest Year Exposures		13,411
(5)	Expected Annual Exposure Increase		1.0%
(6)	Projection Period		2.0
(7)	Projected Exposures		13,681
(8)	Projected Net Reinsurance Cost Per Exposure	$	15.68

(3) = (2) - (1)
(4) From Pure Premium Indication Exhibit
(5) Based on Company Goals
(6) From Midpoint of Latest Year to Midpoint of Reinsurance Contract
[(07/01/2015) to (07/01/2017)]
(7) = (4) x [1.00 + (5)] ^ (6)
(8) = (3) / (7)

State XX
Wicked Good Insurance Company
Homeowners
Loss Development - Countrywide Data

	Reported Losses and Paid ALAE Evaluated as of						
Accident Year	15 Months	27 Months	39 Months	51 Months	63 Months	75 Months	85 Months
2009	45,407,811	47,542,171	47,840,609	47,944,098	48,357,583	48,352,642	48,350,368
2010	42,964,965	44,624,511	45,673,824	45,959,994	45,908,833	45,939,203	
2011	33,313,292	34,495,215	35,097,059	35,141,818	35,182,407		
2012	30,176,335	31,335,306	31,658,815	31,908,268			
2013	30,613,176	31,102,898	31,455,116				
2014	30,932,080	31,923,956					
2015	34,377,105						

Age-to-Age Factors	15-27	27-39	39-51	51-63	63-75	75 to Ult
2009	1.0470	1.0063	1.0022	1.0086	0.9999	1.0000
2010	1.0386	1.0235	1.0063	0.9989	1.0007	
2011	1.0355	1.0174	1.0013	1.0012		
2012	1.0384	1.0103	1.0079			
2013	1.0160	1.0113				
2014	1.0321					
(1) All-Year Average	1.0346	1.0138	1.0044	1.0029		
(2) 3-Year Average	1.0288	1.0130	1.0052	1.0029		
(3) 4-Year Average	1.0305	1.0156	1.0044			
(4) Average Excluding Hi-Lo	1.0362	1.0130	1.0043	1.0012		
(5) Geometric Average	1.0346	1.0137	1.0044	1.0029		
(6) Selected Age-to-Age	1.0362	1.0130	1.0043	1.0012	1.0000	
(7) Age-to-Ultimate	1.0555	1.0186	1.0055	1.0012	1.0000	

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Straight Average Excluding Highest and Lowest Values
(5) = (Product of Age-to-Age Factors) ^ (1.0 / Number of Age-to-Age Factors)
(7) = Cumulative Product of (6)

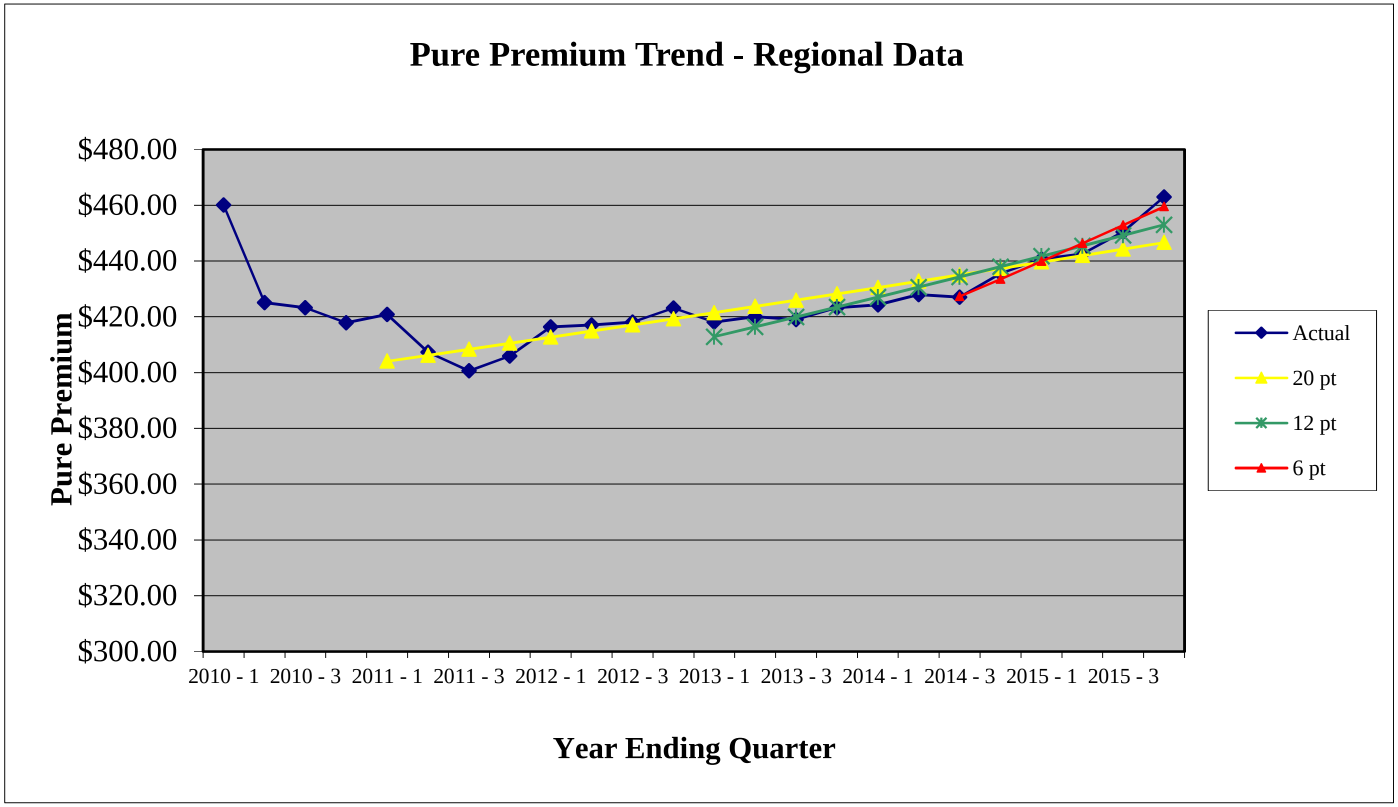
State XX
Wicked Good Insurance Company
Homeowners
Loss Trend Selections - Regional Data

Year Ending Quarter - X	Paid Pure Premium (including ALAE)	Annual Change
2010 - 1	$460.03	
2010 - 2	$425.04	
2010 - 3	$423.31	
2010 - 4	$417.86	
2011 - 1	$420.80	-8.5%
2011 - 2	$407.29	-4.2%
2011 - 3	$400.62	-5.4%
2011 - 4	$405.91	-2.9%
2012 - 1	$416.38	-1.1%
2012 - 2	$417.09	2.4%
2012 - 3	$418.06	4.4%
2012 - 4	$423.13	4.2%
2013 - 1	$418.06	0.4%
2013 - 2	$420.06	0.7%
2013 - 3	$419.06	0.2%
2013 - 4	$423.26	0.0%
2014 - 1	$424.31	1.5%
2014 - 2	$428.01	1.9%
2014 - 3	$427.06	1.9%
2014 - 4	$435.57	2.9%
2015 - 1	$440.73	3.9%
2015 - 2	$442.49	3.4%
2015 - 3	$450.44	5.5%
2015 - 4	$462.98	6.3%

Exponential Trend	Pure Premium
24 pt	1.0%
20 pt	2.1%
16 pt	2.4%
12 pt	3.4%
8 pt	4.8%
6 pt	6.0%
4 pt	6.8%

Selections	
Current	2.0%
Projected	4.0%

State XX
Wicked Good Insurance Company
Homeowners
Pure Premium Trend - Regional Data



Exponential Trend		Selections	
20 pt	2.1%	Current	2.0%
12 pt	3.4%	Prospective	4.0%
6 pt	6.0%		

State XX
Wicked Good Insurance Company
Homeowners
Loss Trend

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Accident Year	Selected Current Trend	Current Cost Trend Period	Current Trend Factor	Selected Projected Trend	Projected Cost Trend Period	Projected Trend Factor	Loss Trend Factor
2011	2.0%	4.00	1.0824	4.0%	2.5	1.1030	1.1939
2012	2.0%	3.00	1.0612	4.0%	2.5	1.1030	1.1705
2013	2.0%	2.00	1.0404	4.0%	2.5	1.1030	1.1476
2014	2.0%	1.00	1.0200	4.0%	2.5	1.1030	1.1251
2015	2.0%	0.00	1.0000	4.0%	2.5	1.1030	1.1030

(1) From Loss Trend Exhibit - 1
(2) From 07/01/20XX to 07/01/2015
(3) = [1.0 + (1)] ^ (2)
(4) From Loss Trend Exhibit - 1
(5) From 07/01/2015 to 01/01/2018
(6) = [1.0 + (4)] ^ (5)
(7) = (3) x (6)

State XX
Wicked Good Insurance Company
Homeowners
ULAE Ratio

Calendar Year	(1) Countrywide Paid Loss and ALAE	(2) Countrywide Paid ULAE	(3) ULAE Ratio
2013	$ 30,985,798	$ 334,665	1.1%
2014	$ 30,903,249	$ 238,788	0.8%
2015	$ 34,683,131	$ 567,247	1.6%
Total	$ 96,572,178	$ 1,140,700	1.2%
		(4) Selected Ratio	1.2%
		(5) ULAE Factor	1.012

(3) = (2) / (1)
(5) = 1.0 + (4)

State XX
Wicked Good Insurance Company
Homeowners
Expense Calculation

	2013	2014	2015	3-Year Average	Selected
(1) General					
a Countrywide Expenses	$2,238,241	$2,301,402	$2,432,343		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a)x(b)]	$1,678,681	$1,726,052	$1,824,257		
d Countrywide Earned Exposures	56,884	57,452	58,027		
e Fixed Expense Per Exposure [(c)/(d)]	$29.51	$30.04	$31.44	$30.33	
f Variable Expense $ [(a)x(1.0-(b))]	$559,560	$575,351	$608,086		
g Countrywide Earned Premium	$51,764,213	$53,143,516	$53,965,296		
h Variable Expense % [(f)/(g)]	1.1%	1.1%	1.1%	1.1%	1.1%
(2) Other Acquisition					
a Countrywide Expenses	$2,582,786	$2,715,731	$2,912,054		
b % Assumed Fixed					75.0%
c Fixed Expense $ [(a)x(b)]	$1,937,090	$2,036,798	$2,184,041		
d Countrywide Written Exposures	56,602	57,740	58,317		
e Fixed Expense Per Exposure [(c)/(d)]	$34.22	$35.28	$37.45	$35.65	
f Variable Expense $ [(a)x(1.0-(b))]	$645,697	$678,933	$728,014		
g Countrywide Written Premium	51,907,954	53,554,406	55,235,122		
h Variable Expense % [(f)/(g)]	1.2%	1.3%	1.3%	1.3%	1.3%
(3) Taxes, Licenses and Fees					
a State Expenses	$200,879	$205,363	$210,002		
b % Assumed Fixed					25.0%
c Fixed Expense $ [(a)x(b)]	$50,220	$51,341	$52,501		
d State Written Exposures	12,820	13,123	13,478		
e Fixed Expense Per Exposure [(c)/(d)]	$3.92	$3.91	$3.90	$3.91	
f Variable Expense $ [(a)x(1.0-(b))]	$150,659	$154,022	$157,502		
g State Written Premium	$11,217,062	$11,810,250	$12,332,420		
h Variable Expense % [(f)/(g)]	1.3%	1.3%	1.3%	1.3%	1.3%
(4) Commission and Brokerage					
a State Expenses	$1,115,970	$1,207,693	$1,244,644		
b % Assumed Fixed					0.0%
c Fixed Expense $ [(a)x(b)]	$0	$0	$0		
d State Written Exposures	12,820	13,123	13,478		
e Fixed Expense Per Exposure [(c)/(d)]	$0.00	$0.00	$0.00	$0.00	
f Variable Expense $ [(a)x(1.0-(b))]	$1,115,970	$1,207,693	$1,244,644		
g State Written Premium	$11,217,062	$11,810,250	$12,332,420		
h Variable Expense % [(f)/(g)]	9.9%	10.2%	10.1%	10.1%	10.1%
(5) Total Fixed Expense Per Exposure (1e+2e+3e+4e)	$67.65	$69.23	$72.79	$69.89	
(6) Fixed Expense Trend (from Expense Exhibit - 2)					3.4%
(7) Trend Period (from 07/01/xxxx to 07/01/2017)	4.00	3.00	2.00		
(8) Fixed Expense Trend Factor [1.0 + (6)] ^ (7)	1.1431	1.1055	1.0692		
(9) Projected Fixed Expenses	$77.33	$76.53	$77.83	$77.23	$77.83
(10) Variable Expense Provision [(1h) + (2h) + (3h) + (4h)]					13.8%

State XX
Wicked Good Insurance Company
Homeowners
Calculation of Annual Expense Trend

(1) Employment Cost Index - Finance, Insurance & Real Estate, excluding Sales Occupations - (annual change over latest 2 years) U.S. Department of Labor	4.8%
(2) % of Other Acquisition, General Expense, and Taxes, Licenses and Fees used for Salaries and Employee Relations & Welfare - Insurance Expense Exhibit, 2015	50.0%
(3) Consumer Price Index, All Items - (annual change over latest 2 years)	1.9%
(4) Annual Expense Trend - [(1) x (2)] + [(3) x {100% - (2) }]	3.4%
Selected Annual Expense Trend	3.4%

APPENDIX C: MEDICAL MALPRACTICE INDICATION

The following exhibits show an example of an overall rate level indication for a medical malpractice insurance program using the loss ratio indication approach. Medical malpractice insurance can be written on an occurrence or claims-made basis; the data used in this example is based on occurrence policies. Due to the long-tailed nature of medical malpractice insurance and the higher frequency of large losses, the data is more volatile and ratemaking techniques are slightly different than those used for personal automobile and homeowners.

All policies are annual and the proposed effective date of the rate change in State XX is May 1, 2016. Rates are expected to be in effect for one year.

The individual exhibits are as follows:

- LR Indication: summarizes the calculation of the overall indicated rate change using the loss ratio methodology based on five years of State XX calendar-accident year experience evaluated as of September 30, 2015.
- Current Rate Level: details the calculation of the current rate level factors using the parallelogram method.
- Loss Development: displays the derivation of the selected ultimate loss and ALAE using a combination of the chain ladder and Bornhuetter-Ferguson methods.
- Net Trend: supports the selection of the net trend factors based on historical changes of frequency, severity, and premium.
- Expense and ULAE Ratio: derives the expense (including ULAE) provision using the all variable projection method.

LR (LOSS RATIO) INDICATION EXHIBIT

The overall rate level indication is calculated on the LR (Loss Ratio) Indication Exhibit. The five-year projected ultimate loss and ALAE ratio is calculated and compared to the permissible loss ratio to obtain the statewide indicated rate change. This statewide rate indication is then credibility-weighted with the countrywide rate indication. Each column of the exhibit is described in detail below. Some inputs are calculated on later exhibits.

Columns 1 through 3 show the calculation of earned premium at current rate level. Column 1 displays the earned premium for each of the five calendar-accident years. Column 2 displays the current rate level adjustment factors used to convert the historical premium to current rate level. Column 3 is the earned premium at current rate level, which is calculated as the product of Columns 1 and 2.

Column 4 shows the ultimate losses and ALAE selected for each accident year. Normally, companies cap losses at the basic limit to minimize the impact of extraordinary losses on the rate level indication; in this case, basic limits losses were not available and total limit losses were used. Column 5 shows the selected net trend factor, which is multiplied by Column 4 to obtain the projected ultimate loss and ALAE in Column 6. These projected ultimate loss and ALAE are then divided by the premium at current rate level in Column 3 to obtain Column 7. The selected loss and ALAE ratio in Row 8 is the five-year weighted projected loss and ALAE ratio.

The permissible loss ratio is derived in Rows 9 through 11. Chapter 7 defined the permissible loss ratio as one minus the underwriting expense provision minus the target underwriting profit provision (all as a percent of premium). In this example, ULAE is measured as a percent of premium so it is considered with the variable underwriting expenses rather than the loss and ALAE. Row 9 is the underwriting expense and ULAE ratio, and Row 10 shows the target underwriting profit provision. Note that the underwriting profit provision is negative. Recall that the insurer's total profit is underwriting profit plus investment income. Since the investment income is expected to be high in this long-tailed line of business, the underwriting profit can actually be negative. The underwriting expense and ULAE ratio and the underwriting profit provision are subtracted from one to obtain the permissible loss ratio shown in Row 11. The statewide rate indication, as shown in Row 12, is calculated by comparing the selected projected loss and ALAE ratio (Row 8) to the permissible loss ratio (Row 11).

Rows 13 through 15 show the calculation of the credibility measure. Row 13 shows the number of reported claims for the five most recent accident years as of September 30, 2015. The standard for full credibility is listed in Row 14 and was determined using the classical credibility approach and assuming no variation in claims costs. The number of claims for full credibility, 683, is derived such that there is a 95% probability that the observed experience will be within 7.5% of the expected experience. Row 15, the credibility measure, is calculated using the square root rule.

The countrywide indication is displayed in Row 16. Row 17 shows the credibility-weighted rate indication of the statewide and countrywide results. A rate change is then selected in Row 18.

CURRENT RATE LEVEL EXHIBIT

These two sheets use the same parallelogram method that was used to adjust earned premium to current rate level in the personal automobile rating example. Sheet 1 shows the derivation of the cumulative rate level indices for each rate level group during or after the historical period. Sheet 2 calculates the current rate level factors.

LOSS DEVELOPMENT EXHIBIT

Since the reported losses and ALAE in the historical data are not fully mature, they need to be developed to ultimate. The Loss Development Exhibit shows the calculation of ultimate loss and ALAE using three loss development techniques. In long-tailed lines of business it is common to use multiple loss development methods when deriving ultimate losses. The results of the three techniques are then used to judgmentally select ultimate loss & ALAE by accident year. The exhibit is described in detail below.

Sheets 1-3

Sheets 1 and 2 show the calculation and selection of age-to-ultimate loss development factors using the chain ladder approach. Sheet 1 is the chain ladder approach applied to paid losses and paid ALAE. Sheet 2 is based on reported losses and paid ALAE. The losses in these exhibits are total limit losses; if capped losses had been available, the loss development analysis would have been conducted on that basis as well.

Sheet 3 shows the calculation of claim count development factors using the chain ladder approach on historical reported claim counts.[55] The resulting ultimate claim counts are used in the derivation of the net loss ratio trend discussed later.

Sheets 4-5

Since medical malpractice is a long-tailed line of business with relatively more large losses than other lines of business, the link ratio patterns are less stable. This is especially true for the more recent evaluation points; consequently, the reported Bornhuetter-Ferguson method (Sheets 4 and 5) is used to develop losses and ALAE to ultimate for the three most recent accident years. In this example, an average expected loss and ALAE ratio is calculated based on older years (2010-2011) and projected to the rate level and cost level of each of the three most recent years (2012, 2013, and 2014). This ratio is multiplied by earned premium to derive expected losses and ALAE for each of the three years. The age-to-ultimate factors from the reported chain ladder method are used to calculate the portion of these losses that are unreported as of September 30, 2015. These estimated unreported losses are added to the actual reported losses as of the same valuation date to derive the ultimate losses and ALAE for each year.

Sheet 4 shows the calculation of the two-year (2010-2011) average ultimate loss and ALAE ratio forecasted to the rate level and cost level of 2011. Column 1 contains earned premium for 2010 and 2011. Column 2 contains ultimate loss and ALAE for 2010 and 2011, which is the straight average of the ultimate loss and ALAE from the reported and paid chain ladder methods. Column 3 is a ratio of Column 2 to Column 1. This two-year average ratio is then adjusted to the average rate level and cost level of 2011. Column 4 is the adjustment to the 2011 average rate level; it is calculated as the ratio of the 2011 average rate level to the average rate level of each respective year. Column 5 is the selected net trend for application in the Bornhuetter-Ferguson method. It is based on an examination of the trend in severity and adjusted frequency from 2005-2011 (which is outlined in the Net Trend – 1 exhibit). As ultimate losses have not yet been derived for the most recent years, this trend analysis (for the purpose of applying the Bornhuetter-Ferguson method) does not consider the most recent years. Column 6 is the trend length, or the number of years from the midpoint of each accident year (July 1, 20xx) until the midpoint of Accident Year 2011 (July 1, 2011). The net trend adjustment in Column 7 is the sum of one plus the selected net trend, raised to the power of the trend length. Column 8 is the ultimate loss and ALAE ratio as of 2011, or the product of Column 3 and Column 7, divided by Column 4.

Sheet 5 shows the calculation of the ultimate loss and ALAE ratio for Accident Years 2012-2014, using the Bornhuetter-Ferguson method. Column 1 contains the two-year average ultimate loss and ALAE ratio calculated in Sheet 4. Columns 2 through 5 derive the adjustment to convert the two-year average loss ratio, which is at the 2011 rate level, to the rate level of each of the respective accident years. The adjustment in Column 5 is the ratio of the average rate level for each accident year in Column 3 to the 2011 rate level in Column 4. Columns 6 through 8 derive the adjustment to forecast the average reported losses from the 2011 cost level to the cost level of each respective accident year. Column 6 shows the same selected net trend as used in Sheet 4. Column 7 displays the net trend length from the midpoint of Accident Year 2011 (July 1, 2011) to the midpoint of each respective year (July 1, 20XX). Column 8 is the sum of 1.00 plus the selected net trend, raised to the power of the trend length. Column 9 is the expected loss and ALAE ratio for each respective year, calculated as the product of Columns 1 and 8,

[55] The developed claims are required for the trend procedure and the calculation of credibility.

divided by Column 5. Column 10 multiplies the expected loss and ALAE ratio by the earned premium in Column 2.

Column 11 shows the reported age-to-ultimate factors derived from the chain ladder method. Column 12 calculates the percent of losses unreported as one minus the reciprocal of Column 11. Column 13 shows the reported losses and ALAE as of September 30, 2015. Column 14 derives the expected losses and ALAE not yet reported as of September 30, 2015, as the product of Column 10 and 12. Column 15, the ultimate losses and ALAE from the Bornhuetter-Ferguson method, is the sum of the reported losses and ALAE (Column 13) and the expected losses and ALAE not yet reported (Column 14) as of September 30, 2015.

Sheet 6

Sheet 6 shows the derivation of the selected ultimate loss and ALAE for each accident year in consideration of the chain ladder and Bornhuetter-Ferguson results. Columns 1 through 6 show the calculation of the indicated ultimate losses using paid development factors and reported development factors from the chain ladder method. Columns 1 and 2 show paid loss and paid ALAE, and reported loss and paid ALAE, respectively. Columns 3 and 4 show the paid and reported chain ladder loss development factors, respectively. Columns 5 and 6 display the ultimate loss and ALAE derived using the paid and reported loss development methods, respectively. Column 7 shows the Bornhuetter-Ferguson ultimate loss and ALAE for the three most recent accident years.

Columns 5 through 7 are used to select ultimate loss and ALAE by accident year. A straight average of the paid and reported chain ladder results are used for Accident Years 2005 through 2011. Because of the volatility in the more recent years, an average of the reported chain ladder and Bornhuetter-Ferguson results is used for Accident Years 2012 and 2013, and the Bornhuetter-Ferguson result is used for Accident Year 2014. In all accident years, an additional criterion is applied to the selected ultimate loss and ALAE: each year's selected ultimate loss and ALAE must be equal to or greater than that year's reported losses and paid ALAE as of September 30, 2015.

NET TREND EXHIBIT

Because the proposed rates will be in effect in a future policy period, the historical loss ratios need to be adjusted to account for expected trends between the two periods. In the personal automobile example, the premium trend and loss trend components are analyzed and selected separately. In this example, premium trend is considered within the loss trend. The adjusted frequency trend is based on historical patterns of the ratio of ultimate claim counts to earned premium at current rate level; therefore, changes in this ratio represent the net effect of changes in frequency and average premium. The severity trend is based on the historical pattern of ultimate loss and ALAE divided by ultimate claim counts (both derived using the chain ladder method). The selected net trend is based on the combination of the severity trend and the adjusted frequency trend.

It is important to note that due to the long-tailed nature of medical malpractice, loss trends are typically based on losses and claim counts developed to ultimate rather than paid losses and reported claim counts (as is common practice in short-tailed lines). This may seem to present a conundrum in this example since losses need to be developed to ultimate before measuring trend, but Bornhuetter-Ferguson requires losses to be trended before projecting to ultimate. In this example, the Bornhuetter-Ferguson method is used to developed losses to ultimate only for the three most recent accident years (2012-2014). The net trend factor is applied to the two-year (2010-2011) average ultimate loss and ALAE. The net trend, therefore, is based on data through 2011 only, and the loss and ALAE are brought to ultimate using the chain ladder method. Sheet 1 outlines the trend analysis conducted for the Bornhuetter-Ferguson method, and Sheet 2 outlines the trend analysis for the LR indication. The only difference between these sheets is the time period considered, and the resulting trend selection.

Sheet 1

On Sheet 1, the severity and adjusted frequency trends are analyzed separately for Accident Years 2005-2011. Exponential trends are fit to the data, and trend selections are made based on the results.

Columns 1 through 5 show the calculation of the severity by accident year. Column 1 displays the selected ultimate loss and ALAE based on the chain ladder analyses. Column 2 displays the reported claim counts. These claim counts are developed using the reported age-to-ultimate factors shown in Column 3 to obtain the ultimate claim counts shown in Column 4. The severity listed in Column 5 is calculated by dividing the selected ultimate loss and ALAE by the developed claim count.

Columns 6 through 9 show the calculation of the adjusted frequency (i.e., ultimate claim count divided by earned premium at current rate level). Column 6 shows the earned premium by accident year. This premium is adjusted to current rate level using the current rate level factors shown in Column 7. The resulting earned premium at current rate level is shown in Column 8. The adjusted frequency shown in Column 9 is calculated by dividing the ultimate claim count (Column 4) by the earned premium at current rate level (Column 8) and multiplying by 1 million (for ease of viewing the values). By dividing developed claim counts by premium instead of exposures, the adjusted frequency is implicitly reflecting frequency and premium trends within one measure.

Rows 10 and 11 display exponential trends fit to the severity and adjusted frequency data. Selected trends are shown in Rows 12 and 13. These selections are made in consideration of the exponential trends and judgment with respect to the volatility of the data. The selected severity and adjusted frequency trends are combined to form the net trend, as shown in Row 14.

Sheet 2

Sheet 2 follows the same format as Sheet 1 except that the most recent accident years (2012-2014) are considered in the trend data. Exponential trends are fit to 2005-2014 as well as 2010-2014. The selected net trend, in Row 16 relies more heavily on the recent period.

Sheet 3

Sheet 3 shows the calculation of each accident year's net trend factors for use in the LR Indication. Column 1 displays the net trend selection for each accident year from Sheet 2. Column 2 shows the trend period for each accident year, which is the number of years between the midpoint of the historical period (July 1, 20XX) and the average expected loss date for when the rates will be in effect (May 1, 2017). The total net trend factor for each accident year (Column 3) is calculated by taking the sum of one and the selected net trend and raising it to the power of the trend period.

EXPENSE AND ULAE RATIO EXHIBIT

The rates charged must include a provision for expenses. Unlike the personal automobile and homeowners examples, all underwriting expenses are treated as variable expense, and ULAE are also measured as a percent of premium. Due to the volatility of this line of business, the ratios for all categories of expense are calculated using countrywide data.

Sheet 1

Sheet 1 shows the derivation of the selected ULAE ratio. Column 1 shows the countrywide earned premium for each of the last five calendar years. Column 2 shows the paid unallocated loss adjustment expense (ULAE) for the same years. Column 3 is the ratio of Column 2 to Column 1. The selected ULAE ratio is based on the five-year ratio in Column 3. While it is more intuitive to study the relationship between ULAE and losses, ULAE are a relatively small portion of the total expenses in this example so comparing ULAE to earned premium is acceptable.

Sheet 2

Sheet 2 calculates an expense ratio for each category of expense (general expenses; other acquisition expenses; taxes, licenses, and fees; and commission and brokerage) using the three most recent calendar years of countrywide data. For each expense category, Row "a" displays the expenses paid for that calendar year and Row "b" displays the premium. Earned premium is used to calculate the expense ratio for general expenses since these expenses are incurred throughout the life of the policy. All other expense ratios use written premium since these expenses are assumed to be incurred at policy inception (when written). All expenses are assumed to be variable (i.e., they vary by amount of premium). The historical variable expense ratios (Row "c") are calculated by dividing Row "a" by Row "b." The three-year ratio is displayed though the ratios from the latest year are selected due to the downward trend exhibited.

The UW expense ratio is calculated in Row 5 by summing the selected ratios for the four categories of expenses listed in Rows 1 through 4. The selected ULAE Ratio is shown on Sheet 1. Row 7 is the total expense ratio, which is the sum of the UW expense ratio (Row 5) and the ULAE ratio (Row 6). This figure is not trended, which implicitly assumes that expenses and premium will increase/decrease at the same rate.

State XX
Wicked Good Insurance Company
Medical Malpractice
Indicated Rate Change

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Calendar-Accident Year	Earned Premium	Current Rate Level Factor	Earned Premium @ CRL	Ultimate Loss and ALAE	Net Trend Factor	Projected Ultimate Loss and ALAE	Projected Ultimate Loss and ALAE Ratio
2010	$ 14,904,664	1.2029	$ 17,928,820	$ 11,673,500	1.7902	$ 20,897,900	116.6%
2011	$ 14,494,543	1.2058	$ 17,477,520	$ 11,200,835	1.6439	$ 18,413,053	105.4%
2012	$ 14,442,449	1.2724	$ 18,376,572	$ 6,290,368	1.5095	$ 9,495,310	51.7%
2013	$ 14,834,605	1.3018	$ 19,311,689	$ 18,254,793	1.3862	$ 25,304,794	131.0%
2014	$ 18,265,093	1.2391	$ 22,632,277	$ 23,371,444	1.2729	$ 29,749,511	131.4%
Total	$ 76,941,354		$ 95,726,878	$ 70,790,940		$ 103,860,568	108.5%

(8)	Selected Loss and ALAE Ratio	108.5%
(9)	Expense and ULAE Ratio	34.7%
(10)	Profit and Contingency Provision	-5.0%
(11)	Permissible Loss Ratio	70.3%
(12)	Statewide Indicated Rate Change	54.3%
(13)	Number of Reported Claims	283
(14)	Claims Required for Full Credility Standard	683
(15)	Credibility	64.4%
(16)	Countrywide Indicated Rate Change	18.5%
(17)	Credibility-Weighted Indicated Rate Change	41.6%
(18)	Selected Rate Change	41.6%

(1) From Net Trend Exhibit - 2
(2) From Current Rate Level Exhibit - 2
(3) = (1) x (2)
(4) From Loss Development Exhibit - 6
(5) From Net Trend Exhibit - 3
(6) = (4) x (5)
(7) = (6) / (3)
(9) From Expense & ULAE Ratio Exhibit - 2
(11) = 100% - (9) - (10)
(12) = [(8) / (11)] - 1.0
(13) Derived from Net Trend Exhibit - 2
(15) = Min{ [(13) / (14)] ^ 0.5, 1.0 }
(17) = (12) x (15) + (16) x [1.0 - (15)]

State XX
Wicked Good Insurance Company
Medical Malpractice
Rate Change History

	(1)	(2)	(3)	(4)
Rate Level Group	Effective Date	Rate Change	Rate Level Index	Cumulative Rate Level Index
A			1.0000	1.0000
B	10/01/11	-7.6%	0.9240	0.9240
C	03/01/14	14.6%	1.1460	1.0589
D	07/01/15	13.6%	1.1360	1.2029

(3) = 1.0 + (2)
(4) = Cumulative Product of (3)

State XX
Wicked Good Insurance Company
Medical Malpractice
Calculation of Current Rate Level Factors

	(1a) Portion of Earned Premium Assumed in Each Rate Level Group				(2)	(3)	(4)
Calendar Year	A	B	C	D	Average Rate Level Index	Current Rate Level Index	CRL Factor
2005	100.000%	0.000%	0.000%	0.000%	1.0000	1.2029	1.2029
2006	100.000%	0.000%	0.000%	0.000%	1.0000	1.2029	1.2029
2007	100.000%	0.000%	0.000%	0.000%	1.0000	1.2029	1.2029
2008	100.000%	0.000%	0.000%	0.000%	1.0000	1.2029	1.2029
2009	100.000%	0.000%	0.000%	0.000%	1.0000	1.2029	1.2029
2010	100.000%	0.000%	0.000%	0.000%	1.0000	1.2029	1.2029
2011	96.875%	3.125%	0.000%	0.000%	0.9976	1.2029	1.2058
2012	28.125%	71.875%	0.000%	0.000%	0.9454	1.2029	1.2724
2013	0.000%	100.000%	0.000%	0.000%	0.9240	1.2029	1.3018
2014	0.000%	65.278%	34.722%	0.000%	0.9708	1.2029	1.2391
2015	0.000%	1.389%	86.111%	12.500%	1.0750	1.2029	1.1190
(1b) Cumulative Rate Level	1.0000	0.9240	1.0589	1.2029			

(1a) Portion of Each Calendar Year's Earned Premium by Rate Level Group
(1b) Cumulative Rate Level for Each Rate Level Group
(2) = (1b) Weighted by (1a) Within Each Calendar Year
(4) = (3) / (2)

State XX
Wicked Good Insurance Company
Medical Malpractice
Paid Loss Development

Accident Year	Paid Losses & Paid ALAE Evaluated As Of 21 Months	33 Months	45 Months	57 Months	69 Months	81 Months	93 Months	105 Months	117 Months	129 Months
2005	$151,700	$318,200	$2,227,400	$4,029,300	$5,727,600	$5,735,000	$5,735,000	$5,735,000	$5,735,000	$5,735,000
2006	$7,400	$48,100	$255,300	$543,900	$906,500	$2,608,500	$2,701,000	$2,701,000	$2,701,000	
2007	$66,600	$255,300	$1,172,900	$3,670,400	$4,014,500	$4,092,200	$4,539,900	$4,591,700		
2008	$18,500	$288,600	$1,594,700	$4,902,500	$7,721,900	$8,269,500	$8,524,800			
2009	$96,200	$358,900	$1,243,200	$6,327,000	$6,878,300	$7,377,800				
2010	$25,900	$666,000	$1,191,400	$3,799,900	$7,770,000					
2011	$11,100	$74,000	$366,300	$7,895,800						
2012	$40,700	$436,900	$1,029,200							
2013	$22,200	$170,200								
2014	$873,200									

Age-to-Age Factors	21-33	33-45	45-57	57-69	69-81	81-93	93-105	105-117	117-129	129 to Ult
2005	2.0976	7.0000	1.8090	1.4215	1.0013	1.0000	1.0000	1.0000	1.0000	
2006	6.5000	5.3077	2.1304	1.6667	2.8776	1.0355	1.0000	1.0000		
2007	3.8333	4.5942	3.1293	1.0938	1.0194	1.1094	1.0114			
2008	15.6000	5.5256	3.0742	1.5751	1.0709	1.0309				
2009	3.7308	3.4639	5.0893	1.0871	1.0726					
2010	25.7143	1.7889	3.1894	2.0448						
2011	6.6667	4.9500	21.5556							
2012	10.7346	2.3557								
2013	7.6667									
(1) All-Year Average	9.1716	4.3733	5.7110	1.4815	1.4084	1.0440	1.0038	1.0000	1.0000	
(2) 3-Year Average	8.3560	3.0315	9.9448	1.5690	1.0543	1.0586	1.0038	1.0000	1.0000	
(3) 4-Year Average	12.6956	3.1396	8.2271	1.4502	1.5101	1.0440	1.0038	1.0000	1.0000	
(4) Average Excluding Hi-Lo	7.8189	4.3662	3.3225	1.4393	1.0543	1.0332	1.0000			
(5) Weighted Average	5.9419	3.7123	3.8713	1.4188	1.1123	1.0384	1.0040	1.0000	1.0000	
(6) Selected Age-to-Age	5.9419	3.7123	3.8713	1.4188	1.1123	1.0384	1.0040	1.0000	1.0000	1.0000
(7) Age-to-Ultimate	140.5057	23.6466	6.3698	1.6454	1.1597	1.0426	1.0040	1.0000	1.0000	1.0000

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Straight Average Excluding Highest and Lowest Values
(5) Average Weighted by Loss
(7) = Cumulative Product of (6)

State XX
Wicked Good Insurance Company
Medical Malpractice
Reported Loss Development

	Reported Losses & Paid ALAE Evaluated As Of									
Accident Year	21 Months	33 Months	45 Months	57 Months	69 Months	81 Months	93 Months	105 Months	117 Months	129 Months
2005	$336,700	$688,200	$3,892,400	$6,804,300	$5,727,600	$5,735,000	$5,735,000	$5,735,000	$5,735,000	$5,735,000
2006	$62,900	$255,300	$643,800	$876,900	$1,147,000	$2,608,500	$2,701,000	$2,701,000	$2,701,000	
2007	$399,600	$1,032,300	$1,690,900	$4,021,900	$4,366,000	$4,406,700	$4,576,900	$4,739,700		
2008	$640,100	$714,100	$4,092,200	$6,885,700	$8,465,600	$8,473,000	$8,543,300			
2009	$373,700	$1,690,900	$4,972,800	$7,215,000	$7,470,300	$7,414,800				
2010	$118,400	$5,568,500	$7,252,000	$10,848,400	$11,673,500					
2011	$11,100	$140,600	$4,299,400	$8,191,800						
2012	$77,700	$1,158,500	$1,954,200							
2013	$22,200	$3,873,900								
2014	$1,298,700									

Age-to-Age Factors	21-33	33-45	45-57	57-69	69-81	81-93	93-105	105-117	117-129	129 to Ult
2005	2.0440	5.6559	1.7481	0.8418	1.0013	1.0000	1.0000	1.0000	1.0000	
2006	4.0588	2.5217	1.3621	1.3080	2.2742	1.0355	1.0000	1.0000		
2007	2.5833	1.6380	2.3786	1.0856	1.0093	1.0386	1.0356			
2008	1.1156	5.7306	1.6826	1.2294	1.0009	1.0083				
2009	4.5248	2.9409	1.4509	1.0354	0.9926					
2010	47.0313	1.3023	1.4959	1.0761						
2011	12.6667	30.5789	1.9053							
2012	14.9099	1.6868								
2013	174.5000									
(1) All-Year Average	29.2705	6.5069	1.7176	1.0961	1.2557	1.0206	1.0119	1.0000	1.0000	
(2) 3-Year Average	67.3589	11.1893	1.6174	1.1136	1.0009	1.0275	1.0119	1.0000	1.0000	
(3) 4-Year Average	62.2770	9.1272	1.6337	1.1066	1.3193	1.0206	1.0119	1.0000	1.0000	
(4) Average Excluding Hi-Lo	12.5455	3.3623	1.6566	1.1066	1.0038	1.0219	1.0000			
(5) Weighted Average	7.4042	2.5602	1.6706	1.0600	1.0538	1.0157	1.0125	1.0000	1.0000	
(6) Selected Age-to-Age	7.4042	2.5602	1.6706	1.0600	1.0538	1.0157	1.0125	1.0000	1.0000	1.0000
(7) Age-to-Ultimate	36.3768	4.9130	1.9190	1.1487	1.0837	1.0284	1.0125	1.0000	1.0000	1.0000

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Straight Average Excluding Highest and Lowest Values
(5) Average Weighted by Loss
(7) = Cumulative Product of (6)

State XX
Wicked Good Insurance Company
Medical Malpractice
Claim Count Development Factors

Reported Claim Counts Evaluated As Of

Accident Year	21 Months	33 Months	45 Months	57 Months	69 Months	81 Months	93 Months	105 Months	117 Months	129 Months
2005	33	41	52	59	63	63	63	63	63	63
2006	15	33	48	48	48	48	48	48	48	
2007	26	52	74	85	85	89	93	96		
2008	37	59	70	85	85	85	85			
2009	44	81	85	107	107	107				
2010	19	44	59	67	67					
2011	15	44	63	63						
2012	48	59	67							
2013	33	56								
2014	30									

Age-to-Age Factors	21-33	33-45	45-57	57-69	69-81	81-93	93-105	105-117	117-129	129 to Ult
2005	1.2424	1.2683	1.1346	1.0678	1.0000	1.0000	1.0000	1.0000	1.0000	
2006	2.2000	1.4545	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
2007	2.0000	1.4231	1.1486	1.0000	1.0471	1.0449	1.0323			
2008	1.5946	1.1864	1.2143	1.0000	1.0000	1.0000				
2009	1.8409	1.0494	1.2588	1.0000	1.0000					
2010	2.3158	1.3409	1.1356	1.0000						
2011	2.9333	1.4318	1.0000							
2012	1.2292	1.1356								
2013	1.6970									
(1) All-Year Average	1.8948	1.2863	1.1274	1.0113	1.0094	1.0112	1.0108	1.0000	1.0000	
(2) 3-Year Average	1.9532	1.3028	1.1315	1.0000	1.0157	1.0150	1.0108	1.0000	1.0000	
(3) 4-Year Average	2.0438	1.2394	1.1522	1.0000	1.0118	1.0112	1.0108	1.0000	1.0000	
(4) Average Excluding Hi-Lo	1.8415	1.2977	1.1266	1.0000	1.0000	1.0000	1.0000			
(5) Weighted Average	1.7370	1.2542	1.1397	1.0089	1.0103	1.0140	1.0147	1.0000	1.0000	
(6) Selected Age-to-Age	1.7370	1.2542	1.1397	1.0089	1.0103	1.0140	1.0147	1.0000	1.0000	1.0000
(7) Age-to-Ultimate	2.6039	1.4991	1.1953	1.0488	1.0395	1.0289	1.0147	1.0000	1.0000	1.0000

(1) Straight Average
(2) Straight Average
(3) Straight Average
(4) Straight Average Excluding Highest and Lowest Values
(5) Average Weighted by Loss
(7) = Cumulative Product of (6)

State XX
Wicked Good Insurance Company
Medical Malpractice
Bornhuetter-Ferguson Developed Losses

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Accident Year	Earned Premium	Ultimate Loss and ALAE	Ultimate Loss and ALAE ratio	Adjustment to Avg Rate Level in 2011	Selected BF Net Trend	Trend Length	Net Trend Adjustment to 2011	Ultimate Loss and ALAE ratio as of 2011
2010	14,904,664	$11,673,500	78.3%	0.9976	13.3%	1.00	1.1330	88.9%
2011	14,494,543	$11,200,835	77.3%	1.0000	13.3%	0.00	1.0000	77.3%
						(9)	2-Year Avg Ultimate Loss and ALAE Ratio (2010-2011)	83.1%

(1) From Net Trend - 1
(2) From Loss Development Exhibit - 6
(3) = (2) / (1)
(4) From (2) in Current Rate Level - 2
(5) from (14) in Net Trend - 1
(6) From 07/01/20XX to 07/01/2011
(7) = [1 + (5)] ^ (6)
(8) = (3) / (4) x (7)
(9) Straight average of (8)

State XX
Wicked Good Insurance Company
Medical Malpractice
Bornhuetter-Ferguson Developed Losses

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Accident Year	2-Year Avg Ultimate Loss and ALAE Ratio (2010-2011)	Earned Premium	Average Rate Level	Rate Level 2011	Average Rate Level Adjustment	Selected BF Net Trend	Trend length from 2011	Net Trend Adjustment	Expected Loss and ALAE Ratio	Expected Losses and ALAE	Reported Age-to-Ult Factor	Percent Unreported	Reported Losses and ALAE a/o 9/30/15	Expected Losses and ALAE Not Yet Reported a/o 9/30/15	B-F Ultimate Losses and ALAE
2012	83.1%	14,442,449	0.9454	0.9976	0.9477	13.3%	1.00	1.133	99.4%	14,355,794	1.9190	47.9%	$1,954,200	$6,876,425	$8,830,625
2013	83.1%	14,834,605	0.9240	0.9976	0.9262	13.3%	2.00	1.284	115.2%	17,089,465	4.9130	79.6%	$3,873,900	$13,603,214	$17,477,114
2014	83.1%	18,265,093	0.9708	0.9976	0.9731	13.3%	3.00	1.454	124.2%	22,685,246	36.3768	97.3%	$1,298,700	$22,072,744	$23,371,444

(1) From Loss Development Exhibit - 4
(2) From Net Trend - 2
(3) From Current Rate Level - 2
(4) From Current Rate Level - 2
(5) = (3) / (4)
(6) From Net Trend - 1
(7) From 07/01/2011 to 07/01/20XX
(8) = [1 + (6)] ^ (7)
(9) = (1) / (5) x (8)
(10) = (2) x (9)
(11) From Loss Development - 2
(12) = 1 - 1 / (11)
(13) From Loss Development - 6
(14) = (10) x (12)
(15) = (13) + (14)

State XX
Wicked Good Insurance Company
Medical Malpractice
Developed Loss Selection

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Accident Year	Paid Losses & ALAE a/o 9/30/15	Reported Losses & Paid ALAE a/o 9/30/15	Paid Age-to-Ultimate Factor	Reported Age-to-Ultimate Factor	Ultimate Losses & ALAE Using Paid Age-to-Ultimate Factors	Ultimate Losses & ALAE Using Reported Age-to-Ultimate Factors	Ultimate Losses Using B-F Method	Selected Loss & ALAE
2005	$ 5,735,000	$ 5,735,000	1.0000	1.0000	$ 5,735,000	$ 5,735,000		$ 5,735,000
2006	$ 2,701,000	$ 2,701,000	1.0000	1.0000	$ 2,701,000	$ 2,701,000		$ 2,701,000
2007	$ 4,591,700	$ 4,739,700	1.0000	1.0000	$ 4,591,700	$ 4,739,700		$ 4,739,700
2008	$ 8,524,800	$ 8,543,300	1.0040	1.0125	$ 8,558,899	$ 8,650,091		$ 8,604,495
2009	$ 7,377,800	$ 7,414,800	1.0426	1.0284	$ 7,692,094	$ 7,625,380		$ 7,658,737
2010	$ 7,770,000	$ 11,673,500	1.1597	1.0837	$ 9,010,869	$ 12,650,572		$ 11,673,500
2011	$ 7,895,800	$ 8,191,800	1.6454	1.1487	$ 12,991,749	$ 9,409,921		$ 11,200,835
2012	$ 1,029,200	$ 1,954,200	6.3698	1.9190	$ 6,555,798	$ 3,750,110	$ 8,830,625	$ 6,290,368
2013	$ 170,200	$ 3,873,900	23.6466	4.9130	$ 4,024,651	$ 19,032,471	$ 17,477,114	$ 18,254,793
2014	$ 873,200	$ 1,298,700	140.5057	36.3768	$ 122,689,577	$ 47,242,550	$ 23,371,444	$ 23,371,444

(1) From Loss Development Exhibit - 1
(2) From Loss Development Exhibit - 2
(3) From Loss Development Exhibit - 1
(4) From Loss Development Exhibit - 2
(5) = (1) x (3)
(6) = (2) x (4)
(7) From Loss Development Exhibit - 5
(8) Judgmentally Selected Based On Combinations of (5), (6), and (7)
2005-2011: max[(2), average of (5) and (6)]
2012-2013 max[(2), average of (6) and (7)]
2014 uses (7) only

State XX
Wicked Good Insurance Company
Medical Malpractice
Net Trend Calculation for Bornhuetter-Ferguson Method

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Accident Year	Selected Ultimate Loss & ALAE	Reported Claim Count	Reported Age-to-Ultimate Factor	Developed Claim Count	Severity	Earned Premium	Current Rate Level Factor	Earned Premium at Current Rate Level	Adjusted Frequency
2005	$ 5,735,000	63	1.0000	63	$ 91,032	$ 17,944,254	1.2029	$ 21,585,143	2.92
2006	$ 2,701,000	48	1.0000	48	$ 56,271	$ 17,942,995	1.2029	$ 21,583,629	2.22
2007	$ 4,739,700	96	1.0000	96	$ 49,372	$ 18,532,758	1.2029	$ 22,293,055	4.31
2008	$ 8,604,495	85	1.0147	86	$ 100,052	$ 18,265,093	1.2029	$ 21,971,080	3.91
2009	$ 7,658,737	107	1.0289	110	$ 69,625	$ 15,590,108	1.2029	$ 18,753,341	5.87
2010	$ 11,673,500	67	1.0395	70	$ 166,764	$ 14,904,664	1.2029	$ 17,928,820	3.90
2011	$ 11,200,835	63	1.0488	66	$ 169,710	$ 14,494,543	1.2058	$ 17,477,520	3.78

		Exponential Trend			Exponential Trend
(10)	2005-2011	17.0%	(11)	2005-2011	8.2%
(12)	Selected Severity Trend for BF	10.0%	(13)	Selected Adjusted Frequency Trend for BF	3.0%
			(14)	Selected Total Net Trend for BF	13.3%

(1) From Loss Development Exhibit - 6
(2) From Loss Development Exhibit - 3
(3) From Loss Development Exhibit - 3
(4) = (2) x (3)
(5) = (1) / (4)
(7) From Current Rate Level Exhibit - 2
(8) = (6) x (7)
(9) = [(4) / (8)] x 1,000,000
(10) Exponential Fit to Severity (2005-2011)
(11) Exponential Fit to Adjusted Frequency (2005-2011)
(12) Forecasted Severity Trend based on (10) and judgment, for use in Bornhuetter Ferguson loss development method
(13) Forecasted Adjusted Frequency Trend based on (11) and judgment, for use in Bornhuetter Ferguson loss development method

State XX
Wicked Good Insurance Company
Medical Malpractice
Net Trend Calculation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Accident Year	Selected Ultimate Loss & ALAE	Reported Claim Count	Reported Age-to-Ultimate Factor	Developed Claim Count	Severity	Earned Premium	Current Rate Level Factor	Earned Premium at Current Rate Level	Adjusted Frequency
2005	$ 5,735,000	63	1.0000	63	$ 91,032	$ 17,944,254	1.2029	$ 21,585,143	2.92
2006	$ 2,701,000	48	1.0000	48	$ 56,271	$ 17,942,995	1.2029	$ 21,583,629	2.22
2007	$ 4,739,700	96	1.0000	96	$ 49,372	$ 18,532,758	1.2029	$ 22,293,055	4.31
2008	$ 8,604,495	85	1.0147	86	$100,052	$ 18,265,093	1.2029	$ 21,971,080	3.91
2009	$ 7,658,737	107	1.0289	110	$ 69,625	$ 15,590,108	1.2029	$ 18,753,341	5.87
2010	$ 11,673,500	67	1.0395	70	$166,764	$ 14,904,664	1.2029	$ 17,928,820	3.90
2011	$ 11,200,835	63	1.0488	66	$169,710	$ 14,494,543	1.2058	$ 17,477,520	3.78
2012	$ 6,290,368	67	1.1953	80	$ 78,630	$ 14,442,449	1.2724	$ 18,376,572	4.35
2013	$ 18,254,793	56	1.4991	84	$217,319	$ 14,834,605	1.3018	$ 19,311,689	4.35
2014	$ 23,371,444	30	2.6039	78	$299,634	$ 18,265,093	1.2391	$ 22,632,277	3.45

		Exponential Trend			Exponential Trend
(10)	2005-2014	16.3%	(11)	2005-2014	3.5%
(12)	2010-2014	15.2%	(13)	2010-2014	-1.0%
(14)	Selected Severity Trend for LR Indication	10.0%	(15)	Selected Adjusted Frequency Trend for LR Indication	-1.0%
			(16)	Selected Total Net Trend for LR indication	8.9%

(1) From Loss Development Exhibit - 6
(2) From Loss Development Exhibit - 3
(3) From Loss Development Exhibit - 3
(4) = (2) x (3)
(5) = (1) / (4)
(7) From Current Rate Level Exhibit - 2
(8) = (6) x (7)
(9) = [(4) / (8)] x 1,000,000
(10) Exponential Fit to Severity (2005-2014)
(11) Exponential Fit to Adjusted Frequency (2005-2014)
(12) Exponential Fit to Severity (2010-2014)
(13) Exponential Fit to Adjusted Frequency (2010-2014)
(14) Forecasted Severity Trend based on (10) and (12) and judgment
(15) Forecasted Adjusted Frequency Trend based on (11) and (13) and judgment
(16) = { [1.0 + (14)] x [1.0 + (15)] } - 1.0; used in LR Indication

State XX
Wicked Good Insurance Company
Medical Malpractice
Net Trend Factors

	(1)	(2)	(3)
Accident Year	Selected Net Trend	Trend Period	Net Trend Factor
2010	8.9%	6.83	1.7902
2011	8.9%	5.83	1.6439
2012	8.9%	4.83	1.5095
2013	8.9%	3.83	1.3862
2014	8.9%	2.83	1.2729

(1) From Net Trend Exhibit - 2
(2) From 07/01/20XX to 05/01/2017
(3) = [1.0 + (1)] ^ (2)

State XX
Wicked Good Insurance Company
Medical Malpractice
ULAE Ratio

Calendar Year	(1) Countrywide Earned Premium ($000s)	(2) Countrywide Paid ULAE ($000s)	(3) ULAE Ratio
2010	$ 455,119	$ 16,310	3.6%
2011	$ 724,423	$ 34,010	4.7%
2012	$ 870,129	$ 4,799	0.6%
2013	$ 596,311	$ 10,086	1.7%
2014	$ 548,096	$ 12,573	2.3%
Total	$ 3,194,078	$ 77,778	2.4%
		(4) Selected Ratio	2.4%

(3) = (2) / (1)

State XX
Wicked Good Insurance Company
Medical Malpractice
Expense and ULAE Ratio Calculation

	2012	2013	2014	3-Year Average	Selected
(1) General Expenses					
a Countrywide Expenses	$ 67,766	$ 41,658	$ 35,243		
b Countrywide Earned Premium	$ 870,129	$ 596,311	$ 548,096		
c Ratio[(a)/(b)]	7.8%	7.0%	6.4%	7.2%	6.4%
(2) Other Acquisition					
a Countrywide Expenses	$ 29,041	$ 17,853	$ 15,103		
b Countrywide Written Premium	$ 768,631	$ 579,383	$ 576,253		
c Ratio[(a)/(b)]	3.8%	3.1%	2.6%	3.2%	2.6%
(3) Taxes, Licenses, and Fees					
a Countrywide Expenses	$ 21,678	$ 14,800	$ 12,225		
b Countrywide Written Premium	$ 768,631	$ 579,383	$ 576,253		
c Ratio[(a)/(b)]	2.8%	2.6%	2.1%	2.5%	2.1%
(4) Commission and Brokerage					
a Countrywide Expenses	$ 159,751	$ 123,221	$ 122,211		
b Countrywide Written Premium	$ 768,631	$ 579,383	$ 576,253		
c Ratio[(a)/(b)]	20.8%	21.3%	21.2%	21.1%	21.2%
(5) UW Expense Ratio	(1c) + (2c) + (3c) + (4c)				32.3%
(6) ULAE Ratio	From Expense and ULAE Ratio Exhibit - 1				2.4%
(7) UW Expense and ULAE Ratio	(5) + (6)				34.7%

(1b) from Expense and ULAE Ratio - 1
(3b) from (2b)
(4b) from (2b)

APPENDIX D: WORKERS COMPENSATION INDICATION

The following exhibits show an example of an overall rate level indication using the loss ratio approach. This example is based on workers compensation industry data that is used to determine advisory loss costs, including loss adjustment expenses. Individual workers compensation insurers that intend to use these loss costs as a basis for rates must include their own underwriting expense and profit assumptions, as described later in the appendix.

This example uses five accident years of experience evaluated as of December 31, 2016. Since it is industry data, the experience is more stable than that of an individual workers compensation insurer. An individual insurer performing its own rate level indication may wish to use more years of data to increase the stability of the results. The term for these policies is annual, and the proposed effective date for the revised loss costs is July 1, 2017. These loss costs are expected to be relevant for one year.

The exhibits included in this appendix are as follows:

- Premium: calculates the projected loss cost premium.
- Indemnity: derives the indemnity loss ratio for each accident year.
- Medical: derives the medical loss ratio for each accident year.
- LAE: derives the ALAE and ULAE factors.
- Indication: combines the medical and indemnity loss ratios with the ALAE and ULAE ratios to develop an indicated change to the advisory loss costs.
- Company: calculates the adjustment necessary to account for individual company underwriting expenses and profit, as well as deviations to expected losses.

PREMIUM EXHIBIT

This analysis indicates a change to the advisory loss costs, not earned premiums as in Appendices A and C. The denominator of this loss ratio indication is loss cost premium, which is the hypothetical portion of the premium charged by individual companies assuming the current advisory loss costs and historical experience modification factors were used (i.e., it does not reflect any company deviations from the advisory loss costs or any provision for expense and profit). Historical loss cost premium needs to be adjusted to the level expected in the future policy period. This involves adjustments for current rate level, exposure trend, and expected experience modification factors.

Column 1 shows the industry loss cost premium, which has already been adjusted for any subsequent changes in advisory loss costs (i.e., brought to current level) using the extension of exposures technique. Columns 2 through 5 show the calculation of the adjustment to loss cost premium to account for exposure trend. The exposure base for workers compensation insurance is payroll. Since payroll is inflation-sensitive, the premium changes as payroll changes. Column 2 shows the historical changes in payroll by accident year, assuming a constant number of workers. Column 3 converts the annual changes into cumulative factors such that the factor for the most recent accident year period (2016) is indexed to one. Column 4 is the wage increase expected between the most recent historical period and the time the rates are to be in effect. The selected trend of 6.1% is based on an assumed trend of 3.0% for two years (=

(1.03^2) -1.0). Column 5 combines the current and projected future wage changes into a composite exposure trend factor.

Columns 6 and 7 display the historical and expected average experience modification factors. As described in Chapter 15, insurers use experience rating to modify the manual rate for larger risks based on their actual experience. Column 6 shows the average experience modification factor for each historical accident year, and Column 7 shows the experience modification factor expected during the projected period. These factors are determined via a separate study. Loss cost premium in Column 1 is derived using the assumption that historical average experience modification factors were used. Multiplying the historical loss cost premium by the ratio of Column 7 to Column 6 adjusts the loss cost premium to the level of experience modification expected during the projected period. Column 8 combines the exposure trend and experience modification adjustments to calculate the projected loss cost premium.

INDEMNITY EXHIBITS

Sheet 1: Indemnity Loss Development

This sheet displays the reported link ratios by accident year for indemnity losses, starting with the 12-to-24 month link ratios and progressing through to the 336-to-348 month link ratios. The three-year average and the all-year average excluding the highest and lowest link ratio are displayed. The selected link ratios are based on the average excluding the highest and lowest link ratios.

A tail factor was selected based on a separate study; the tail factor represents the development expected beyond 348 months. In this example, the reported losses are expected to reach their ultimate level by 348 months, so the tail factor is set to 1.00. The age-to-ultimate factor at any point is calculated as the product of all subsequent selected link ratios and the tail factor. For example, the 36-to-ultimate factor is the product of all the selected link ratios between and including 36-to-48 months and 336-to-348 months, multiplied by the selected tail factor.

Sheet 2: Indemnity Benefit Cost Level Factors

Indemnity loss costs are impacted by changes in the legislative benefits, changes in utilization of indemnity benefits for each accident year, and general inflationary pressures.

Column 1 displays the estimated average annual impact of changes in the applicable indemnity benefit levels, considering both direct and indirect effects. The Accident Year 2014 effect of -30% is due to a law change, and the impact was calculated in a separate study. The last row includes any known changes in benefits that occur after the experience period.

As indemnity benefits are tied to wage levels, the indemnity benefits change as wages change. Column 2 displays the annual impact of wage inflation on benefits. These figures were calculated in a separate study and reflect the impact of any maximum and minimum benefit level restrictions. The last row for Column 2 is the expected increase in benefits due to wage increases that will occur between the historical period and the projected period; the selection is based on an estimated 1% trend for two years (i.e., from the average loss date of the latest accident year, July 1, 2016, to the average loss date of the policy projection period, July 1, 2018). Note the figures in Column 2 are significantly lower than the factors used to adjust loss cost premium to future wage level (in Sheet 1) due to the impact of maximum benefit level restrictions.

Column 3 is the combined impact of both benefit level changes and wage inflation. Column 4 calculates the factor needed to adjust each historical accident year's reported losses to the projected level.

Sheet 3: Indemnity Loss Ratios

This sheet calculates the expected indemnity loss ratios for each accident year in the experience period. Column 1 is the projected loss cost premium, which is calculated in the Premium Exhibit.

Columns 2 through 5 comprise the calculation of ultimate indemnity losses. Column 2 displays the reported indemnity losses for each accident year in the experience period. Columns 3 and 4 display the loss development and benefit cost level adjustment factors calculated in the prior two sheets. Column 5 is the product of Columns 2 through 4. Column 6 is the ratio of the ultimate projected losses in Column 5 divided by projected premium in Column 1.

MEDICAL EXHIBITS

Sheet 1: Medical Loss Development

This sheet represents the development triangle for the reported medical losses by accident year. This sheet is organized in the same way as described in the Indemnity Loss Development section.

The selected factors are based on the all-year average excluding the highest and lowest factors. Unlike indemnity losses, the reported medical losses in this example are expected to develop beyond 348 months, so a tail factor greater than unity is selected.

Sheet 2: Medical Benefit Cost Level Factors

Legislative and regulatory changes also impact the cost of medical benefits. The fees for many but not all medical services in workers compensation are subject to a fee schedule. Thus, the medical loss costs are impacted by changes in the medical fee schedules as well as changes due to general utilization and inflation.

Column 1 displays the estimated average changes in the applicable medical fee schedule by accident year, considering both direct and indirect effects. The average medical fee based on the schedule decreased in 2014 and subsequently increased in 2016. The medical fee schedule is not expected to change from the most recent period through the projected time period.

Column 2 shows the annual average change in medical benefits not subject to the medical fee schedule. These figures are based on the medical component of the Consumer Price Index (CPI). The projected "other medical" change is based on an expected annual change of 4% for two years. This considers any expected changes between the most recent period and the projected period.

Column 3 shows the selected percentages of medical losses by accident year assumed to be subject to the fee schedule. These percentages and their complements are used as weights to combine the changes in Column 2 (due to schedule changes) and the changes in Column 3 (changes unrelated to schedule). The result is the combined effect in Column 4. Column 5 converts the changes in Column 4 into the factors needed to adjust historical accident year reported medical losses to the projected loss cost levels.

Sheet 3: Medical Loss Ratios

This sheet calculates the expected medical loss ratios for each accident year in the experience period. The calculations are the same as described in the Indemnity Loss Ratio section.

LAE EXHIBITS

Sheet 1: ALAE Development

This sheet represents the development triangle for paid ALAE by accident year and is organized in the same way as described in the Indemnity Loss Development section.

The selected factors are based on the all-year average excluding the highest and lowest factors. In this example, paid ALAE are expected to develop beyond 348 months, so a tail factor greater than unity is selected.

Sheet 2: ALAE Ratio

This sheet calculates the ratio of ultimate ALAE to ultimate projected losses. ALAE are compared to losses rather than premium in the indication because ALAE are more directly related to the amount of losses than the amount of premium. The sum of the projected ultimate indemnity and medical losses is displayed in Column 1. The ultimate ALAE (Column 4) are the product of the paid ALAE (Column 2) and the ALAE development factor (Column 3). Column 5 is the ratio of the ultimate ALAE to ultimate losses. Row 6 is the selected ALAE ratio, based on the all-year average.

Sheet 3: ULAE Ratio

This exhibit calculates the ULAE ratio based on the historical relationship of calendar year paid ULAE to paid losses. Columns 1 and 2 include the calendar year paid losses (indemnity and medical) and paid ULAE, respectively. Column 3 is the ratio of ULAE to losses by calendar year, and these percentages are the basis of the selection included in Row 4. The selection is based on the latest two years because the actuary expects those years to be more representative of the future.

INDICATION EXHIBIT

This exhibit brings together the results from the previous exhibits and calculates the indicated loss cost premium change. The indemnity and medical expected loss ratios (Columns 1 and 2) are summed and then multiplied by one plus the sum of the ALAE (Column 3) and ULAE (Column 4) ratios to determine the projected loss and LAE ratio for each accident year (Column 5). Row 6 is the selected loss and LAE ratio, which is based on the five-year weighted average.

As the objective of the analysis is to determine the advisory loss costs, the premium does not include any underwriting expenses or profit; therefore, the target loss ratio is 100%. Subtracting one from the selected loss ratio produces the overall indicated change to the current advisory loss cost premium. A separate analysis should be conducted to determine whether the change should be applied uniformly to all risks or whether it should vary by type of risk.

COMPANY EXHIBIT

This exhibit calculates the adjustment an individual company should make to the advisory loss costs to account for underwriting expenses, profit targets, and any operational differences that would affect loss cost levels.

Rows 1 through 4 show the expected underwriting expense as a percentage of total premium for each major expense category. Row 5 is the target profit as a percentage of total premium. Row 6 is the total of the expense and profit percentages. Row 7 is calculated as the reciprocal of one minus the total expense and profit percentages. This adjustment applies multiplicatively to the advisory loss costs to include a provision for underwriting expenses and profit.[56]

Row 8 displays the expected difference in loss costs due to any known operational differences between the individual company and the industry. In this case, an overall average adjustment of -5% was selected to reflect an expectation of lower losses attributable to the company's more stringent underwriting and claims handling practices. The selection is converted into a factor in Row 9.

Row 10 combines the adjustment for expenses and profit with the adjustment for operational differences. This figure represents the deviation factor that the company should apply to the industry advisory loss costs.

Row 11 is the current company deviation factor, and Row 12 is the industry loss cost change. Row 13 combines the change in deviation factors and the loss cost change to calculate the indicated rate change for the company. This assumes that the company's distribution of risks is similar to the industry distribution, and that the industry loss cost change applies uniformly to all risks. If that is not the case, the actual impact for the company may be different from the industry loss cost change.

[56] Equivalently, this adjustment is often expressed as the advisory loss costs divided by one minus the total expense and profit percentages.

Workers Compensation
Calculation of Projected Premium

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Exposure Trend			Historical	Expected	
			Factor to	Expected	Factor to Adjust	Average	Average	
Accident Year	**Industry Loss Cost Premium**	**Annual Payroll Level Change**	**Current Wage Level**	**Future Wage Level Change**	**to Future Wage Level**	**Experience Modification**	**Experience Modification**	**Projected Loss Cost Premium**
2012	$ 3,900,972,841	2.5%	1.152	6.1%	1.222	0.991	0.970	$ 4,665,972,903
2013	$ 4,148,612,420	3.0%	1.118	6.1%	1.186	0.985	0.970	$ 4,845,326,599
2014	$ 4,334,300,493	3.7%	1.078	6.1%	1.144	0.981	0.970	$ 4,902,840,541
2015	$ 4,659,789,168	4.2%	1.035	6.1%	1.098	0.982	0.970	$ 5,053,925,714
2016	$ 4,795,461,580	3.5%	1.000	6.1%	1.061	0.957	0.970	$ 5,157,100,516
Total	$ 21,839,136,502							$ 24,625,166,273

(1) Industry loss costs at current rate level (assuming no company deviations and no provision for expense and profit)
(2) Determined in separate study
(3) = [1.0 + (2NextRow)] x (3NextRow)
(4) Based on 3% trend projected for 2 years
(5) = (3) x [1.0 + (4)]
(6) Determined in a separate analysis
(7) Selected
(8) = (1) x (5) x (7) / (6)

Workers Compensation
Reported Indemnity Loss Development

Age-to-Age Development (in months):

Accident Year	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to 84	84 to 96	96 to 108	108 to 120	120 to 132	132 to 144	144 to 156	156 to 168	168 to 180	180 to 192	192 to 204	204 to 216	216 to 228	228 to 240	240 to 252	252 to 264	264 to 276	276 to 288	288 to 300	300 to 312	312 to 324	324 to 336	336 to 348
1988																				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1989																			1.002	0.998	1.002	1.001	1.001	1.001	1.001	1.001	1.000	
1990																		1.001	1.001	1.002	1.001	1.002	1.003	1.002	1.001	1.001		
1991																	1.000	1.003	1.000	1.002	1.000	1.002	1.000	1.001	1.000			
1992																1.000	1.001	1.000	1.001	1.001	1.002	1.002	1.001	1.001				
1993															0.999	1.001	1.000	1.001	1.001	1.001	1.000	1.001	1.000					
1994														0.999	1.002	1.000	1.000	1.001	1.001	1.000	1.001	1.001						
1995													0.999	1.001	1.001	1.001	1.000	1.001	1.000	1.000	1.000							
1996												1.001	1.001	1.001	1.000	1.000	1.002	0.999	1.000	1.000								
1997											1.001	1.004	1.001	1.000	1.001	1.000	1.001	1.001	1.000									
1998										1.002	1.003	1.001	1.002	1.001	1.002	1.000	1.003	1.000										
1999									1.002	1.003	1.004	1.003	1.001	1.000	1.001	1.001	1.000											
2000								1.006	1.008	1.004	1.003	1.002	1.001	1.000	1.003	1.000												
2001							1.009	1.007	1.008	1.005	1.003	1.006	1.002	1.002	1.001													
2002						1.016	1.013	1.015	1.006	1.005	1.004	1.001	1.002	1.001														
2003					1.031	1.022	1.020	1.013	1.009	1.007	1.000	1.002	1.002															
2004				1.048	1.038	1.031	1.016	1.017	1.007	0.998	1.003	1.003																
2005			1.092	1.062	1.047	1.030	1.022	1.011	1.003	1.001	1.004																	
2006		1.230	1.109	1.071	1.042	1.026	1.013	1.002	1.007	1.005																		
2007	1.861	1.260	1.117	1.068	1.045	1.021	1.007	1.008	1.003																			
2008	1.910	1.291	1.118	1.068	1.034	1.014	1.011	1.006																				
2009	1.931	1.276	1.123	1.052	1.021	1.015	1.012																					
2010	1.873	1.325	1.106	1.035	1.023	1.021																						
2011	1.952	1.263	1.069	1.033	1.032																							
2012	1.782	1.187	1.069	1.055																								
2013	1.448	1.158	1.087																									
2014	1.503	1.221																										
2015	1.684																											
3-Year Average	1.545	1.189	1.075	1.041	1.025	1.017	1.010	1.005	1.004	1.001	1.002	1.002	1.002	1.001	1.002	1.000	1.001	1.000	1.000	1.000	1.000	1.001	1.000	1.001	1.001	1.001	1.000	1.000
Average xHi Lo	1.792	1.247	1.100	1.055	1.035	1.022	1.013	1.009	1.006	1.004	1.003	1.002	1.001	1.001	1.001	1.000	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001		
Selected	1.792	1.247	1.100	1.055	1.035	1.022	1.013	1.009	1.006	1.004	1.003	1.002	1.001	1.001	1.001	1.000	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.000	1.000
Selected Tail Factor	1.000																											
Cumulative	2.883	1.609	1.290	1.173	1.112	1.074	1.051	1.038	1.028	1.022	1.018	1.015	1.013	1.012	1.011	1.010	1.010	1.009	1.008	1.007	1.006	1.005	1.004	1.003	1.002	1.001	1.000	1.000

Workers Compensation
Indemnity Benefit Cost Level Factors

	(1)	(2)	(3)	(4)
Accident Year	Benefit Level Change	Annual Impact on Benefits due to Wage Inflation	Combined Impact on Benefits	Factor to Adjust Indemnity Benefits to Projected Cost Level
2012	0.0%	1.0%	1.0%	0.760
2013	0.0%	2.0%	2.0%	0.745
2014	-30.0%	2.0%	-28.6%	1.044
2015	0.0%	1.5%	1.5%	1.029
2016	0.0%	0.9%	0.9%	1.020
Projected	0.0%	2.0%	2.0%	1.000

(1) Based on average impact of legislative changes
(1Proj) Selected
(2) Based on the weekly wages of injured workers
(2Proj) Selected (1% annual trend)
(3) = [1.0 + (1)] x [1.0 + (2)] - 1.0
(4) = [1.0 + (3NextRow)] x (4NextRow)

Workers Compensation
Loss Ratios-Indemnity Losses Only

Year	(1) Projected Loss Cost Premium	(2) Reported Indemnity Losses	(3) Indemnity Loss Development Factor	(4) Factor to Adjust Indemnity Benefits to Projected Cost	(5) Projected Ultimate Indemnity Losses	(6) Expected Indemnity Loss Ratio
2012	$ 4,665,972,903	$ 1,678,705,592	1.112	0.760	$ 1,418,707,670	30.4%
2013	$ 4,845,326,599	$ 1,982,528,857	1.173	0.745	$ 1,732,502,230	35.8%
2014	$ 4,902,840,541	$ 1,345,482,170	1.290	1.044	$ 1,812,041,567	37.0%
2015	$ 5,053,925,714	$ 931,871,212	1.609	1.029	$ 1,542,862,823	30.5%
2016	$ 5,157,100,516	$ 668,971,913	2.883	1.020	$ 1,967,218,946	38.1%
Total	$ 24,625,166,273	$ 6,607,559,744			$ 8,473,333,236	34.4%

(1) From Premium Exhibit
(2) Input
(3) From Indemnity Sheet 1 (Development)
(4) From Indemnity Sheet 2 (Cost Change)
(5) = (2) x (3) x (4)
(6) = (5) / (1)

Workers Compensation
Reported Medical Loss Development

Age-to-Age Development (in months):

Accident Year	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to 84	84 to 96	96 to 108	108 to 120	120 to 132	132 to 144	144 to 156	156 to 168	168 to 180	180 to 192	192 to 204	204 to 216	216 to 228	228 to 240	240 to 252	252 to 264	264 to 276	276 to 288	288 to 300	300 to 312	312 to 324	324 to 336	336 to 348
1988																				1.016	1.011	1.009	1.014	1.010	1.004	1.006	1.007	1.003
1989																			1.015	1.003	1.003	1.020	1.009	1.014	1.003	1.005	1.005	
1990																		1.009	1.008	1.009	1.011	1.003	1.007	1.004	1.006	1.005		
1991																	1.006	1.016	1.012	1.009	1.009	1.009	1.008	1.005	1.015			
1992																1.005	1.005	1.007	1.008	1.009	0.998	1.001	1.005	1.004				
1993															1.004	1.005	1.005	1.006	1.003	1.007	1.002	1.004	1.002					
1994														1.006	1.006	1.003	1.009	1.007	1.008	1.008	1.004	1.000						
1995													1.001	1.004	1.007	1.007	1.009	1.007	1.004	1.001	1.005							
1996												1.005	1.003	1.008	1.007	1.016	1.004	0.998	1.006	1.000								
1997											1.002	1.010	1.006	1.008	1.009	1.005	1.004	1.004	1.002									
1998										1.003	1.009	1.009	1.009	1.015	1.003	1.002	0.999	1.006										
1999									1.004	1.011	1.008	1.012	1.012	1.006	1.001	1.004	1.003											
2000								1.005	1.009	1.010	1.012	1.009	1.008	1.006	1.011	1.004												
2001							1.010	1.013	1.017	1.014	1.021	1.010	1.011	1.002	1.010													
2002						1.011	1.021	1.028	1.024	1.021	1.022	1.012	1.009	1.013														
2003					1.032	1.028	1.033	1.034	1.029	1.025	1.011	1.018	1.008															
2004				1.037	1.038	1.047	1.036	1.044	1.026	1.018	1.011	1.023																
2005			1.067	1.050	1.053	1.052	1.046	1.028	1.019	1.019	1.014																	
2006		1.113	1.087	1.070	1.072	1.062	1.048	1.021	1.015	1.023																		
2007	1.443	1.169	1.112	1.095	1.081	1.042	1.022	1.024	1.036																			
2008	1.517	1.219	1.125	1.097	1.060	1.032	1.026	1.038																				
2009	1.598	1.226	1.131	1.072	1.038	1.029	1.044																					
2010	1.658	1.274	1.107	1.047	1.041	1.045																						
2011	1.632	1.203	1.059	1.038	1.055																							
2012	1.565	1.119	1.057	1.058																								
2013	1.348	1.134	1.111																									
2014	1.385	1.168																										
2015	1.447																											
3-Year Average	1.393	1.140	1.076	1.048	1.045	1.035	1.031	1.028	1.023	1.020	1.012	1.018	1.009	1.007	1.007	1.003	1.002	1.003	1.004	1.003	1.004	1.002	1.005	1.004	1.008	1.005	1.006	1.003
Average xHi Lo	1.512	1.177	1.095	1.061	1.051	1.039	1.033	1.027	1.020	1.017	1.012	1.011	1.008	1.007	1.007	1.005	1.005	1.007	1.007	1.007	1.006	1.005	1.007	1.006	1.005	1.005		
Selected	1.512	1.177	1.095	1.061	1.051	1.039	1.033	1.027	1.020	1.017	1.012	1.011	1.008	1.007	1.007	1.005	1.005	1.007	1.007	1.007	1.006	1.005	1.007	1.006	1.005	1.005	1.006	1.003
Selected Tail Factor	1.005																											
Cumulative	2.811	1.859	1.580	1.443	1.360	1.294	1.245	1.205	1.174	1.151	1.132	1.118	1.106	1.097	1.090	1.082	1.077	1.071	1.064	1.056	1.049	1.043	1.038	1.030	1.024	1.019	1.014	1.008

Workers Compensation
Medical Benefit Cost Level Factors

	(1)	(2)	(3)	(4)	(5)
Accident Year	Medical Fee Schedule Change	Annual "Other Medical" Level Change	Portion of Medical Losses Subject to Fee Schedules	Combined Effect	Factor to Adjust Medical Benefits to Projected Cost Level
2012	0%	2.5%	75.0%	0.6%	0.983
2013	0%	2.0%	75.0%	0.5%	0.978
2014	-20%	4.0%	70.0%	-12.8%	1.122
2015	0%	4.1%	70.0%	1.2%	1.109
2016	10%	3.9%	70.0%	8.2%	1.025
Projected	0%	8.2%	70.0%	2.5%	

(1) Based on evaluations of the cost impact of changes to the Fee Schedule
(1Proj) Selected
(2) Based on a medical component of the Consumer Price Index
(2Proj) Selected (4% annual trend)
(3) Selected based on separate study
(4) = (1) x (3) + [(2) x (1 - (3)]
(5) = [1.0 + (4NextRow)] x (5NextRow)

Workers Compensation
Loss Ratios-Medical Losses Only

	(1)	(2)	(3)	(4)	(5)	(6)
Year	Projected Loss Cost Premium	Reported Medical Losses	Medical Loss Development Factor	Factor to Adjust Medical Benefits to Projected Cost Level	Projected Ultimate Medical Losses	Expected Medical Loss Ratio
2012	$ 4,665,972,903	$ 2,188,888,983	1.360	0.983	$ 2,926,281,904	62.7%
2013	$ 4,845,326,599	$ 1,908,889,082	1.443	0.978	$ 2,693,927,353	55.6%
2014	$ 4,902,840,541	$ 1,576,129,809	1.580	1.122	$ 2,794,099,880	57.0%
2015	$ 5,053,925,714	$ 1,449,781,011	1.859	1.109	$ 2,988,913,475	59.1%
2016	$ 5,157,100,516	$ 954,283,007	2.811	1.025	$ 2,749,551,771	53.3%
Total	$ 24,625,166,273	$ 8,077,971,892			$ 14,152,774,383	57.5%

(1) From Premium Exhibit
(2) Input
(3) From Medical Sheet 1 (Development)
(4) From Medical Sheet 2 (Cost Change)
(5) = (2) x (3) x (4)
(6) = (5) / (1)

Workers Compensation
Paid Allocated Loss Adjustment Expense Development

Age-to-Age Development (in months):

Accident Year	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to 84	84 to 96	96 to 108	108 to 120	120 to 132	132 to 144	144 to 156	156 to 168	168 to 180	180 to 192	192 to 204	204 to 216	216 to 228	228 to 240	240 to 252	252 to 264	264 to 276	276 to 288	288 to 300	300 to 312	312 to 324	324 to 336	336 to 348
1988																				1.012	1.014	1.013	1.009	1.009	1.008	1.007	1.006	1.005
1989																			1.009	1.009	1.010	1.012	1.006	1.008	1.007	1.005	1.004	
1990																		1.011	1.013	1.010	1.008	1.007	1.008	1.008	1.012	1.008		
1991																	1.040	1.003	1.016	1.011	1.010	1.012	1.010	1.011	1.009			
1992																1.014	1.046	1.010	1.016	1.009	1.009	1.007	1.008	1.009				
1993															0.986	1.014	1.041	1.004	1.011	1.009	1.009	1.010	1.008					
1994														1.019	0.982	1.018	1.033	1.000	1.008	1.004	1.010	1.009						
1995													1.013	1.010	0.984	1.007	1.031	0.999	1.007	1.006	1.005							
1996												1.010	1.009	1.018	0.978	1.006	1.031	1.000	1.006	1.004								
1997											1.010	1.010	1.012	1.011	0.979	1.007	1.031	0.999	1.008									
1998										1.012	1.009	1.014	1.006	1.012	0.979	1.007	1.031	1.001										
1999									1.017	1.012	1.017	1.008	1.004	1.011	0.978	1.006	1.031											
2000								1.025	1.017	1.012	1.007	1.005	1.004	1.013	0.978	1.008												
2001							1.049	1.018	1.017	1.009	1.007	1.009	1.005	1.011	0.979													
2002						1.049	1.044	1.017	1.012	1.008	1.007	1.006	1.004	1.012														
2003					1.057	1.048	1.049	1.015	1.016	1.024	1.009	1.008	1.006															
2004				1.137	1.059	1.054	1.052	1.021	1.018	1.016	1.011	1.013																
2005			1.228	1.130	1.068	1.054	1.051	1.022	1.023	1.018	1.018																	
2006		1.533	1.242	1.141	1.066	1.054	1.057	1.031	1.026	1.023																		
2007	2.231	1.466	1.242	1.130	1.059	1.062	1.065	1.037	1.035																			
2008	2.065	1.459	1.211	1.121	1.067	1.071	1.065	1.037																				
2009	2.109	1.456	1.221	1.134	1.081	1.080	1.067																					
2010	2.317	1.498	1.240	1.159	1.087	1.076																						
2011	2.270	1.532	1.266	1.159	1.087																							
2012	2.356	1.539	1.254	1.156																								
2013	2.344	1.494	1.241																									
2014	2.234	1.484																										
2015	2.271																											
3-Year Average	2.283	1.506	1.254	1.158	1.085	1.076	1.066	1.035	1.028	1.019	1.013	1.009	1.005	1.012	0.978	1.007	1.031	1.000	1.007	1.005	1.008	1.009	1.009	1.009	1.009	1.007	1.005	1.005
Average xHi Lo	2.254	1.495	1.238	1.141	1.070	1.060	1.055	1.024	1.019	1.015	1.010	1.009	1.007	1.013	0.980	1.009	1.034	1.002	1.010	1.008	1.009	1.010	1.008	1.009	1.009	1.007		
Selected	2.254	1.495	1.238	1.141	1.070	1.060	1.055	1.024	1.019	1.015	1.010	1.009	1.007	1.013	0.980	1.009	1.034	1.002	1.010	1.008	1.009	1.010	1.008	1.009	1.009	1.007	1.005	1.005
Selected Tail Factor	1.005																											
Cumulative	6.992	3.102	2.075	1.676	1.469	1.373	1.295	1.228	1.199	1.176	1.159	1.148	1.137	1.129	1.115	1.138	1.128	1.091	1.088	1.078	1.069	1.059	1.049	1.041	1.031	1.022	1.015	1.010

Workers Compensation
ALAE Ratio

	(1)	(2)	(3)	(4)	(5)
Accident Year	**Projected Ultimate Indemnity and Medical Losses**	**Paid ALAE**	**ALAE Development Factor**	**Ultimate ALAE**	**ALAE Ratio**
2012	$ 4,344,989,574	$ 350,034,124	1.469	$ 514,200,128	11.8%
2013	$ 4,426,429,583	$ 336,178,599	1.676	$ 563,435,332	12.7%
2014	$ 4,606,141,447	$ 201,330,551	2.075	$ 417,760,893	9.1%
2015	$ 4,531,776,298	$ 155,896,057	3.102	$ 483,589,569	10.7%
2016	$ 4,716,770,717	$ 93,338,368	6.992	$ 652,621,869	13.8%
Total	$ 22,626,107,619	$ 1,136,777,699		$ 2,631,607,791	11.6%
			(6)	Selected Ratio	11.6%

(1) Derived from Indemnity Sheet 3 and Medical Sheet 3
(2) Input
(3) From LAE, Sheet 1 (Development)
(4) = (2) x (3)
(5) = (4) / (1)
(6) Selected

Workers Compensation
ULAE Ratio

	(1)	(2)	(3)
Calendar Year	Calendar Year Paid Indemnity and Medical Losses	Calendar Year Paid ULAE	ULAE as % of Losses
2012	$ 4,306,514,977	$ 288,536,503	6.7%
2013	$ 4,007,631,598	$ 272,518,949	6.8%
2014	$ 3,641,833,560	$ 320,481,353	8.8%
2015	$ 3,203,661,824	$ 288,329,564	9.0%
2016	$ 3,034,498,823	$ 273,104,894	9.0%
Total	$ 18,194,140,782	$ 1,442,971,263	7.9%

(4) Selected Percentage 9.0%

(1) Input
(2) Input
(3) = (2) / (1)
(4) Selected

Workers Compensation
Overall Indication

	(1)	(2)	(3)	(4)	(5)
Accident Year	**Expected Indemnity Loss Ratio**	**Expected Medical Loss Ratio**	**Expected ALAE Ratio**	**Expected ULAE Ratio**	**Expected Loss & LAE Ratio**
2012	30.4%	62.7%	11.6%	9.0%	112.3%
2013	35.8%	55.6%	11.6%	9.0%	110.2%
2014	37.0%	57.0%	11.6%	9.0%	113.4%
2015	30.5%	59.1%	11.6%	9.0%	108.1%
2016	38.1%	53.3%	11.6%	9.0%	110.2%
Total	34.4%	57.5%	11.6%	9.0%	110.8%

(6) Selected	110.8%
(7) Indication	10.8%

(1) From Indemnity Sheet 3
(2) From Medical Sheet 3
(3) From LAE Sheet 2
(4) From ULAE Sheet 2
(5) = [(1) + (2)] x [1.0 + (3) + (4)]
(6) Selected
(7) = (6) - 1.0

Workers Compensation
Company Adjustment

(1)	**General Expenses**	10.0%
(2)	**Other Acquistion Costs**	8.0%
(3)	**Taxes, License and Fees**	2.5%
(4)	**Commissions and Brokerage Fees**	8.0%
(5)	**Target Profit Provision**	1.5%
(6)	**Total Expense and Profit**	30.0%
(7)	**Expense and Profit Adjustment**	1.429
(8)	**Expected Loss Cost Difference**	-5.0%
(9)	**Operational Adjustment**	0.950
(10)	**Proposed Deviation**	1.358
(11)	**Current Deviation**	1.400
(12)	**Industry Loss Cost Change**	10.8%
(13)	**Company Change**	7.5%

(1)-(5)	Inputs
(6)	= (1) + (2) + (3) + (4) + (5)
(7)	= 1.0 / [1.0 - (6)]
(8)	Selection
(9)	= 1.0 + (8)
(10)	= (7) x (9)
(11)	Given
(12)	From Indication Sheet
(13)	= (10) / (11) x [1.0 + (12)] - 1.0

APPENDIX E: UNIVARIATE CLASSIFICATION EXAMPLE

The following two exhibits show examples of traditional (univariate) classification analysis using a pure premium and loss ratio analysis. Though not explicitly stated, each analysis uses multiple years of exposure, premium, and loss data.

PURE PREMIUM APPROACH

Column 1 displays the earned exposures by class. As discussed in earlier chapters, earned exposures are normally used as the best match to the reported losses.

Column 2 displays the calendar accident year reported loss and ALAE. In this example, loss development and trend are assumed to have a negligible effect on the pure premium relativities and therefore have been ignored. Column 3 displays the pure premium, or average loss and ALAE per exposure. Column 4 converts the pure premiums into pure premium relativities by dividing the pure premium for each class by the total pure premium. Expressing the class experience relative to the total is important for comparing these indicated pure premium relativities to those currently used by the company or used by competitors (assuming those are expressed relative to the total, also). Column 5 shows the current class relativities as specified in the rating manual. The base class is Class J, as evidenced by its relativity of 1.00. Column 6 displays the current class relativities normalized so that the total exposure-weighted average relativity is 1.00. (It is preferable to weight the relativities using premium adjusted to the base class, but exposures are used as a proxy.) By normalizing these relativities, the actuary can compare them on an apples-to-apples basis to the indicated relativities in Column 4.

Column 7 contains the credibility measure for each class. The full credibility standard is 11,050 exposures, and partial credibility is calculated using the square root rule. The 11,050 figure is derived based on the 663 claim standard[57] and an expected frequency of 6%. Column 8 shows the credibility-weighted indicated relativity, which is determined by credibility-weighting the indicated relativities with the normalized current relativities. Another commonly used complement of credibility is the all class pure premium, but that was ruled out due to the significant variation between the classes. Column 9 shows the credibility-weighted indicated relativities after they are adjusted to the base class.

Column 10 displays the selected relativities. Column 11 shows the expected change in premium for each class due to the change between the current and selected manual relativities. The fact that the total exposure-weighted average relativity changed by -0.2% (= 1.2776 / 1.2802 - 1.0) means that if the selected class relativities are implemented without any other changes, the overall premium will change by -0.2%. The base rate needs to be increased, or “offset,” by the reciprocal of that change factor (1.0 / (1.0 + -0.2%)) if no overall premium change is desired (i.e., to make the rate change revenue neutral). Column 12 displays the percent change by class assuming the selected relativities and the base rate offset.

[57] As discussed in Chapter 12, the 663 standard assumes no variation in the size of loss and that there is a 99% chance that the observed value will be within 10% of the true value.

LOSS RATIO APPROACH

Column 1 shows the earned premium at current rate level. Chapter 5 discusses several methods for adjusting premium to present rate level. For the purposes of the relativity analysis, it is critical that the premium be adjusted at the granular level rather than at the aggregate level. In other words, it is not sufficient to use the parallelogram method at the aggregate level if the rate changes varied by the classes being examined.

Column 2 displays the reported loss and ALAE. The same comments about trend and development made in the pure premium approach apply.

Column 3 is the loss ratio for each class and for all classes combined. Column 4 converts the loss ratios to indicated changes by dividing the loss ratio for each class by the loss ratio of all classes combined and subtracting one. The indicated change is the percentage the current class relativities (displayed in Column 8) need to be increased or decreased so that the expected loss ratio will be the same for every class.

Columns 5 through 7 derive the credibility-weighted indicated change. Column 6 shows the calculation of the credibility assigned to each class based on the claim counts shown in Column 5. The full credibility standard is 663 claims, and partial credibility is calculated using the square root rule. Column 7 is the credibility-weighted indicated change where the complement of credibility is no change (i.e., 0%).

The current relativities in Column 8 are adjusted by the credibility-weighted indicated change to determine the credibility-weighted indicated relativities in Column 9. The relativities in Column 9 are adjusted to the base class level in Column 10.

Column 11 contains the selected relativities, and Column 12 is the calculation of the relativity change for each class. The total change in Column 12 is the weighted average of the class changes using premium at current rate level as the weight. This represents the expected change in premium due to the selected class relativity changes, and is the amount the base rate needs to be offset if these relativity changes are to be implemented on a revenue-neutral basis. Column 13 is the change for each class if the selected relativities are implemented and the base rate is offset.

Wicked Good Auto Insurance Company
Classification Relativities

Class	(1) Earned Exposures	(2) Reported Loss & ALAE	(3) Pure Premium	(4) Indicated Relativity	(5) Current Relativity	(6) Normalized Current Relativity	(7) Credibility	(8) Credibility-Weighted Indicated Relativity	(9) Credibility-Weighted Indicated Relativity @ Base Class	(10) Selected Relativity	(11) Relativity Change	(12) Percent Change with Off-Balance
J	16,520	$ 878,200	$ 53.16	0.7831	1.00	0.7811	1.00	0.7831	1.0000	1.00	0.0%	0.2%
K	11,328	$ 740,940	$ 65.41	0.9636	1.15	0.8983	1.00	0.9636	1.2305	1.23	7.0%	7.2%
L	1,266	$ 136,830	$ 108.08	1.5922	1.95	1.5232	0.34	1.5467	1.9751	1.98	1.5%	1.7%
M	12,836	$ 888,582	$ 69.23	1.0199	1.35	1.0545	1.00	1.0199	1.3024	1.30	-3.7%	-3.5%
N	4,200	$ 753,156	$ 179.32	2.6417	3.50	2.7339	0.62	2.6767	3.4181	3.42	-2.3%	-2.1%
P	11,538	$ 518,146	$ 44.91	0.6616	0.85	0.6640	1.00	0.6616	0.8448	0.84	-1.2%	-1.0%
TOTAL	57,688	$ 3,915,854	$ 67.88	1.0000	1.2802	1.0000		1.0016		1.2776	-0.2%	0.0%

(3) = (2) / (1)
(4) = (3) / (Tot3)
(Tot5) = (5) weighted by (1)
(6) = (5) / (Tot5)
(7) = [(1) / 11,050] ^ 0.5 limited to 1.0
(8) = (4) x (7) + [1.0 - (7)] x (6)
(Tot8) = (8) weighted by (1)
(9) = (8) / (Base8)
(Tot10) = (10) weighted by (1)
(11) = (10) / (5) - 1.0
(12) = [1.0 + (11)] / [1.0 + (Tot11)] - 1.0

Wicked Good Auto Insurance Company
Classification Relativities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Class	**Premium at Current Rate Level**	**Reported Loss and ALAE**	**Loss Ratio**	**Indicated Change**	**Number of Claims**	**Credibility**	**Credibility-Weighted Indicated Change**	**Current Relativity**	**Credibility-Weighted Indicated Relativity**	**Credibility-Weighted Indicated Relativity @ Base Class**	**Selected Relativity @ Base Class**	**Relativity Change**	**Percent Change with Off-Balance**
J	$ 1,114,932	$ 878,200	78.8%	2.3%	826	1.00	2.3%	1.00	1.0230	1.0000	1.00	0.0%	2.4%
K	$ 917,284	$ 740,940	80.8%	4.9%	652	0.99	4.9%	1.15	1.2064	1.1793	1.18	2.6%	5.0%
L	$ 166,314	$ 136,830	82.3%	6.9%	124	0.43	3.0%	1.95	2.0085	1.9633	1.96	0.5%	2.9%
M	$ 1,162,236	$ 888,582	76.5%	-0.6%	866	1.00	-0.6%	1.35	1.3419	1.3117	1.31	-3.0%	-0.7%
N	$ 1,056,318	$ 753,156	71.3%	-7.4%	736	1.00	-7.4%	3.50	3.2410	3.1681	3.17	-9.4%	-7.3%
P	$ 666,978	$ 518,146	77.7%	0.9%	490	0.86	0.8%	0.85	0.8568	0.8375	0.84	-1.2%	1.1%
TOTAL	$ 5,084,062	$ 3,915,854	77.0%	0.0%	3,694							-2.3%	0.0%

(3) = (2) / (1)
(4) = (3) / (Tot3) - 1.0
(6) = [(5) / 663] ^ 0.5 limited to 1.0
(7) = (4) x (6) + 0.0% x [1.0-(6)]
(9) = [1.0 + (7)] x (8)
(10) = (9) / (Base9)
(12) = (11) / (8) - 1.0
(Tot12) = (12) weighted by (1)
(13) = [1.0 + (12)] / [1.0 + (Tot12)] - 1.0

APPENDIX F: MULTIVARIATE CLASSIFICATION EXAMPLE

This appendix includes example output from a GLM analysis. It includes several tests used to evaluate the predictive power of a potential rating variable and hold-out sample testing used to evaluate the overall effectiveness of a particular model.

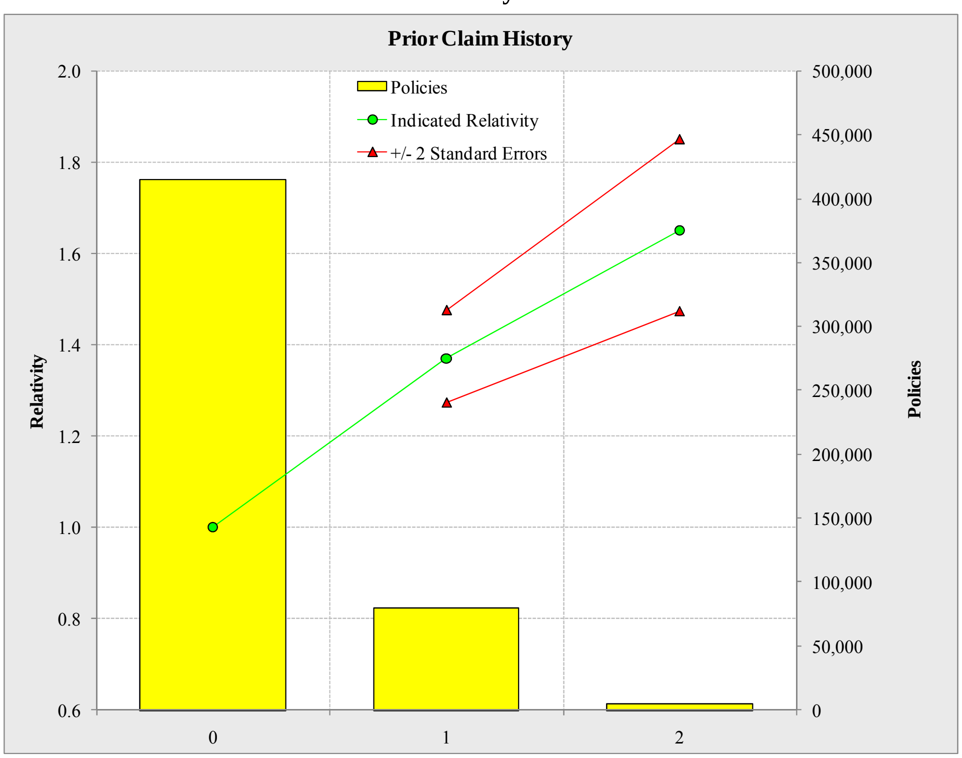
EXAMPLE PREDICTIVE VARIABLE

This section contains sample output from a multiplicative GLM fit to homeowners water damage frequency[58] data. The graphical output isolates the effect of the prior claim history variable as a significant predictor of water damage frequency, though the model contains other explanatory variables that must be considered in conjunction with the prior claims history effect.

Parameters and Standard Errors

The following graph displays the indicated frequency relativities for prior claims history, all other variables considered. The categories on the x-axis represent the levels of the variable (0, 1, or 2 claims). The level for zero prior claims is the base level, and the relativities for the other levels are expressed relative to it. The bars relate to the right y-axis, showing the number of policies in each level. The line with the circle marker shows the indicated relativities, and the lines with the triangle markers represent two standard errors on either side of the indicated relativities.

F.1 Main Effect Test for Prior Claim History



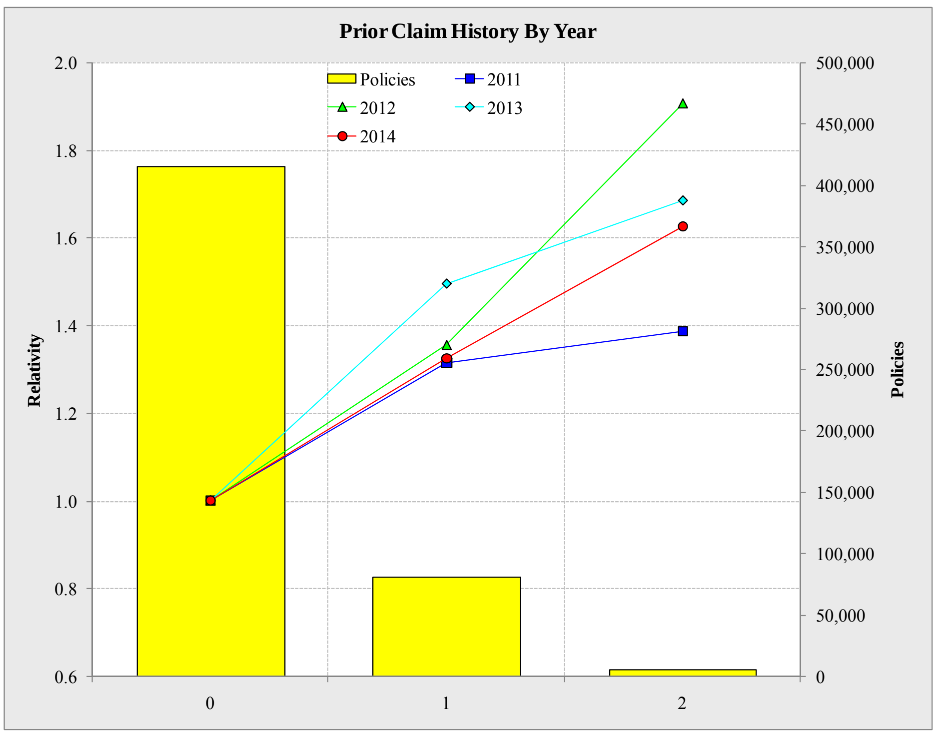
[58] It is common for actuaries to build frequency and severity models for each major peril or cause of loss.

The fact that the indicated relativity line is upward sloping with relatively tight standard errors suggests that the expected frequency is higher for risks with prior claims. More specifically, risks with one or two prior claims have a frequency that is approximately 35% and 65% higher than risks with no prior claims.

Consistency Test

The prior graph shows the indicated relativities for the whole dataset. The following graph shows the pattern of relativities for each of the individual years included in the analysis. (In some cases, the actuary may use random segments of the dataset rather than individual years.) Like the last figure, the categories on the x-axis represent the number of prior claims, and the bars are the number of policies in each level. The lines represent the indicated frequency relativities for prior claims history, separately for each year.

F.2 Consistency Test for Prior Claim History



The fact that each year's indicated line slopes upward with roughly the same shape suggests that the pattern is consistent over time. This provides the actuary with a practical test supporting the stability of this variable's predictive power.

Statistical Test

The actuary can also test the predictive power of a variable using statistical diagnostics such as deviances. One common deviance test is the Chi-Square test. In this test, the actuary fits models with and without the variable being studied and analyzes the trade-off between the increased accuracy of the model with the variable included versus the additional complexity of having additional parameters to estimate. The null hypothesis is that these two models are essentially the same. A Chi-Square percentage is calculated based on the results of the two models. A Chi-Square percentage of less than 5% generally suggests the actuary should reject the null hypothesis that the models are the same and should use the model with the greater number of parameters.

In this example, the Chi-Square percentage is 0.02%. Thus, the actuary rejects the null hypothesis and selects the model with the greater number of parameters. In other words, the actuary selects the model with the prior claims history variable in it.

Judgment

It is important that the actuary evaluate the reasonableness of the model and diagnostic results based on knowledge of the claims experience being modeled. In this case, the statistical results are consistent with the intuitive expectation that frequency is higher with the presence of prior claims.

Decision

All four tests suggest the rating variable is predictive and should be included in the model (and ultimately the rating algorithm).

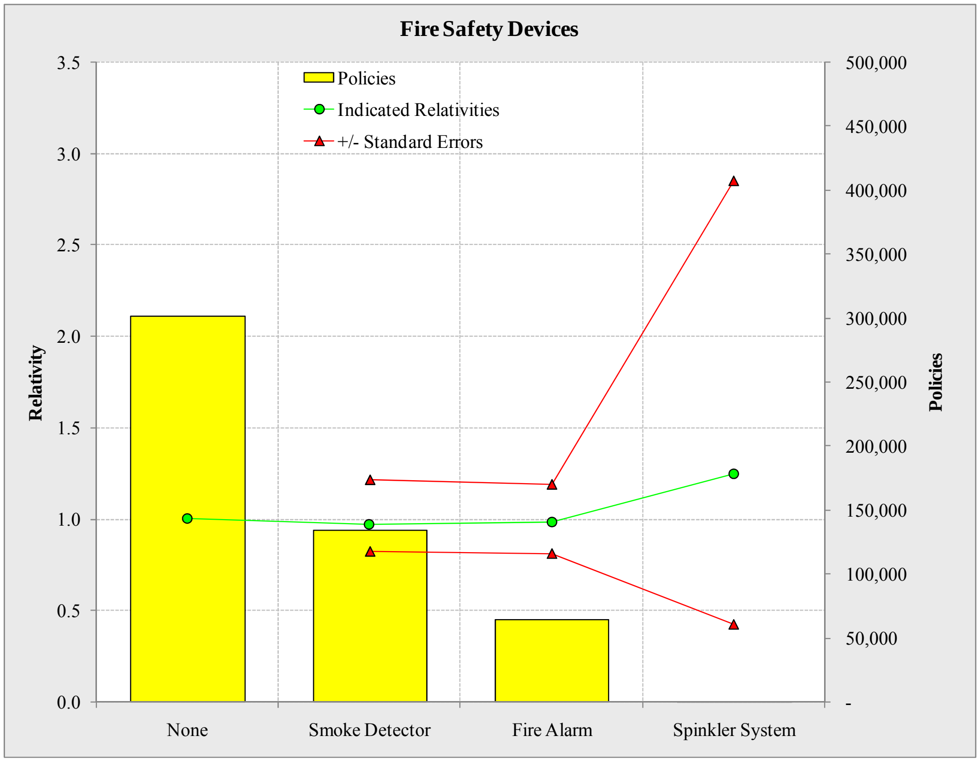
EXAMPLE UNPREDICTIVE VARIABLE

This section contains sample output from a multiplicative GLM fit to homeowners wind damage frequency data. The output isolates the effect of fire safety devices as an insignificant predictor of wind damage frequency, though the model contains other explanatory variables that must be considered in conjunction with this variable.

Parameters and Standard Errors

The following graph shows the indicated frequency relativities for the fire safety device variable, all other variables considered. The x-axis categories represent the different fire safety devices (the base being the level “none”), and the bars are the number of policies in each level. The lines represent the indicated wind damage frequency relativities and two standard errors on either side of the indicated relativities.

F.3 Main Effect Test for Fire Safety Device

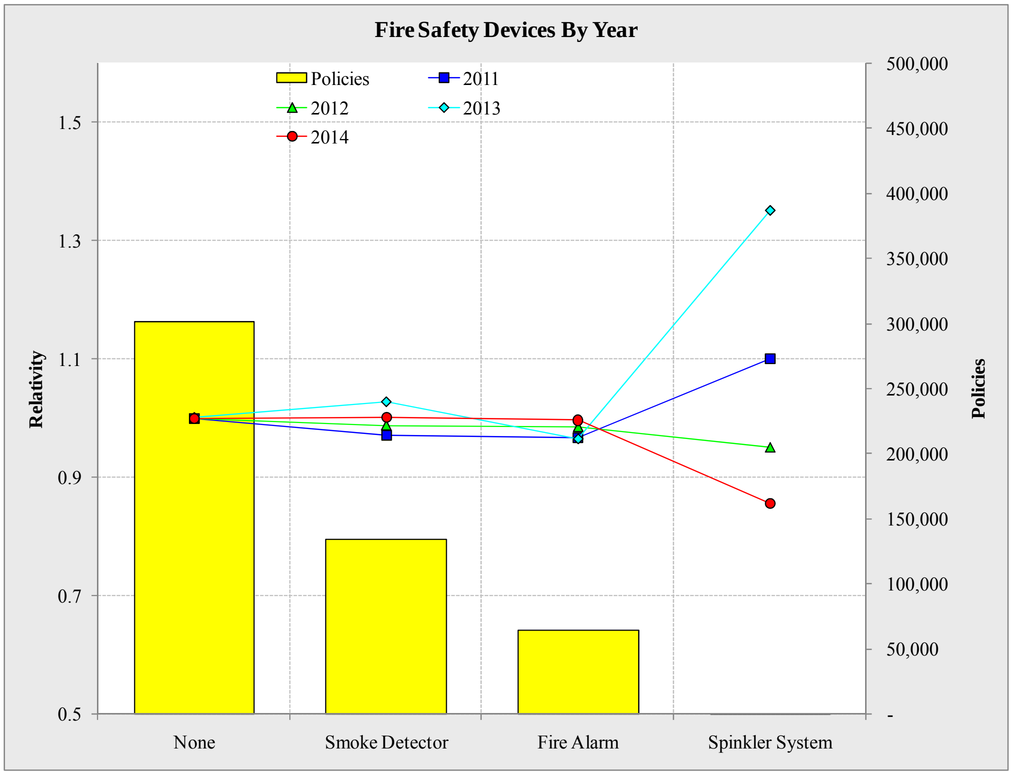


The indicated line is basically flat (i.e., indicated relativities are close to 1.00) for the levels that have a significant number of policies. The one category that has an indication substantially different than 1.0 (sprinkler system) has very wide standard errors around the indicated relativity, which is likely due to the small number of policies in that category. Thus, there appears to be little predictive power in this variable, and it should be removed from the wind damage frequency model.

Consistency Test

The following figure shows the pattern for each of the individual years included in the analysis. Like the last graph, the categories on the x-axis represent different fire safety devices, and the bars are the number of policies in each level. The lines represent the indicated relativities for each year.

F.4 Consistency Test for Fire Safety Device Claim



The patterns are consistent across the years for all categories but the sprinkler system. That category has little data, and the predictions are very volatile. These results confirm the conclusions derived from the parameter results and standard errors.

Statistical Test

The Chi-Square percentage for this variable is 74%. Percentages above 30% indicate that the null hypothesis, which asserts the models are the same, should not be rejected. If the models are "the same," then the actuary should select the simpler model that does not include the additional variable. (Chi-Square percentages between 5% and 30% are often thought to be inconclusive based on this test alone.)

Judgment

The existence of smoke detectors, sprinklers, and fire alarms does not seem to have any statistical effect on the frequency of wind damage losses. This is consistent with intuition.

Decision

All four tests suggest the rating variable is not predictive and should be excluded from the wind damage frequency model.

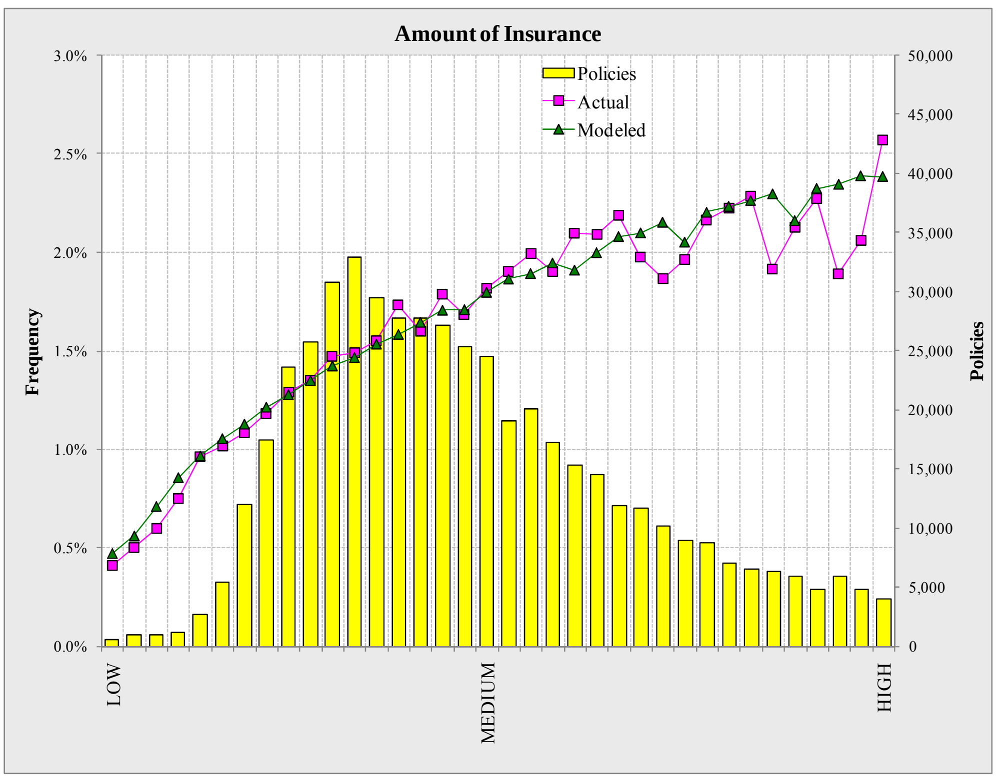
OVERALL MODEL VALIDATION

There are many tests that analyze the overall effectiveness of a given model, the most common of which compares predictions made by the model to actual results on a hold-out dataset (i.e., data not used to develop the model). This test does require that companies set aside a portion of the data for testing; this may not always be possible for smaller companies.

Validation Test Segmented by Variable

The following graph shows the observed and predicted frequencies for various levels of amount of insurance. If the model is predictive, then these frequencies should be close for any level with enough volume to produce stable results. The random nature of the insurance process will create small differences between the lines; however, either large or systematic differences or both should be investigated as possible indicators of an ineffective model. For example, the model may contain too much noise caused by retaining statistically insignificant variables or not have enough explanatory power because statistically significant variables are omitted.

F.5 Actual Results v Modeled Results for AOI

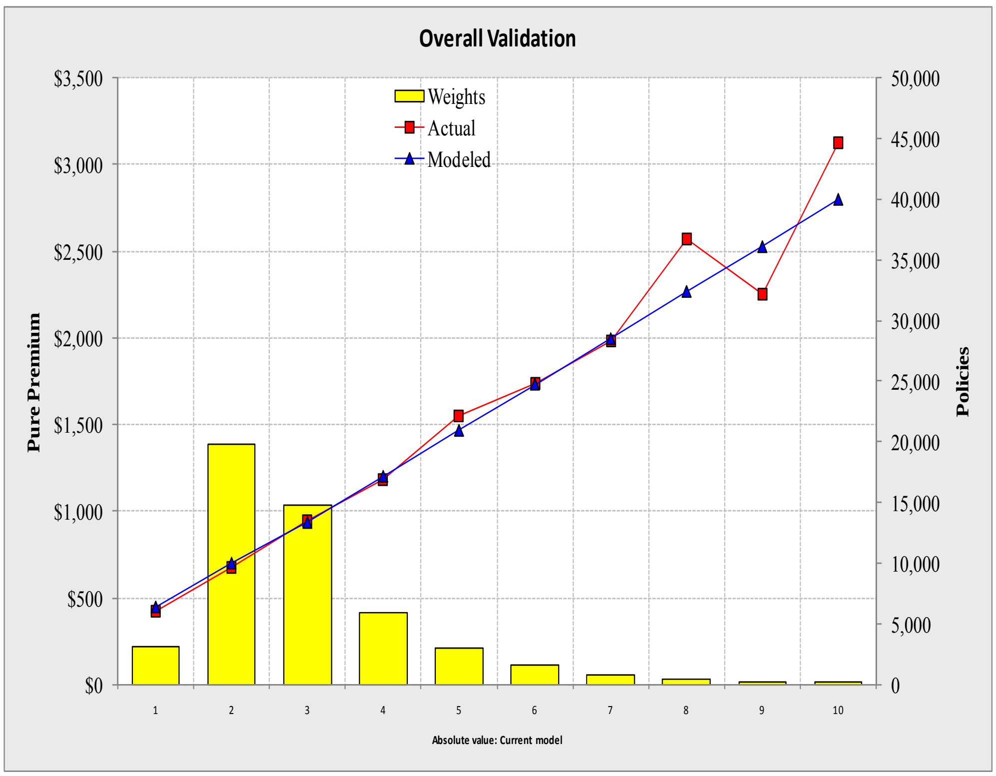


In viewing this graph, it is important to note that amount of insurance is a variable for which there is a natural order to the different levels (i.e., amount of insurance $201,000 is between amounts of insurance $200,000 and $202,000). In general, the results show a close match between expected frequencies from the model and actual claim frequencies. In particular, however, the modeled results for the first four levels appear to be higher than the actual results, suggesting that the model may be over-predicting the frequency for homes with low amounts of insurance. Similar-sized discrepancies can be seen for the medium amounts of insurance (where the actual results appear higher than the modeled results) and the high amounts of insurance (where the actual results appear lower than modeled results but with considerable volatility).

Validation Test Segmented by Fitted Value

In the following figure, the underlying frequency and severity models were used to determine a modeled pure premium for each observation in a hold-out dataset. Then, each observation was ordered according to the modeled pure premium result from the lowest to highest expected value. The observations were then grouped into 10 groups, and the actual and modeled results for each group are compared on the same chart. If the model is predictive, the actual result will be close to the modeled result for each group. Special attention should be paid to the lowest and highest groups where the results are more likely to deviate as models are generally less able to predict observations at the extremes.

F.6 Actual Results v Modeled Results



In this case, the actual results are very close to the modeled results for the first seven groups. There appears to be a lot of difference between actual and modeled results for the last few groups, but the low volume in those groups suggests the results may be distorted by noise and therefore less valid.

Summary of Changes to *Basic Ratemaking* from Version 4 (October 2010) to Version 5 (May 2016)

Chapter 1
On page 3, in the definition of IBNER, the order of the terms in the difference has been switched for greater clarity (difference between ultimate and reported rather than the difference between reported and ultimate)

Chapter 2
On pages 16 & 25, a definition of manual rate has been added to sections discussing schedule rating. Previously schedule rating was described as an adjustment to the manual rate but no definition of manual rate was provided.

Chapter 5
On page 87, an extra "%" has been removed from the text

Chapter 6
On pages 113-116, Charts 6.15 through 6.19 have been changed to reference Policy Year (PY) 15 instead of the incorrect reference to Policy Year (PY) 13

Chapter 10
On page 172, a sentence has been added to help readers understand why initial (or seed) relativities are required when applying the minimum bias approach

Chapter 11
On page 212, the references to left-skewed and right-skewed have been switched. The new definition of having left-skewed be large losses dominating and right-skewed be small losses dominating is consistent with Friedland's text on Exam 5.

Chapter 12
On page 216, the second criteria for measures of credibility has been changed to refer to the increase in the size of the risk (not the number of risks). The third criteria includes additional qualifying language: "as the size of the risk increases (all else being equal)…"

On page 219, the words "assuming Poisson frequency" have been added to the formula involving coefficient of variation squared. Without this change, the ratio was the formula for the coefficient of variation of severity and would have needed a frequency element.

On page 220, a disadvantage of the Classical credibility method has been added - that judgment is required to pick an appropriate complement

On page 221, a sentence has been added (in the paragraph to the left of Graph 12.2) regarding types of errors (model error or random fluctuations) that the derivations of EPV and VHM are subject.

On page 230, language has been added toward the top of the page to clarify that the selected annual loss trend is often consistent with the trend used in the latest rate level indication

Chapter 14
On page 278, the footer formula in Table 14.8 has been changed to (Tot9) = (Tot8)/(Tot7). It previously had an incorrect formula of (Tot9) = (9) Weighted by (6).

On page 283, the title of Table 14.13 has been changed to refer to capping the base level instead of the non-base level

Chapter 15
On page 297, the sentence describing the application of the experience modification factor has been changed to reflect application to *manual* premium (rather than *standard* premium)

On page 298-299, the paragraphs on composite rating have been changed to make the discussion clearer and consistent with Chapter 4

Appendix A
On page A-8, the note below row (5) has been changed to refer to Current Rate Level Exhibit – 1 rather than Current Rate Level Exhibit – 2

On page A-13, footer (1) has been changed to reference Current Rate Level Exhibit – 2 rather than Current Rate Level Exhibit – 1

Appendix B
On page B-15, the row header for (2) has been changed to include Taxes/Licenses/Fees since a portion of Taxes/Licenses/Fees is fixed

Appendix C
On page C-18, the footer has been changed to refer to Net Trend – 2 instead of Net Trend – 1

Appendix F
On page F-3, the Chi-Squared percentage has been changed from 0% to 0.02% since the percentage will never be exactly 0%

On page F-5 in the section on Statistical Test, wording regarding the null hypothesis has been changed to say “not be rejected” instead of “accepted.” This is appropriate statistical language.