CASUALTY ACTUARIAL SOCIETY FORUM

Summer 1993 Edition

CASUALTY ACTUARIAL SOCIETY
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CASUALTY ACTUARIAL SOCIETY

Date: June 1993

To: CAS Readership

Re: The Forum

The Summer 1993 issue of The Forum offers a wide range of reading for our members. We have a number of papers on surplus requirements. One is A Synopsis and Analysis of Research on Surplus Requirements for Property and Casualty Insurance Companies, which was commissioned by the Committee on Financial Analysis of the CAS. Another is a Report on Reserving and Underwriting Risk Factors from the American Academy of Actuaries Property/Casualty Risk-Based Capital Task Force. A third is a Report on Covariance Method for Property-Casualty Risk-Based Capital by the Actuarial Advisory Committee to the NAIC P/C Risk-Based Capital Working Group.

Other subjects include risk loads, alternative exposure bases, ratemaking, the underwriting cycle and the residual markets. In addition, we have a forty year old letter by John Carleton, the revised instructions for the 1992 annual statement blank regarding the statement of actuarial opinion, and a very relevant court case.

On the lighter side, we have an excerpt from a Civil War diary, and a new musical comedy by David Skurnick.

We continue to encourage you to submit your papers or articles to the Forum. You can send the articles to me at my yearbook address, or to anyone on the Forum Committee.

Yours Very Truly,

Joel Kleinman
Chairperson, The Forum Committee

The Casualty Actuarial Society Forum is a non-refereed journal printed by the Casualty Actuarial Society. The viewpoints expressed in it do not necessarily reflect the view of the Casualty Actuarial Society.

The Forum is edited by the Forum Committee. The Forum Committee invites all members of the CAS to submit papers on topics of interest to the actuarial community. Articles need not be written by a member of the CAS, but should have content of interest to the CAS membership.

The Forum is printed on a periodic basis, based on the number of articles submitted. Its goal is to publish two editions during the calendar year.

Any comments or questions you have may directed to The Forum Committee.

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A SYNOPSIS AND ANALYSIS OF RESEARCH ON SURPLUS REQUIREMENTS FOR PROPERTY AND CASUALTY INSURANCE COMPANIES

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A SYNOPSIS AND ANALYSIS OF RESEARCH ON SURPLUS REQUIREMENTS FOR PROPERTY AND CASUALTY INSURANCE COMPANIES

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INTRODUCTION

The continuing solvency of property and casualty insurance companies, as well as of other financial institutions, has become an issue of great importance and major concern during the past decade. While solvency has always been a major consideration for actuaries, the experience of multiple failures of financial institutions in the past several years has caused the profession to focus more attention on the problem. The emerging role of the valuation actuary, as well as the renewed interest of legislators in the solvency issue, have added a sense of urgency to the profession's need to better evaluate solvency.

This report has been commissioned by the Committee on Financial Analysis of the Casualty Actuarial Society to lay the groundwork for future research on surplus requirements for property and casualty insurers in a North American context. The largest part of this report is an annotated bibliography of relevant research papers. These are found in the bibliography. The bibliography provides a foundation for future research. For convenience, all papers cited have been grouped according to general subject area. The subject classification, which contains a list of the major approaches to the solvency problem itself, is described in the first section of this report. Papers are listed alphabetically by author and are also grouped according to subject classification. The most promising approaches for further study and development are evaluated and discussed in the second section.

1. CLASSIFICATION OF RESEARCH AREAS

The bibliography to this report contains a comprehensive listing of research reports published in English which relate to the solvency of property and casualty insurance companies. Each paper has been classified according to its primary approach or subject matter. A particular paper may touch on categories other than its primary classification. The classification system is described below. The categories listed span an area wider than the strict subject of solvency; many of the papers cited have implications for solvency but are not strictly papers on solvency.

I. Classical Risk Theory

One approach to solvency evaluation has been through classical risk theory, particularly the branch known as ruin theory. This is a well-established area, described in a number of well-known text books as listed in the bibliography to this report. Also included in this category are papers which study solvency through various probabilistic models which do not involve detailed cash flow simulations.

II. Projection Simulation Models

With the development of computers, renewed attention has been focused on the use of cash flow projection models to study, among other things, the continuing solvency of insurance companies and their sensitivity to various sources of risk. This is a very promising area of research.

III. Financial Economics

Applications of modern financial economics, particularly the capital asset pricing model (CAPM) and option pricing methods, have been proposed for insurance during the past fifteen years. These methods offer a novel approach to the solvency problem. Of particular interest is the emphasis on a unified view of the firm, based on both assets and liabilities.

IV. Loss Reserving

Loss reserves have a major impact on an insurer's balance sheet; they are a major determinant of surplus. Since they are estimates of future costs arising from past losses, they are subject to considerable uncertainty. Many of the works in this category aim to improve the accuracy of loss reserve estimation. Some papers treat methods for explicit provisions for adverse deviations (although these cannot currently be applied for GAAP reserves in the U.S.).

V. Statistical Methods

A number of research studies center on the utility of various systems of financial ratios and indices as predictors of continuing solvency. Many papers in this category analyze the performance of such systems based on historical data.

VI. Regulation

A primary purpose of regulation is the monitoring of the solvency of the regulated insurers. These papers discuss changes in regulation and the effectiveness of regulation.

VII. Financial Reporting and Surplus Management

Since solvency is usually understood to mean the existence of non-negative surplus, the methods used to measure surplus, the various financial reporting systems, as well as related management actions in managing surplus, will have a significant impact on the assessment of an insurer's financial condition.

VIII. Life Insurance

Recent studies, particularly in Canada and in the United Kingdom, on approaches to evaluating the solvency of life insurers and on minimum surplus requirements may have significant application to property and casualty insurers. The Canadian approach to dynamic solvency testing for life insurance companies is shortly to be extended to property and casualty insurers.

IX. Investment Models

Solvency depends upon the entire scope of an insurer's operations, including its products and its investments. Interest rate and investment models are major components of projection simulation models; they are important in the evaluation of an insurer's solvency. Papers on asset-liability matching and investment strategy are also included here.

X. Ratemaking

Proper product pricing, in particular the provision of adequate profit or risk margins in rates, is an important determinant of future solvency. This category has considerable overlap with category III since many recent applications of the capital asset pricing model have focused on ratemaking. In such cases, papers have often been classified under category III only.

XI. General

In this classification are contained a number of wide-ranging papers which span many of the previous categories but do not fit easily into any of them.

2. REVIEW OF SIGNIFICANT APPROACHES TO SOLVENCY STUDIES

The primary aim of this study is to summarize and categorize methods to study the financial condition of individual companies. One aspect is the measurement of a company's condition at a particular time. A second is the selection of leading indicators which might provide early warning of possible future difficulty. Third is the determination of necessary amounts of capital and surplus. The last, and perhaps most important, is to arrive at an understanding of all sources of risk to which the company is exposed and to have the ability to advise management as to the likely consequences for the company's financial condition of future changes in the external environment or in company strategies and operations.

A dictionary definition of solvency is "the ability to pay all just debts". Conventionally, a company is deemed solvent on the basis of its balance sheet if assets exceed liabilities. There are several caveats associated with this conventional view.

1. Since balance sheets are usually prepared with specific frequencies, such as quarterly or annually, an outside observer can only assess the adequacy of a company's surplus at discrete times. Moreover, since the preparation of accounting statements requires considerable effort and time, such statements are usually available only after their reporting dates; the traditional view of solvency is usually retrospective.

2. The traditional notion of solvency depends on the financial reporting system in use. There is no unique or preferred system. Many companies report on two bases: statutory, and GAAP. A third basis is used for tax purposes in the U.S. and some other jurisdictions. Moreover, the statutory systems in different jurisdictions vary considerably. A company which operates internationally and reports on multiple financial bases might have a number of markedly different views of its own financial health. It is not immediately clear which basis better portrays the ability of the company to meet its obligations.

3. Whether a company is truly able to pay all just debts incurred depends on the current assets, investment income they will generate, the actual claim amounts to be paid in the future, and future expenses involved in handling investments, claim payments, and general administration. At any given time, most of these values are not available; we must use estimates (eg: loss reserves). This problem extends to the value of assets as well as liabilities; assets may be valued using book or market values, or something in between. Because many of these items are random variables, no reporting system will be able to identify with certainty whether a company will be able to pay all its just debts.

Even if one takes these caveats into account, it must be recognized that it is necessary to pay significant attention to the conventional accounting definition of solvency and standard financial reporting systems. In particular, a company's licence to continue doing business will depend on its meeting regulatory surplus tests calculated on a statutory basis. This is, after all, the main purpose of statutory financial reporting.

However, we are usually not concerned only with the current licence but also with the company's ability to maintain its licence. The notion of solvency takes on a dynamic or continuing nature. In the best of situations, we want to be assured that with an acceptably high degree of probability, the company will be able to meet the balance sheet solvency test at any future time.

To achieve this, one provides margins in pricing and establishes minimum surplus requirements that are intended to provide for errors in pricing, in loss reserving, and in other areas. The literature contained in this review deals with each of these to some extent.

A: Surplus and Risk Theory

Since we are concerned with ongoing solvency, it is usually not satisfactory to require only that surplus be positive without requiring some positive minimum value for it. One minor reason is that the financial statement, and hence the determination of solvency on a balance sheet basis, is never completely up to date. Therefore, it is important to make allowance for some deterioration in the company's financial position from the reporting date until the time at which action can be taken to correct any financial problems.

A more important reason for maintaining a minimum positive value for surplus is illuminated by classical risk theory. Risk theory considers the aggregate annual losses for a block of business. This is treated as a random variable; the distribution of this variable is usually treated as a compound distribution composed of the distribution of the number of claims and the claim size distribution (distribution of claim amounts). It is important to note that this decomposition of the distribution of aggregate losses is the result of having made simplifying mathematical assumptions. For an actual book of business, it is important to satisfy oneself that the underlying assumptions are at least approximately true before using the common techniques of risk theory. In order to model the distribution of the number of claims, one must assume the claim frequencies and the distribution of claim sizes have been estimated correctly. It is possible to introduce an element of uncertainty in these estimates into the model at a cost of complicating the model. The standard models and techniques for calculating them are described in standard texts which are found on the CAS examination syllabus.

A fundamental purpose of risk theory is to consider the probability that aggregate losses will exceed premium income and available surplus; this is the problem of ruin. If the time period is a single year, the problem is not too difficult to solve for the narrowly defined theoretical situations typically assumed. However, if the time period exceeds the period used in describing the number-of-claims random variable, the mathematics becomes much more complicated. In fact, approximate analytic solutions are usually available for an infinitely long time period (ruin ever). For finite time periods, with recent improvements in computing power, it is often possible to obtain numerical solutions. Since these are often not in closed form, they do not offer much insight into the underlying process.

Ruin theory attempts to give the probability of ruin or insolvency within a fixed time period depending on initial surplus, the risk loading in the premium, usually expressed as a fraction of expected losses, and the probability distribution of aggregate losses. A standard method of applying ruin theory is to choose an acceptably small probability of ruin within the time period and determine the initial surplus which will keep the probability of ruin below the desired level. In the absence of a closed solution (eg: finite time) this is quite difficult. Therefore, most applications are based on keeping the probability of ultimate ruin at a low level. Fortunately, from an actuarial point of view, this is a conservative approach since the probability of ruin in a finite time period is smaller than the probability of ultimate ruin.

As mentioned above, the calculation depends on the premium loading. The classical theory totally ignores the effect of interest or inflation. Some extensions of classical results can handle interest but are difficult to compute. There is an extension which takes policyholder dividends or experience rating into consideration; however, the mathematics is difficult and the results sometimes are counter-intuitive. For this, see the textbook by Gerber.

In short, the classical theory treats losses on future claims as the only random variable. Changes in claim frequencies and severities or the make-up of the book of business are not easily handled. Interest and expenses are usually ignored. Although it is possible to incorporate claim cost inflation into the loss distribution, this does not translate easily into the ruin situation. The theory does not treat risks associated with existing liabilities and assets. Important sources of risk such as misestimation of loss reserves, unanticipated future inflation, and adverse court decisions or changes in the law fall outside the scope of this theory. These risks are significant and must be considered when evaluating an insurer's surplus and solvency.

At best, ruin theory can give an indication of the amount of initial surplus required to maintain solvency with a desired degree of probability. This surplus will cover only the risks related to random fluctuation in total losses. It is not likely that we can base a practical method of monitoring solvency strictly on ruin theory. One recent paper which does consider the more complicated situation in a finite time interval is (Meyers, 1986).

A more recent development concerning surplus requirements is the emergence of risk-based surplus formulas. These are under development by NAIC and follow the introduction of similar requirements in the European Economic Community (Council of the European Communities, 1979) and, for life insurers, in Canada (Canadian Life and Health Insurance Association, 1991). The usual form of such formulas is to require, for each major source of risk, surplus equal to the product of some measure of a company's exposure to that risk and a fixed factor. For risks related to random non-systematic fluctuations in losses relating to future premium earnings, these factors may be derived using ruin theory.

Papers on this subject area are to be found under subject classification I.

B: Loss Reserving

The extensive literature on loss reserving falls outside the scope of this study. Only papers which make an explicit connection between loss reserving and solvency are included. Very few of these discuss explicit provision of margins within reserves. Among these are (Arata, 1983), (Ashe, 1986), (Byrnes, 1986), (De Jong and Zehnwirth, 1982), and (Sogn, 1984). Perhaps the most useful work in this area does not appear in the bibliography since it is still in preparation; this is the work of the Canadian Institute of Actuaries Committee on Property and Casualty Insurance Financial Reporting on provisions for adverse deviations in loss reserves. The need for this provision was studied in (Panjer and Brown, 1990). In this context, these provisions for adverse deviations are expected to cover errors due to misestimation of claim amounts and timing of claim payments. This approach may be difficult to implement in the U.S. since margins for adverse deviations cannot be included in GAAP reserves. However, the absence of discounting in these reserves may lead to an implicit provision for adverse deviations.

Papers on this subject area are to be found under subject classification IV.

C: Financial Economics

The historical impetus for rate regulation has often been taken to be the maintenance of solvency. From this point of view, the regulatory interest would appear to be avoidance of insufficient or deficient premiums. Some papers which discuss margins in this way are (Ramlau-Hansen, 1988 Part II), (Taylor, 1988), and (Martin-Lof, 1983). The bulk of the research literature in the bibliography suggests a diametrically opposed perspective. The majority of papers treat rate regulation for insurers in a manner analogous to that used for public utilities. This is particularly so for the significant body of work stemming from financial economics, reviewed below.

A sizable literature has developed on the application of financial economics, particularly CAPM and option pricing theory, to insurance. The main application has been to pricing or ratemaking. A description of these applications can be found in (Cummins, 1991). A discussion of the utility of this approach for solvency studies is found in (Daykin and Hey, 1990). In general, this approach does not give direct solvency-related information about a particular company. The emphasis in these papers is on a ratemaking procedure which will give insurers a fair rate of return on equity. Solvency enters into the discussion when the fair rate is considered. However, the risks faced by an insurer in carrying out its business are not usually explicitly considered. Solvency determination must examine the total risk of the company, while most financial economic theory only examines non-diversifiable risk. The principal exception is the paper (Cummins, 1986) on risk based premiums for insurance guaranty funds; this paper attempts to put a price on a company's financial condition. This approach, if continued and refined, shows promise as an approach to solvency studies.

Perhaps the most important point to be taken from this finance literature is that solvency is a matter involving all aspects of the company, including assets, investment policy, and capital structure. In addition, financial market forces cannot be ignored. Important sources for information on asset-liability matching for insurance companies are (Platt, 1986), (Tilley, 1980), and (Boyle, 1978).

As Daykin and Hey conclude, the papers based on applications of financial economics give an alternative way of describing what is going on in the market place but are not of much direct use in analyzing the situation of a particular company, particularly when alternative courses of action are being considered.

There is, however, a possible future link between the actuarial and financial economics approaches which merits further study. Recent experience in the life insurance industry in Canada has shown that as the Minimum Continuing Capital and Surplus Requirement, a risk-based formula, has come into effect, companies have begun to use the requirement determined by each line of business (including its supporting assets) as a measure of the company's equity invested in the line; this is important in considering return on equity in pricing. If risk-based surplus requirements are introduced into other segments of the insurance industry, they would be used as one measure of the needed invested capital when doing ROI calculations. Application of methods based on financial economics, particularly option pricing theory, to ratemaking in which the goal is to produce a fair rate of return on required risk based surplus could provide useful links between pricing and the maintenance of solvency.

Papers on this subject area are to be found under subject classification III.

D: Projection Simulation Models

None of the approaches to solvency studies which have been discussed seem to offer direct application to the study of particular companies. These approaches are mathematical in nature. In order to arrive at mathematical settings which one has any hope of solving, it is usually necessary to make simplifying assumptions. While these assumptions improve our chances of obtaining answers, they also guarantee the answers will be of limited use since they ignore important aspects of the real world situation.

An alternate approach is to simulate a company by computer models. One gives up the possibility of nice analytic solutions. Thanks to recent increases in computing power at greatly reduced cost, one gains the ability to vary beginning assumptions and test the model and the company under a wide variety of scenarios of possible future experience. This approach shows great promise, given the current state of our mathematical knowledge, for studying insurers' solvency.

There are two important series of works which have developed this approach. The first comes from Finland as a series of papers by Pentikainen and his colleagues. Their work is best summarized in the book (Pentikainen, Bonsdorff, Pesonen, Rantala, and Ruohonen, 1989). The second series stems from the activities of a working party of the Institute of Actuaries in the United Kingdom, concerning the solvency of general insurance companies. This has resulted in a series of works by Daykin and his colleagues. The most recent, and useful, paper in this series is (Daykin and Hey, 1990).

This modelling approach to solvency has been implemented in Canada as a professional technique under the name Dynamic Solvency Testing. The approach taken is described in (Canadian Institute of Actuaries, 1989) and (Brender, 1991). Initially, Dynamic Solvency Testing has been applied to life insurers. However, it is expected to be extended to property and casualty insurers in 1992 or 1993. This procedure forms the basis for the annual report on a company's financial condition which, under new Canadian legislation, the appointed actuary must make to the board of directors for both life and property and casualty insurance companies.

An important question in adopting the simulation approach is the length of the projection period. There is a temptation to consider the property and casualty business as short term, and therefore not requiring extensive projections. However, there is broad recognition that the industry is subject to underwriting cycles of the order of five to eight years. Moreover, times to settlement of claims are often very long, exposing insurers to significant inflation risk and other estimation error. These observations suggest projections must be done for a period at least as great as a typical underwriting cycle; a ten year projection would not appear to be excessive.

Projections are usually carried out using different scenarios of possible future experience and management decisions. One must consider whether these scenarios will be deterministic or stochastically generated. Both the Finnish and British groups have taken a stochastic approach. A fundamental stochastic element has been the model which generates the economic assumptions. Both groups have used the basic approach of (Wilkie, 1986). On the other hand, the Canadian Dynamic Solvency Testing process uses deterministic scenarios. In principle, the stochastic approach is preferable. However, if its results are to be relied on in operating actual companies, one must be assured that the models used to generate scenarios do in fact accurately reflect our real environment. It can be argued that the Wilkie model does not meet this condition in the United Kingdom (Geoghegan et al, 1992); it certainly does not describe the situation in North America without modification. Work is in progress in this area on a number of fronts. If the stochastic simulation approach to solvency is adopted, it will be necessary for (North American) actuaries to undertake considerable work in models for generating scenarios. It should also be noted that simulation models generally produce voluminous numerical results. When many scenarios are run, the results can be overwhelming. Methods of analyzing these results to make them comprehensible will require further development.

The advantage of the deterministic scenario approach is that sensitivities to specific changes in variables can be assessed. For example, one can address the question "Can the company withstand a 3% increase in inflation (and the likely resulting increase in interest rates)?". This approach does not produce probabilities of ruin as does the stochastic scenario approach. However, without a lot of detailed work, the stochastic scenario approach does not identify the causes of insolvency.

Papers on this subject area are to be found under subject classification II.

E: Ratio Tests

Those in the insurance industry are familiar with a number of financial ratio tests which are used as 'quick and dirty' indicators of a company's financial condition. Most important in this category is the NAIC's IRIS system. Certain indicators used by various rating agencies are also of this type. Several papers study the effectiveness of these tests (Ambrose and Seward, 1988), (Bar-Niv and Hershbarger, 1988), (Pinches and Trieschmann, 1974). Although these tests may appear to be rather crude when compared with the information which can be obtained from simulation models, nevertheless they will probably always be with us. There is a genuine need, particularly on the part of regulators, for tests based on current, and usually public, financial data. It seems that it would be profitable to improve on the tests currently in use. Possible approaches are suggested in (Harrington and Nelson, 1986), (Ludwig and McAuley, 1988) and (Salzmann, 1981). The multivariate discriminant analysis approach, as described, for example, in the works by Altman listed in the bibliography, seems to be promising in this regard.

Papers on this subject area are to be found under subject classification V.

RISK THEORY TEXTS

BEARD, R.E., PENTIKAINEN, T., PESONEN, E., *Risk Theory* third edition, Chapman and Hall, London, 1984

BUHLMANN, HANS, *Mathematical Methods in Risk Theory*, Springer-Verlag, Berlin, 1970

GERBER, HANS U., *An Introduction to Mathematical Risk Theory*, S.S. Huebner Foundation for Insurance Education, Richard D. Irwin Inc., Homewood, 1979

PANJER, H.H., WILLMOT, G.W., *Insurance Risk Models*, Society of Actuaries, Schaumberg, 1992, to appear

SEAL, HILARY L., *Stochastic Theory of a Risk Business*, John Wiley & Sons, New York, 1969

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NOTE: In addition to the papers contained in this bibliography, the reader should also consult the two-volume set *Insurer Financial Solvency*, the proceedings of the 1992 CAS Discussion Paper Program in Chicago. These papers appeared after this bibliography was prepared.

APPENDIX B

Papers listed by subject

B - I

Papers on Classical Risk Theory

BACHMAN, J.E. "Capitalization Requirements for Multiple Line Property – Liability Insurance Companies". Huebner Foundation Monograph, University of Pennsylvania 1978.

The author considers product line combinations and capitalization requirements. He uses a general random walk model to determine the amount of capital required to preserve solvency over various time horizons within a given level of probability. The study concludes that a uniform ratio of premium to surplus cannot be applied on an industry-wide basis, and also that the composition of the investment portfolio has a major effect on solvency, in fact greater than underwriting activity alone. Thirdly, the study concludes that an insurer can increase its premium-surplus ratio without increasing its probability of ruin merely by changing its insurance product line mix. A combination of a high premium-surplus ratio and an all bond portfolio offers a greater expected total rate of return and a smaller probability of ruin (and hence requires less capital) than the combination of a low premium-surplus ratio and an investment portfolio which emphasizes common stocks.

BOHMAN, H. "Rule of Thumb for the Determination of a Sufficient Risk Reserve". Scandinavian Actuarial Journal (1974) 237-240.

The author suggests a heuristic method based on a random walk method to determine the probability that the risk reserve is non-negative at the end of the planning period and for arbitrarily many discrete intermediate points.

BOHMAN, H. "Solvency and Profitability Standards". Scandinavian Actuarial Journal (1976) 111-113.

The author defines a solvency standard and profitability standard. He then solves the following problem: Under what conditions can a new contract be added to a portfolio that contains only profitable contracts? He shows that if the new contract is profitable, then the expanded portfolio will also be profitable, but the existing reserve must be great enough to accommodate the new contract, in order for the expanded portfolio to remain solvent.

BROWN, A. "Insuring the Solvency Margin of a Capital Guaranteed Fund". Transactions of the International Congress of Actuaries (1988).

A simple model is constructed of a capital guaranteed fund. The probability that the solvency margin falls below a specified level is calculated from this model. The cost of insuring the solvency margin on a stop-loss basis can be determined from the probabilities. The maximum net return on the assets after allowing for this insurance indicates an appropriate investment strategy.

CUMMINS, J.D. "Statistical and Financial Models of Insurance Pricing and the Insurance Firm". Journal of Risk and Insurance 58 (1991) 261-302

The author tries to reconcile the actuarial and the financial models of insurance, beginning with the idea of insurance pricing. He gives a brief background of statistical models of insurance, based on risk theory; then he gives a brief background to financial models of insurance, based on CAPM. Then he lists five areas where the integration of statistical and financial models would be valuable:

(1) the development of asset/liability management models that take into account more sophisticated models of the reserve run-off,

(2) financial models of reinsurance using option pricing theory, taking into account the fact that insurance claims are non-traded assets, and using probability distributions other than the lognormal,

(3) development of multiperiod option pricing models for long-tail insurance contracts, instead of using a funds generating or "k" factors approach to model the claims runoff process,

(4) adaptation of pricing and asset/liability management models to incorporate stochastic interest rates,

(5) endogenization of surplus.

MEYERS, G. "Equilibrium in the Capital Structure of an Insurance Company". International Conference on Insurance Solvency I, 1986

This paper uses finite ruin theory to predict the amount of surplus that will support a given rate of return. This calculation takes into account many relevant factors such as the size of the company, characteristics of the lines of insurance written by the company, parameter uncertainty, excess of loss insurance and investment income. Particular attention is paid to uncertainty in loss reserves, security loads and the underwriting cycle.

PENTIKAINEN, T., RANTALA, J. "Solvency of Insurers and Equalization Reserves". Vol. I (General Aspects), Vol. II (Risk Theoretical Model), Insurance Publishing Company Ltd. 1982, Helsinki

This is a research report under the directorship of T. Pentikainen, proposed for the Insurance Department of the Ministry of Social Affairs and Health of Finland. The following topics are discussed:

Vol. I

(1) solvency politics and background factors,

(2) empirical data,

(3) risk-theoretical model,

(4) solvency ratios,

(5) solvency margins,

(6) measuring solvency,

(7) fluctuation reserve.

Vol. II

(1) distribution of total claim amount,

(2) stochastic dynamic model of insurance company,

(3) analytic treatment of model,

(4) fluctuation range of solvency margin, minimum safety loadings and solvency test,

(5) simulation of total claims caused by catastrophes,

(6) reinsurance, solvency margin and policyholders,

(7) regulation of equalization reserves of Finnish non-life insurers.

PENTIKAINEN, T., BONSDORFF, H., PESONEN, M., RANTALA, J., RUOHONEN, M. "Insurance Solvency and Financial Strength". Finnish Insurance Training and Publishing Company Ltd., 1989, Helsinki

This book gives a general survey of the subject matter, and tries to bridge the gap between theory and practice i.e. between academicians and practicing actuaries. The book covers the areas of risks and effects, including claims, business cycles, premiums, investment return and asset risks, expenses, taxes, dividends, and inflation. The authors also discuss public solvency control and financial strength as an element in insurance management. A simulation model is described and an explicit example is worked out using this model. The authors also discuss international regulatory issues. The text is self-contained with most of the risk-theoretic analysis following the lines of "Risk Theory" by Beard, Pentikainen, E. Pesonen.

RAMLAU-HANSEN, H. "A Solvency Study in Non-Life Insurance Part I". Scandinavian Actuarial Journal (1988) 3-34

This paper describes a study of statistical analyses of policy and claims data of a portfolio of fire, windstorm, and glass liabilities of single family houses and dwellings. Claim frequencies and claim size distributions are estimated, and the results are used to derive moments of the annual claim amounts and to provide examples of solvency margin requirements for different classes of business.

RAMLAU-HANSEN, H. "A Solvency Study in Non-Life Insurance Part II". Scandinavian Actuarial Journal (1988) 35-59

This paper shows how the solvency margin depends on portfolio composition and volume, reinsurance, time horizon, probability of ruin, and the values of some of the basis parameters. The results show that 8-28% of premium income is necessary to cover the random fluctuations in claim costs. However, statutory requirements should be higher (25-43%) to provide reasonable protection against inadequate safety loadings.

SEAL, H.L. "Simulation of the Ruin Potential of Non-life Insurance Companies". Transactions of the Society of Actuaries 21 (1969) 563-590

A simplified stochastic model of a casualty insurance company consists of two independent and unchanging probability distributions. The first of these is the distribution of intervals between successive claims, and the second is the distribution of individual claim amounts. Financially, the company may be pictured as accumulating a steady flow of risk-loaded premiums in its risk reserve and paying claims therefrom at intervals determined by the first distribution and in amounts determined by the second. This model was used to run a computer simulation of ten randomly chosen companies over a forty year period. All the companies commenced business with a fairly substantial risk reserve, but several failed during the period, even though they charged theoretically correct pure premiums. Standard experience-rating methods were found to be a poor protection against adverse change fluctuations whose cumulative effects were often substantial.

SHAKED, I. "Measuring Prospective Probabilities of Insolvency: An Application to the Life Insurance Industry". Journal of Risk and Insurance 52 (1985) 59-80

The author calculates the probability of failure of several publicly traded life insurers. These probabilities are derived by assuming that asset returns are lognormally distributed and then calculating the parameters of that distribution for each insurer. As indicated by the findings, most life insurers are reasonably safe. However, the distribution of failure probability is skewed, so that several life insurers pose a large enough insolvency risk to warrant regulatory attention. In addition, the paper examines the sensitivity of insolvency risk to the estimated parameters of the basic framework.

SUGARS, E.G. "A Risk Theoretic Prescription for Regulated Ratemaking". Journal of Risk and Insurance" 39 (1972) 475-478

The author suggests a method, based on risk theory, for determining a fair rate of return in the non-life insurance business. The paper contains the idea that rates should be loaded only enough to allow the insurer a fair return on that part of policyholder surplus funds required to run a prudent insurance business.

SUGARS, E.G. "Selected Results from a Risk-Theoretic Simulation of an Insurance Company". Journal of Risk and Insurance 41 (1974) 221-228

The discussion studies the consequences of complying with the one-to-one solvency rule as opposed to adhering to a 0.001 ruin criterion. In four of the five cases studied the 0.001 criterion yields distinctly different consequences for policyholders, shareholders or both. The fifth case permits an indefinitely large premium volume with comparable results for both criteria.

TAPIERO, C.S., ZUCKERMAN, D., KAHANE, Y. "Optimal Investment-Dividends Policy of an Insurance Firm under Regulation". Scandinavian Actuarial Journal (1983) 65-76

An insurance decision model including intervention by a regulating agency is defined. The insurance firm's problem is to establish an investment policy as well as a dividend strategy. Regulation is exercised by a minimal barrier policy for cash holding and penalties for violating this barrier. The joint Insurance Firm-Regulating Agency problem is discussed by using concepts from Stackleberg strategies in game theory. As in the classical model of collective risk theory it is assumed that premium payments are received deterministically from policyholders at a constant rate, while the claim process is compound Poisson. A diffusion approximation is used in order to obtain tractable results for a general claim size distribution.

B - II

Papers on Projection Simulation Models

BALZER, L.A., BENJAMIN, S. "Dynamic Response of Insurance Systems with Delayed Profit/Loss - Sharing Feedback to Isolated Unpredicted Claims". Journal of the Institute of Actuaries 107 (1980) 513-528

A mathematical model of the dynamic behaviour of an insurance system with delayed profit/loss sharing feedback is developed. The model is then subject to a disturbance input consisting of an isolated group of unpredicted claims and the dynamic responses of cash flow and accumulated cash flow determined. Increasing delays are seen to lead first to undesirable oscillatory responses and eventually to instability, where the responses become unbounded. Such behaviour is noted to be independent of the type of business and to be a property of the feedback mechanism and not related to the type of disturbance input.

BALZER, L.A. "Control of Insurance Systems with Delayed Profit/Loss - Sharing Feedback and Persisting Unpredicted Claims". Journal of the Institute of Actuaries 109 (1982) 285-316.

The profit/loss sharing scheme introduced by Balzer & Benjamin (1980) has been subjected to further analysis, which gives greater insight into its dynamic behaviour. Under the more demanding disturbance of a persisting stream of unpredicted claims, a significant non-zero accumulated cash flow is found to accrue after steady state conditions are reached. The dynamic behaviour was then investigated using the root-locus technique and improved. The addition of integral action was seen to drive the steady state value of the accumulated cash flow to the desirable value of zero. Finally, derivative action was shown conclusively to offer no improvements due to the time delay present in the system.

CANADIAN INSTITUTE OF ACTUARIES "A Primer on Dynamic Solvency Testing", 1989

This paper describes in detail the two main steps in the DST process, namely the projection of surplus trends, and modeling. The projection component is carried out as follows:

(1) calculate historical patterns of actual free surplus and the corresponding required amounts for the most recent three-year period,

(2) project these calculations forward for five years using best estimates of experience and business plans of the company,

(3) recalculate the five-year projections on a set of 10 prescribed scenarios, each of which focuses on a specific single potentially adverse trend in experience,

(4) recalculate the same five-year projections on additional appropriate combination of adverse trends, so as to provide adequate information to management on the hypothetical, plausible and significant threats to the company's financial well-being.

The first scenario tested has the future experience projected based on the best estimates of each relevant factor. This is known as the base scenario. Subsequent scenarios are defined by making prescribed changes in the following areas: mortality, morbidity, withdrawals, increasing interest rates, decreasing interest rates, level new sales, high new sales, sudden high mortality and morbidity, increased default rates, expense rates.

The modeling component of DST involves the development of algorithms to simulate future events, and the selection of cells, or representative blocks of policies and assets which reflect the company's actual portfolio. One possible modeling technique is the projection of gains (or margins) by source. Another possibility is extrapolation in aggregate, meaning that financial statements are projected by studying recent trends in aggregate data for the product line to be projected. The political and economic environment of business must also be considered in the modeling process. Finally, the model must be sufficiently flexible to reflect the variability of the real world.

COUTTS, S.M., DEVITT, E.R.F., ROSS, G.A. "A Probabilistic Approach to Assessing the Financial Strength of a General Insurance Company". Transactions of the International Congress of Actuaries (1984).

This paper develops a conceptual framework for measuring the financial strength of a non-life insurance company from a supervisor's point of view; that is, it looks at the financial information at a point of time and assumes that company ceases trading. However the paper does not adopt the conventional approach of looking just at the balance sheet values, but argues that a more realistic answer is obtained if projected run-offs for assets and liabilities are modelled. The framework takes account of not only assets, liabilities, and economic risk, but also acknowledges the micro and macro aspects of these. An algorithm is given to arrive at a measure of financial strength by employing simulation techniques. This uses the present asset holdings, a probabilistic model to predict future asset values and investment income together with a set of decision rules for investment strategy, and bivariate probability distribution of claim payments by amount and time.

COUTTS, S.M., DEVITT, E.R.F. "The Assessment of the Financial Strength of Insurance Companies by a Generalized Cash Flow Model". International Congress on Insurance Solvency I, 1986.

The central concept of this paper is that the subject of financial solidity within the insurance industry can be dealt with in terms of one integrated model which is applicable to all types of insurance operations. The authors believe that the correct way to approach the determination of the financial strength of an insurance company is to look in terms of the relationship between the projected cash inflows and outflows. Since the projection of future cashflows cannot be made with certainty, these streams of future income and outgo must be modelled. Any realistic model must take account of the variability inherent in such predictions and a practical way to address this problem is through the use of simulation techniques.

COUTTS, S.M., DEVITT, E.R.F. "Simulation Models and the Management of a Reinsurance Company". Transactions of the International Congress of Actuaries (1988).

This paper rejects the traditional balance sheet approach to the measurement of solvency and capital strength of an insurance company in favour of an emerging costs approach. It discusses the particular problems of modeling future cash flows of a reinsurer and suggests solutions for some of them. It sets out an algorithm for the measurement of a reinsurer's capital strength and summarizes the advantages of the emerging costs approach.

DAYKIN, C.D., BERNSTEIN, G.D., COUTTS, S.M., DEVITT, E.R., HEY, G.B., REYNOLDS, D.I.W. and SMITH, P.D. "The Solvency of a General Insurance Company in Terms of Emerging Costs". Astin Bulletin 17 (1987) 85-132.

The authors challenge the traditional balance sheet concept of solvency of a general insurance company and put forward an emerging costs concept which enables the true nature of assets and liabilities to be taken into account, including their essential variability. A simulation model is used to explore various aspects of the company's financial position. It suggests the need for an appropriate asset margin assessed individually for each company. The effectiveness of supervision based on the balance sheet and a crude solvency margin is limited. More responsibility should be placed on an actuary or other suitably qualified professional to report on the overall financial strength of the company, both to management and to supervisory authorities.

DAYKIN, C.D. "Handling Uncertainty in Examining the Financial Strength of a General Insurance Company". Transactions of the International Congress of Actuaries (1988).

The traditional balance sheet approach to the assessment of financial strength of a general insurance company offers limited scope for exploring the effects of uncertainty. An alternative approach is to project the cash flow in future years and to use stochastic models to represent the uncertain factors. A model developed along these lines is described and some results presented. The wide variation in the risk of ruin according to the precise circumstances of the company points to the need for actuarial reports on the financial strength of general insurance companies. Simulation models provide a technique which could be used for such reports, enabling the key assumptions to be made explicit.

DAYKIN, C.D., HEY, G.B. "A Management Model of a General Insurance Company Using Simulation Techniques". International Conference on Insurance Solvency II, 1988.

The accounts of a general insurance company are not drawn up in such a way as to bring out the uncertainties involved in making an assessment of a company's financial strength or of its future profit earning capacity. An analysis of the possible emergence of profit in future years, and the development of the balance sheet, implies the ability to model the way in which the various items in profit and loss account and the balance sheet will behave in uncertain conditions. An approach to the analysis of such uncertainty using cash flows, or emerging costs, was described by Daykin et al. (1987) as an effective alternative to the traditional balance sheet approach. The purpose of this paper is to translate the concepts of the earlier paper into the framework of a company assessed as a going concern, where business can be assumed to continue to be written for the forseeable future.

DAYKIN, C.D., HEY, G.B. "Modeling the Operations of a General Insurance Company by Simulation". Journal of the Institute of Actuaries 116 (1989) 639-662.

A cash flow model is proposed as a way of analyzing uncertainty in the future development of a general insurance company. The company is modelled alongside the market in aggregate so that the impact of changes in premium rates relative to the market can be assessed. An extensive computer model is developed along these lines, intended for use in practical applications by actuaries advising the management of general insurance companies. Simulation methods are used to explore the consequences of uncertainty, particularly in regard to inflation and investments. Some comments are made on the role of actuaries in general insurance. Alternative approaches to describing the behaviour of an insurance firm in the market are considered.

DAYKIN, C.D., HEY, G.B. "Managing Uncertainty in a General Insurance Office". Journal of Institute of Actuaries 117 (1990) 173-277.

The authors use the emerging costs paradigm to assess the future financial strength of an insurance company. A model is devised which characterizes the pattern of inflows and outflows at any time. An important aspect of the model is the variability of future assets, for which Wilkie's results were extensively used. The model was generalized to the situation of a company operating as a going concern. The generalized model represents the behaviour of the company as it operates in the wider market. It considers premium and investment income, claims and expense costs, as well as taxes and dividends. However, reinsurance is not considered.

DAYKIN, C.D., HEY, G.B. "Applications of a Simulation Model of a General Insurance Company". International Conference on Insurance Solvency III, 1991.

A simulation model of a general insurance company has already been presented by the authors at various stages of its development. In this paper a general description of the model is given and some results are presented from using the model to explore a variety of different scenarios. The model is based on the emerging costs paradigm. Important features of the business can be taken into account in as realistic a way as possible, including tax and dividend payments, as well as premium income expenses, claim outgo, investment income, asset values, and investment strategy. At a more sophisticated level, appropriate allowance can be made for feedback mechanisms and for interactions between the variables. Uncertainty can be modelled directly. The results of some calculations for given distributions are then presented and it is shown that government regulation may still be necessary.

DAYKIN, C.D., BERNSTEIN, G.C., COUTTS, S.M., DEVITT, E.R.F., HEY, G.B., REYNOLDS, D.I.W., SMITH, P.D. "Assessing the Solvency and Financial Strength of a General Insurance Company". Journal of the Institute of Actuaries, 114 (1987) 227-325.

The authors put forward an emerging costs approach for examining the strength of a company. Simulation is suggested as a means for examining the financial strength of a company and exploring the impact of alternative scenarios. A particular example of such a simulation model is presented and used to explore the resilience of a company's financial position to variations in a wide variety of parameters. The model enables the user to quantify the probability that the assets will prove adequate to meet the liabilities with or without an assumption of continuing business. This in turn permits an appropriate asset margin to be assessed individually for any particular company in the light of the strategy that the company intends to follow. Some of the implications of this approach for the management and supervision of general insurance companies are reported.

DAYKIN, C.D., DEVITT, E.R.F., KHAN, M.R., McCAUGHAN, J.P. "The Solvency of General Insurance Companies". Journal of the Institute of Actuaries 111 (1984) 279-336.

This paper tries to establish a framework for consideration of solvency of a general insurance company, particularly from the point of view of whether a company has adequate resources to continue to write business. Attention is focussed on the importance of setting adequate standards of prudence for technical reserves. The authors investigate variability as it affects the assets side of the balance sheet and conclude that mismatching reserves should be included in the technical reserves and that an element of the solvency margin should be required to provide against this risk. A conceptual framework is drawn up for setting the line of demarcation between technical reserves and the solvency margin. The report concludes with some pointers to a possible reserving standard embracing concepts of variability which could form the basis for a more satisfactory system of reporting technical reserves from the point of view of demonstrating solvency and suggests a rational approach to the appropriate level for statutory solvency margins, having regard to the nature of the risks and the possible variability of the out-turn.

FRANCIS, L.A. "A Model for Combining Timing, Interest Rate, and Aggregate Loss Risk". Valuation Issues Special Interest Seminar, Casualty Actuarial Society, 1989, 155-216.

Models are developed to simultaneously analyze timing risk, investment return uncertainty, and aggregate loss variability. These are based on collective risk theory, payment pattern regressions, and time series stochastic models for interest rates. An application to the calculation of capital requirements for a capture insuring automobile liability is described. A second application is to modelling capital requirements for the medical malpractice line.

GALITZ, L. "The ASIR Model - An Introduction". The Geneva Papers on Risk and Insurance No. 25 (Oct. 1982)

This paper describes the development of the ASIR model for simulating insurance and reinsurance operations. The model can be run either deterministically, or stochastically, depending on the application. Next, the model is descriptive rather than optimizing, and uses an accounting rather than empirical approach. Two examples of research studies are given, one for the effect of inflation on interest rates, and the other concerning fluctuating exchange rates.

GENTRY, J.A. "Simulation of the Financial Planning Process of P-L Insurers "Journal of Risk and Insurance 39 (1972) 383-396.

The author develops a model that simulates the long run financing process of property and liability insurance companies. A key variable determined by the model is the rate of return required on new investments in order to produce management's desired earnings per share growth objective. Thus, the model links the investment and financing processes of property and liability insurance companies and provides decision makers probabilistic oriented information for analyzing investment alternatives.

HEY, G.B., BERNSTEIN, G.D. "Simulating the Cash Flow of a General Insurer". Transactions of the International Congress of Actuaries (1988)

This paper describes extensive simulation work carried out by the authors for the Solvency Working Party of the General Insurance Studies Group of the Institute of Actuaries. The program projects the cash flows of an insurer from a given date, being the date at which its solvency is being investigated to a time in the future when all of its liabilities have been run off. The program can allow for a period during which new business continues to be written. It also allows for variations in the claim amounts (in real terms), claim inflation, future investment income, assets charges, tax and dividends. The initial portfolio of assets and liabilities is taken as given.

NYE, D.J. "A Simulation Analysis of Capital Structure in a Property Insurance Firm". Huebner Foundation Monograph, University of Pennsylvania, 1975

The purpose of this study was two-fold: first, to measure the effect of capital structure on three variables - ruin probability, rate of return on equity, and variability of return; and second, to further the development of quantitative criteria which could be utilized by regulatory officials to supervise property insurance companies and by management in the development of long-term plans. Using simulation techniques, experiments were performed on two types of firms, one an established, ongoing firm, and the other a new firm entering the market. In both cases, firms were restricted to automobile insurance. A novel aspect of this study is the use of senior securities as a financing device.

PAULSON, A.S., DIXIT, R. "Cash Flow Simulation Models for Premium and Surplus Analysis". International Conference on Insurance Solvency I, 1986

This paper summarizes some typical results generated from a set of general cash flow simulation models which were produced to mimic a statutory insurance company operating in a general economic environment. The flows resulting from the underwriting and investment sides of the business are treated in an integrated and dynamic fashion. A large number of economic, company-specific, tax-specific, surplus-specific, and other factors are allowed in these models. Several results concerning the influence of size of underwriting firm, combined ratio, variability of losses, impairment of capital, and probability of insolvency, are given.

PENTIKAINEN, T. "A Model of Stochastic-Dynamic Prognosis". Scandinavian Actuarial Journal (1975) 29-53

The article develops the different phases in the process of managing an insurance business:

(1) information of the state and past development of the business,

(2) decisions needed,

(3) long range planning by means of prognosis,

(4) business goals, which include:

  (a) solvency,

  (b) maximization of profit or dividends,

  (c) expansion of the business.

A mathematical model is developed, with most of the ideas drawn from Beard, Pentikainen, Pesonen, "Risk Theory". The author then makes some simplifying assumptions to apply the general model to a specific example.

PENTIKAINEN, T. "Stochastic-Dynamic Prognosis". Transactions of the International Congress of Actuaries (1976)

A model is constructed which describes the state of an insurance company as well as the rules for decision making. The future flow of business depends, in addition to the strategy chosen, also on stochastic elements such as the amount of claims. It is possible to calculate the limits of the state parameters, free reserves, premiums, etc. at any future time point by a given probability, as well as to evaluate the risk of ruin. Different strategies can be compared in this way and an optimal one arrived at. A simple numerical application is given.

PENTIKAINEN, T. "A Solvency Testing Model-Building Approach for Business Planning". Scandinavian Actuarial Journal (1978) 19-37

The purpose of this paper is to incorporate stochastic elements into business models using techniques which have been developed in risk theory for the evaluation of risk fluctuations. Some applications concerning competitive business strategies are presented. This method allows various goals to be pursued, subject to a solvency indicator remaining within predetermined constraints. Some results are given from simulation experiments concerning solvency testing.

PENTIKAINEN, T., RANTALA, J. "Evaluation of the Capacity of Risk-Carriers by Means of Stochastic-Dynamic Programming". Astin Bulletin 12 (1981) 1-21

The problem of capacity of risk carriers is treated by means of

(1) an empirical approach observing actual fluctuations in underwriting gains of insurers,

(2) a theoretical approach, constructing a stochastic-dynamic model and studying its behaviour, especially its sensitivity to numerous background factors.

The methods of investigation are described and their application is then demonstrated using some numerical data. Consideration here is limited to stochastic risks, omitting the fact that the solvency of an insurer is also jeopardized by numerous "non-stochastic" risks, such as investment failure, etc.

PENTIKAINEN, T., RANTALA, J. "Solvency of Insurers and Equalization Reserves". Vol. I (General Aspects), Vol. II (Risk Theoretical Model), Insurance Publishing Company Ltd. 1982, Helsinki

This is a research report under the directorship of T. Pentikainen, proposed for the Insurance Department of the Ministry of Social Affairs and Health of Finland. The following topics are discussed:

Vol. I

(1) solvency politics and background factors,

(2) empirical data,

(3) risk-theoretical model,

(4) solvency ratios,

(5) solvency margins,

(6) measuring solvency,

(7) fluctuation reserve.

Vol. II

(1) distribution of total claim amount,

(2) stochastic dynamic model of insurance company,

(3) analytic treatment of model,

(4) fluctuation range of solvency margin, minimum safety loadings and solvency test,

(5) simulation of total claims caused by catastrophes,

(6) reinsurance, solvency margin and policyholders,

(7) regulation of equalization reserves of Finnish non-life insurers.

PENTIKAINEN, T., RANTALA, J. "Run-off Risk as a Part of Claims Fluctuation". Astin Bulletin 16 (1986) 113-147

The purpose of this paper is to discuss how the run-off risk could be incorporated into the standard risk theory model as a separate entry, and to find some evaluation of the order of magnitude of the extra fluctuation so rendered. At this stage of the research, the impact of parametric estimation is excluded from consideration. Therefore, the results and numerical examples do not describe the total uncertainty of claims or reserves. The authors study both the going-concern case, and the break-up case. They also use a simulation technique, which allows for more general assumptions about inflation.

PENTIKAINEN, T., PESONEN, M. "Stochastic Dynamic Analysis of Life Insurance". Transactions of the International Congress of Actuaries (1988)

The authors treat the life insurance business as a stochastic process consisting of the flow of entering, developing and terminating cohorts of policies. The exemplified model allows for the stochastic fluctuation of mortality, inflation and interest, and the process is controlled by the delivery of bonuses and/or dividends according to the simulated financial position. The benefits and premiums can be linked to the cost of living index. The model is aimed to be used in analyzing solvency conditions and the adequacy of safety loadings that are included in the calculation bases of premiums and reserves.

PENTIKAINEN, T., BONSDORFF, H., PESONEN, M., RANTALA, J., RUOHONEN, M. "Insurance Solvency and Financial Strength". Finnish Insurance Training and Publishing Company Ltd., 1989, Helsinki

This book gives a general survey of the subject matter, and tries to bridge the gap between theory and practice i.e. between academicians and practicing actuaries. The book covers the areas of risks and effects, including claims, business cycles, premiums, investment return and asset risks, expenses, taxes, dividends, and inflation. The authors also discuss public solvency control and financial strength as an element in insurance management. A simulation model is described and an explicit example is worked out using this model. The authors also discuss international regulatory issues. The text is self-contained with most of the risk-theoretic analysis following the lines of "Risk Theory" by Beard, Pentikainen, E. Pesonen.

RANTALA, J. "Method for the Analyzing the Effects of Underwriting Risk on the Insurers Long-Term Solvency". International Conference on Insurance Solvency I, 1986

The aim of this paper is to develop further the ideas put forward in the Finnish solvency report (Pentikainen, Rantala, 1982), and to provide a framework for analyzing how the insurers' solvency is affected by the underwriting risk. The focus is primarily on long-term relations and properties. The insurer is viewed as a filter transforming the claims process, the most important outputs being claims reserve, accumulated profit and the future premium rates. Main points of interest are the variability of both premiums and accumulated profit and the long term need for the safety loading where the rating rules are applied. The methods of time series theory and stochastic control theory are utilized. Also, a practical example is considered.

REYNOLDS, D.I.W., SMITH, P.D. "Changes in the Probability of Insolvency – Results from A General Insurance Simulation Model". Transactions of the International Congress of Actuaries (1988)

A simulation model is used to investigate how the probability of insolvency changes in response to random movements in asset values, inflation, claims settlement amounts and claims experience on new business. Rates of inflation above expected values cause the greatest increase in the chance of insolvency. The authors suggest that investment in index-linked securities would

therefore be appropriate for U.K. insurance companies.

ROY, Y., CUMMINS, J.D. "A Stochastic Simulation Model for Reinsurance Decision Making by Ceding Companies". Strategic Planning and Modeling in Property-Liability Insurance (ed. Cummins) 1985, Kluwer-Nijhoff, Boston

This study develops a prototype model which applies to the fire and earthquake risks of a hypothetical company. A computer model is designed to simulate the financial results the company would experience under various reinsurance arrangements. The model generates the company's probability distributions of net worth and net income under alternative reinsurance strategies, permitting management to select an optimal arrangement by comparing the resulting distributions.

RYAN, J.P. "An Application of Model Office Techniques to the Solvency Question". Transactions of the International Congress of Actuaries (1980)

A computer simulation is described which shows the resulting distribution of solvency margins after 5 years for companies making varying levels of profits. The programme enables simulation of both claims experience and investment experience. The claims experience allows for stochastic variation as well as random inflation. The investments are in the form of equities and fixed interest. The interest rates are determined relative to the inflation rate, with no random variation. However, stock prices are determined using a random walk model.

RYAN, J.P. "Application of Simulation Techniques to Solvency Testing for a Non-life Office". Transactions of the International Congress of Actuaries (1984)

The paper outlines a stochastic approach which analyzes the various risks (including investment) to solvency. The paper discusses the problem of lack of independence of risk and parameter variation over time as well as any correlations between results of different classes of business. The paper concludes by showing how such an analysis can be used to determine capital requirements of a company in relation to different business strategies including variations in investment policy.

SEAL, H.L. "Simulation of the Ruin Potential of Non-life Insurance Companies". Transactions of the Society of Actuaries 21 (1969) 563-590

A simplified stochastic model of a casualty insurance company consists of two independent and unchanging probability distributions. The first of these is the distribution of intervals between successive claims, and the second is the distribution of individual claim amounts. Financially, the company may be pictured as accumulating a steady flow of risk-loaded premiums in its risk reserve and paying claims therefrom at intervals determined by the first distribution and in amounts determined by the second. This model was used to run a computer simulation of ten randomly chosen companies over a forty year period. All the companies commenced business with a fairly substantial risk reserve, but several failed during the period, even though they charged theoretically correct pure premiums. Standard experience-rating methods were found to be a poor protection against adverse change fluctuations whose cumulative effects were often substantial.

TAPIERO, C.S. "A Dynamic Insurance Firm Model and Dividend Optimization". Journal of Large Scale Systems 9 (1985) 19-33

The purpose of this paper is twofold. First, to formulate a dynamical model of a stock insurance firm and, second, to solve the insurance firm problem (in terms of its loading factor, investment-disinvestment and dividend policies), granted that its objective is (discounted) dividend maximization. The mathematical problem defined is a two-states stochastic control problem which is solved and interpreted to yield insights regarding the management of insurance firms.

TRIESCHMANN, J.S., DAVIS, K.R., LEVERETT, E.J. "A Probabilistic Valuation Model for a Property-Liability Insurance Agency". Journal of Risk and Insurance 42 (1975) 289-302

This model uses Monte Carlo simulation and discounted cash flow analysis. The model allows one to look at fluctuating levels of expenses and commissions. The results show that the old rule of thumb gross commission method of valuation tends to produce valuations that are too high. Sensitivity analysis shows that the most important variables for valuation purposes are number of years of upgrading commissions, selling and operating expenses, and persistency of year before purchase commissions. The variables that have the least effect are change in accounts payable, change in accounts receivable, and rate of inflation.

VEIT, K.P. "The Use of Systems Dynamics Simulation Models for Corporate Long Range Strategic Planning". Transactions of the International Congress of Actuaries (1976)

The paper contrasts systems dynamics models in general with the more traditional asset share and profit models with which most North American actuaries are familiar. The major benefits of using this type of model are:

(1) the ability to handle multiple inter-relationships and complex feedback loops where a large number of variables are interacting with each other over time,

(2) the ability to handle variables with largely subjective values,

(3) the better understanding of how one's own organization really functions which arises out of the model construction process.

WATERS, H.R. "Some Aspects of Life Assurance Solvency". International Conference on Insurance Solvency I, 1986

This paper uses a stochastic investment model developed by A.D. Wilkie to study in probabilistic terms the investment risk to the solvency of a life assurance company. Two probabilities are considered for a cohort of policies:

(i) the probability that the premium paid together with investment income and any initial reserve will be insufficient to pay for the claims,

(ii) the probability that at any time during the term of the policies the investment experience will have been sufficiently bad for a valuation to produce a deficit.

These probabilities are studied numerically for different investment strategies.

B - III

Papers on Financial Economics

ASHE, F. "Non-Parametric Analysis of Asset-Liability Management". International Conference on Insurance Solvency III, 1991.

The paper considers the asset-liability management of a major-class of insurance and super annuation contracts in Australia by simulating asset returns and liability values for discrete time periods and for a wide variety of models. The form of the constraints on the nature of the assets, on transactions, and on desired outcomes suggests a linear program to solve for the initial asset mix, in the simplest case. More complex analyses allow dynamic strategies to be found. Particular advantages of this approach are the ability to allow for major holdings of option contracts as assets, and to model aspects of managers' views of assets and liabilities that are hard to capture in a formula.

BORCH, K. "Insurance and the Theory of Asset Prices". Transactions of the International Congress of Actuaries (1980).

The paper gives an outline of the Asset Price Model. The author gives some examples of how this model can be applied in insurance and discusses some of the shortcomings of the model. He also presents an alternate model based on exponential utility functions. This model leads to loadings proportional to variance and to cumulants of higher order.

BORCH, K. "A Theory of Insurance Premiums". The Geneva Papers on Risk and Insurance No. 10 (July, 1985) 192-208.

The author presents a model of an insurance market and shows that a full generalization of CAPM is fairly simple. He also gives some examples and indicates how the model can be applied in practice. He claims that the "actuarial theory of risk" has lost considerable contact with economic reality.

BUTSIC, R.P. "Risk and Return for Property-Casualty Insurers". Total Return Due a Property-Casualty Insurance Company Discussion Paper Program, Casualty Actuarial Society, 1979, 52-95.

A study of the relationships between risk and return for property-casualty insurers, using concepts of the theory of financial economics.

CUMMINS, J.D., HARRINGTON, S. "Property-Liability Insurance Rate Regulation: Estimation of Underwriting Betas Using Quarterly Profit Data". Journal of Risk and Insurance 52 (1985) 16-43.

The underwriting beta is an important parameter in the application of financial theory to property-liability insurance pricing and rate regulation. This paper presents the results of using quarterly profit data to estimate underwriting betas for 14 property-liability insurers. Sensitivity of the estimates to alternative model specifications, market return series, and estimation periods is examined. The results imply that underwriting betas may have been subject to signficant instability during the 1970's. This finding suggests extreme caution if underwriting betas are to be used to establish fair profit margins in rate regulations. Possible reasons for instability in the estimated underwriting betas are discussed.

CUMMINS, J.D. "Risk Based Premiums for Insurance Guaranty Funds". International Conference on Insurance Solvency I, 1986.

This article develops premium equations for 3 cases:

(1) an ongoing insurer with stochastic assets and liabilities, but no additional sources of risk,

(2) an insurer with stochastic assets and liabilities and randomly occuring, lognormally distributed jumps in liabilities (catastrophes),

(3) a policy cohort, where the insurer's liability is gradually reduced as claims are paid.

These models provide a link between capital market theory and traditional actuarial ruin models.

CUMMINS, J.D., HARRINGTON, S.E. "The Relationship Between Risk and Return: Evidence for Property - Liability Insurance Stocks". Journal of Risk and Insurance 55 (1988) 15-31.

This paper tests the relationship between property-liability insurer stock returns and systematic risk, unsystematic risk, and co-skewness during the period 1970-83. The study is motivated by the use of CAPM and other financial models in insurance rate regulation. Insurance stock return patterns are consistent with CAPM during the period 1980-83 but inconsistent with the CAPM during earlier periods. Unsystematic risk is significantly related to returns in some of the equations, contrary to the predictions of the CAPM. The results imply that determining the fair rate of return solely on the basis of the CAPM may lead to incorrect results.

CUMMINS, J.D., DANZON, P.M. "Price Shocks and Capital Flows in Liability Insurance". International Conference on Insurance Solvency III, 1991

The authors use an option model of the firm to analyze the firm's response to a retroactive change in expected losses on prior policies that depletes capital, increases leverage and thereby disturbs the firm's target capital structure. If the target capital structure is to be restored, this must occur primarily through retained earnings, which requires that prices rise temporarily above long-run equilibrium levels. Price increases are feasible if firm-level demand is imperfectly elastic in the short run, because of information costs facing new entrants and costs to policyholders of switching. New equity will not flow in as long as the adequacy of reserves on prior years remains uncertain.

Empirical analysis, using firm-level data for the period 1980-1988, is generally consistent with the theoretical predictions. Safer firms tend to command higher prices in long-run equilibrium, but temporary losses of capital from normal long-run levels are associated with price increases. The addition of external capital is associated with higher prices, which is consistent with the "pecking order" theory, that external capital is more costly to the firm. Loss reserve adjustment on prior years is also associated with price increases, as required if a target capital structure is to be restored through retained earnings.

Issues of new capital are positively associated with shocks that leave capital below its long run equilibrium level, and with increases in premium rates and premium volume. These finding are also consistent with the target capital structure hypothesis.

CUMMINS, J.D. "Statistical and Financial Models of Insurance Pricing and the Insurance Firm". Journal of Risk and Insurance 58 (1991) 261-302

The author tries to reconcile the actuarial and the financial models of insurance, beginning with the idea of insurance pricing. He gives a brief background of statistical models of insurance, based on risk theory; then he gives a brief background to financial models of insurance, based on CAPM. Then he lists five areas where the integration of statistical and financial models would be valuable:

(1) the development of asset/liability management models that take into account more sophisticated models of the reserve run-off,

(2) financial models of reinsurance using option pricing theory, taking into account the fact that insurance claims are non-traded assets, and using probability distributions other than the lognormal,

(3) development of multiperiod option pricing models for long-tail insurance contracts, instead of using a funds generating or "k" factors approach to model the claims runoff process,

(4) adaptation of pricing and asset/liability management models to incorporate stochastic interest rates,

(5) endogenization of surplus.

DOHERTY, N. "On the Capital Structure of Insurance Firms". International Conference on Insurance Solvency I, 1986.

The author examines the capital structure of property-liability stock insurers. First, it is assumed that customers are unable to monitor the financial condition of the firm. Next, he examines the capital structure with financial monitoring showing the effect of product demand elasticities and cost functions. When time inconsistent incentives are considered, a zero surplus corner solution is found to be optimal. The zero surplus capital structure leaves an open question on the existence of an insurance market. However, it is then shown that existing regulations may promote constrained interior optimal solutions thereby providing an explanation for the presence of insurance carriers. Finally, the model predicts that the distribution of capital structures chosen by firms will be clustered within the constraint. Cross-section evidence is compatible with this prediction.

DOHERTY, N.A., KANG, H.B. "Interest Rates and Insurance Price Cycles". Journal of Banking and Finance 12 (1988) 199-214.

Property-liability insurance prices and profit appear to move in a six year cycle. Many industry analysts claim that the insurance market is inherently unstable and prices fail to converge on clearing levels. The authors have a different explanation. They identify spot equilibrium prices using CAPM. But informational, regulatory, and contractual lags preclude instantaneous adjustment. So they model the temporal movement of prices using a partial adjustment model in which actors form rational expectations. The actual movement of insurance prices does seem to track closely those estimated by the partial adjustment model. The cycle may be better viewed as a series of converging responses to changing spot prices.

FAIRLEY, W.B. "Investment Income and Profit Margins in Property-Liability Insurance: Theory and Empirical Results". Bell Journal of Economics 10 (1979) 192-210.

Capital market equilibrium rates of return on equity for property-liability insurers and underwriting profit margins by line that are consistent with these are derived by using the capital asset pricing model and measurements of cash flows by line. The profit solutions depend on the cash flows and systematic risks of the lines and on the yield of risk-free securities, but not on company investment portfolios. Recent historical profit margins by line are shown to be much closer to the solutions derived than to the traditional profit margin factors routinely included in rate filings in almost every state.

FELDBLUM, SHOLOM "Risk Loads for Insurers" Proceedings of the Casualty Actuarial Society, 77 (1990), 160-195.

Traditional methods of selecting risk loads are based on some of i) higher moments of the loss distribution ii) utility theory iii) the probability of ruin and iv) reinsurance costs. The author claims these methods are theoretically unsound. He goes on to suggest the proper approach is through modern portfolio theory, in particular application of the Capital Asset Pricing Model.

FERRARI, J. "A Theoretical Portfolio Selection Approach for Insuring Property and Liability Lines". Proceedings of the Casualty Actuarial Society, (1990), 33-69.

Portfolio selection theory, as developed by Markowitz for selection of investments, is applied to suggest the theoretical, optimal diversification of lines of insurance written by property and liability insurance companies.

FIELDS, J.A., VENEZIAN, E.C. "Interest Rates and Profit Cycles: A Disaggregated Approach". Journal of Risk and Insurance 56 (1989) 312-319

The authors redefine the nature of the returns that are studied and conclude that disaggregated models with interest rate terms perform better than simple autoregressive models in explaining the behaviour of profits.

GARVEN, J.R. "On the Application of Finance Theory to the Insurance Firm". International Conference on Insurance Solvency I, 1986.

The author applies financial theory to the question of insurance solvency. He analyzes optimal capital decisions in the context of an unregulated insurance market. This analysis suggests that, even in an unregulated market, insurers would voluntarily limit their premium-capital ratios in an effort to economize on contracting costs. Furthermore, mutual insurers are likely (all other things being equal) to be less highly levered than insurers organized as stock corporations.

HAMMOND, J.D., MELANDER, E.R., SHILLING, N. "Risk, Return, and the Capital Market". Journal of Financial and Quantitative Analysis 11 (1976) 115-131

The authors studied the investment results of a sample of property-liability insurers. The analysis shows that insurer investment performance parallels that of other investors: greater returns are associated with greater variability. However, with the acquisition of higher levels of investment, risk insurers generally reduce the level of underwriting risk which is undertaken. Thus, management attempts to keep ruin probabilities within some undefinable but clearly present limits. In the process of trading off between investment and underwriting risk, a higher rate of return to net worth is sacrificed.

HAMMOND, J.D., SHILLING, N. "Some Relationships of Portfolio Theory to the Regulation of Insurer Solidity". Journal of Risk and Insurance 45 (1978) 377-400

Underwriting risk and return data for a sample of both established and known high-risk insurers are examined in relation to actual and estimated maximum ratios of premium to surplus. Risks of ruin associated with these ratios are part of the analysis. Efficient underwriting frontiers for the industry and two sample insurers are presented. Limitations of the theory's application are noted. Its principal contributions to solidity regulation are to generate underwriting risk and return data in an integrated frame of reference and to generate information to supplement regulatory judgments about insurer solidity.

HAUGEN, R.A., KRONCKE, C.O. "Optimizing the Structure of Capital Claims and Assets of a Stock Insurance Company". Journal of Risk and Insurance 37 (1970) 41-48

This paper presents a technique to aid management in optimizing the portfolios of claims and investments and the degree of leverage in the capital structure. To invest capital optimally, management must measure capital costs and investment return accurately and be able to relate the risk-return characteristics of the array of capital claims to each other as well as to its portfolio of assets.

HILL, R.D., MODIGLIANI, F. "The Massachusetts Model of Profit Regulation in Non-life Insurance: An Appraisal and Extensions". Fair Rate of Return in Property Liability Insurance (ed. Cummins, Harrington) 1987, Kluwer-Nijhoff, Boston

This is an appraisal of the Fairly model of insurance pricing. There are two principal advantages of the Fairley model:

(1) it relies on current yields available to investors,

(2) it is the only one that provides a quantifiable measure of underwriting risk. However, the model is based on the CAPM, which has been faulted on a number of grounds. However, the fact remains that the CAPM is attractive because of its potential testability.

HILL, R.D. "Profit Regulation in Property-Liability Insurance". Bell Journal of Economics 10 (1979) 172-191

This article uses the capital asset pricing model to determine the competitive insurance premium and profit rate. Fair profit rates for real lines of insurance are then calculated and compared with actual profit rates. The comparison suggests that rule-of-thumb profit rates used in regulation lie above the level that would occur in a competitive insurance market.

HOYT, R.E., TRIESCHMANN, J.S. "Risk/Return Relationships for Life-Health, Property-Liability and Diversified Insurers". Journal of Risk and Insurance 58 (1991) 322-330

The authors do a risk/return analysis using both mean-variance and CAPM approaches. Both accounting and market data are used to measure profitability. The results show that, for the years 1973-1987, investment in individual life-health and property-liability insurers was better than investment in diversified insurers. Evidence also indicates that accounting measures of profitability may be poor proxies for market performance.

KAHANE, Y. "Determination of the Product Mix and the Business Policy of an Insurance Company - A Portfolio Approach". Management Science 23 (1977) 1060-1069

The author sets out a model which simultaneously determines the optimal composition of the insurance and investment portfolios of an insurance company using Sharpe's Single-Index Technique. This method takes into account both risks and rates of return to determine the best mix of product lines for a firm to offer.

KAHANE, Y., NYE, D. "A Portfolio Approach to the Property-Liability Insurance Industry". Journal of Risk and Insurance 42 (1975) 579-598

This paper contains an analysis of a portfolio model which simultaneously optimizes the investment and insurance portfolios of the property-liability insurance industry. The mathematical formulation is an extension of earlier approaches in that it permits the direct development of the envelope efficiency frontier for all levels of insurance coverage. Using data on nineteen insurance lines and two types of assets for the period 1956-1971, efficient portfolios for both constrained and unconstrained solutions are obtained. In each case, some insurance lines tend to be consistently excluded from the optimal portfolios because of their risk-return characteristics. The implications of this effect on the availability of insurance and ratemaking are discussed. Finally, in contrast to accepted practice and theory it is found that the investment policy of the firm need not necessarily become more conservative as the insurance portfolio becomes more risky.

KAHANE, Y., TAPIERO, C.S., JACQUES, L. "Concepts and Trends in the Study of Insurers' Solvency". International Conference on Insurance Solvency I, 1986

This paper emphasizes the micro-economic and financial aspects of insurance insolvency. The classical approach to ruin is reviewed to provide a continuous-state stochastic approach to valuations of the asset-liability paradigm. Solvency is analyzed in analogy to the financial leverge problem, as well as being a problem of information exchange and incentives in a "game".

KROUSE, C.G. "Portfolio Balancing Corporate Assets and Liabilities with Special Application to Insurance Management". Journal of Financial and Quantitative Analysis 5 (1970) 77-105

This paper considers the simultaneous selection of investments, underwriting lines, and capital financing to form efficient mean-variance corporate portfolios. The analysis is directed toward development of decision rules for use in structuring the firm's business in terms of its balance sheet. The intent is to specify optimal target levels for balance sheet accounts consistent with broad corporate goals, especially in view of the various interrelationships among these "separate" accounts and, consequently, without the suboptimization inherent when considering the properties of each in isolation. The model for unifying these principal, and traditionally disparate, insurance management activities involves only an extension of conventional mean-variance portfolio techniques to include proper specification of:

(1) conservation equations balancing the firm's sources and uses of funds,

(2) constraints setting legal, market, and institutional restrictions on these sources and uses.

LAUNIE, J.J. "The Cost of Capital of Insurance Companies". Journal of Risk and Insurance 38 (1971) 263-268

This article shows that the accounting data contained in an insurance company balance sheet can be construed in a conventional cost of capital framework. The funds which are generated through the medium of the insurance operation such as the loss reserve and the unearned premium reserve in a property-liability company are considered as "quasi-debt". The loss on operations is one portion of their imputed cost. The constraints which state insurance regulations place upon the portfolio of an insurer represent another element of imputed cost. While estimation of the cost of equity capital of an insurance enterprise differs little from its industrial counterpart, the imputed cost of "quasi-debt" is difficult to quantify.

LEE, C.F., FORBES, S.W. "Dividend Policy, Equity Value, and Cost of Capital Estimates for the Property and Liability Insurance Industry". Journal of Risk and Insurance 47 (1980) 205-222

Based upon the corporate finance theory and concept, possible impacts of dividend policy on the market value of equity for the property and liability insurance industry are theoretically and empirically investigated. The finding is that some effects of dividend policy on the market value of equity exist in the property and liability insurance industry. In addition, alternative methods for estimating cost of capital also are empirically applied to the property and liability insurance industry.

McCABE, G.M., WITT, R.C. "Insurer Optimizing Behaviour and Capital Market Equilibrium". Journal of Risk and Insurance 44 (1977) 447-467

This paper develops a financial model of a non-life insurer selling in a monopolistically competitive market. Optimal values of pricing and claims settlement policy are found simultaneously when profits are maximized. The necessary conditions for equilibrium and stability in the model and the sensitivity of the optimal decision variables to changes in parameters of the model are also analyzed. The implications of the model are assessed for capital market equilibrium and for the equilibrium market price per share of insurer's stock.

MYERS, S.C., COHN, R.A. "A Discounted Cash Flow Approach to Property-Liability Insurance Regulation". Fair Rate of Return in Property Liability Insurance (ed. Cummins, Harrington) 1987, Kluwer-Nijhoff, Boston

This paper discusses the difficulties in calculating the discount rate from the CAPM, which requires that the beta of the insurance policy be measured. Measuring the betas can be extremely difficult, for several reasons:

(1) portfolio composition varies widely from company to company and over time,

(2) random error in measuring beta for common stocks,

(3) insurance companies which have investments outside the insurance industry,

(4) the beta values vary widely for different lines of insurance.

QUIRIN, G.D., WATERS, W.R. "Market Efficiency and the Cost of Capital: The Strange Case of Fire and Casualty Insurance Companies". Journal of Finance 30 (1975) 427-450

The authors studied a sample of 25 Canadian insurance companies from 1961-1971. The results show that these companies earned rates of return in excess of that predicted by the Capital Asset Pricing Model. The authors' preferred explanation is that "risk of ruin" is a third argument (in addition to expected rate of return and variance) in the utility functions of company management. The authors believe that the rationale for this lies in the fact that insurance companies are subject to regulatory constraints which may render them technically insolvent even though policyholders' surplus has not been fully exhausted.

REID, D.H. "Solvency: The Expression of the Relationship Between Capital and Insurance Markets". Transactions of the International Congress of Actuaries (1984)

This paper is concerned essentially with non-life insurance business and the following questions:

(1) how do the requirements of the stock market translate into objectives at line or underwriting level in the insurance market?

(2) is it possible to measure the extent to which returns available in the insurance market satisfy, in principle, the trading needs of a quoted insurance company?

By studying a model of U.K. insurance business, it is found that the insurance aspects relevant to reasonable corporate objectives are characterized by the growth/profitability relationship available in the insurance market, and that this relationship is sufficient, under the assumption of the model, to determine progress toward certain specified objectives.

SCOTT, J.H. "A Theory of Optimal Capital Structure". Bell Journal of Economics 7 (1976) 33-54

This paper presents a multiperiod model of firm valuation derived under the assumptions that bankruptcy is possible and that secondary markets for assets are imperfect. Given the assumption that the probability of bankruptcy is zero, the model is formally identical to that proposed by Modigliani and Miller. Under plausible conditions the model implies a unique optimal capital structure. Comparative statics analysis is used to obtain a number of testable hypotheses which specify the parameters on which optimal financial policy depends. Implications for the debt policy of the regulated firm are also considered.

STAKING, K.B., BABBEL, D.F. "Interest Rate Sensitivity and the Value of Surplus in the Property-Liability Insurance Industry". International Conference on Insurance Solvency III, 1991

The relationship between leverage, interest rate risk and firm value is investigated in the property-liability insurance industry. The market reward for financial structure measured using Tobins q, the ratio of market value to replacement value of surplus is found to be related to a firm's choice of financial structure. Firm value at first increases with leverage but then declines at higher levels of leverage. Interest rate risk has the opposite effect. Insurer value declines with interest rate risk, but there is some evidence that high levels of interest rate risk are associated with increased value. These results support theories on leverage and interest rate risk for financial intermediaries.

TAPIERO, C.S., ZUCKERMAN, D., KAHANE, Y. "Optimal Investment-Dividends Policy of an Insurance Firm under Regulation". Scandinavian Actuarial Journal (1983) 65-76

An insurance decision model including intervention by a regulating agency is defined. The insurance firm's problem is to establish an investment policy as well as a dividend strategy. Regulation is exercised by a minimal barrier policy for cash holding and penalties for violating this barrier. The joint Insurance Firm-Regulating Agency problem is discussed by using concepts from Stackleberg strategies in game theory. As in the classical model of collective risk theory it is assumed that premium payments are received deterministically from policyholders at a constant rate, while the claim process is compound Poisson. A diffusion approximation is used in order to obtain tractable results for a general claim size distribution.

TURNER, A.L. "Insurance in an Equilibrium Asset Pricing Model". Fair Rate of Return in Property-Liability Insurance (ed. Cummins, Harrington) 1987, Kluwer-Nijhoff, Boston

This paper develops a theory of insurance markets in response to real-asset risks. Once insurance is added to the general economy, the value of any asset is the present value of the certainty-equivalent cash flows on the asset. However, this does not mean that the price mechanism is independent of individual risks. In fact, for very generally defined individual risks (i.e. not necessarily independent), the individual risks in the economy are involved in pricing every asset. For the special case of independent individual risks, the main previous results are preserved.

VENEZIAN, E.C. "Insurer Capital Needs Under Parameter Uncertainty". Journal of Risk and Insurance 50 (1983) 19-32

With uncertainty in the parameters, the safety capital must be defined in terms of a desire to meet a solvency criterion with a given reliability. Using such a definition, the effect of pooling risks on the financial efficiency depends on the characteristics of the uncertainty. If the variance in the estimates declines as the inverse of the number of policies on which information is available, the elasticity of capital per risk with respect to risks pooled is basically the same as with known parameters. If the uncertainty is independent of the number of risks in the data base, the elasticity declines with the size of the insurer. The elasticity of capital per risk with respect to the number of risks on which information is available declines as the ratio of relevant data on past losses to insured risk increases. If the variance in the estimates is independent of the data on the losses, pooling loss information has no effect on financial efficiency.

VENEZIAN, E.C. "Effect of Serially Autocorrelated Profit Margins on the Solvency of Insurers". International Conference on Insurance Solvency II, 1988

The determination of profit margins using modern financial methods has been discussed by a number of authors. The analysis has always been based on the requirements of competitive equilibrium in financial markets. The work has never continued to establish other essential elements, specifically the implications for solvency of the calculated rates. This paper assesses the impact of equilibrium rates on the solvency of insurers. Two measures of solvency are used, the probability of remaining solvent, and the present value of the future net worth discounted at the rate appropriate under the Capital Asset Pricing Model. The second measure, assessed when the insurer pays no dividends, is termed the capacity ratio. The paper explores these margins of solvency as a function of the serial autocorrelation of the profit margins. Autocorrelation has a profound effect on solvency. Strong autocorrelation, such as that found for industry-wide margins, may improve the probability of remaining solvent, but reduces the capacity ratio.

von EIJE, J.H. "The Value of Ceded Reinsurance". International Conference on Insurance Solvency II, 1988

While actuaries consider ceded reinsurance to be valuable because of its positive impact on solvency, financial economists frequently contest the value of the reinsurance to the shareholders of a primary insurance company. This paper presents an integration of these views. It is shown that, under traditional premium calculation principles, reinsurance cessions may improve stockholders' wealth if:

1. improvements in solvency increase the expected future cash flows,
2. systematic risk is reduced.

Actuarial concepts like "the normal power approximation" and "structure variation" are used. The economic theory is illustrated with results of a reinsurance optimizing routine.

von EIJE, J.H. "Solvency Margins and the Optimal Amount of Equity in Insurance Companies". International Conference on Insurance Solvency III, 1991

In 1985, Borch used the value of a company to its owners as a criterion on offering insurance cover. He showed that the additional equity invested will increase the value of the company. The maximum value will be found if company value equals the amount of equity invested in the company. Both value and equity are, however, measured in monetary terms. The investment of an additional unit of equity is therefore only considered if it creates at least one additional unit of company value. Maximizing the value of the company will - within a certain range - however result into negative monetary returns on equity invested. Therefore, instead of maximizing the value of the company, owners will be induced to maximize the amount of goodwill, which is the difference between company value and equity invested. According to Borch, the government would not need to set solvency margins, because the strive for company value would reduce the probability of ruin. If, however, shareholders maximize goodwill, solvency regulations may still be needed in order to protect the clients. The author first summarizes the ideas of Borch. Then he discusses the optimizing criterion used and tries to show why rational investors will maximize company goodwill and not company value. The results of some calculations for given distributions are then presented and it is shown that government regulations may still be necessary.

B - IV

Papers on Loss Reserving

ARATA, D.A. "Loss Reserving for Solvency". Proceedings of the Casualty Actuarial Society 70 (1983) 1-21.

The author discusses the role of loss-reserving in protecting a casualty insurer's solvency, specifically the fact that loss reserving plays a different role in different sized companies. He states that most small firms do not choose loss reserving policies appropriate to their specific type of capitalization. This paper gives an example of how a small company can improve its capital structure by appropriate loss reserving policies.

ASHE, F. "An Essay at Measuring the Variance of Estimates of Outstanding Claim Payments". Astin Bulletin 16, S (1986), 99-113

This paper examines the variance of statistical elements of outstanding claim payments for long-tailed general insurance portfolios. The variance's three components are discussed. As there is no accepted technique for measuring this variance, three methods are investigated empirically for its measurement - a parametric method, the jackknife method, and the bootstrap method. No method stands out as superior to the others and it is recommended that all three be evaluated and used to gauge the possible errors in the estimation of outstanding claims.

BENJAMIN, S. "Solvency and Profitability in Insurance". Transactions of the International Congress of Actuaries (1980).

This paper gives reasons why the actuarial profession should beware of discussing the financial position of an insurance company (a) within the conceptual framework of GAAP as used for life insurance companies in the U.S.A., and (b) within the conceptual framework of conventional accounting throughout the world for non-life companies. The paper argues that the conventional split between (i) technical provisions (reserves) and (ii) the free assets forming the solvency margin is false. Hence the practice whereby (i) is estimated without regard to the arbitrary level of (ii) which is set by the control authorities, should be unacceptable to the actuarial profession.

The paper argues that the traditional actuarial approach to cautious reserves in life insurance without arbitrary external solvency margins gives an acceptable conceptual framework for both life and non-life insurance accounts, and is consistent with good supervision in a free competitive market. A simple method of assessing the strength of an insurance company, based on past loss-ratios is suggested in an Appendix.

BUTSIC, R.P., "Determining the Proper Interest Rate for Loss Reserve Discounting: An Economic Approach". Evaluating Insurance Company Liabilities Discussion Paper Program, Casualty Actuarial Society, 1988, 147-188.

The discount rate for loss reserves should be the riskless yield rate (for government bonds) less risk adjustment. The adjustment reflects the degree of risk present in the outstanding reserve. Analysis of industry data over a 15-year period, using an industry pricing model, leads to estimates for the risk adjustment.

BUTIC, R.P. "The Effect of Inflation on Losses and Premiums for Property-Liability Insurers", Inflation Implications for Property-Casualty Insurance. Discussion Paper Program, Casualty Actuarial Society, 1981, 58-109.

A thorough discussion of the effect of inflation on losses, loss reserves, and discounting. The effects of inflation are mitigated by taking investment income into account. More stable estimates of true liabilities may be obtained if loss reserves are discounted.

BYRNES, J.F. "A Survey of the Relationship Between Claims Reserves and Solvency Margins". Insurance Mathematics and Economics 5 (1986) 3-29.

The extent to which the valuation of claims reserves for regulatory purposes is influenced by the existence of solvency margins is necessarily an administrative and legal problem rather than actuarial. However, actuarial concerns are considered and this paper compares various approaches to the solvency margin that were current when the Australian supervising legislation was developed. If any of them were actually consulted then it would appear that the Australian solvency margin is not to provide a buffer on claims reserves, which must be provided separately. Moreover it was a relatively stringent margin. The paper further explains how it came to be further tightened.

DAYKIN, C. "The Development of Concepts of Adequacy and Solvency in Non-life Insurance in the EEC". Transactions of the International Congress of Actuaries (1984).

This paper traces the development of requirements for minimum solvency margins in non-life insurance in the EEC, starting with work caused out under the auspices of OECD by Professor Campagne. It considers the relationship between the explicit solvency margin and what is understood to be covered by the technical reserves, the rationale for an explicit solvency margin and the origins of the particular level of solvency margin chosen. The paper concludes with some thoughts on a rational framework for defining technical reserves and an appropriate corresponding solvency requirement.

DE JONG, P., ZEHNWIRTH, B. "Claims Reserving, State-Space Models and the Kalman Filter". Journal of the Institute of Actuaries 110 (1982) 157-182

This paper describes a consistent and justifiable means of establishing adequate claims provisions in general insurance. The author discusses the claims reserving problem as well as the general state-space framework and Kalman filter. A suitable state space model is then developed for the claims reserving context. This approach emphasizes the forecasting nature of the claims reserving problem and takes advantage of the fact that the Kalman filter is a "real-time" device: every new observation leads to a simple update of existing estimates without needing to keep track of all previous information. The method is illustrated using a simple example taken from the experience of a U.K. general insurer from 1970-1974. Finally, the issue of forecasting future payments is described.

FINSINGER, J., PAULY, M. "Reserve Levels and Reserve Requirements for Profit Maximizing Insurance Firms". Risk and Capital (ed. Bamberg, Spremann) 1983, Springer-Verlag, Heidelberg

The authors study the conditions that determine the level of reserves that a company would hold in the absence of regulation. In the case where there is no covariance of firm risk with market return, agency costs are small, and fixed costs moderate, then regulation is probably unnecessary. In other cases, however, there is a social gain to be had from regulation.

GRACE, E.V. "Property-Liability Insurer Reserve Errors: A Theoretical and Empirical Analysis". Journal of Risk and Insurance 57 (1990) 28-46

This article formulates hypotheses concerning property-liability insurer use of reserving errors from 1966 to 1979. A general theory is developed in which an insurer maximizes discounted cash flow subject to estimation errors and income smoothing constraints. Empirical tests suggest that the theory appears to be consistent with insurer behaviour. Prior to 1972, reserving practices aided in reduction of tax bills subject to uncertain future claims costs. From 1972 to 1979, the causes of reserve errors appear to have altered somewhat. Reserve errors in the 1970's are related to taxable income and smoothing, as well as inflation rate changes.

GREELY, C., LEFF, H.B. "Reserves and Solvency in a Fluctuating Interest Rate Environment" Transactions of the International Congress of Actuaries (1984)

The paper reviews the evolution in laws and regulation that occurred in the U.S. in the 1970's and early 1980's. The authors stress the need for new approaches to the determination of reserve levels. It is no longer sufficient for the actuary to consider only the liabilities of the company. Instead, account must be taken of outside economic and other forces that give rise to present and future market value losses.

Reserves". Proceedings of the Casualty Actuarial Society, 76 (1989), 77-110.

The elements of collective risk theory are introduced with references to the recent literature. Application is made to the distribution of IBNR reserves. Higher moments of this distribution give an indication of the variability in the reserves.

PANJER, H.H., BROWN, R.L. "An Analysis of Loss Reserves in Canada". Institute of Insurance and Pension Research, Report #90-07, University of Waterloo, 1990.

This paper investigates the accuracy of loss reserves. Estimates made from 1975-1983 by Canadian property and casualty insurers were compared with results five years later. The variation of results is analyzed based on: size of company, domestic versus foreign companies, direct insurers versus reinsurers, year and company. The ultimate purpose is to provide an estimate of the amount of variability which cannot be explained by the listed factors. The resulting amount of variability gives an indication of the amount required for a provision for adverse deviation (PAD).

The authors discovered significant effects that have influenced the direction of the excess/deficiency of the loss reserves in the past. These effects were extracted and left a residual variation of about 35% of the original variation. This residual variation represents the degree of inherent instability of reserves of an individual company under the assumption that reserves are unbiased estimates of outstanding claims. The analysis showed that about half of the total variation was due to the tendency of individual companies to consistently under-reserve or consistenly over-reserve.

PENTIKAINEN, T., RANTALA, J. "Run-off Risk as a Part of Claims Fluctuation". Astin Bulletin 16 (1986) 113-147

The purpose of this paper is to discuss how the run-off risk could be incorporated into the standard risk theory model as a separate entry, and to find some evaluation of the order of magnitude of the extra fluctuation so rendered. At this stage of the research, the impact of parametric estimation is excluded from consideration. Therefore, the results and numerical examples do not describe the total uncertainty of claims or reserves. The authors study both the going-concern case, and the break-up case. They also use a simulation technique, which allows for more general assumptions about inflation.

PLYMEN, J. "Profitability and Reserve Strength of Non-life Insurers". Transactions of the International Congress of Actuaries (1976)

The author analyzed the accounts of the seven leading British world-wide insurance companies studying from their combined results, the average profitability of the fire and accident business, the strength of the free reserves, and the contribution to profits from interest on investments. The study shows that premiums gained 27 times between 1936-1973, but reserves only 11 times and dividends 8 times. Hence the growth of shareholders' dividends lagged behind the growth of premium income. The author uses a financial model to show how a company could operate successfully with lower reserve levels.

SOGN, E.T. "Aspects of Solvency Consideration in Non-life Insurance". Transactions of the International Congress of Actuaries (1984)

This paper gives some background for the solvency control project in Norway, initiated in 1982. Its working party was appointed with the task of setting rules for the technical reserves, and also asked what general capital requirements should be imposed upon non-life companies. Only the first task is treated in this paper. The author discusses different aspects to be covered in such a work and also outlines general principles for further development.

VAN SLYKE, O.E. "Regulatory Standards for Reserves". Financial Analysis of Insurance Companies Discussion Paper Program, Casualty Actuarial Society, 1987, 368-421

A reserving method is proposed which reflects the risk associated with possible eventual claim payments as well as with the expected value of those claim payments. The method involves consideration of a variety of possible future scenarios and an application of utility theory.

VENEZIAN, E.C. "Effect of Reserve Smoothing on Solvency and Financial Performance When Profit Margins are Serially Autocorrelated". International Conference on Insurance Solvency III, 1991

This paper uses simulation methods to determine the effect on solvency when management bases the relation between premiums and net worth on estimates of net worth that are derived from smoothed values of the reserves for unpaid losses. Two measures of solvency are used, the probability of remaining solvent and capacity ratio which is the present value of the future net worth discounted at the rate appropriate under the Capital Asset Pricing Model assuming the insurer pays no dividends. The extent of smoothing has a strong effect on solvency, especially at large values of the ratio of premiums to net worth. Except in extreme cases smoothing increases the probability of remaining solvent over long periods of time and also increases the expected value of the capacity ratio. At ratios of premiums to net worth of five or six the effect is strong enough that the natural selection of companies that smooth results would, over a century or so, lead to a market dominated by smoothers. At lower ratios the effect is perceptible but not strong enough to affect the market composition over the course of one century.

B - V

Papers on Statistical Methods

AMBROSE, J.M., SEWARD, J.A. "Best's Ratings , Financial Ratios and Prior Probabilities in Insolvency Prediction." Journal of Risk and Insurance 55 (1988) 229-244.

The authors used multivariate linear discriminant functions to compare the insolvency prediction abilities of Best's ratings, sets of financial ratios, and a two-stage prior probability approach. It was found that the performances of Best's ratings and financial ratios were statistically equivalent. The two-stage technique outperformed the others in identifying insolvent firms but misclassified a higher proportion of solvent firms. The paper concludes that Best's rating method is valid, but prediction capability could be improved with a two-stage approach. The prior probabilities from a Best's ratings analysis could be calculated from the population of all rated insurers.

ALTMAN, E.I. "Corporate Financial Distress - A Compute Guide to Predicting, Avoiding, and Dealing with Bankruptcy", John Wiley & Sons, New York, 1983

ALTMAN, E.I. The Success of Business Failure Prediction Models, Journal of Banking and Finance, No. 8, 1984, 171-198

ALTMAN, E.I. "The Prediction of Corporate Bankruptcy - A Discriminant Analysis", Garland Publishing 1988

ARTHUR D. LITTLE. "Studies on the Profitability, Industrial Structure, Finance and Solvency of the Property and Liability Insurance Industry". Publication #71948, 1970.

This paper, written by Irving Plotkin, Senior Economist at ADL, reviews, updates, and extends his original work on profitability. It discusses the criticisms of his study offered by various authors. It also discusses some of the legislative/regulatory history of his studies, and extends his work to cover the effect of premium - surplus ratios on profitability, investor risk, insolvency and capital attraction. The results of these investigations were used in the (then) recently completed New Jersey rate case.

BAR-NIV, R., HERSHBARGER, R.A. "Classifying Financial Distress in the Life Insurance Industry". International Conference on Insurance Solvency II, 1988

The scope of this paper is to review the financial operations of life insurance companies in order to detect variables which will be helpful in identifying potential insolvencies. Three multivariate analyses are used in this paper: Multidiscriminant Analysis (MDA), nonparametric analysis, and a logit analysis. The NAIC-IRIS tests the decomposition measures and other financial ratios are found to be accurate measures for classifying failures in a multivariate framework one and two years prior to insolvency. The analyses correctly classify between 82 and 91 percent of the life insurance companies one and two years prior to insolvency. Cross-sectional validation on 31 publicly traded life insurers indicates that these large insurers are relatively safe. All these life insurers are correctly classified as solvent companies. However, further analyses of these models and a prospective probability model indicate that more than one multivariate analysis may be required for measuring the probability of failure.

BECKMAN, R.W., TREMELLING, R.N. "The Relationship Between Net Premium Written and Policyholders' Surplus". Proceedings of the Casualty Actuarial Society 59 (1972) 203-220.

The authors make the following arguments based on the stock insurance industry premium-surplus ratio for the period 1928-1970:

(1) the stock market is the major factor affecting policyholders' surplus and the premium-surplus ratio.

(2) the premium-surplus ratio measures the leverage of an insurance company and so the stockholders should prefer a higher ratio, but from the policyholders' viewpoint, this ratio is an indication of the strength of the insurer and thus a lower ratio indicates a more heavily capitalized and "stronger" insurer.

(3) the net premium written – policyholders' surplus ratio is distorted because policyholders' surplus has been overstated.

BEENSTOCK, M., DICKINSON, G., KHAJURIA, S. "The Relationship Between Property-Liability Insurance Premiums and Income: An International Analysis". Journal of Risk and Insurance 55 (1988) 259-272

Annual cross-section data for 12 industrialized countries observed over 1970-1981 are pooled in an econometric investigation of the relationship between income and spending on property-liability insurance. A theoretical framework is specified for the supply and demand for insurance in which premiums depend on income and interest rates. The econometric results are used to measure the short and long run marginal propensities to insure across the 12 countries. The paper concludes with a cross-section analysis of 45 countries in 1982 in which the relationship between economic development and property-liability insurance premiums is investigated.

CUMMINS, J.D., NYE, D.J. "The Stochastic Characteristics of Property-Liability Insurance Company Underwriting Profits". Journal of Risk and Insurance 47 (1980) 61-77.

Research on property-liability insurance often depends on the assumptions that combined ratios are normally distributed and/or uncorrelated with yield rates on common stocks. This study examines 206 combined-ratio time series for nine major lines of insurance in order to guage the accuracy of these assumptions. The normality hypothesis is accepted for approximately one-half of the series, many are highly correlated with the industry-wide combined-ratio, and almost none are significantly correlated with equity yields. An important implication is that mean-variance models should not be used in insurance research without validating the normality assumption or determining the impact of departures from normality.

DAYKIN, C. "The Development of Concepts of Adequacy and Solvency in Non-life Insurance in the EEC". Transactions of the International Congress of Actuaries (1984).

This paper traces the development of requirements for minimum solvency margins in non-life insurance in the EEC, starting with work caused out under the auspices of OECD by Professor Campagne. It considers the relationship between the explicit solvency margin and what is understood to be covered by the technical reserves, the rationale for an explicit solvency margin and the origins of the particular level of solvency margin chosen. The paper concludes with some thoughts on a rational framework for defining technical reserves and an appropriate corresponding solvency requirement.

de WIT, G.W., KASTELIJN, W.M. "The Solvency Margin in Non-life Insurance Companies". Astin Bulletin 11 (1980) 136-144.

This paper reviews the O.E.C.D. calculations applying to the Netherlands for 1952-57, and discusses two ideas from O.E.C.D. report: expense ratio and claims ratio. In 1952-57, with probability of ruin = 0.003, the necessary solvency margin was 31%. In 1976-1978 with the same probability of ruin, the necessary solvency margin was 60% (again for Netherlands). The level of the solvency margin is determined not only by the claims and expense ratio, but more specifically, by the variance of these figures.

FORBES, S.W. "Capital Gains, Losses and Financial Results in the Non-Life Insurance Industry". Journal of Risk and Insurance 42 (1975) 625-638.

This paper studies the period 1956-72 to explore the impact of capital gains and losses upon the risk/return and solvency positions of stock and mutual non-life insurers. For most insurers, the risk/return ratio deteriorated when capital gains and losses were included in earnings. If risk dimension is ignored, most insurers appeared heavily dependent on capital gains for average earning improvements. Ample capital and/or surplus margins were available to enable most of the insurers to absorb substantially greater capital losses than those which had occurred. The main conclusion is that equity investments provided additional regulatory problems but did not on the average contribute to the efficiency of these firms.

GABUS, A., HAGEMANN, S. "Solvency Margin and its Effects on Competition". The Geneva Papers on Risk and Insurance No. 19 (April 1981) 3-84

This study has tried to identify disparities among companies classifiable, a priori, according to the following characteristics:

(1) meeting the current solvency margin/financing future margin,
(2) growth on a single national market/foreign markets,
(3) long term/short term,
(4) subjective/objective.

The following areas have been studied:

(1) economic consequences of uniform calculation of the margin,
(2) principle of supervision and the practice of the solvency certificate,
(3) accounting for hidden reserves due to underestimation of assets or overestimation of liabilities,
(4) financing the margin whether the disparities arise from differences in operating conditions, financing conditions, or general economic conditions.

The study is restricted to members of the EEC.

HARRINGTON, S.E., NELSON, J.M. "A Regression-Based Methodology for Solvency Surveillance in the Property-Liability Insurance Industry". Journal of Risk and Insurance 53 (1986) 583-605

This paper suggests a new method for assessing property-liability insurer financial strength. The procedure uses regression analysis to estimate the relationship between premium-surplus ratios and insurer characteristics including asset and product mix variables. Analysis of the regression residuals then identifies insurers with ratios that are substantially higher than those for insurers with similar characteristics. The method is illustrated by using data for solvent and insolvent insurers. Its ability to identify insurers that later became insolvent is compared to that of the NAIC Insurance Regulatory Information System.

LUDWIG, S.J., McAULEY, R.F. "A Nonparametric Approach to Evaluating Reinsurers' Relative Financial Strength". Proceedings of the Casualty Actuarial Society 75 (1988) 219-240

This article presents a model that uses properties of a ranking distribution. The Wilcoxon rank sum test is initially used to determine which financial ratios have historically discriminated between "strong" and "weak" companies. For those ratios that are selected as good discriminators, the test ranks are summed for each company. This statistic is then used as the measure of relative financial strength.

MUNCH, P., SMALLWOOD, D.E. "Solvency Regulation in the Property-Liability Insurance Industry: Empirical Evidence". Bell Journal of Economics 11 (1980) 261-279

This article reports empirical evidence concerning the effects of solvency regulation on the number of companies and frequency of insolvencies. Minimum capital requirements appear to reduce insolvencies by reducing the number of small, domestic firms. This supports the view of capital requirements as a differentially higher tax on small, new firms. Other forms of regulation have ambiguous effects or none. A comparison of the characteristics of insolvent and solvent firms supports the model of insolvency as the unlucky outcome of value-maximizing risk-taking.

PINCHES, G.E., TRIESCHMANN, J.S. "Efficiency of Alternative Models for Solvency Surveillance in the Insurance Industry". Journal of Risk and Insurance 41 (1974) 563-577

The authors examined the efficiency of alternative models for solvency surveillance of property-liability insurance firms employing financial ratios. The two models investigated are:

1. financial ratios individually or in groups on a univariate basis,
2. set of financial ratios in a multivariate context based on a multiple discriminant model.

It is shown that the second model does a better job of identifying firms with a high probability of distress.

PLOTKIN, I.H. "Rates of Return in the Property-Liability Insurance Industry: A Comparative Analysis". Journal of Risk and Insurance 36 (1969) 173-200

This paper reports on a comprehensive study of the profitability of the *P* and *L* insurance industry undertaken as part of a general investigation of insurance prices and investment income. From a socio-economic point of view it compares risk and returns on invested capital with numerous other financial and nonfinancial sectors of the American economy. In measuring return, all possible sources of income have been considered including unrealized capital gains as well as incomes attributable to the use of mixed cash/accrual accounting systems. The risk/return comparisons are based on a 60 industry, 16 year econometric study. The conclusions are based not on a sample, but on industry aggregates as well as on several measures of financial return. No evidence of excessive return was found. These theoretical conclusions are examined against and verified by current industry experience.

RAMLAU-HANSEN, H. "A Solvency Study in Non-Life Insurance Part I". Scandinavian Actuarial Journal (1988) 3-34

This paper describes a study of statistical analyses of policy and claims data of a portfolio of fire, windstorm, and glass liabilities of single family houses and dwellings. Claim frequencies and claim size distributions are estimated, and the results are used to derive moments of the annual claim amounts and to provide examples of solvency margin requirements for different classes of business.

RAMLAU-HANSEN, H. "A Solvency Study in Non-Life Insurance Part II". Scandinavian Actuarial Journal (1988) 35-59

This paper shows how the solvency margin depends on portfolio composition and volume, reinsurance, time horizon, probability of ruin, and the values of some of the basis parameters. The results show that 8-28% of premium income is necessary to cover the random fluctuations in claim costs. However, statutory requirements should be higher (25-43%) to provide reasonable protection against inadequate safety loadings.

ROSS, J.A., POUNTAIN, C.C. "Comparison of International General Insurance Underwriting Results and their Volatility". Transactions of the International Congress of Actuaries (1988)

This paper studies underwriting results in seven major international markets over the period 1975-1984. The reason for the study is that many companies try to mitigate the underwriting cycle by international diversification. The study shows that Japan, followed by Germany, was the most profitable market, with France being the least. Germany and France had the least variable markets while Australia, followed by the U.S.A., was the most variable. All markets were positively correlated, with Germany being the least so. The conclusion is that since international markets tend to move in the same direction, diversification can limit the worst effects of the cycle but not overcome it.

SALZMANN, R.E. "RLS Yardsticks to Identify Financial Weakness". Proceedings of the Casualty Actuarial Society 68 (1981) 172-194

This paper proposes a third method of identifying financially troubled insurers. (The first two are the NAIC IRIS ratios, and the AIA Index of Financial Strength). The author claims that there are seven areas of critical financial significance: reserve level, surplus level, liquidity, quality of assets, operating results, excessive growth and reinsurance protection. The RLS method places primary emphasis on reserve, liquidity, surplus levels. An insurer is exposed to insolvency hazards because of both insufficient surplus and insufficient financial flexibility levels. Therefore, this method uses one index to measure surplus position and another to measure liquidity position.

TREEN, W.R., THOMSON, A.K. "The Effects of Financial Factors on General Business Solvency". Transactions of the International Congress of Actuaries (1984)

This paper investigates the fluctuation in solvency caused by variations in claim inflation rates, interest rates, and asset values. The period under study was 1955-1980 in the U.K. Variations between the actual and expected claims liabilities were obtained and then related to solvency levels. The claims fund was also traced on the assumption that the investments were either Government securities, equities, or a mixture of asset types typical of the insurance business. The variation between expected and actual levels of this fund were seen to have a considerable effect on solvency levels.

TRIESCHMANN, J.S., PINCHES, G.E. "A Multivariate Model for Predicting Financially Distressed P.L. Insurers". Journal of Risk and Insurance 40 (1973) 327-338

A multiple discriminant analysis was used to classify firms into two groups (solvent or distress). Financial distress is defined as a firm that went into liquidation, receivership, conservatorship, or rehabilitation during the period of the study (1966-1971). The model was correctly able to classify forty nine out of fifty two firms in the study. One solvent firm was classified as being distress while two of the distress firms were classified as solvent. The six variables used in the study were:

(1) agents balance/total asset ratio,
(2) stocks cost/stocks market ratio,
(3) bonds cost/bonds market ratio,
(4) loss adjustment & underwriting/net premium ratio,
(5) combined ratio,
(6) premiums written direct/surplus ratio.

B - VI

Papers on Regulation

BORCH, K. "Capital Markets and the Supervision of Insurance Companies". Journal of Risk and Insurance 41 (1974) 397-405.

An insurance policy offers adequate security only if the company holds large reserves. In a free economy such reserve capital can be obtained only from the market, and investors will be ready to provide the capital only if the insurance company can be expected to earn sufficient profits. The main task of the government supervisor is to make certain that the company's reserves remain adequate. This can be achieved only if the company is allowed to charge premiums which will lead to profits found satisfactory by investors. Good insurance at low prices may be impossible in an economy with free capital markets.

BORCH, K. "Is Regulation and Supervision of Insurance Companies Necessary?" Scandinavian Actuarial Journal (1981) 179-190.

The author states that if the company is primarily interested in making a quick profit, regulation may be necessary. On the other hand, if the management of the company takes a long-term view, no regulation should be necessary. He also shows that there are limits to what a government can achieve by regulation of private insurance companies which operate in a free economy.

CUMMINS, J.D., HARRINGTON, S. "Property-Liability Insurance Rate Regulation: Estimation of Underwriting Betas Using Quarterly Profit Data". Journal of Risk and Insurance 52 (1985) 16-43.

The underwriting beta is an important parameter in the application of financial theory to property-liability insurance pricing and rate regulation. This paper presents the results of using quarterly profit data to estimate underwriting betas for 14 property-liability insurers. Sensitivity of the estimates to alternative model specifications, market return series, and estimation periods is examined. The results imply that underwriting betas may have been subject to signficant instability during the 1970's. This finding suggests extreme caution if underwriting betas are to be used to establish fair profit margins in rate regulations. Possible reasons for instability in the estimated underwriting betas are discussed.

DOHERTY, N.A., GARVEN, J.R. "Price Regulation in Property Liability Insurance: A Contingent Claims Approach". Journal of Finance 41 (1986) 1031-1050.

A discrete-time option-pricing model is used to derive the "fair" rate of return for the property-liability insurance firm. The rationale for the use of this model is that the financial claims of shareholders, policyholders, and tax authorities can be modelled as European options written on the income generated by the insurers asset portfolio. This portfolio consists mostly of traded financial assets and is therefore relatively easy to value. By setting the value of the shareholders' option equal to the initial surplus, an implicit solution for the fair insurance price may be derived. Unlike previous insurance regulatory models, this approach addresses the ruin probability of the insurer as well as a nonlinear tax effect.

FINSINGER, J., PAULY, M. "Reserve Levels and Reserve Requirements for Profit Maximizing Insurance Firms". Risk and Capital (ed. Bamberg, Spremann) 1983, Springer-Verlag, Heidelberg

The authors study the conditions that determine the level of reserves that a company would hold in the absence of regulation. In the case where there is no covariance of firm risk with market return, agency costs are small, and fixed costs moderate, then regulation is probably unnecessary. In other cases, however, there is a social gain to be had from regulation.

HAMMOND, J.D., SHILLING, N. "Some Relationships of Portfolio Theory to the Regulation of Insurer Solidity". Journal of Risk and Insurance 45 (1978) 377-400

Underwriting risk and return data for a sample of both established and known high-risk insurers are examined in relation to actual and estimated maximum ratios of premium to surplus. Risks of ruin associated with these ratios are part of the analysis. Efficient underwriting frontiers for the industry and two sample insurers are presented. Limitations of the theory's application are noted. Its principal contributions to solidity regulation are to generate underwriting risk and return data in an integrated frame of reference and to generate information to supplement regulatory judgments about insurer solidity.

HAUGEN, R.A., KRONCKE, C.O. "Rate Regulation and the Cost of Capital in the Insurance Industry". Journal of Financial and Quantitative Analysis 6 (1971) 1283-1305

The authors discuss some of the effects of rate regulation in the property and casualty insurance industry. One consequence of the regulatory environment is that an optimal capital structure may clearly exist in this industry. If the rate of return to the insureds is generally deficient, it is expected that property and casualty stock companies would have an incentive to lever themselves to the maximum extent permissible by selling insurance. The classic monopoly of the economic literature finances its lucrative investment opportunities in a competitive capital market. The stock insurance company invests in that market, but the relative distribution of the return earned there may be less than equitable due to the process and standards of rate regulation.

HILL, R.D., MODIGLIANI, F. "The Massachusetts Model of Profit Regulation in Non-life Insurance: An Appraisal and Extensions". Fair Rate of Return in Property Liability Insurance (ed. Cummins, Harrington) 1987, Kluwer-Nijhoff, Boston

This is an appraisal of the Fairly model of insurance pricing. There are two principal advantages of the Fairley model:

(1) it relies on current yields available to investors,

(2) it is the only one that provides a quantifiable measure of underwriting risk. However, the model is based on the CAPM, which has been faulted on a number of grounds. However, the fact remains that the CAPM is attractive because of its potential testability.

HILL, R.D. "Profit Regulation in Property-Liability Insurance". Bell Journal of Economics 10 (1979) 172-191

This article uses the capital asset pricing model to determine the competitive insurance premium and profit rate. Fair profit rates for real lines of insurance are then calculated and compared with actual profit rates. The comparison suggests that rule-of-thumb profit rates used in regulation lie above the level that would occur in a competitive insurance market.

HUMPHRYS, R. "Standards and Solvency Requirements Under Canadian Insurance Legislation". Transactions of the International Congress of Actuaries (1984)

This paper discusses concepts of solvency and solvency standards under federal insurance legislation in Canada. Defects in the traditional balance sheet presentation are noted and suggestions made for improvement. In this light, Canadian capital and surplus margins are described. Special emphasis is placed on revised methods of reflecting both realized and unrealized capital gains in income statements. The importance of cash flow forecasting is stressed. Reference is made to recent reinsurance problems and the possible effect on balance sheet and other requirements.

KAHANE, Y. "Capital Adequacy and the Regulation of Financial Intermediaries". Journal of Banking and Finance 1 (1977) 207-218

This paper shows that constraining the portfolio composition of the intermediary, per se, cannot generally be regarded as an effective means for bounding the firm's probability of ruin; nor can the minimum capital requirement, per se. However, a combination of these regulatory practices may reach the desired effect.

KAHANE, Y. "Solidity, Leverage and the Regulation of Insurance Companies". The Geneva Papers on Risk and Insurance No. 14 (Dec. 1979) 3-19.

The purpose of this paper is to examine the effectiveness of regulatory policies and their adequacy for guaranteeing the soundness of the insurer's financial position. Three distinct models are examined. The first two models analyze the problem of ruin within a discrete time period through the application of the instruments of portfolio theory. The analysis is based on the proposition that capital requirement must be related to the overall performance of the insurance company. The overall performance is a function of both underwriting and investment incomes and their risks. For the third model the insurer is assumed to have only one activity, but the analysis is carried within a continuous time framework. It is argued that the desired regulatory effects can be achieved by introducing a set of penalties rather than through direct interference in the firms activities.

LAUNIE, J.J., PHILLIPS, G.M. "The Effect of Solvency Regulation in the Underwriting Cycle". International Conference on Insurance Solvency II (1988)

This paper focuses on the frequently utilized regulatory test for capacity which states that net premiums written should not be greater than three times policyholders' surplus. The difficulty with this solvency measure is that net premiums written is immediately affected by price changes. A simple example of the manner in which flows on this measure may exacerbate the underwriting cycle is given. This is followed by a formal model which measures the extent to which changes in net premium written reflects price changes rather than real changes in insurance exposure.

MYERS, S.C., COHN, R.A. "A Discounted Cash Flow Approach to Property-Liability Insurance Regulation". Fair Rate of Return in Property Liability Insurance (ed. Cummins, Harrington) 1987, Kluwer-Nijhoff, Boston

This paper discusses the difficulties in calculating the discount rate from the CAPM, which requires that the beta of the insurance policy be measured. Measuring the betas can be extremely difficult, for several reasons:

(1) portfolio composition varies widely from company to company and over time,

(2) random error in measuring beta for common stocks,

(3) insurance companies which have investments outside the insurance industry,

(4) the beta values vary widely for different lines of insurance.

NORBERG, R., SUNDT, B. "Draft of a System for Solvency Control in Non-Life Insurance". Astin Bulletin 15 (1985) 149-169

An outline is given of a proposed system for solvency control in non-life insurance that has recently been discussed within a Working Party appointed by the Norwegian supervisory authorities. According to this system the factual technical reserves must at any time be sufficient to meet, with high probability, all future liabilities stipulated by insurance contracts that have either expired or are currently in force. The system is applied to a provisional, simple model that has been fitted to claims data assembled from Norwegian non-life companies. The numerical examples illustrate how the required reserve depends on the volume of the business, the portfolio mix, and the reinsurance cover.

ROTH, R.J. "Measuring Solvency and the Adequacy of Casualty Loss and Expense Reserves from the Point of View of Insurance Regulation". Transactions of the International Congress of Actuaries (1984)

Loss reserves have been growing faster than written premiums and surplus, therefore increasing the importance of proper reserving. However, due to the growth of reinsurance, loss reserving has become even more difficult. Reforms are badly needed in the reporting of reinsurance transactions. Also, the solvency of many property-casualty insurers is being threatened by prolonged underwriting cycles.

SOGN, E.T. "Aspects of Solvency Consideration in Non-life Insurance". Transactions of the International Congress of Actuaries (1984)

This paper gives some background for the solvency control project in Norway, initiated in 1982. Its working party was appointed with the task of setting rules for the technical reserves, and also asked what general capital requirements should be imposed upon non-life companies. Only the first task is treated in this paper. The author discusses different aspects to be covered in such a work and also outlines general principles for further development.

SUGARS, E.G. "A Risk Theoretic Prescription for Regulated Ratemaking". Journal of Risk and Insurance" 39 (1972) 475-478

The author suggests a method, based on risk theory, for determining a fair rate of return in the non-life insurance business. The paper contains the idea that rates should be loaded only enough to allow the insurer a fair return on that part of policyholder surplus funds required to run a prudent insurance business.

ZELTEN, R.A. "Solvency Surveillance: The Problem and a Solution". Journal of Risk and Insurance 39 (1972) 573-588

This study investigates insurance department examinations of insurance companies, and reveals the present examination system to be deficient in every respect. The author believes that annual independent audits should replace the mandatory, full scale, routine examinations of every insurer.

B - VII

Papers on Financial Reporting and Surplus Management

ALDIN, N. and JONES, B. "Measuring R.O.E. from a Financial Planning Perspective". Financial Analysis of Insurance Companies Discussion Paper Program, Casualty Actuarial Society, 1987, 3-23.

A method is proposed for assessing a financial product's performance in terms of return on equity. The equity backing the product is the appropriate level of risk surplus needed to account for the various risks inherent in the product. An application is made to a retrospectively rated workers' compensation product.

ANDERSON, J.J. "Alternative Methods of Accounting for Equity Investments in the Stock P-L Insurance Industry". Journal of Risk and Insurance 42 (1975) 263-275

The author discusses two accounting methods which were used in the property-liability insurance industry at the time, as well as two other methods which would reflect changes in unrealized appreciation on the equity security portfolio in the income statement. The article discusses the current status of the issue in the accounting community, describes the methods under consideration and evaluates them in terms of their intrinsic merit and their potential implications for the industry.

BENJAMIN, S. "Profit and Other Financial Concepts in Insurance". Journal of the Institute of Actuaries 103 (1976) 233-305.

The purpose of this paper is to introduce accountants and others working in insurance to the concepts and language of actuaries. Among other topics, the author discusses valuation of insurance companies. He criticizes the GAAP approach in the following manner: given two companies which are identical with respect to premium rates, volume of business, experience, etc., the only difference being that the first reserves on a stronger basis than the second, then the former is worth less to its shareholders in terms of rate of return. The actual reserving basis is ignored under GAAP and hence that real difference is ignored. The author also discusses the ideas of surplus analysis, and asset-liability matching.

BENJAMIN, S. "Solvency and Profitability in Insurance". Transactions of the International Congress of Actuaries (1980).

This paper gives reasons why the actuarial profession should beware of discussing the financial position of an insurance company (a) within the conceptual framework of GAAP as used for life insurance companies in the U.S.A., and (b) within the conceptual framework of conventional accounting throughout the world for non-life companies. The paper argues that the conventional split between (i) technical provisions (reserves) and (ii) the free assets forming the solvency margin is false. Hence the practice whereby (i) is estimated without regard to the arbitrary level of (ii) which is set by the control authorities, should be unacceptable to the actuarial profession.

The paper argues that the traditional actuarial approach to cautious reserves in life insurance without arbitrary external solvency margins gives an acceptable conceptual framework for both life and non-life insurance accounts, and is consistent with good supervision in a free competitive market. A simple method of assessing the strength of an insurance company, based on past loss-ratios is suggested in an Appendix.

BRUBAKER, R.E. "A Constrained Profit Maximization Model for a Multi-Line Property/Liability Company". Total Return Due a Property-Casualty Insurance Company Discussion Paper Program, Casualty Actuarial Society, 1979, 28-50.

The selection of product mix is presented as a constrained optimization problem: optimization of profits constrained by available capital needed to support various lines. The author applies a basic microeconomic model. It is assumed capital is allocated among lines so as to keep the probability of insolvency or impairment for each line within acceptable bounds.

BURROWS, R.P., FICKES, S.W. "Measuring the Financial Performance of Insurance Companies". Transactions of the International Congress of Actuaries (1988).

The authors state that methods such as statutory accounting, GAAP, and cash flow accounting are very poor indicators of the performance of insurance operations. A system currently in operation which effectively monitors insurance performance is the value-added reporting system. This system has the ability to measure financial results against targets and also provides meaningful information to management regarding the financial strength of the company. It has been implemented successfully by a number of insurance companies worldwide.

CHRISTENSEN, J.E. "Contingency Reserves in Surplus Allocation". Transactions of the International Congress of Actuaries (1984).

This paper suggests how contingency reserves might be used in surplus allocation. By splitting the portfolio according to underwriting year and allocating to each underwriting year a capital needed to ensure solvency (with a given probability), a distribution of the internal rate of return on that capital is established. The focus is on the function of the contingency reserve as a way to stabilize profits. A stabilization criterion based on the distribution of the internal rate of return is suggested which could be the basis for establishing appropriate transfer rules.

DE HULLU, A. "A Management Oriented Approach to Solvency". Transactions of the Institutional Congress of Actuaries (1984).

This paper aims to provide an overview of the various elements to be considered in an analysis of the solvency position of a specific insurance company and to describe a systematic approach in terms oriented toward management. Illustrations are taken from actual company or intercompany experience. Potential deviations from the projected annual solvency contributions are also studied. These may be caused by stochastic fluctuations, by investment or expense risks, as well as by elements of solidarity among policyholders or by options grants.

FERRARI, J.R. "The Relationship of Underwriting, Investment, Leverage, and Exposure to Return on Owners' Equity". Proceedings of the Casualty Actuarial Society, 55 (1968), 295-302.

The paper sets out basic relationships concerning the return on owners' equity. The importance of investment income is stressed. The actuary must be concerned with the broad financial management objectives of the firm and, in particular, with the analysis of the optimum capital structure.

HARVEY, R.M. "Problems of International Comparability - The Emergence of General Insurance Surplus Under Different Accounting Conventions". Transactions of the International Congress of Actuaries (1988)

This paper identifies the main differences in accounting approaches used in the major European insurance markets and in the U.S.; it illustrates the pattern of profitability and the development of net assets in the period 1971-1985 and reviews recent, current and possible prospective changes in accounting for general insurance. The author believes that there is a clear and important role for the actuarial profession, not just in monitoring, but also in influencing developments in this area alongside the accounting profession.

HUMPHRYS, R. "Standards and Solvency Requirements Under Canadian Insurance Legislation". Transactions of the International Congress of Actuaries (1984)

This paper discusses concepts of solvency and solvency standards under federal insurance legislation in Canada. Defects in the traditional balance sheet presentation are noted and suggestions made for improvement. In this light, Canadian capital and surplus margins are described. Special emphasis is placed on revised methods of reflecting both realized and unrealized capital gains in income statements. The importance of cash flow forecasting is stressed. Reference is made to recent reinsurance problems and the possible effect on balance sheet and other requirements.

KIMBALL, S. and DENENBERG, H. (eds) "Capital and Surplus Requirements". Chapter 6 in Insurance, Government, and Social Policy, Richard D. Irwin Inc., 1969.

The chapter introduces the notion of required capital and surplus and the complementary notion of surplus surplus. The authors argue for ongoing minimum surplus requirements, particularly in respect of insurers owned by holding companies and whose surplus might be transferred to the holding company. The chapter includes a contribution by A.E. Hofflander of UCLA which attempts to provide a framework for a minimum capital and surplus requirement for non-life insurers.

KNEUER, P.J. "Allocation of Surplus for a Multi-Line Insurer". Financial Analysis of Insurance Companies Discussion Paper Program, Casualty Actuarial Society, 1987, 191-228.

Practical difficulties presented by traditional methods for the allocation of surplus to various lines of business are discussed. None of the traditional allocation methods is found to be appropriate. The author goes on to discuss the functions of surplus and practical considerations for making meaningful allocations. It is suggested that performance and profitability measurements be based on insurance operating profit margin rather than on allocations of surplus.

MEYERS, G. "An Analysis of the Capital Structure of an Insurance Company". Proceedings of the Casualty Actuarial Society, 76 (1989), 147-170.

A model of an insurance company is introduced. This model incorporates a collective risk model to describe incurred losses. Account is taken of the underwriting cycle and investors' requirements for a reasonable return on equity. Emerging surplus, which is governed by investors' requirements, is compared to surplus required according to ruin theory and to requirements imposed by regulators.

ROHOLTE, C. "A Fluctuation Reserve System in Non-Life Insurance". Transactions of the International Congress of Actuaries (1988)

This paper presents a fluctuation reserve system in non-life insurance where special emphasis is placed on rules of transition to/from the fluctuation reserve. For a given class of business it is assumed that an aggregate loss distribution can be established, ie. variations in claims experience (number of claims, size of claims, trends and cycles, etc.) is reflected in the distribution function of the yearly aggregated claims. The fluctuation reserve system is characterized by a number of system parameters (system frequency, upper bound, initial reserve, ruin probabilities, etc.) and by an unbiased transition rule. An example is given to show how the system works.

SUGARS, E.G. "A Risk Theoretic Prescription for Regulated Ratemaking". Journal of Risk and Insurance" 39 (1972) 475-478

The author suggests a method, based on risk theory, for determining a fair rate of return in the non-life insurance business. The paper contains the idea that rates should be loaded only enough to allow the insurer a fair return on that part of policyholder surplus funds required to run a prudent insurance business.

B - VIII

Papers on Life Insurance

BRENDER, A. "Solvency Requirements for Life Insurers in Canada". Transactions of the International Congress of Actuaries (1988)

The author discusses the development of life insurance solvency requirements in Canada. The role of the Valuation Actuary is discussed as well as the establishment of guarantee funds. In addition, methods of financial reporting for life insurance are described as well as the development of provisions for adverse deviations. The paper also describes areas of further research into the expanded responsibility of the Valuation Actuary.

BRENDER, A. "The Evolution of Solvency Standards for Life Insurance Companies in Canada". Institute of Insurance and Pension Research, Report #91-10, University of Waterloo, 1991

This paper describes the emergence of the solvency tests and standards for Canadian life insurance companies. The creation and development of the position of Valuation Actuary is discussed. Also, important changes in financial reporting have been introduced in Canada for insurance companies. All reserves will now be on a GAAP basis, and this would apply to both stock and mutual companies. Another important change was the introduction of a Minimum Continuing Capital and Surplus Requirement (MCCSR). The MCCSR is calculated on a going concern basis, at the end of the insurer's fiscal year. A second testing procedure, Dynamic Solvency Testing (DST), has also been developed. The actuary projects the company's affairs under a variety of possible future experiences and tests whether there is sufficient capital and surplus to run off the business. A projection period of five years is suggested. In the initial stages, DST will be carried out using deterministic, rather than stochastic models. The actuary first projects the company's future using "best guess" assumptions, then investigates other scenarios by changing various combinations of variables in the model. These hypothetical results will be examined by company's management and supervising authorities. The model is sufficiently flexible to allow the introduction of stochastic elements whenever the actuary considers this to be warranted.

CANADIAN INSTITUTE OF ACTUARIES "A Primer on Dynamic Solvency Testing", 1989

This paper describes in detail the two main steps in the DST process, namely the projection of surplus trends, and modeling. The projection component is carried out as follows:

(1) calculate historical patterns of actual free surplus and the corresponding required amounts for the most recent three-year period,

(2) project these calculations forward for five years using best estimates of experience and business plans of the company,

(3) recalculate the five-year projections on a set of 10 prescribed scenarios, each of which focuses on a specific single potentially adverse trend in experience,

(4) recalculate the same five-year projections on additional appropriate combination of adverse trends, so as to provide adequate information to management on the hypothetical, plausible and significant threats to the company's financial well-being.

The first scenario tested has the future experience projected based on the best estimates of each relevant factor. This is known as the base scenario. Subsequent scenarios are defined by making prescribed changes in the following areas: mortality, morbidity, withdrawals, increasing interest rates, decreasing interest rates, level new sales, high new sales, sudden high mortality and morbidity, increased default rates, expense rates.

The modeling component of DST involves the development of algorithms to simulate future events, and the selection of cells, or representative blocks of policies and assets which reflect the company's actual portfolio. One possible modeling technique is the projection of gains (or margins) by source. Another possibility is extrapolation in aggregate, meaning that financial statements are projected by studying recent trends in aggregate data for the product line to be projected. The political and economic environment of business must also be considered in the modeling process. Finally, the model must be sufficiently flexible to reflect the variability of the real world.

CANADIAN LIFE AND HEALTH INSURANCE ASSOCIATION "CLHIA Formula for Minimum Continuing Capital and Surplus Requirements", 1991

This paper gives the formula for determining the MCCSR. Each of the following elements receives a particular weight, the total of which comprises the MCCSR.

A. Life Insurance

1. Mortality Risk

(a) Insurance (including accidental death and dismemberment)

(b) Disability and other Morbidity Risks

(c) Annuities Involving Life Contingencies

2. Interest Margin Pricing Risk

(a) participating and non-participating business

(b)

all other business

3. Asset Default (C-1) Risk
   - (a) Short Term Securities
   - (b) Bonds
   - (c) Mortgages
   - (d) Transportation Equipment Trust Certificates
   - (e) Bulk Adjustment for Unamortized Gains and Losses on the Disposition of Debt Securities
   - (f) Stocks
   - (g) Real Estate
   - (h) Oil and Gas Production Properties
   - (i) Investment Income Due and Accrued
4. Changes in Interest Rate Environment (C-3) Risk

B. Accident and Sickness Insurance

1. Morbidity Risk
   - (a) Disability Income Insurance
   - (b) Accidental Death and Dismemberment
   - (c) Other Accident and Sickness Benefits
   - (d) Credits for Reinsurance and Special Policyholder Arrangements
   - (e) Adjustments for Statistical Fluctuation.
2. Financial Risk

C. Miscellaneous Requirements

- (a) Reserve for Cash Value Deficiencies and Amounts of Negative Reserve
- (b) Valuation Reserve for Miscellaneous Assets and Other Investments
- (c) Statutory Currency Reserves
- (d) Reserve for Reinsurance Ceded to Unregistered Reinsurers
- (e) Surplus appropriated for special risks not covered by the formula.

FACULTY OF ACTUARIES WORKING PARTY "The Solvency of Life Assurance Companies". Transactions of the Faculty of Actuaries 39 (1986) 251-340

This report represents four years of study by this group although the authors consider their work to be not yet complete. The report describes the work carried out and conclusions reached thus far. One of their conclusions is that the E.E.C. Life Directive solvency requirements do not appear to be based on sound theoretical analysis applicable to current conditions. They also conclude that, by necessity, a stochastic approach must be adopted to establish the solvency margin. Another factor of primary importance in determining a company's solvency is the propriety of asset-liability matching for the company. Finally, the report concludes that it is unlikely that any simple solvency margin, expressed as a percentage of reserves (even if these are calculated on a statutory minimum basis) will be adequate for all companies regardless of the nature of their assets or liabilities.
(II)

HARDY, M. "Aspects of the Assessment of Life Office Solvency". International Conference on Insurance Solvency III, 1991

The standard deterministic methods that U.K. life offices use to assess their own solvency position are compared with stochastic methods for a few very simple model life offices. The stochastic methods, and the model offices used, follow Pentikainen and Pesonen (1988). The deterministic investigations include some ideas adapted from Brender (1988). It is concluded that some stochastic investigation is necessary, if only to determine the "worst case" parameters of a deterministic test.

LAMM-TENNANT, J. "Asset/Liability Management for the Life Insurer: Situation Analysis and Strategy Formulation". Journal of Risk and Insurance 56 (1989) 501-517

This study examines the current operational status and planning procedures of seven asset/liability management processes appropriate for life insurers and offers recommendations. The author discovers that, although most firms consider asset-liability matching to be an important objective, very little has been done to achieve it. The author suggests several methods of integrating asset-liability management into the investment strategy of the insurance business. The objectives of these various methods range from providing solvency on the one extreme, to maximizing returns on the other.

MARTIN-LOF, A. "A Stochastic Theory of Life Insurance". Scandinavian Actuarial Journal (1986) 65-81

A theory of life insurance is considered in which the interest rate is variable and the random fluctuations in the collective are taken into account. The theory explicitly includes a description of how the benefits are changed depending on these factors. A linear feedback which adapts the benefits to the surplus is necessary in order to stabilize the system in the sense that the variance of the surplus remains bounded. Martingale decomposition is a useful tool for the analysis of the fluctuations.

B - IX

Papers on Investment Models

BEEKMAN, J.A. "A Stochastic Investment Model". Transactions of the Society of Actuaries 32(1980) 9-24.

The purpose of this paper is to provide a method for calculating special contingency reserves for investment losses. The method is derived by first building a stochastic investment model and then utilizing its probabilistic structure. The model is essentially the collective risk model used in various ways with respect to insurance claims (both life and non-life). Several examples are examined in considerable detail.

BORCH, K. "The Optimal Portfolio of Assets in an Insurance Company". Transactions of the International Congress of Actuaries (1968).

The author considers the different investment opportunities available to an insurance company. It is assumed that the investments which give the highest return are the least liquid. If the company should be forced to sell such assets in order to pay claims, it will suffer a loss. The author determines the optimal portfolio of assets under different variations of this assumption.

BOYLE, P.P. "Immunization Under Stochastic Models of the Term Structure". Journal of the Institute of Actuaries 105 (1978) 177-187

The author gives a survey of some new results concerning the term structure of interest rates and discusses actuarial applications. The term structure model used in this case assumes zero arbitrage profits. Thus, it represents an equilibrium situation. An immunization strategy is then developed under this assumption. The model does not consider net liability outflow as a random variable, effectively ignoring mortality and other contingencies. In the case of a company with a large portfolio of contracts this procedure can be justified by an appeal to the law of large numbers.

CLARKSON, R.S. "The Measurement of Investment Risk". Transactions of the Faculty of Actuaries 41 (1990) 677-750

The author develops an axiomatic, general theory of investment risk, and demonstrates it with a practical example. The model is then compared to the Markowitz approach. This paper also states that Modern Portfolio Theory is a too narrow interpretation of Markowitz and hence has limited validity. The author also concludes that using the variance of return to measure investment risk is essentially irrelevant in practice, and more effort should be made using advanced analytic techniques to improve the expected return. This paper also makes reference to the work of Wilkie and Wise.

COOPER, R.W. "Investment Return and Property-Liability Insurance Ratemaking". Huebner Foundation Studies, University of Pennsylvania, 1974

This book examines the issue of how to include investment return in the ratemaking process. Four topics are considered: whether to focus on the total resources of the insurer or on the resources required to run the business; necessary level of capital; total rate of return on invested capital; relationship between total rate of return on invested capital, investment return and property-liability insurance rate levels. The author concluded that the focus of regulation should be on the resources required to support a company's insurance business. With regard to the second topic, a formula was derived to determine the necessary level of invested capital, and using this method, the author contends that the ratios of premium to capital and surplus imposed by state regulatory authorities may be too restrictive. To answer the third question, the author used capital market equilibrium theory to derive a "competitive" total rate of return. A model was then derived which addresses the relationship between return on necessary capital, expected investment return and profit provision for a given line of insurance.

COUTTS, S.M., CLARK, G.J. "A Stochastic Approach to the Allocation of Assets for Insurance Companies". International Conference on Insurance Solvency III, 1991.

The authors consider the background to the development of asset and liability modeling and provide an outline of the construction of a particular model. The practical applications of the model are demonstrated, in the first instance by an example of its application in relation to the formulation of investment policy for a U.K. final salary pension scheme. A parallel development appropriate to a general insurance company is then considered, concentrating upon the problem of allocating assets between different asset classes available. The paper concludes with a brief consideration of both the advantages and difficulties of adopting a cash flow approach. A cash flow approach is also proposed as a measure of relative solvency between "peer group" insurance companies.

CUMMINS, J.D., NYE, D.J. "Portfolio Optimization Models for Property-Liability Insurance Companies: An Analysis and Some Extensions". Management Science 27 (1981) 414-430

This paper presents a model to assist property-liability insurance companies in making product and investment mix decisions. A quadratic programming approach is used to generate mean-variance efficient frontiers that reflect the covariability of returns on insurance lines and assets. The solution indicates the overall premium-surplus ratio, the distribution of premiums among insurance lines, and the proportion of assets in each major investment class that are consistent with the minimum level of risk for a given rate of return on net worth. A method is also suggested for including taxes in the model. This paper also discusses the links between ruin theory and utility theory and shows how these decision rules can be used to select operating points along the efficient frontier. A numerical example is given based on the published financial data of a major insurance company.

GEOGHEGAN, T.J. et al. "Report on the Wilkie Stochastic Investment Model". Presented to the Institute of Actuaries, Jan. 27, 1992; to be published in the Journal of the Institute of Actuaries

A FIMAG Working Party was set up in 1989 to consider the stochastic investment model proposed by A.D. Wilkie, which had been used by a number of actuaries for various purposes but had not itself been discussed at the Institute. This is the Report of that Working Party. The Wilkie model is described and reviewed and alternative types of models are discussed. Possible applications of the model are considered, and the important question of "actuarial judgement" is introduced. Finally, the Report looks at possible future developments. In appendices, Clarkson describes a specific alternative model for inflation, and Wilkie describes some experiments with ARCH models. In further appendices possible applications of stochastic investment models to pension funds, to life assurance and to investment management are discussed.

HAUGEN, R.A. "Insurer Risk Under Alternative Investment and Financing Strategies". Journal of Risk and Insurance 38 (1971) 71-80

This article is concerned with the problem of optimizing the structure of assets and liabilities of stock insurance companies. Specifically, an attempt is made to derive some empirical estimates of the risk of return to common stockholders under the assumption that capital is obtained by underwriting insurance from a given line and invested in a securities portfolio of a given nature. By observing and relating the historical performance of insurance and investment portfolios, the variability of the rate of return to equity capital is simulated though the techniques of portfolio analysis.

KAHANE, Y. "Generation of Investable Funds and the Portfolio Behaviour of Non-Life Insurers". Journal of Risk and Insurance 45 (1978) 65-77

In this paper, new parameters, representing the funds generated by the insurance transaction, are introduced into the portfolio model which balances the investment and underwriting activities of an insurer. An insurance activity with a higher funds-generating coefficient may affect both the insurer's expected profit and its risk level. These effects may operate in opposite directions, and the net result would be that a line with a higher coefficient will be less desirable under certain circumstances. Such a surprising impact of the coefficient could have occurred in practice, but the recent experience of insurers, where large underwriting losses are reported, makes this effect less likely today.

KROUSE, C.G. "Portfolio Balancing Corporate Assets and Liabilities with Special Application to Insurance Management". Journal of Financial and Quantitative Analysis 5 (1970) 77-105

This paper considers the simultaneous selection of investments, underwriting lines, and capital financing to form efficient mean-variance corporate portfolios. The analysis is directed toward development of decision rules for use in structuring the firm's business in terms of its balance sheet. The intent is to specify optimal target levels for balance sheet accounts consistent with broad corporate goals, especially in view of the various interrelationships among these "separate" accounts and, consequently, without the suboptimization inherent when considering the properties of each in isolation. The model for unifying these principal, and traditionally disparate, insurance management activities involves only an extension of conventional mean-variance portfolio techniques to include proper specification of:

(1) conservation equations balancing the firm's sources and uses of funds,

(2) constraints setting legal, market, and institutional restrictions on these sources and uses.

LAMM-TENNANT, J. "Asset/Liability Management for the Life Insurer: Situation Analysis and Strategy Formulation". Journal of Risk and Insurance 56 (1989) 501-517

This study examines the current operational status and planning procedures of seven asset/liability management processes appropriate for life insurers and offers recommendations. The author discovers that, although most firms consider asset-liability matching to be an important objective, very little has been done to achieve it. The author suggests several methods of integrating asset-liability management into the investment strategy of the insurance business. The objectives of these various methods range from providing solvency on the one extreme, to maximizing returns on the other.

PEREZ, E. PRIETO "Determination of the Amounts Available for Long-Term Investment for an Insurance Company". The Geneva Papers on Risk and Insurance No. 11 (January, 1979) 47-51

The author describes two stochastic models (one with, and the other without, reinsurance) to determine the amount that an insurance company can invest for the long term. The models show that the optimal investment decision depends on:

(i) the return on the portfolio of assets.

(ii) the cost of forced liquidation of assets in order to pay claims.

(iii) the shape of the claim distribution function $F(x)$.

PEREZ, E. PRIETO "Administration of the Portfolio of an Insurance Company". Transactions of the International Congress of Actuaries (1984)

The author refers to the fact that the demand for a minimum solvency margin from insurance companies permits the partial liberalization of financial resources and implies dropping other methods howsoever aimed at securing the solvency of the insurance company. He recommends the Markowitz method of portfolio selection.

PLATT, ROBERT, B. editor, "Controlling Interest Rate Risk", John Wiley & Sons, New York, 1986

TAPIERO, C.S., ZUCKERMAN, D. "Optimal Investment Policy of an Insurance Firm". Insurance Mathematics and Economics 2 (1983) 103-112

The authors consider an investment problem by an insurance firm. As in the classical model of collective risk, it is assumed that the premium payments are received deterministically from policyholders at a constant rate, while the claim process is determined by a compound Poisson process. They introduce a conversion mechanism of funds from cash into investments and vice versa. Contrary to the conventional model, they do not assume a ruin barrier. Instead they introduce conversion costs to account for the problems implicit in reaching the zero boundary. The objective of the firm is to maximize its net profit by selecting an appropriate investment strategy. A diffusion approximation is suggested in order to obtain tractable results for a general claim size distribution.

TILLEY, J.A. "The Matching of Assets and Liabilities". Transactions of the Society of Actuaries 32 (1980) 263-304

A general model for matching assets and liabilities is developed. Three aspects of the investment problem are discussed: initial investment strategy, reinvestment strategy, and asset liquidation strategy. Reinvestments and disinvestments are handled by an investment-year method. Explicit provision is made for different new-money rates in each future year. The model is defined by specifying:

(1) the schedule of interest and principal payments for representative investment instruments comprising the initial portfolio,

(2) the expected net cash outflows of the pension fund or other block of business,

(3) rollover rates for reinvestments,

(4) a set of patterns of future new-money interest rates.

The model solves for a region of strategies that result in a nonnegative total fund value at the end of the investment horizon for each interest rate pattern in the set described in item 4.

TRIESCHMANN, J.S., MONROE, R.J. "Investment Performance of P-L Insurers' Common Stock Portfolio". Journal of Risk and Insurance 39 (1972) 545-554

This study compares stock P-L, mutual P-L and investment companies with respect to the rate of return on their common stock portfolios. It was found that investment companies earned signficantly higher rates of return, but average risk levels were also higher for these companies. Therefore, investment companies did not earn significantly higher risk-adjusted rates of return than P-L companies. Within the P-L industry, stock companies earned signficantly higher risk-adjusted returns than mutual companies. It was also found that portfolio size and profitability had a low correlation, and that the performance ranking was independent of method of measuring profitability.

VANDEBROEK, M., DHAENE, J. "Optimal Premium Control in a Non-Life Insurance Business". Scandinavian Actuarial Journal (1990) 3-13

Optimal premium control in non-life insurance business is determined using dynamic programming techniques. The optimality is measured in terms of solvency and a sufficient smoothing of the problem and the surplus variations in time.

WILKIE, A.D. "Portfolio Selection in the Presence of Fixed Liabilities". Journal of the Institute of Actuaries 112 (1985) 229-277

This paper was inspired by a paper "The Matching of Assets to Liabilities", JIA (1984), by A.J. Wise. The author discusses assets that are not marketable and cannot be disposed of, so in this sense they are fixed. However, their monetary value is a random variable. This paper is concerned not so much with finding the quantities of assets that match the given liabilities, but rather, finding the most desirable set of assets having regard also to their present prices. The author has generalized conventional portfolio theory by including the price of the portfolio as a third dimension, in addition to the expectation and variance of the ultimate surplus.

WILKIE, A.D. "A Stochastic Investment Model for Actuarial Use". Transactions of the Faculty of Actuaries 39 (1986) 341-403

The author proposes a model to simulate "possible futures". The model is appropriate for long-term studies without being too concerned with short-term fluctuations. This method can be used for valuation of insurance companies, and has been used in many solvency studies. The model treats inflation stochastically, and has four variables to describe the investments for actuarial purposes: retail price index, share yield, share dividend, government securities yield.

WISE, A.J. "The Matching of Assets to Liabilities". Journal of the Institute of Actuaries 111 (1984) 445-501

The purpose of this paper is to present the results of a new study in which the matching position is well defined by reference to appropriate actuarial models. The new theory leads to specific portfolio structures which comprise fixed interest and equity or index-linked investments and which, in a defined sense are the best match to the given liabilities. As will be shown, the advantages of this approach emerge in a variety of applications. In particular it is found possible to quantify aspects of actuarial valuation which would otherwise only be considered in the light of general reasoning. The author restricts his attention to matching portfolios which contain no negative asset holdings.

WISE, A.J. "The Matching of Assets to Liabilities". Journal of the Institute of Actuaries 111 (1984) 445-501

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WISE, A.J. "Matching and Portfolio Selection: Parts I, II". Journal of the Institute of Actuaries 114 (1987) 113-133, 551-568

This paper shows how any efficient portfolio can be divided into three mutually exclusive and distinct components:

(1) the matching portfolio, which is defined by the property that the expected ultimate surplus is zero and the variance of the ultimate surplus is minimized,

(2) a component which is related to the expected return on the portfolio but not to its degree of risk,

(3) a component which is related to the degree of risk in the portfolio but not to its expected return.

The paper is concerned with investment portfolios which involve the liabilities of a long-term investing situation such as a pension fund or a life office. The author addresses the issue that actuarial valuations based on pure matching did not take into account the likely advantage of favouring riskier but potentially more profitable investments. The methods of this paper allow the actuary to choose preferred values for return and risk in the portfolio relative to the liabilities. The author then investigates the problem of finding optimum portfolios with prescribed values of return and risk, but with no negative asset holdings.

B - X

Papers on Ratemaking

BECKMAN, R.W., TREMELLING, R.N. "The Relationship Between Net Premium Written and Policyholders' Surplus". Proceedings of the Casualty Actuarial Society 59 (1972) 203-220.

The authors make the following arguments based on the stock insurance industry premium-surplus ratio for the period 1928-1970:

(1) the stock market is the major factor affecting policyholders' surplus and the premium-surplus ratio.

(2) the premium-surplus ratio measures the leverage of an insurance company and so the stockholders should prefer a higher ratio, but from the policyholders' viewpoint, this ratio is an indication of the strength of the insurer and thus a lower ratio indicates a more heavily capitalized and "stronger" insurer.

(3) the net premium written – policyholders' surplus ratio is distorted because policyholders' surplus has been overstated.

COOPER, R.W. "Investment Return and Property-Liability Insurance Ratemaking". Huebner Foundation Studies, University of Pennsylvania, 1974

This book examines the issue of how to include investment return in the ratemaking process. Four topics are considered: whether to focus on the total resources of the insurer or on the resources required to run the business; necessary level of capital; total rate of return on invested capital; relationship between total rate of return on invested capital, investment return and property-liability insurance rate levels. The author concluded that the focus of regulation should be on the resources required to support a company's insurance business. With regard to the second topic, a formula was derived to determine the necessary level of invested capital, and using this method, the author contends that the ratios of premium to capital and surplus imposed by state regulatory authorities may be too restrictive. To answer the third question, the author used capital market equilibrium theory to derive a "competitive" total rate of return. A model was then derived which addresses the relationship between return on necessary capital, expected investment return and profit provision for a given line of insurance.

CUMMINS, J.D. "Multi-Period Discounted Cash Flow Ratemaking Models in Property-Liability Insurance". *Journal of Risk and Insurance* 57 (1990) 79-109

Discounted cash flow (DCF) models have become increasingly important in property-liability insurance pricing. This article analyzes the two most common DCF models – the Myers-Cohn (MC) model and the National Council on Compensation Insurance (NCCI) model. The MC model is shown to imply constant capital structure based on present value concepts, while the NCCI model implies constant capital structure based on book values of reserves and surplus. The models reflect alternative and potentially testable hypotheses regarding the timing of equity flows involved in the insurance transaction. Because the equity timing differs, the models do not generally give the same result.

D'ARCY, S.P., GARVEN, J.R. "Property-Liability Insurance Pricing Models: An Empirical Evaluation". Journal of Risk and Insurance 57 (1990) 391-430

In this article, the major property-liability insurance pricing models are evaluated for the period 1926-1985, and the results of the various models are compared in terms of the ability to predict actual underwriting profit margins. Differences between model predictions and realized underwriting profit margin series are examined over the entire period as well as various sub-periods in order to demonstrate how individual models perform under different conditions.

DERRIG, R.A. "Solvency Levels and Risk Loadings Appropriate for Fully Guaranteed Property-Liability Insurance Contracts: A Financial View". International Conference on Insurance Solvency I, 1986.

A model is proposed which applies financial theory concepts, specifically options pricing to the question of required solvency margins. A financial criterion for required solvency margins was proposed as a replacement for the usual statistical ruin criterion. Briefly, a company with an asset/liability ratio of x is solvent at a level $\varepsilon > 0$ if the premium necessary to reinsure its outstanding liabilities is less than ε.

DERRIG, R.A. "The Use of Investment Income in Massachusetts Private Passenger Automobile and Workers' Compensation Ratemaking". Fair Rate of Return in Property-Liability Insurance (ed. Cummins, Harrington) 1987, Kluwer-Nijhoff, Boston

This paper reviews the development of the methodology used to establish underwriting profit provisions for two insurance lines under rate regulation during 1975-1983. Summaries are given of the rates of each of the two lines. A survey of the key parameters and important issues concerning rate measurement is presented. The paper also illustrates the sensitivity of underwriting provisions to the parameters chosen, and compares the actual results for the two lines to the target results established by the various rate approvals.

DOHERTY, N.A., GARVEN, J.R. "Price Regulation in Property Liability Insurance: A Contingent Claims Approach". Journal of Finance 41 (1986) 1031-1050.

A discrete-time option-pricing model is used to derive the "fair" rate of return for the property-liability insurance firm. The rationale for the use of this model is that the financial claims of shareholders, policyholders, and tax authorities can be modelled as European options written on the income generated by the insurers asset portfolio. This portfolio consists mostly of traded financial assets and is therefore relatively easy to value. By setting the value of the shareholders' option equal to the initial surplus, an implicit solution for the fair insurance price may be derived. Unlike previous insurance regulatory models, this approach addresses the ruin probability of the insurer as well as a nonlinear tax effect.

DOHERTY, N.A., KANG, H.B. "Interest Rates and Insurance Price Cycles". Journal of Banking and Finance 12 (1988) 199-214.

Property-liability insurance prices and profit appear to move in a six year cycle. Many industry analysts claim that the insurance market is inherently unstable and prices fail to converge on clearing levels. The authors have a different explanation. They identify spot equilibrium prices using CAPM. But informational, regulatory, and contractual lags preclude instantaneous adjustment. So they model the temporal movement of prices using a partial adjustment model in which actors form rational expectations. The actual movement of insurance prices does seem to track closely those estimated by the partial adjustment model. The cycle may be better viewed as a series of converging responses to changing spot prices.

DOHERTY, N.A., GARVEN, J.R. "Capacity and the Cyclicality of the Insurance Markets". International Conference on Insurance Solvency III, 1991.

Although financial pricing models imply that profits and property-liability insurance firms should conform to an unpredictable time series process, cycles are widely reported. Some controversy exists as to whether the "underwriting cycle" is a mere accounting artifact or whether it has real resource effects. This paper shows that changes in interest rates simultaneously affect the insurer's capital structure and the equilibrium level of underwriting profit. Depending on factors such as asset and liability durations, access to capital markets, and availability of capital substances such as reinsurance, insurers will be differently affected by changing interest rates. Over time, it is found that the average market response to changing interest rates roughly tracks market clearing prices although the response is somewhat damped. However, firms with mismatched assets and liabilities as well as those with more costly access to new capital and reinsurance, are more likely to respond to interest rate changes by either rationing or abnormal price changes.

HAUGEN, R.A., KRONCKE, C.O. "Rate Regulation and the Cost of Capital in the Insurance Industry". Journal of Financial and Quantitative Analysis 6 (1971) 1283-1305

The authors discuss some of the effects of rate regulation in the property and casualty insurance industry. One consequence of the regulatory environment is that an optimal capital structure may clearly exist in this industry. If the rate of return to the insureds is generally deficient, it is expected that property and casualty stock companies would have an incentive to lever themselves to the maximum extent permissible by selling insurance. The classic monopoly of the economic literature finances its lucrative investment opportunities in a competitive capital market. The stock insurance company invests in that market, but the relative distribution of the return earned there may be less than equitable due to the process and standards of rate regulation.

KRAUS, A., ROSS, S.A. "The Determination of Fair Profits for the Property-Liability Insurance Firm". Journal of Finance 37 (1982) 1015-1028

Single period and dynamic valuation models in continuous time, under certainty and uncertainty, are developed for a property-liability insurance contract to determine the "fair" (competitive) premium and underwriting profit. The intertemporal stochastic model assumes that the claim frequency and the price index of claim settlements are functions of a set of underlying state variables which follow a multivariate Wiener process. The competitive premium is shown to be proportional to the claim frequency and the price index for claim settlements at the time the policy is issued. The factor of proportionality varies directly with the claim settlement rate and the length of coverage, and inversely with the risk-adjusted real interest rate on the dollar-valued claim rate.

LAUNIE, J.J., PHILLIPS, G.M. "The Effect of Solvency Regulation in the Underwriting Cycle". International Conference on Insurance Solvency II (1988)

This paper focuses on the frequently utilized regulatory test for capacity which states that net premiums written should not be greater than three times policyholders' surplus. The difficulty with this solvency measure is that net premiums written is immediately affected by price changes. A simple example of the manner in which flows on this measure may exacerbate the underwriting cycle is given. This is followed by a formal model which measures the extent to which changes in net premium written reflects price changes rather than real changes in insurance exposure.

MARTIN-LOF, A. "Premium Control in an Insurance System; An Approach using Linear Control Theory". Scandinavian Actuarial Journal (1983) 1-27

A mathematical model of cash flows and reserves is discussed and a linear control law with feedback for the premium is discussed. The behaviour of the system is analyzed using the methods of control theory. It is shown that stability is maintained only if the feedback is not too strong, and that undesirable oscillations can easily be produced caused by delays in the system. It is shown how a quantitative measure of necessary solidity can be naturally introduced, and consideration is given to the problem of determining the control so that a desired solidity is obtained.

ROSS, J.A., POUNTAIN, C.C. "Comparison of International General Insurance Underwriting Results and their Volatility". Transactions of the International Congress of Actuaries (1988)

This paper studies underwriting results in seven major international markets over the period 1975-1984. The reason for the study is that many companies try to mitigate the underwriting cycle by international diversification. The study shows that Japan, followed by Germany, was the most profitable market, with France being the least. Germany and France had the least variable markets while Australia, followed by the U.S.A., was the most variable. All markets were positively correlated, with Germany being the least so. The conclusion is that since international markets tend to move in the same direction, diversification can limit the worst effects of the cycle but not overcome it.

TAYLOR, G.C. "Solvency Margin Funding for General Insurance Companies". Journal of the Institute of Actuaries 111 (1984) 173-179

The author disagrees with the idea that growth of an insurance company should be financed by premium loadings entirely. He believes that the solvency margin should be viewed as part of the working capital needed to run the company. This will make it necessary to ensure that each year's business produces a return on this margin commensurate with the risks undertaken in the business. However, premiums may still need to contain some loading to provide appropriate return on shareholders' funds. In a sense, then, all growth is to be financed by premium loadings, but only in the form of return on equity, not in the form of what amounts to permanent subscription of capital by policyholders.

TAYLOR, G.C. "An Analysis of Underwriting Cycles in Relation to Insurance Pricing and Solvency". International Conference on Insurance Solvency II, 1988

It is the conventional wisdom of the insurance industry that the total operating profit exhibits cyclical behaviour over time. This paper tries to determine the mechanisms responsible for causing this cycle. It also examines the effects of the cycle in terms of insurer pricing and solvency, and discusses whether regulatory policies might eliminate or mitigate these cycles.

TRIESCHMANN, J.S. "Property-Liability Profits: A Comparative Study". Journal of Risk and Insurance 38 (1971) 437-453

The author studied the risk-adjusted rate of return of the property-liability insurance industry and compared it with non-insurance industries. He concluded that the insurance industry had a statistically significantly lower rate of return than the non-insurance industries that were tested, for the years 1955-1968. He also discovered that "small" insurance firms had significantly lower rates of return than "medium" and "large" insurance firms, but the latter two were not significantly different from each other.

VENEZIAN, E.C. "Ratemaking Methods and Profit Cycles in Property and Liability Insurance". Journal of Risk and Insurance 52 (1985) 477-500

Insurers and rating bureaus often use regression of past costs, or of loss ratios, on time as a way of estimating future rate requirements. A model of this process suggests that the rates set by such methods would create a quasi-cyclical pattern of underwriting profit margins. The details of the forecasting method determine the characteristics of the cyclical pattern, so different lines may have different periods or different phases. Empirical data on major lines of property and liability insurance are consistent with the hypothesis that ratemaking methods contribute to the fluctuations of underwriting profit margins.

B - XI

Miscellaneous Papers

BENJAMIN, S. "Solvency and Profitability in Insurance". Transactions of the International Congress of Actuaries (1980).

This paper gives reasons why the actuarial profession should beware of discussing the financial position of an insurance company (a) within the conceptual framework of GAAP as used for life insurance companies in the U.S.A., and (b) within the conceptual framework of conventional accounting throughout the world for non-life companies. The paper argues that the conventional split between (i) technical provisions (reserves) and (ii) the free assets forming the solvency margin is false. Hence the practice whereby (i) is estimated without regard to the arbitrary level of (ii) which is set by the control authorities, should be unacceptable to the actuarial profession.

The paper argues that the traditional actuarial approach to cautious reserves in life insurance without arbitrary external solvency margins gives an acceptable conceptual framework for both life and non-life insurance accounts, and is consistent with good supervision in a free competitive market. A simple method of assessing the strength of an insurance company, based on past loss-ratios is suggested in an Appendix.

CANADIAN LIFE AND HEALTH INSURANCE ASSOCIATION "CLHIA Formula for Minimum Continuing Capital and Surplus Requirements", 1991

This paper gives the formula for determining the MCCSR. Each of the following elements receives a particular weight, the total of which comprises the MCCSR.

A. Life Insurance
   1. Mortality Risk
      (a) Insurance (including accidental death and dismemberment)
      (b) Disability and other Morbidity Risks
      (c) Annuities Involving Life Contingencies
   2. Interest Margin Pricing Risk
      (a) participating and non-participating business
      (b) all other business
   3. Asset Default (C-1) Risk
      (a) Short Term Securities
      (b) Bonds
      (c) Mortgages
      (d) Transportation Equipment Trust Certificates
      (e) Bulk Adjustment for Unamortized Gains and Losses on the Disposition of Debt Securities
      (f) Stocks
      (g) Real Estate
      (h)

Oil and Gas Production Properties

(i) Investment Income Due and Accrued

4. Changes in Interest Rate Environment (C-3) Risk

B. Accident and Sickness Insurance

1. Morbidity Risk

(a) Disability Income Insurance

(b) Accidental Death and Dismemberment

(c) Other Accident and Sickness Benefits

(d) Credits for Reinsurance and Special Policyholder Arrangements

(e) Adjustments for Statistical Fluctuation.

2. Financial Risk

C. Miscellaneous Requirements

(a) Reserve for Cash Value Deficiencies and Amounts of Negative Reserve

(b) Valuation Reserve for Miscellaneous Assets and Other Investments

(c) Statutory Currency Reserves

(d) Reserve for Reinsurance Ceded to Unregistered Reinsurers

(e) Surplus appropriated for special risks not covered by the formula.

(THE) COUNCIL OF THE EUROPEAN COMMUNITIES "First Council Directive for Direct Life Assurance", 1979

This paper gives a determination of the risk-based solvency margin for life insurance companies in the EEC. The solvency margin shall consist of:

(1) assets, including paid-up share capital or paid-up mutual fund; half of unpaid-up share capital or fund once 25% of such capital or fund are paid up; statutory reserves and free reserves not corresponding to underwriting liabilities; any carry-forward of profits.

(2) profit reserves appearing in the balance sheet where they may be used to cover any losses which may arise and where they have not been made available for distribution to policyholders.

(3) (i) an amount equal to 50% of the undertaking's future profits,

(ii) the difference between a non-Zillmerized mathematical reserve and a mathematical reserve Zillmerized at a rate equal to the loading for acquisition costs included in the premium,

(iii) any hidden reserves resulting from underestimation of assets or overestimation of liabilities other than mathematical reserves.

Based on these rules, a minimum solvency margin is then determined for the various classes of insurance. One third of the minimum solvency margin shall constitute the guarantee fund, and at least 50% of this fund shall consist of items (1) and (2) above. In addition to this document, a similar one has been drawn up for general insurance.

CUMMINS, J.D., OUTREVILLE, J.F. "An International Analysis of Underwriting Cycles in Property-Liability Insurance". Journal of Risk and Insurance 54 (1987) 246-262

Most prior analyses of underwriting cycles have explained cycles as a supply-side phenomenon involving irrational behaviour on the part of insurers. This paper proposes instead that insurance prices are set according to rational expectations. Although rational expectations per se would be inconsistent with an underwriting cycle, the authors hypothesize that cycles are "created" in an otherwise rational market through the intervention of institutional, regulatory, and accounting factors. Empirical evidence is presented indicating that underwriting profits in several industrialized nations are consistent with this hypothesis.

KASTELIJN, W.M., REMMERSWAAL, J.C.M. "Solvency", Surveys of Actuarial Studies, (May, 1986) No. 3 Nationale-Nederlanden N.V., Rotterdam

This book gives a survey of methods that can be used to calculate solvency margins. The book discusses methods based on ratios, as well as methods based on claims fluctuations or ruin theory. The book also covers the two most comprehensive models in existence: The Finnish Solvency Study, and the GISG Reports on Solvency. The authors also discuss the economic aspects of solvency.

McGUINNESS, J.S. "An Economic Perspective for Controlling Fluctuations in Insurers' Business Results". Transactions of the International Congress of Actuaries (1988).

This paper explores the possibility of establishing criteria for a complete model for studying or controlling the strength of individual insurers. An economic perspective is first suggested for business operations and for their management. Insurance and other security-related activities are next fitted into the managerial pattern. The vital need for a comprehensive approach to managing in a coordinated fashion both random risk and non-random risk is then discussed. Practical implications and applications are finally considered and some conclusions drawn.

NIELSON, N.L., GRACE, E.V. "Capacity as an Indicator of Insurer Solvency". International Conference on Insurance Solvency II, 1988

This paper indicates that, when capacity is defined without consideration of reinsurance, a large proportion of the variance in capacity utilization can be explained by the size of the company, its perceived financial strength, its product mix and capitalization requirements, its organizational form, and the risk of its investment operation. When capacity is defined to include reinsurance the variance in capacity utilization can be more fully explained with half the number of variables. In this formulation a company's perceived financial strength, capitalization requirements, and investment risk offer signficant explanation of capacity underutilization.

OUTREVILLE, J.F. "The Transactions Demand for Cash Balances by Property-Liability Insurance Companies". Journal of Risk and Insurance 54 (1987) 557-568

The critical nature of the demand for cash balances by firms has generated a considerable amount of theoretical and empirical research, although much controversy remains. The study developed in this paper provides empirical evidence in the insurance sector that is consistent with the literature on the existence of economies of scale in the demand for cash balances and the influence of interest rates.

PARDO-VIVERO, A. "Reinsurance, Reserves, and Solvency". Transactions of the International Congress of Actuaries (1984)

It is shown that the rules of thumb used by supervisory authorities are not adequate to guarantee solvency in all cases, and in conditions of stagflation it is not rational to tie up money in solvency funds. Reinsurance arrangements are available which can support solvency without the need for excessive funding. This feature has been overlooked lately, as has the need for a rational and consistent taxation policy.

PENTIKAINEN, T. "Aspects on the Solvency of Insurers". Transactions of the International Congress of Actuaries (1984)

The problems related to solvency are reviewed and some solutions and applications are discussed. The importance of profitability, cycles, and inflation is emphasized, taking into account the possibilities of inaccuracies arising from the evaluating of liabilities, and from the fluctuation of the yield of interest, and asset risk. Further, there exists a wide range of miscellaneous incalculable risks in addition to the normal underwriting risks.

PENTIKAINEN, T. "On the Solvency of Insurers". International Conference on Insurance Solvency I, 1986

The author gives an overall view of the solvency issue as he sees it. The following topics are discussed:

(1) public supervision and management control,

(2) risk analysis, both theoretical and empirical,

(3) public solvency control,

(4) accounting and analysis systems for solvency management.

RAMLAU-HANSEN, H. "An Application of Credibility Theory to Solvency Margins: Some Comments on a Paper by G.W. de Wit and W.M. Kastelijn". Astin Bulletin 13 (1982) 37-45

This paper criticizes the work of de Wit and Kastelijn. The author argues that the solvency margin need not be the same for all non-life insurance companies. He also considers the figure calculated by de Wit and Kastelijn to be very high. He further states that loss ratio figures alone should not determine solvency margins, but analysts should consider portfolio mixture, claim occurrence, claim distribution, inflation rate and interest earned on premium income.

RANTALA, J. "Adequate Contingency Reserves in Credit Insurance: Report on a Financial Study". Transactions of the International Congress of Actuaries (1984)

This article comprises a summary of a study made in Finland in 1982 concerning the solvency issue in credit insurance. A model is estimated for bankruptcy intensity and average claim size. This model is then used to evaluate the variance in the solvency ratio of the credit insurer. The solvency ratio and appropriate safety loading level are discussed, as well as the potential effects on a credit insurer's solvency of a major economic depression.

SLEE, D.J. "Solvency and Adequacy of Reserves for a Direct Writer of Worker's Compensation Insurance in Australia". Transactions of the International Congress of Actuaries (1984)

The paper suggests that:

(a) the current solvency formula in Australia is quite arbitrary and by itself it is of little value,

(b) the actuary is best positioned to monitor and test rather than provide figures for reserves,

(c) because different lines require different treatment, authorities must have a degree of flexibility in this control of solvency,

(d) to achieve control with flexibility, companies must not merely pass a static test, but provide a meaningful forward position with an individual pre-agreed solvency plan,

(e) income generating such pre-agreed solvency requirement should be tax-free,

(f) bonds should not necessarily be taken at market value for solvency purposes,

(e) unless all the above concessions are granted, authorities will become inflexible and inevitably stiffen requirements to the point of shareholders throwing in the towel to State monopoly.

STONE, J.M. "A Theory of Capacity and the Insurance of Catastrophe Risks". Journal of Risk and Insurance 40 (1973) 231-243, 339-355

This paper proposes a formal structure for the study of insurance company capacity problems. The first part develops the theory by applying a maximization (of profit) subject to constraints (on stability and survival) model to the risk selection and underwriting process. It is concluded that the stability constraint is generally the operative one and that capacity may be measured as a probability distance from the constraint boundary. In the second part, this format is employed to explore hypothetical examples in catastrophe underwriting and to draw implications about the future of the capacity problem. Here it is shown that the present capacity shortage in the industry could be substantially alleviated by the increased participation of personal lines insurers in the industrial markets and that the shortage may be intensified by the current trend toward corporate self-insurance.

STURGIS, R.W. "Actuarial Valuation of Property/Casualty Insurance Companies". Proceedings of the Casualty Actuarial Society 68 (1981) 146-159

The author describes a basic method for the actuarial valuation of property/casualty companies, based on the economic value of the company. For this purpose he has adapted a classical life company valuation method to determine the capitalized value of expected future earnings. The business in force is considered to be the run of unearned premiums and the losses, expenses, and investment income on premiums already written. Projected earnings on new business are evaluated separately. An example is given of a company writing only workers' compensation, but it can be extended to any number of lines.

TAYLOR, G.C. "Solvency Margin Funding for General Insurance Companies". Journal of the Institute of Actuaries 111 (1984) 173-179

The author disagrees with the idea that growth of an insurance company should be financed by premium loadings entirely. He believes that the solvency margin should be viewed as part of the working capital needed to run the company. This will make it necessary to ensure that each year's business produces a return on this margin commensurate with the risks undertaken in the business. However, premiums may still need to contain some loading to provide appropriate return on shareholders' funds. In a sense, then, all growth is to be financed by premium loadings, but only in the form of return on equity, not in the form of what amounts to permanent subscription of capital by policyholders.

TAYLOR, G.C., BUCHANAN, R.A. "The Management of Solvency". International Conference on Insurance Solvency I, 1986

The authors discuss the following topics:

1. measurement of solvency,
2. factors affecting solvency,
3. management of solvency.

The authors conclude that the solvency margin depends on the following variables:

1. relative exposures to insolvency due to future claims fluctuation and asset fluctuation respectively, measured by the ratio of risk premium to value of liabilities,
2. estimated value of liabilities,
3. expected future rate of increase and variability of unit asset values,
4. size of portfolio, as broadly indicated by claim frequency,
5. contribution to risk of the different lines of business underwritten.

REPORT ON RESERVE AND UNDERWRITING RISK FACTORS

American Academy of Actuaries Property/Casualty Risk-Based Capital Task Force

P&C Risk-Based Capital

One of the components of the proposed Property & Casualty Risk-Based Capital formula is reserve and underwriting risk factors. The American Academy of Actuaries Property & Casualty Risk-Based Capital Task Force has prepared the following report on these risk factors and recommended them to the NAIC P&C Risk-Based Capital Working Group. The Task Force recognizes that the measurement of risk is an emerging area of thought and technology. The Task Force views this report as a good foundation for further study of this critical issue, and not as the "definitive word" on the subject. Hopefully this report will stimulate further study of and papers on this subject.

Another component of the formula is covariance. Also included here is a report on this topic to the Working Group.

American Academy of Actuaries
P&C Risk-Based Capital Task Force

David G. Hartman, Chairman	Allan M. Kaufman
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Report on Reserve and Underwriting Risk Factors

From the
American Academy of Actuaries
Property/Casualty Risk-Based Capital
Task Force

Management Report

May 20, 1993

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Introduction

Until its abolition in March of 1993, the Actuarial Advisory Committee to the NAIC Property/Casualty Risk-Based Capital (RBC) Working Group had been engaged in a comprehensive study of the factors for reserve and underwriting risk in the risk-based capital formula. This study included reviewing and testing the current draft factors, and also the development of reserve and underwriting factors by several alternative means. The American Academy of Actuaries Property/Casualty Risk-Based Capital Task Force has continued, and completed that study.

This report summarizes our analysis, conclusions and recommendations. It is supplemented by a set of Technical Appendices which document our analysis and supporting calculations more fully.

This report starts with a critique of the method that was used by the Working Group to develop the current reserve and underwriting risk factors. Next, these factors are compared to the alternative factors recommended by the Academy Task Force. The balance of the report describes the methodology that the Task Force developed to produce the recommended alternative risk factors.

The reserve and underwriting risk factors in the risk-based capital formula imply a set of charges by line of business. *The focus of this study is on the appropriateness of the level of these charges and not on the specific formula mechanics through which the factors would be applied.* For example, it is not the purpose of this report to discuss whether or how individual company experience should be reflected in developing the risk charges, or whether reserve risk charges should be converted to factors applicable to historical premiums rather than held reserves. Instead, we are considering the basic issue of the level of the risk charges by line of business.

Critique of Current Reserve and Underwriting Risk Factors

The current factors are based on industry "worst-case" experience.

The current reserve and underwriting risk factors in the draft risk-based capital formula are based on the "worst case" experience of the industry over the ten years from 1981-1990, as reported in 1990 Annual Statements. Specifically:

- The reserve risk factors for each line reflect the average company's reported reserve development in the worst year of development for the industry for that line.

- The written premium risk factors for each line reflect the average company's reported loss ratio in the worst year of experience for the industry for that line.

- In the RBC formula, all of the reserve and underwriting risk factors are offset by a credit for the time value of money, using a flat 5% interest rate and loss payout patterns derived using IRS methodology.

For example, the industry's worst reserve inadequacy for Homeowners occurred in December, 1983. Through December, 1990 the average company has reported adverse Homeowners reserve development of 19.3%. Offsetting that development for interest at 5% (a factor of .910) produces a net development, and a net RBC charge of 8.6% of Homeowners reserves.

Similarly in 1989, the worst year of the last ten, the average company experienced a Homeowners' loss ratio of 82.2%. Discounting that loss ratio for interest at 5% (a factor of .919) reduces it to 75.5%. Adding underwriting expenses of 31.8% produces a combined ratio of 107.3%, and a net RBC charge of 7.3% of written premium.

The chart on the following page summarizes the current RBC factors for each line, and the net charges they imply.

Current Reserve and Underwriting Risk Charges

Line of Business	Reserve Risk: Nominal Factor	Reserve Risk: Discount Factor	Reserve Risk: Net Charge	Underwriting Risk: Loss Ratio	Underwriting Risk: Discount Factor	Underwriting Risk: Expense Ratio	Underwriting Risk: Net Charge
Homeowners/Farmowners	0.193	0.910	0.086	0.822	0.919	0.318	0.073
Private Passenger Auto Liability	0.223	0.917	0.121	1.047	0.921	0.239	0.203
Commercial Auto Liability	0.278	0.917	0.172	1.087	0.921	0.301	0.302
Workers Compensation	0.228	0.818	0.005	1.026	0.856	0.179	0.057
Commercial Multiperil	0.434	0.910	0.305	0.923	0.919	0.371	0.219
Products Liability	0.512	0.829	0.253	1.087	0.825	0.260	0.157
General Liability	0.512	0.829	0.253	1.087	0.825	0.267	0.164
Medical Malpractice	0.597	0.786	0.255	1.730	0.763	0.159	0.479
Special Liability	0.163	0.908	0.056	0.890	0.919	0.399	0.217
2-Year Line Composite	-0.037	0.962	-0.074	0.718	0.961	0.274	-0.036
Property Reinsurance	0.423	0.924	0.315	1.507	0.925	0.251	0.645
Casualty Reinsurance	0.844	0.731	0.348	1.433	0.728	0.251	0.294

It should be noted that the net charges shown in the above chart are the charges applicable to the average company. In the current draft formula, the charges applicable to individual companies will vary from those shown above, due to the influence of their own reserve development, underwriting experience, and expense ratios.

We believe that the *first* level of testing should be to assure that these net risk-based capital charges by line of insurance are reasonable. The focus of this study is, therefore, on the appropriateness of these net charges, and *not* on the specific formula mechanics through which they would be applied. Issues of formula mechanics are subsidiary to the basic issue of the levels of the net risk charges. In this report, we are neither endorsing nor repudiating the existing formula mechanics; we are merely setting aside mechanics-related issues to focus solely on the level of the charges. Once the level of net charges is established, those charges can be converted into factors that accommodate any chosen set of formula mechanics.

The current factors emphasize the specific forces underlying the last industry down-cycle, rather than the current and future risks to the industry.

The current factors reflect the historical experience of the industry in the last underwriting down-cycle. In particular, they reflect the severe adverse reserve development that occurred in general liability, medical malpractice and reinsurance, and the very severe loss ratios in malpractice and reinsurance.

The experience during this particular cycle is dominated by several factors:

- The tort liability explosion, particularly in respect to asbestos and environmental liabilities.
- A great deal of naive capacity, focused especially on general liability and reinsurance lines.
- High interest rates, creating intense pressures to engage in cash flow underwriting.
- High inflation rates.

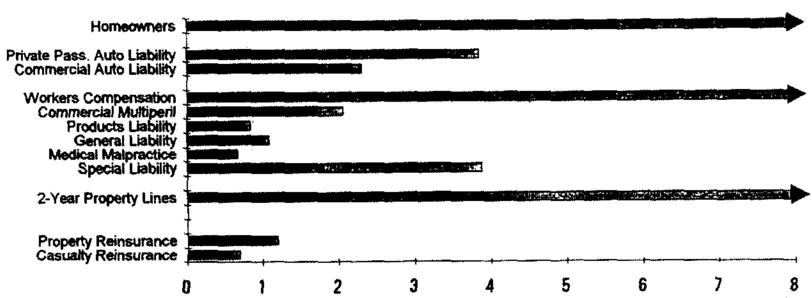
While the next down-cycle could easily be as severe, the specific forces that drive it will probably be different (as they are in each cycle), such that the incidence of adverse results by line will probably also be different. For example, industry observers currently see Workers Compensation as a line in great distress. However, during the last cycle Workers Compensation loss ratios and reserve developments were not particularly unfavorable. As a result, the current reserve and underwriting risk factors for Workers Compensation are relatively modest. A similar observation might apply to Homeowners, given the recent catastrophe experience.

The methodology underlying the current factors, therefore, seems somewhat overly focused on the specifics of the recent past. While past experience is useful as a guide, it needs to be interpreted in terms of the current and future risks faced by the industry.

The current factors create very high capital requirements (relative to industry norms) for some lines, and very low ones for others. Their implementation may cause significant market dislocations.

To test the reserve and underwriting risk factors for each line of business, we developed an industry Premium-to-Surplus ratio model. In that model, each set of reserve and underwriting risk factors were combined with those applicable to assets to produce the overall risk-based capital for the line. The resulting risk-based capital can then be compared to the premium volume to determine the implied Premium-to-Surplus ratio. These results are presented below.

Implied Premium-to-Surplus Ratios - Current Factors



As can be seen, the current factors imply very different Premium-to-Surplus ratios by line of business. Capital requirements are quite high for Liability, Medical Malpractice and Reinsurance; and quite low for Homeowners, Workers Compensation and Property.

In reviewing the above chart, it is important to understand that the above Premium-to-Surplus ratios represent maximums. If the industry (or an average company) were to actually operate above the Premium-to-Surplus ratio shown, it will have crossed the risk-based capital threshold; with actual surplus below the risk-based capital requirement. The industry will, therefore, have to capitalize each line *below* the Premium-to-Surplus ratios shown to prevent individual companies from triggering regulatory attention.

Our use of the Premium-to-Surplus ratio as a test of the formula should not be misinterpreted as an endorsement of this test as a measure of the capital adequacy of an individual company. The Premium-to-Surplus ratio has been justifiably criticized for its shortcomings as a measure of leverage. Here we are only using it to present overall *industry* capital requirements for each line, using a conventional measure as a matter of convenience.

Premium-to-Surplus ratios do vary among different segments of the industry, reflecting different risk profiles of the mix of business written by each industry segment (see the recent study by ISO, for example). *The Academy Task Force fully supports the notion that the Risk-Based Capital requirements by line should reflect discernable differences in the riskiness of each line.* However, we are concerned that the swings in capital requirements displayed in the preceding chart seem greater than most would think reasonable.

Based on current industry norms, the implied capital requirements for products and general liability, medical malpractice, and reinsurance seem to be too high. This is a critical issue as it is likely to affect the available capacity in these lines. Companies will tend to reduce their future writings in lines where they perceive that capital requirements are too high, focusing instead on lines where capital requirements are less. If the differences between current perceptions of capital requirements by line and RBC calculated requirements by line are large, the significant market implications of the differences require that the assumptions underlying the RBC factors be analyzed critically.

Finally, we would caution that the Premium-to-Surplus ratio model was developed as a heuristic tool to aid in reviewing the implications of the level of the various risk-based capital charges. The model required a number of simplifying assumptions that are reasonable at the overall industry level, but are not appropriate for use in evaluating the impact of the formula on an individual company. For example, in the model we assume an industry average mix of invested assets for each line, and we do not consider any of the charges for investments in affiliates. Due to these simplifying assumptions, the model understates the total risk-based capital generated by the formula, by an estimated 15 to 20%. Despite these limitations, we believe the model is a useful tool for comparing the relative risk-based capital requirements by line of business.

The assumptions underlying the Premium-to-Surplus rate model are summarized in the last section of this report. Further details can be found in Appendix C.

Recommended Reserve and Underwriting Risk Factors

Our recommended factors reflect the inherent riskiness of each line of insurance.

After testing a variety of approaches, the Academy Task Force has developed a set of alternative reserve and underwriting risk factors, which it recommends the Working Group adopt and incorporate into the draft RBC formula.

The methodology, rationale and supporting data that underlie our recommended alternative factors are described in the next section of this report. Additional supporting detail is provided in a set of Technical Appendices. While the methodology underlying the recommended factors is somewhat complex, we believe the resulting factors better reflect the inherent riskiness of each line of insurance.

Our recommended alternative reserve and underwriting risk factors are summarized in the chart below.

Proposed Alternative Reserve and Underwriting Risk Charges

Line of Business		Reserve Risk Nominal Factor	Reserve Risk Discount Factor	Reserve Risk Net Charge	Underwriting Risk Loss Ratio	Underwriting Risk Discount Factor	Underwriting Risk Expense Ratio	Underwriting Risk Net Charge
Homeowners/Farmowners		0.304	0.928	0.210	1.012	0.941	0.318	0.270
Private Passenger Auto Liability		0.209	0.918	0.110	0.899	0.924	0.239	0.070
Commercial Auto Liability		0.232	0.901	0.110	0.967	0.899	0.301	0.170
Workers Compensation		0.282	0.850	0.090	1.101	0.882	0.179	0.150
Commercial Multiperil		0.293	0.882	0.140	0.873	0.881	0.371	0.140
Products Liability -	Claims-made	0.269	0.875	0.110	1.133	0.847	0.260	0.220
	Occurrence	0.411	0.815	0.150	1.407	0.789	0.260	0.370
General Liability -	Claims-made	0.243	0.885	0.100	1.080	0.864	0.267	0.200
	Occurrence	0.370	0.825	0.130	1.320	0.805	0.267	0.330
Medical Malpractice -	Claims-made	0.254	0.845	0.060	1.326	0.823	0.159	0.250
	Occurrence	0.399	0.765	0.070	1.666	0.745	0.159	0.400
Special Liability		0.293	0.897	0.160	0.845	0.912	0.399	0.170
2-Year Line Composite		0.325	0.966	0.280	0.941	0.963	0.274	0.180
International		0.339	0.859	0.150	1.154	0.882	0.262	0.280
Property Reinsurance		0.400	0.914	0.280	1.310	0.915	0.251	0.450
Casualty Reinsurance		0.465	0.751	0.100	1.389	0.748	0.251	0.290

The overall level of risk-based capital is a key judgement that must be made before the formula can be finalized. Raising the charges increases the level of capital, which increases the security afforded to policyholders. At the same time, the higher level of capital implies higher costs for policyholders, to provide the necessary returns on the higher capital. Ultimately, the formula must strike a balance between the competing objectives of security and cost.

Our recommended factors are meant to be "neutral" on this issue. We have calibrated them so that they produce the *same* amount of total risk-based capital for the primary insurance industry as the current factors. This was done largely to permit their comparability to the current factors, and should not be interpreted as an endorsement of the resulting level of capital, per se.

If, after review and testing, the Working Group wishes to raise or lower the level of capital, our factors can easily be recalculated to reflect the desired level. As will be seen in subsequent sections, the methodology we have developed to calculate the factors makes use of an explicit capital standard (the Expected Policyholder Deficit) as an input. We calculated factors at several alternative capital standards before settling on our recommendation.

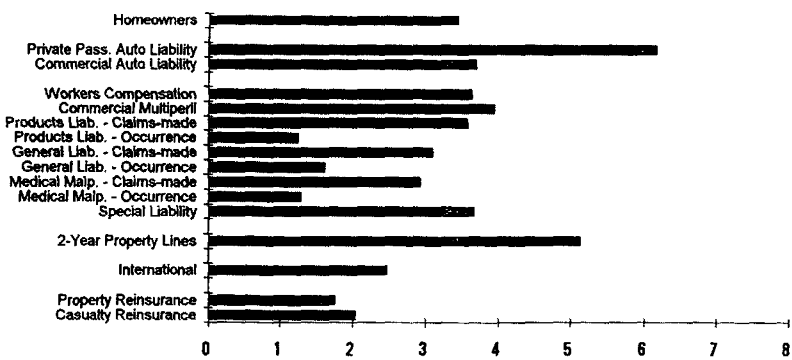
Note that the recommended risk factors include separate factors for claims-made versus occurrence business. As part of our analysis, we performed a separate study of the relative riskiness of the two coverage forms. Based on that study, we are recommending lower factors for claims-made business than for occurrence business.

Our study also updates the discount factors to reflect 1991 Schedule P experience. The discount factors continue to be based on IRS payout pattern methodology and a 5% interest rate.

Finally as a simplification to the formula we have constructed underwriting risk factors that include provision for the risk associated with both written and unearned premium, but are applicable *only* to written premium. Thus, if our factors were adopted, it would be appropriate to delete the unearned premium component in the formula.

The resulting capital requirements for each line are more reasonable. Our recommended alternative factors also imply maximum Premium-to-Surplus ratios, as summarized in the chart below.

Implied Premium-to-Surplus Ratios - Proposed Alternative Factors



Not only are the proposed alternative factors more rigorously developed, but, as can be seen, they do not produce the wide differences in Premium-to-Surplus ratios as do the current factors. Most importantly, they do not imply unreasonably stringent capital levels for any line. The variation in Premium-to-Surplus ratios is more consistent with the observed variation in capitalization across different segments of the industry.

As was noted in an earlier section, since the Premium-to-Surplus ratio model does not capture all elements of the risk-based capital formula, it understates the total risk-based capital the formula will generate. The implied Premium-to-Surplus ratios for all lines are correspondingly overstated. We do not believe this shortcoming of the model distorts the overall picture presented in the preceding chart.

It is essential that work continue to improve and refine the measurement of risk.

The Academy Task Force believes that its recommended alternative factors, and the approach it has developed to measure risk, are a substantial improvement over the current draft factors. However, the Task Force also recognizes that the measurement of risk is an emerging area of thought and technology. The Task Force views this report as a good foundation for further study of this critical issue, and not as the "definitive word" on the subject.

Development of Alternative Measures of Reserve and Underwriting Risk

The approach underlying the current factors can be summarized as follows:

- Industry-wide bias in reserving and pricing was identified as a major risk factor, and it was measured from Schedule P information on an undiscounted basis.

- It was agreed that investment income on assets corresponding to loss reserves and premium should be considered before using the values from Step 1.

- Individual company fluctuation around the industry bias was considered relevant, but was not reflected because (a) the factors derived from Steps 1 and 2 above were already sufficiently conservative, and (b) there was not readily available a method to measure individual company variation.

The approach that the Academy Task Force has taken improves on the current approach in the following ways:

1. The method continues to use Schedule P runoff information as a starting point.

2. Rather than using a flat 5% interest rate, the interest rate is based on the prevailing interest rate during the historical period. Since company earnings actually reflected these prevailing rates, the variable rates better measure the risk.

3. Measurements of industry variability over time and individual company variability around the industry average have been prepared in a form which can be reflected in the analysis.

With these improvements, the alternative reserve and underwriting risk factors have been developed, as described further in the sections below.

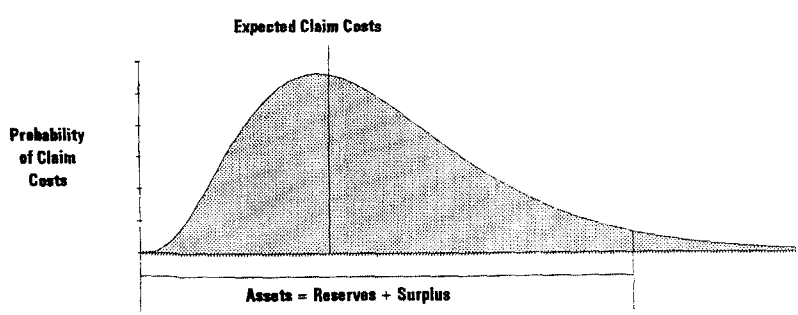
Our reserve and underwriting risk factors are developed using a consistent conceptual approach.

The fundamental risk associated with insurance contracts is that the actual cost of claim liabilities will vary from expected costs.

This risk obviously exists on all future business, because the insured events may or may not occur. In addition, the claim costs of the events that do occur are affected by the future social and economic conditions during which they are settled, adding to the uncertainty of their cost. A portion of the risk therefore remains on past business, to the extent that not all claims are settled.

Because claims can take several years or more to settle, their economic cost needs to be measured on a present value basis, using interest rates prevailing at the time.

In order to minimize the adverse consequences of risk, an insurer's resources (i.e., assets) must exceed the expected cost of its claim liabilities by a margin sufficient to handle all but the most extreme fluctuations in actual claim costs. The insurer's resources are equal to its reserves and its surplus. Pictorially:



At the right hand extreme in the preceding chart, there is a small probability that actual claim costs will be sufficiently large so as to exceed all of the insurer's resources. In such circumstances, the insurer would be economically insolvent, with resources inadequate to finance its claim costs.

For each line of insurance, we attempted to measure the extent to which a company's actual (present value) claim costs can vary from expected. In other words, we attempted to measure the shape of the probability distribution in the preceding chart. We measured this variation by looking at historical claim experience over the last ten years, comparing actual claims to expected claims.

- For reserve risk, we compared the present value of the actual claim runoff that has emerged to the reserves that were originally established for those claims.

- For underwriting risk, we compared the present value of the actual accident year claim payments to the loss portion of the earned premium, after deducting underwriting expenses.

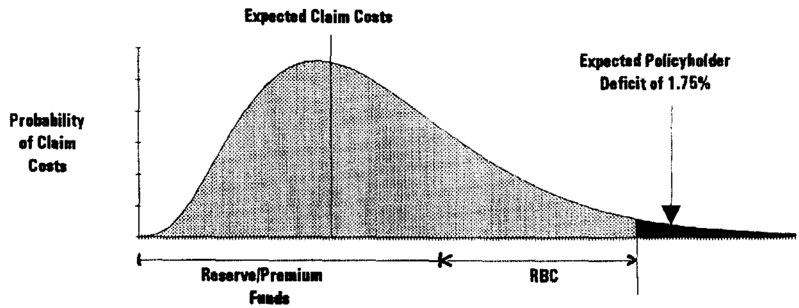
We measured the variability for each line by studying the variation in industry experience over time, and also the variation in individual company experience from the industry. The total variability for the line is the combination of the two.

Once the shape of the probability distribution has been estimated, the risk-based capital charges can be derived. The latter is determined by:

- Selecting an acceptably small probability of insolvency, represented by the right-hand tail of the distribution.

- Determining the amount of funding already provided directly by reserve requirements and premiums.

The measurement of risk-based capital is displayed pictorially below:



As was discussed in the former NAIC Actuarial Advisory Committee's Conceptual Framework, dated February 1992, risk-based capital requirements must consider the potential costs of insolvencies, as well as their probabilities. They developed the concept of the Expected Policyholder Deficit (EPD) as a way to consistently assess insolvency risk. For each different risk (e.g., investment, credit, reserve, etc.) the net risk capital charges should be set high enough so that the expected cost of insolvency due to that risk is reduced to an acceptably low level. The principal advantage of the EPD approach is that each risk (and each line of business) is given consistent risk-capital treatment.

The recommended risk-based capital charges were selected to achieve (approximately) an Expected Policyholder Deficit equal to 1.75% of expected claim liabilities. The 1.75% EPD standard was chosen arbitrarily; it appears to produce total risk-based capital for the primary insurance industry that is roughly equal to that produced by the current charges. The standard can easily be raised or lowered during the testing phase, as the overall formula is "calibrated."

Note that in the diagram above, reserve/premium funding is intentionally not equal to expected costs. This illustrates the point that conservatism in the chosen accounting standard can create implicit capital requirements in addition to explicit requirements set through the risk-based capital formula. The most significant items in this area are:

- The requirement that loss and LAE liabilities be recorded at their full, undiscounted value creates an implicit capital margin equal to the difference between the full and discounted value.

- The requirement that acquisition costs be fully expensed without any offsetting reduction in the unearned premium reserve creates a similar implicit capital margin.

Our recommended alternative risk-based capital factors reflect the presence of these implicit capital margins, inherent in statutory accounting.

Consideration must also be given to any bias in the reserves or premiums. Bias is a statistical term that measures the extent to which an estimate differs from the true ultimate value of an unknown quantity. If the estimate consistently overstates or understates the true value, it is said to be biased.

First, our starting point was the same as that underlying the current factors: historical industry experience.

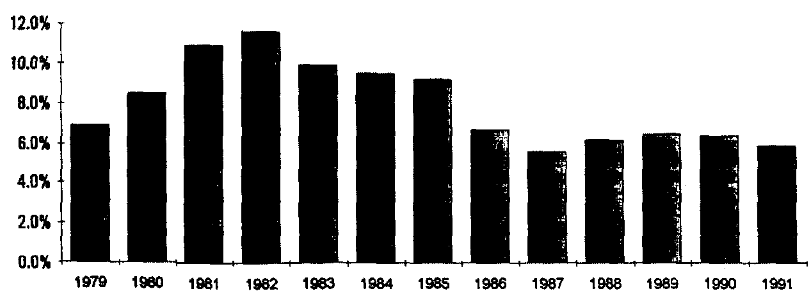
Using a database of Schedule P data purchased from A.M. Best, we analyzed the historical experience of the industry over the ten year period from 1982 to 1991. (Thus, our analysis is a year more recent than underlies the current factors.) As was done by the Working Group, we segregated the experience of the reinsurers from the primary insurers (we used A.M. Best's classification of companies to do this). We also used the same approach as the Working Group to construct approximate ten-year histories for the 2-year property lines, and the non-proportional reinsurance lines.

Second, rather than using a flat 5% interest rate, we varied the rate based on prevailing interest rates during the historical period.

The current factors are based on nominal reserve development and nominal loss ratios. Separately, credit for the time value of money is given using a constant 5% interest rate. This approach overlooks the correlation between the level of interest rates and industry underwriting experience. Intuitively, it makes sense that during periods of high interest rates loss ratios will be higher, because market considerations force companies to set their prices in anticipation of investment income. Since high interest rates often occur during high inflation periods, it also makes sense that reserve development will be worse during periods of high interest rates. Industry experience over the last ten years generally supports both of these hypotheses.

In our review of historical reserve development, we compared the held reserves at each year end to the present value of the actual payments against those reserves through 12/91, plus the present value of projected payments beyond that point. In these calculations, we used a *dynamic* interest rate. The rate applicable to each accident year was set equal to the average prevailing rate on 5-year U.S. treasuries, less 2%. For the older years, the interest rates are relatively high; for the more recent years they are roughly comparable to the 5% rate that is currently employed in the draft RBC formula. The chart below displays the accident year interest rates calculated in this manner.

Accident Year Interest Rates - Five Year Treasuries Less 2%



The intent of this approach was to compare the true economic cost of the liabilities to the industry's reserve provision for them. The chart below illustrates these calculations for the Commercial Multiperil line.

Industry Historical Reserve Adequacy - Commercial Multiperil

	YEAR ENDING									
	12/82	12/83	12/84	12/85	12/86	12/87	12/88	12/89	12/90	12/91
(1) Industry Carried Reserves	5,712	6,545	7,834	9,813	11,877	13,762	15,566	17,872	19,932	21,728
(2) Current (12/91) Implied Reserves										
(a) Nominal	7,738	9,523	11,253	12,881	13,904	15,121	16,449	18,865	20,169	21,728
(b) Discount Factor	0.749	0.767	0.776	0.783	0.803	0.825	0.835	0.845	0.843	0.852
(c) Present Value	5,793	7,308	8,733	10,087	11,170	12,476	13,740	15,938	17,000	18,503
(3) Deficiency/(Redundancy)										
(a) Nominal	2,026	2,978	3,419	3,068	2,027	1,359	883	993	237	0
(b) Present Value	81	763	899	274	(707)	(1,286)	(1,826)	(1,934)	(2,932)	(3,225)
(c) Nominal Percent	35.5%	45.5%	43.6%	31.3%	17.1%	9.9%	5.7%	5.6%	1.2%	0.0%
(d) Present Value Percent	1.4%	11.7%	11.5%	2.8%	-6.0%	-9.3%	-11.7%	-10.8%	-14.7%	-14.8%

Parallel calculations were performed on accident year losses to measure underwriting risk. The present value of losses and loss adjustment expenses were compared to the loss portion of the premium for each accident year. These calculations are illustrated for the Commercial Multiperil line in the following chart.

Industry Historical Premium Adequacy - Commercial Multiperil

	ACCIDENT YEAR									
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
(1) Industry Premiums	6,437	6,671	7,268	9,592	13,582	15,753	16,583	16,545	16,869	16,610
(2) Underwriting Expense Ratio	0.371	0.371	0.371	0.371	0.371	0.371	0.371	0.371	0.371	0.371
(3) Loss Portion of Premium	4,049	4,196	4,572	6,033	8,543	9,909	10,431	10,407	10,611	10,448
(4) Current (12/91) Indicated Losses										
(a) Nominal	5,542	6,360	7,367	8,109	7,650	8,326	9,391	11,447	11,458	11,929
(b) Discount Factor	0.835	0.845	0.845	0.849	0.876	0.892	0.887	0.888	0.877	0.895
(c) Present Value	4,626	5,375	6,225	6,882	6,705	7,424	8,329	10,160	10,054	10,676
(5) Deficiency/(Redundancy)										
(a) Nominal	1,494	2,164	2,795	2,075	(893)	(1,583)	(1,039)	1,040	847	1,482
(b) Present Value	577	1,179	1,653	848	(1,838)	(2,485)	(2,102)	(247)	(556)	228
(c) Nominal Percent	36.9%	51.6%	61.1%	34.4%	-10.5%	-16.0%	-10.0%	10.0%	8.0%	14.2%
(d) Present Value Percent	14.3%	28.1%	36.2%	14.1%	-21.5%	-25.1%	-20.2%	-2.4%	-5.2%	2.2%

The details of both of these sets of calculations for each line of business are presented in Appendix A.

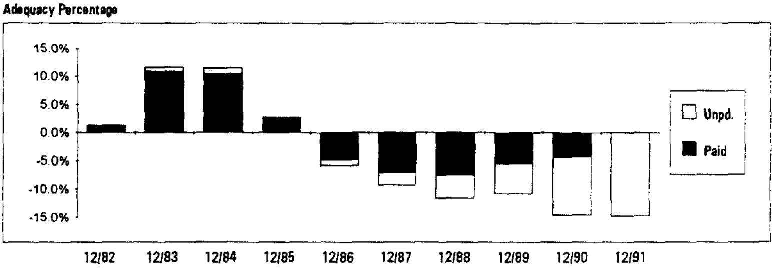
Third, we feel the best measure of risk is one that looks at the variability in results, not at their absolute level.

As has already been noted, the current reserve and underwriting risk factors focus on the "worst-case" level of industry experience. For Commercial Multiperil, the worst year of reserve development (as reported through 12/91) was December, 1983 when reserves were 45.5% inadequate on a nominal basis and 11.7% inadequate on a present value basis. The worst year for underwriting was 1984 when the loss ratio was 101.4%. In that year, industry premiums were inadequate by 61.1% of losses on a nominal basis and 36.2% of losses on a present value basis.

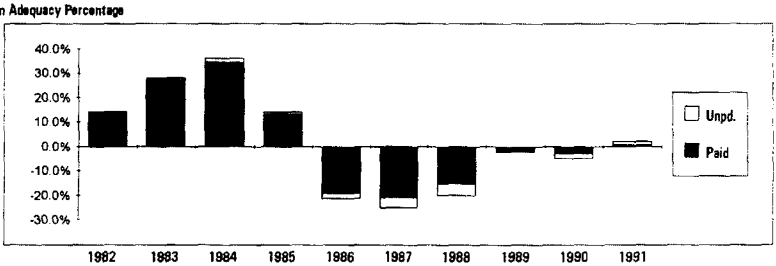
We believe that risk is more appropriately measured by analyzing the *variability* of results (statistically, the standard deviation), rather than their absolute level. The latter has been influenced by the particular circumstances of the last underwriting down-cycle. Using reserve and underwriting variability measures is also consistent with the approaches used to develop charges for other risk-capital elements. For example, the stock risk factor is based on a variability measure, rather than the worst-case decline in the stock market. Also, it should be recognized that the historical deficiencies *are* included in the variability calculations. The variability in Commercial Multiperil results is displayed graphically below.

Variability in Reserve and Premium Adequacy - Commercial Multiperil

Reserve Adequacy Percentage



Premium Adequacy Percentage



(The shading of the bars reflect the proportion of losses that are *paid* (and therefore known) as of 12/91.)

The results of our analysis of industry risk are summarized on Exhibit 1. For each line, we have computed both the mean reserve and premium deficiency, and the standard deviation of those deficiencies. Both statistics have been computed on a simple and a weighted basis; in the latter case the weights are the percentage of losses that are actually paid as of 12/91. The weighted statistics have the advantage of giving greater credence to the more mature years, where the experience is more certain.

In reviewing Exhibit 1, several observations are noteworthy:

- During the entire ten year period, aggregate industry reserves were *never inadequate* on an economic basis. At their weakest point, December 1984, the economic margin was only 4.2%, but it was positive.

- During the entire ten year period, aggregate industry rates were inadequate in four of the ten years. In 1984, premiums were inadequate on an economic basis by roughly 10%.

- Over the ten year period, the average economic margin in the loss reserves was about 12%, as compared to an expected margin of about 20% based on the payouts and interest rates that prevailed. One could tentatively conclude from this that on average roughly 40% (8% of 20%) of the intended margin is taken up by an inherent bias towards optimistic estimates in the reserve setting process.

- Over the ten year period, the average margin in the premiums was a profit of about 1.5%, suggesting that they exhibit a small positive bias over the long run.

- Finally, a comparison of the combination of the by line standard deviations (labeled Primary, Reinsurance and Industry "Total" on the Exhibit) to the standard deviations of calculations performed on the all-lines composites shows the value of diversifying across lines of business. The overall industry result is only half as variable as the average of the by-line variability.

In addition to variability of industry results, there is also the risk that an individual company will vary from the industry.

Industry results can be expected to vary from year to year, due to cycles, catastrophes and changing economic conditions. In addition, individual companies can be expected to vary from the industry result. To measure "company" risk, we ran identical calculations to those we did for the industry on each company group for the 1985 year. (1985 was chosen because it is the most mature year in the 1991 Schedule P for which the company's growth over the prior three years can be observed. Other studies suggest that rapid growth contributes to risk, and we therefore wanted to be able to isolate companies that were growing rapidly from those that were not.) Because the 1985 results were particularly adverse, the actual results calculated for each company group were re-scaled to reflect "normal" results for the industry. The results of these calculations were used to generate distributions of company results about the industry mean result, which were then used to measure "company" variability.

Our analysis of company variation about the industry mean is illustrated in the charts on the next four pages for the Commercial Multiperil line. (Similar exhibits are displayed for each line of business in Appendix B.) Previous studies have shown that company size and rate of growth affect risk. Accordingly, we segmented the total population of companies by both criteria. Generally, the company variation data confirms that:

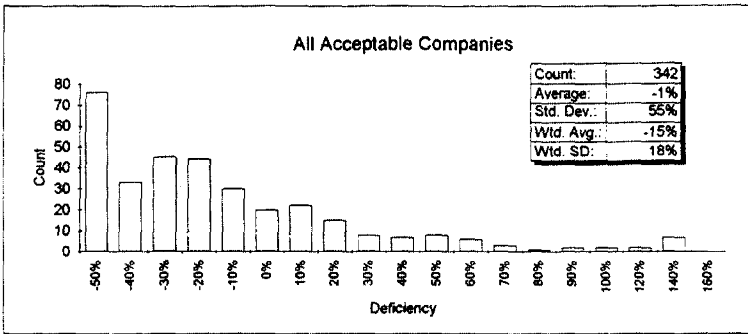
- Small companies (those with premium or reserves under $50-million) have more volatile results than large companies.

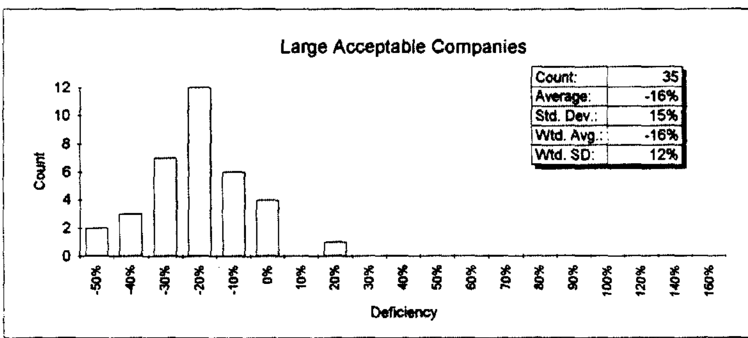
- Rapidly growing companies (those with three-year average premium growth above 10%) have worse results than stable companies.

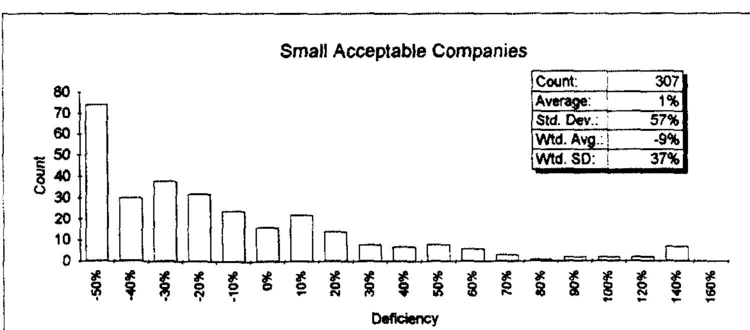
For each population of companies, we computed simple and weighted means and standard deviations. (Here the weights are the reserves or premiums of the company.) Our results are summarized in Exhibit 2.

Commercial Multiple Peril

Present Value Reserve Deficiency Analysis

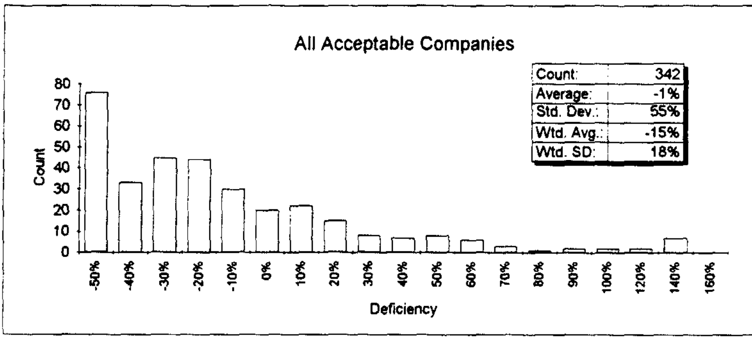


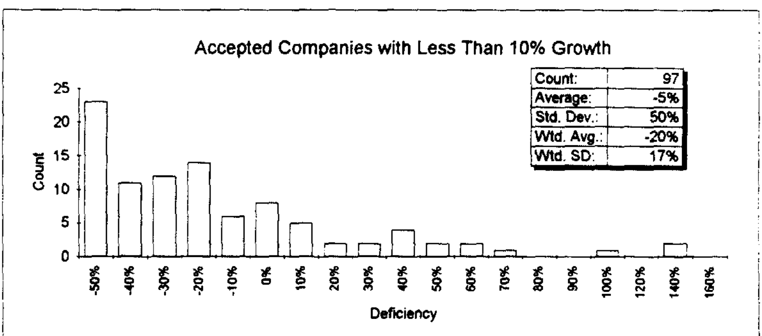


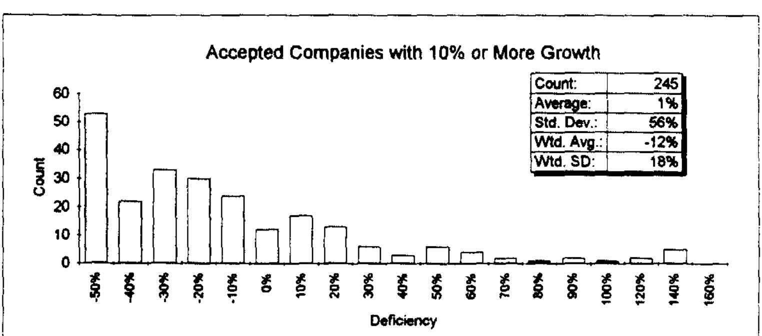


Commercial Multiple Peril

Present Value Reserve Deficiency Analysis

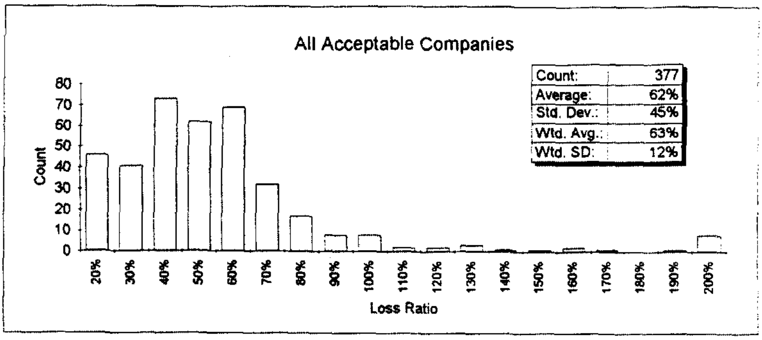


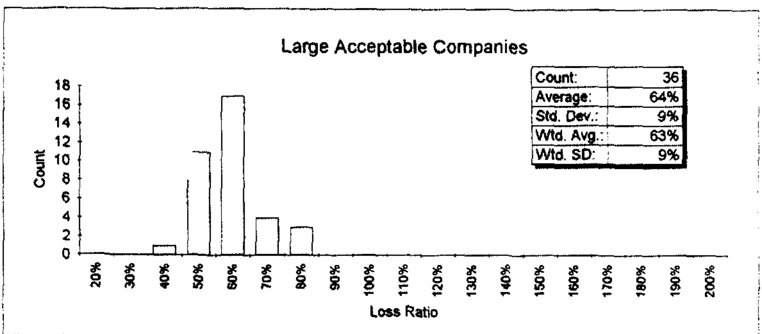


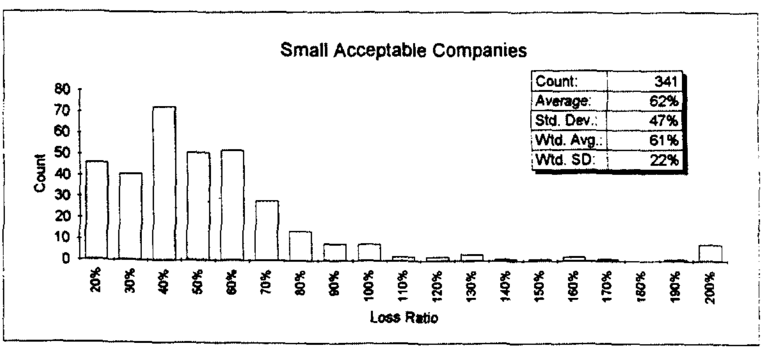


Commercial Multiple Peril

Present Value Loss Ratio Analysis

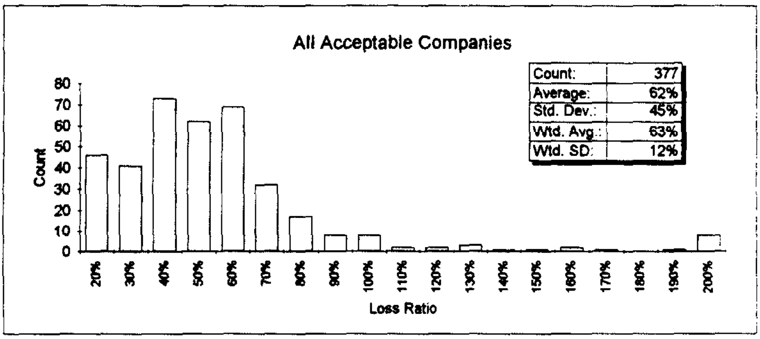


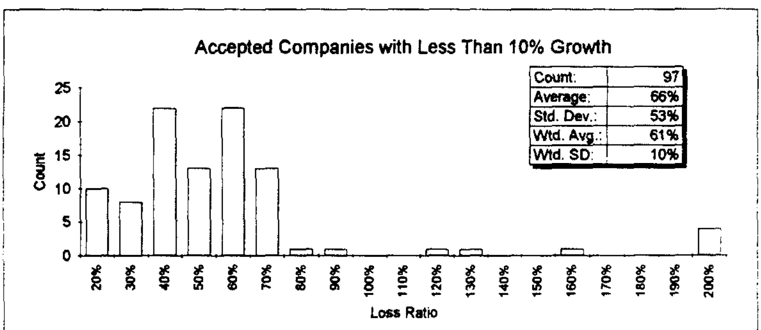


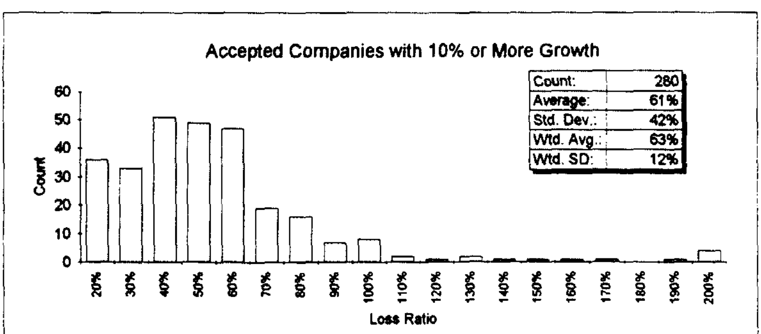


Commercial Multiple Peril

Present Value Loss Ratio Analysis







(Note that the standard deviations on the preceding two pages, and in Appendix B, are the standard deviations of the loss and ALAE ratios. Ultimately, we chose to measure underwriting risk as the standard deviation of the adequacy of the loss and LAE portion of the premium. This necessitated an adjustment to the Appendix B results, to account for underwriting and unallocated loss adjustment expenses. This adjustment is reflected in the standard deviations in Exhibit 2.)

The total risk a company faces is a combination of "industry" risk and "company" risk.

The "industry" risk measures and "company" risk measures calculated for each line in Appendices A and B are summarized in Exhibit 3. As a next step, the two sources of risk are combined to produce an indicated total risk for each line. Finally, from the total risk an indicated total funding level is calculated at various Expected Policyholder Deficit levels.

Working across Exhibit 3 from left to right:

- The "industry" risk standard deviations reflect the observed variation of industry results over time. Both simple and weighted standard deviations are shown, along with a standard deviation that is a 50-50 weighting of the weighted standard deviation for the line and the weighted standard deviation for the industry total. The latter reflects the lack of full credibility that should be attached to the individual line data.

  The "selected" industry risk standard deviations are based on the 50-50 weighted standard deviation, except where a judgmental selection was required by special circumstances. Those situations are noted below:

  - For Products and General Liability, the selections reflect the composite indications and a selected 1% differential. These lines were split for the first time with the 1992 Annual Statement. Companies were required to construct the entire ten year histories at that time, requiring allocations of bulk reserves and other adjustments. While the data suggests that Products Liability is riskier, we feel that the individual line data is probably distorted by misallocations and other data problems. These distortions would tend to overstate the risk of the lines.

- For International, the selected standard deviations are weighted averages of the primary and reinsurer indications. Since this business is virtually all reinsurance, we do not believe that the risk factors for this line should vary by type of company.

- For Property Reinsurance (A&C), we selected the standard deviations judgmentally, by reference to the other lines. The data for this line is "inferred" by subtracting the casualty lines from the Schedule P summary. We do not believe the resulting data produces an entirely credible result.

- For Casualty Reinsurance (D), we selected the standard deviation of the Reinsurance (B) line; since Reinsurance (D) is in runoff, ten years of data does not exist. Also, by the time the risk-based capital formula is implemented, all that will realistically be left in Reinsurance (D) will be casualty reinsurance.

- For Homeowners underwriting risk, we selected a higher standard deviation because we believe that the ten year period used is not fully indicative of the catastrophe risk that exists in this line. Preliminary calculations based on estimates for the 1992 accident year produce an eleven year standard deviation of 22.7%, which probably overstates the risk.

- The "company" risk standard deviations reflect the observed variations of company results from the industry. As was noted earlier, small companies exhibit greater variation than large companies. This difference is accounted for by the explicit inclusion of a size charge applicable to small companies in the RBC formula. The basic risk charges need, therefore, only account for the variation observed among large companies. The exhibit shows the simple standard deviations for large companies and the weighted standard deviations for all companies. While the former statistic is technically better, it sometimes reflects too small a sample of companies to be fully credible. In such circumstance, the weighted standard deviation is an acceptable alternative.

As was the case with "industry" risk, we relied on the 50-50 weighted standard deviations, in all but a few instances:

- For Products and General Liability, the selections are based on the Composite results, for the reason noted earlier.

- For Medical Malpractice reserve risk, the selected standard deviation reflects a downward adjustment in recognition that the year-end 1985 reserves, on which the "company" risk is based, reflect a greater proportion of occurrence business than is currently the case. As will be seen later, occurrence business appears to have greater reserve risk than claims-made business.

- For International, the "company" risk standard deviations are selected judgmentally as no credible data was available.

- The total risk for each line is calculated by combining the selected industry and company risk measures, using a "square-root rule." Such an approach inherently assumes independence between industry and company variation.

- Finally, the total measures of risk are used to calculate total funding requirements (a lognormal statistical distribution was assumed) at three different confidence levels. The total funding represents the margin above expected (present value) losses that is required to reduce the expected policyholder deficit cost to an acceptably low level. For example, on the selected risk measures, Homeowners loss and loss expense liabilities require a 24.1% margin above their expected present value in order to reduce the EPD cost to 2%.

We have developed separate reserve and underwriting risk factors for claims-made and occurrence policies.

The historical database used to develop measures of reserve and underwriting risk reflect a combination of claims-made and occurrence policy forms for the commercial liability lines.

Intuitively, the claims-made form should pose less reserve and underwriting risk because only the cost of reported claims must be estimated.

Unfortunately, it is not possible to segregate the ten years of historical Schedule P experience between claims-made and occurrence business in our database. In Exhibit 4, Sheets 2 and 3, a comparison of available experience for Medical Malpractice is presented. That experience shows clearly that, based on rough measures of variability, claims-made is significantly less risky than occurrence business. In reviewing the experience, however, it is apparent that much of the difference between the claims-made and the occurrence standard deviations is attributable to the extremely poor occurrence experience in 1982-1984. During that period, some companies discounted their loss reserves and/or their rates substantially; their experience may be distorting the comparison.

On Sheet 1 of Exhibit 4, we have developed separate risk measures and funding requirements for each policy form. The calculations parallel those on Exhibit 3. We have selected a risk relativity for claims-made of 80% of occurrence. While the data on Sheets 2 and 3 indicate a lower relativity, we believe the 80% factor is appropriate. The experience on Sheets 2 and 3 is very limited, and should therefore not be treated as fully credible. The 80% relativity produces risk factors that are consistent with the risk factors for other lines. For example, the claims-made risk factors are generally higher than the personal lines factors, while the occurrence factors are generally lower than the casualty reinsurance factors.

The total required funding must be compared to the funding already available from reserves and premiums to determine the appropriate risk-based capital charges.

In Exhibit 5, the total funding requirements derived in Exhibits 3 and 4 are converted to risk-based capital charges applicable to reserves and written premium.

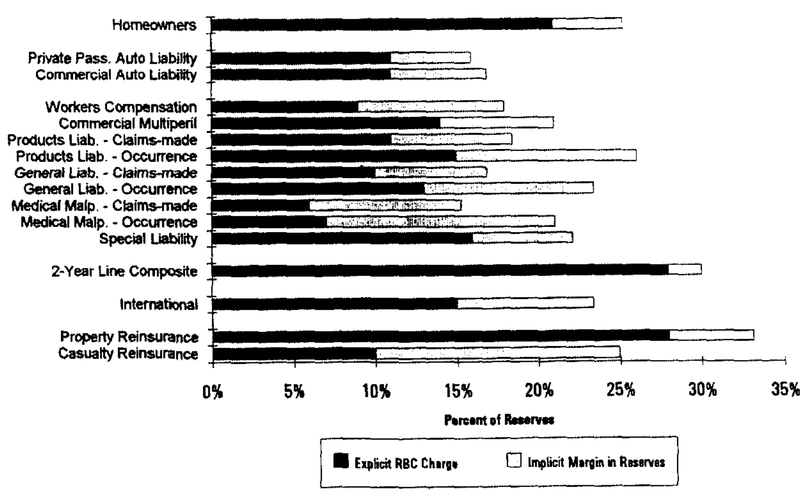
Sheet 1 presents calculations relating to reserve risk. The total funding requirements have been reduced by the implicit margins inherent in the use of full value loss reserves.

As was noted in a previous section, the industry reserves have historically shown a bias towards underestimating the full ultimate liabilities. For whatever reason, optimism in the reserve estimates has, historically, absorbed roughly 40% of the full value margin. In calculating risk-based capital charges, we have assumed that this situation will continue to exist, crediting only 60% of the full value reserve margin.

In evaluating the resulting reserve risk charges this adjustment must be kept in mind. The "long tail" lines do exhibit greater reserve risk. However, they also have the largest implicit margin already built into them. This explains the apparently anomalous results, where in some cases the risk charges are smaller for the long tail lines than the short tail lines.

The chart below summarizes the total reserve risk capital (explicit and implicit) by line, based on the selected reserve risk charges.

Total Reserve Risk Margins



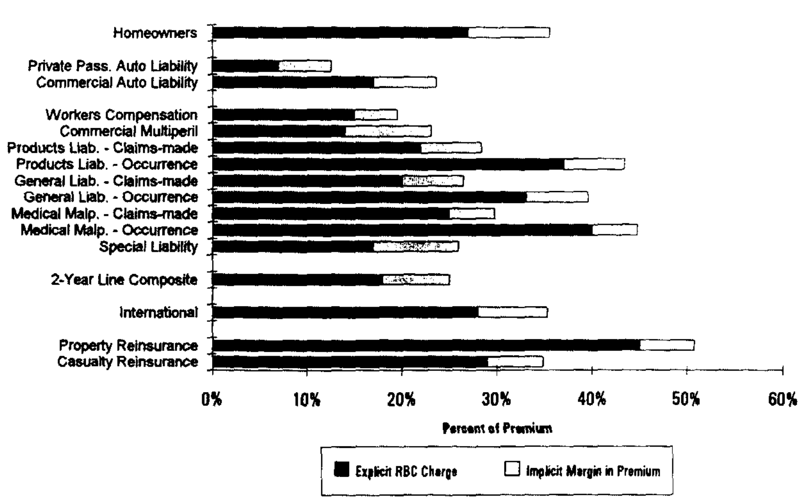
Sheet 2 presents calculations relating to underwriting risk. Premiums include provision for underwriting expenses, profit margins and expected claim costs. As was indicated previously, the industry average profit margin over the last ten years was roughly 1.5% of premium. The total funding requirements have been reduced by this margin.

In addition, the funding for unearned premiums have been reduced for prepaid acquisition expenses. These have been assumed to be roughly 2/3 of underwriting expenses.

Finally, it should be noted that the derived risk-based capital factors have been calculated to apply to written premium only, but include provision for unearned as well as written premium risk.

The chart below summarizes that total underwriting risk capital (explicit and implicit) by line, based on the selected underwriting risk charges.

Total Underwriting Risk Margins



The indicated risk-based capital charges were run through the Premium-to-Surplus ratio model. The results were used to make the final selections.

As a final test of the risk-based capital charges, the indicated charges of all three Expected Policyholder Deficit standards were run through the Premium-to-Surplus ratio model. Based on the results, which are presented in Exhibits 6 and 7, the recommended alternative factors were finally selected. As was noted earlier, the final selections are designed to produce roughly the same total risk-based capital for the primary industry as do the current factors.

Lastly, the exhibits on the next five pages compare the amounts of risk-based capital generated by each component of the formula for each line of business. For comparative purposes, all of the dollar amounts have been expressed as a percentage of earned premium. For each line, the amounts generated by the recommended factors are compared to the amounts generated by the current factors.

As we have already noted, the results of our Premium-to-Surplus ratio model depend heavily on a specific set of assumptions. These fall in three major areas:

- *The other components in the RBC formula*

  We have assumed that the factors for credit risk and investment risk will not change from those in the current draft formula. We have used the covariance adjustment recommended in our recent report of February, 1993.

- *The allocation of other assets and liabilities to line of business*

  The model requires that assets, other than invested assets, be allocated to line of business. Other assets include premium balances, reinsurance recoverables, EDP equipment, and other receivables. Similarly, all liabilities must be allocated to line of business.

- *The mix of invested assets by class*

  We have assumed an industry average mix of invested assets. Specifically, we have assumed the following mix of invested assets.

Bonds	81.9%
Other Fixed	2.4
Subtotal	84.4
Common Stock	12.0
Other Non-Fixed	3.6
Subtotal	15.6
Total	100.0%

In addition, the model does not account for all elements of the current formula. It does not consider

- size charges applicable to small insurers
- growth charges applicable to companies experiencing rapid growth
- charges for investments in affiliates
- the effect of the line concentration adjustment in the covariance calculation
- the net effect (positive or negative) of adjustments for individual company experience in the reserve and underwriting risk calculations
- the net effect of individual company variations in expense ratio
- risk-based capital on any actual surplus in excess of the risk-based capital requirement
- asset concentration factors

Failure to account for these formula elements causes our model to *understate* the total risk-based capital generated by the formula. We have estimated that understatement to be on the order of 15 to 20%, based on other test results of the full formula applied to individual companies. The chart on the following page summarizes the estimated differences by component.

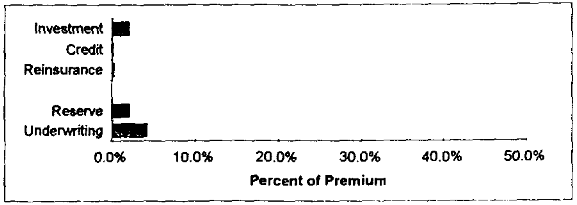
	Premium to Surplus Model	Company Detail Calculations	Difference	Reason for Difference
Reserve Risk Capital	37,499	37,979	480	Company experience adjustments
Written Premium Risk Capital	38,462	42,319	3,857	Company experience and expenses
Other Asset Risk Capital	1,021	1,021	0	
Reinsurance Risk Capital	5,817	5,817	0	
Investment Risk Capital	17,254	22,052	4,798	Assets in excess of required assets
Affiliate Risk Capital	0	22,901	22,901	Not included in P/S model
Size/Growth Risk Capital	0	2,490	2,490	Not included in P/S model
Total Before Covaraince	100,053	134,579	34,526	
Covariance Adjustment	-43,413	-63,928	-20,515	Line concentration, company vs. industry
Net Risk-Based Capital	56,640	70,651	14,011	

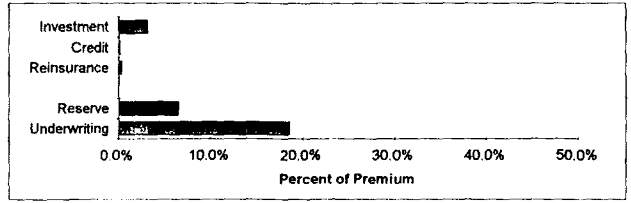
Additional details on the Premium-to-Surplus ratio model can be found in Appendix C.

Risk-Based Capital Components

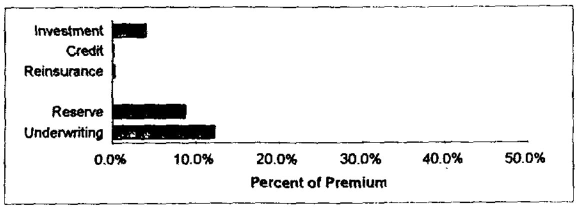
Current	***Proposed***

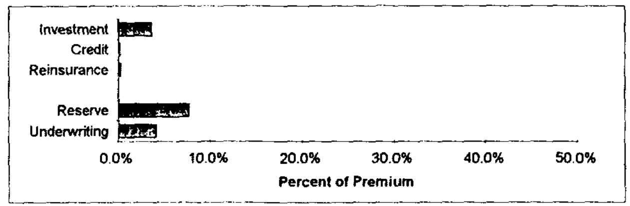
Homeowners/Farmowners



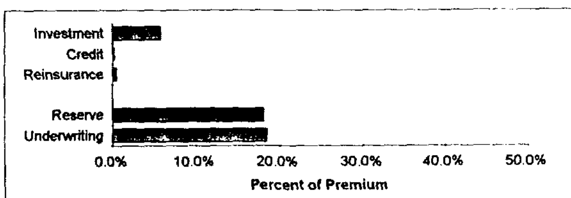


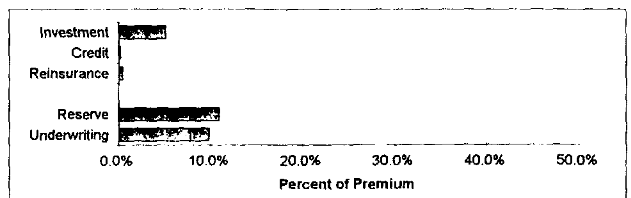
Private Passenger Auto Liability





Commercial Auto Liability





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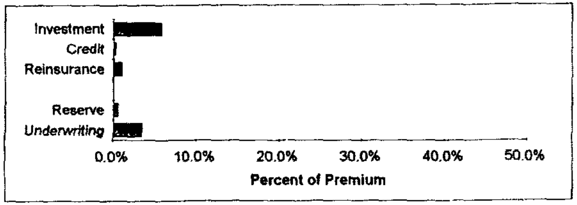
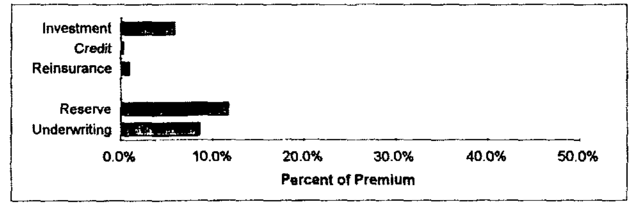
Risk-Based Capital Components

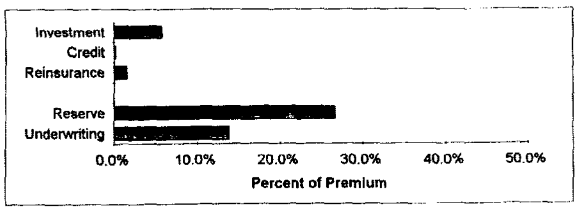
Current	*Proposed*

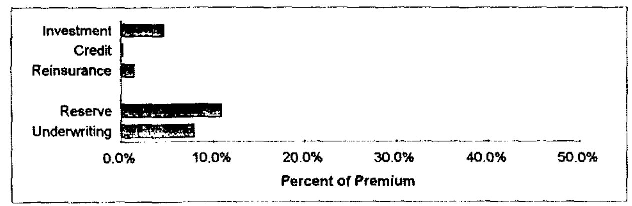
Workers Compensation



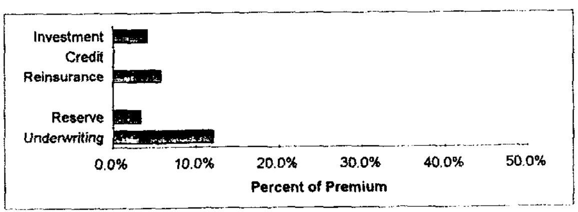


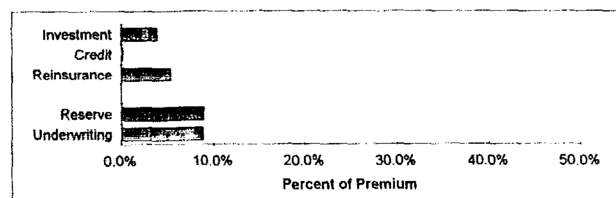
Commercial Multiperil





Special Liability

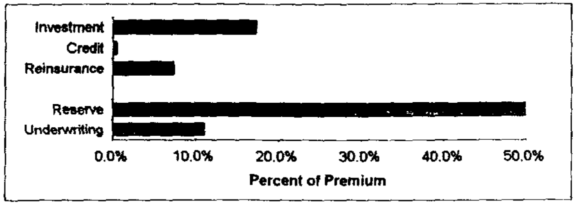


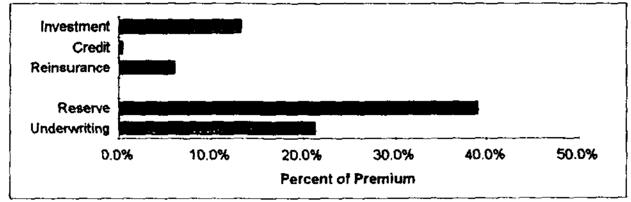


Risk-Based Capital Components

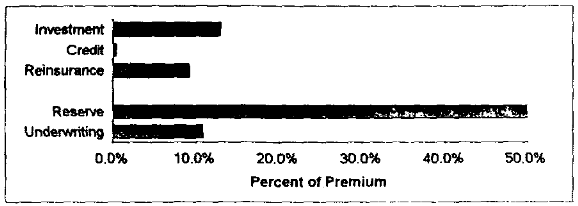
Current | ***Proposed***

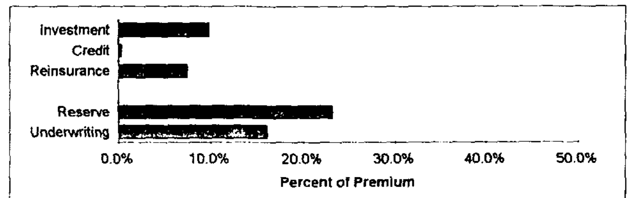
Products Liability: Composite



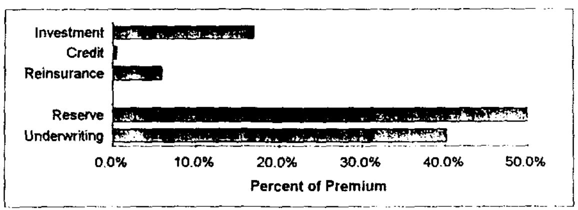


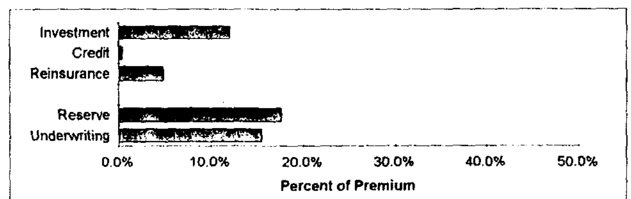
General Liability: Composite





Medical Malpractice: Composite





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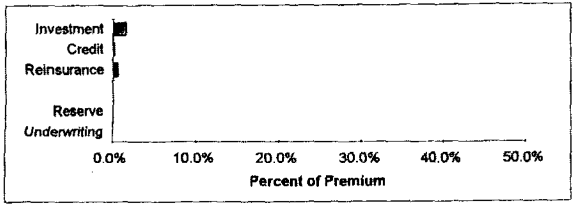
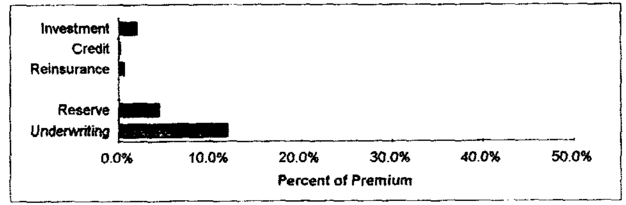
Risk-Based Capital Components

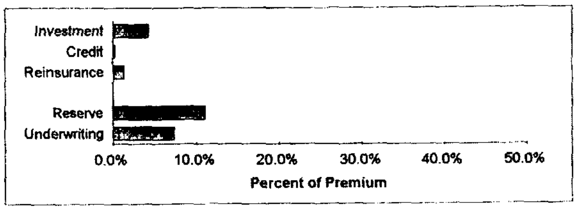
Current	***Proposed***

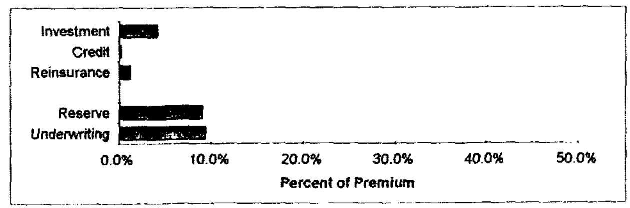
2-Year Line Composite





Primary - All Lines

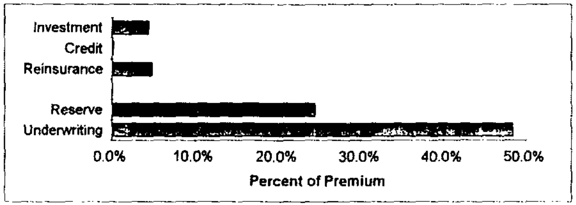


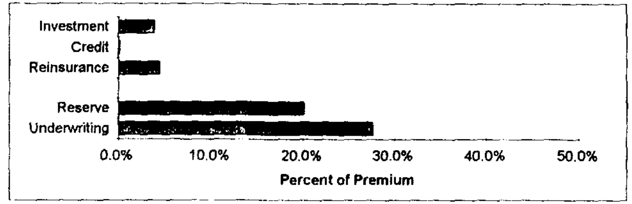


Risk-Based Capital Components

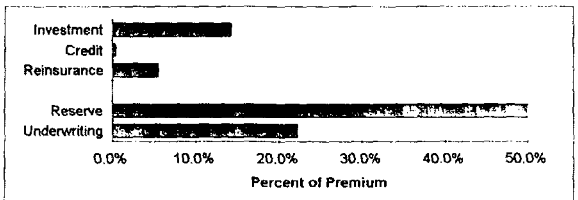
Current | ***Proposed***

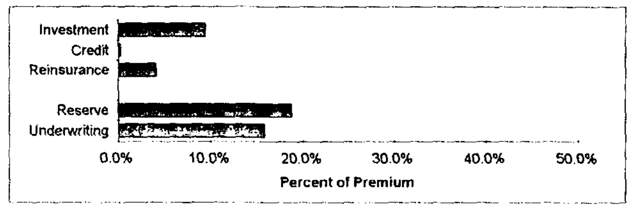
Property Reinsurance (A+C)



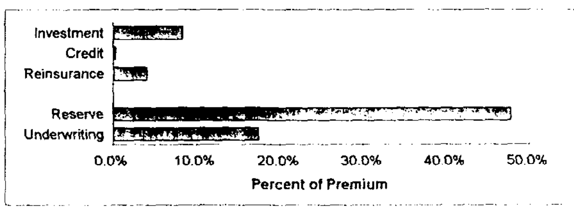


Casualty Reinsurance: Composite





Reinsurers - All Lines



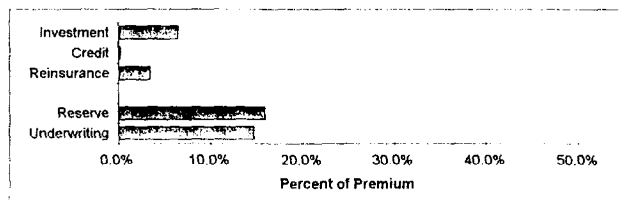


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Exhibit 1
Sheet 1

Risk-Based Capital - Analysis of "Industry" Reserve Risk

Present Value Reserve Deficiency (Redundancy) as Percentage of Held Loss & LAE Reserves

	YEAR ENDING										Simple Average	Weighted Average	Standard Deviation	Weighted Deviation
	12/82	12/83	12/84	12/85	12/86	12/87	12/88	12/89	12/90	12/91				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Homeowners/Farmowners	-5.2%	6.5%	0.7%	-3.3%	-13.1%	-11.0%	-11.8%	-9.2%	-13.2%	-8.7%	-6.8%	-6.0%	6.2%	6.6%
Private Passenger Auto Liability	-18.5%	-16.2%	-11.0%	-9.6%	-10.3%	-10.6%	-11.4%	-11.3%	-11.7%	-9.6%	-12.0%	-12.4%	2.8%	3.0%
Commercial Auto Liability	-8.2%	-3.3%	0.1%	0.2%	-4.5%	-7.9%	-9.2%	-11.0%	-12.2%	-11.5%	-6.8%	-5.4%	4.4%	4.1%
Workers Compensation	-31.3%	-25.6%	-20.2%	-15.4%	-13.8%	-13.1%	-12.4%	-11.5%	-11.2%	-12.4%	-16.7%	-18.3%	6.5%	6.9%
Commercial Multiperil	1.4%	11.7%	11.5%	2.8%	-6.0%	-9.3%	-11.7%	-10.8%	-14.7%	-14.8%	-4.0%	-0.6%	9.6%	9.2%
Products Liability	28.7%	23.6%	20.2%	14.3%	-0.6%	-8.7%	-16.3%	-21.4%	-20.0%	-21.1%	-0.1%	7.5%	19.1%	17.5%
General Liability	8.6%	16.8%	21.2%	9.4%	-6.0%	-15.6%	-19.6%	-21.0%	-21.5%	-20.9%	-4.9%	1.5%	16.3%	15.4%
Composite	12.4%	18.2%	21.0%	10.4%	-5.0%	-14.3%	-19.0%	-21.1%	-21.2%	-20.9%	-4.0%	2.7%	16.7%	15.7%
Medical Malpractice	-9.3%	-9.0%	-8.5%	-26.9%	-34.4%	-37.4%	-39.8%	-34.7%	-30.5%	-23.7%	-25.4%	-22.4%	11.7%	12.8%
Special Liability	-22.8%	-11.2%	-11.9%	-10.9%	-12.2%	-13.6%	-13.4%	-7.1%	-12.9%	-14.6%	-13.1%	-13.1%	3.8%	4.1%
2-Year Line Composite	-28.0%	-20.5%	-17.7%	-22.5%	-25.4%	-28.3%	-27.8%	-24.4%	-25.8%	-4.3%	-22.5%	-24.3%	6.9%	3.6%
International Primary	-6.5%	8.7%	5.7%	-4.5%	-6.8%	-4.1%	-4.0%	-3.4%	-7.3%	-16.0%	-3.8%	-1.9%	6.5%	5.9%
Primary Total													**8.2%**	**8.0%**
Primary Composite	**-14.6%**	**-9.1%**	**-5.7%**	**-8.2%**	**-12.7%**	**-15.3%**	**-16.7%**	**-16.0%**	**-16.1%**	**-14.0%**	**-12.8%**	**-12.1%**	**3.6%**	**3.8%**
Property Reinsurance (A&C)	-50.2%	-45.7%	-31.3%	-17.0%	-17.0%	-8.3%	-3.4%	-3.9%	-6.7%	-9.3%	-19.3%	-23.5%	16.4%	17.3%
Casualty Reinsurance (B)	-8.7%	6.7%	12.8%	2.6%	-13.9%	-23.3%	-29.0%	-29.2%	-27.7%	-28.5%	-13.8%	-7.4%	15.5%	14.7%
Casualty Reinsurance (D)	1.2%	13.7%	18.3%	15.2%	-6.2%	-19.8%					3.7%	5.0%	13.6%	12.8%
Composite	-2.6%	11.0%	16.0%	9.7%	-9.7%	-21.5%	-26.2%	-27.0%	-26.3%	-27.4%	-10.4%	-3.3%	16.8%	15.6%
International Reinsurance	-25.0%	-6.7%	-23.1%	-17.6%	-20.0%	0.0%	-12.5%	20.0%	-7.8%	-15.3%	-10.8%	-10.5%	12.6%	13.4%
Reinsurance Total													**16.7%**	**15.8%**
Reinsurance Composite	**-8.0%**	**4.9%**	**10.8%**	**6.9%**	**-10.4%**	**-20.3%**	**-24.6%**	**-25.3%**	**-24.9%**	**-26.2%**	**-11.7%**	**-6.2%**	**14.0%**	**13.1%**
Industry Total													**9.0%**	**8.7%**
Industry Composite	**-14.0%**	**-7.8%**	**-4.2%**	**-6.8%**	**-12.6%**	**-15.9%**	**-17.5%**	**-16.8%**	**-16.9%**	**-15.1%**	**-12.8%**	**-11.7%**	**4.5%**	**4.7%**

Exhibit 1
Sheet 2

Risk-Based Capital - Analysis of "Industry" Underwriting Risk

Present Value Premium Deficiency (Redundancy) as Percentage of Loss and LAE Portion of Premium

	ACCIDENT YEAR										Simple Average	Weighted Average	Standard Deviation	Weighted Deviation
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Homeowners/Farmowners	4.6%	4.7%	3.2%	10.3%	-3.8%	-7.7%	-3.9%	16.3%	9.9%	21.6%	5.5%	4.9%	8.8%	8.4%
Private Passenger Auto Liability	-2.5%	2.9%	10.3%	12.9%	11.6%	11.1%	10.7%	12.7%	13.1%	10.9%	9.4%	9.0%	4.8%	5.1%
Commercial Auto Liability	12.0%	27.2%	40.3%	24.1%	0.8%	-2.5%	0.4%	6.2%	5.3%	6.8%	12.1%	13.8%	13.2%	14.2%
Workers Compensation	-24.2%	-11.7%	1.0%	0.3%	-2.0%	-2.6%	-1.6%	0.0%	0.1%	1.2%	-4.0%	-4.9%	7.6%	8.2%
Commercial Multiperil	14.3%	28.1%	36.2%	14.1%	-21.5%	-25.1%	-20.2%	-2.4%	-5.2%	2.2%	2.1%	3.8%	20.0%	21.2%
Products Liability	-9.3%	13.4%	22.9%	-0.8%	-29.6%	-39.3%	-33.0%	-24.8%	-17.7%	-8.2%	-12.6%	-7.6%	19.2%	21.0%
General Liability	3.8%	21.5%	35.4%	9.3%	-29.9%	-32.5%	-27.6%	-22.0%	-19.1%	-16.9%	-7.8%	-0.9%	22.5%	24.2%
Composite	1.3%	19.9%	33.2%	7.7%	-29.9%	-33.5%	-28.3%	-22.4%	-19.0%	-15.8%	-8.7%	-2.1%	21.8%	23.5%
Medical Malpractice	10.7%	21.9%	14.8%	-5.2%	-24.3%	-26.8%	-26.0%	-21.0%	-9.6%	3.7%	-6.2%	-1.6%	17.3%	18.6%
Special Liability	4.5%	18.3%	14.4%	0.5%	-11.2%	-13.2%	0.8%	17.1%	10.1%	7.2%	4.9%	4.5%	10.4%	10.7%
2-Year Line Composite	-3.7%	-3.9%	-0.6%	-4.1%	-13.2%	-16.2%	-13.9%	-6.6%	-10.6%	-9.1%	-8.2%	-8.1%	4.9%	5.0%
International Primary	-28.8%	0.0%	-35.7%	-24.3%	-15.7%	-2.6%	14.9%	13.0%	13.6%	-28.3%	-9.4%	-10.1%	18.6%	18.0%
Primary Total													**9.1%**	**9.5%**
Primary Composite	**-3.5%**	**2.6%**	**8.7%**	**5.3%**	**-7.2%**	**-9.6%**	**-7.0%**	**0.3%**	**-0.7%**	**1.7%**	**-0.9%**	**-1.0%**	**5.6%**	**5.8%**
Property Reinsurance (A&C)	-7.5%	20.6%	48.5%	27.5%	-20.8%	-25.1%	-18.4%	14.2%	-1.8%	-17.0%	2.0%	3.8%	23.3%	23.9%
Casualty Reinsurance (B)	6.8%	25.2%	35.3%	-2.4%	-33.2%	-31.6%	-27.4%	-26.0%	-24.1%	-21.3%	-9.9%	-2.0%	23.5%	25.5%
Casualty Reinsurance (D)	-0.7%	10.6%	5.5%	-10.3%	-39.6%	-41.1%					-12.6%	-10.9%	20.6%	20.1%
Composite	2.0%	16.3%	16.6%	-7.0%	-36.5%	-36.1%	-27.4%	-26.0%	-24.1%	-21.3%	-14.4%	-8.8%	19.1%	21.0%
International Reinsurance	-15.9%	0.0%	-20.8%	-42.3%	9.7%	11.3%	-20.6%	42.2%	-4.3%	-17.2%	-5.8%	-5.8%	22.1%	22.7%
Reinsurance Total													**20.0%**	**21.7%**
Reinsurance Composite	**-0.6%**	**17.3%**	**22.7%**	**-0.9%**	**-33.2%**	**-33.3%**	**-25.3%**	**-16.5%**	**-19.2%**	**-20.3%**	**-10.9%**	**-7.0%**	**18.8%**	**20.5%**
Industry Total													**9.6%**	**10.1%**
Industry Composite	**-3.4%**	**3.4%**	**9.5%**	**4.8%**	**-9.3%**	**-11.3%**	**-7.5%**	**-0.2%**	**-1.3%**	**0.9%**	**-1.4%**	**-1.4%**	**6.2%**	**6.5%**

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Notes to Exhibit 1

Column	Note
(1) to (10)	All figures shown are based on the calculations presented in Appendix A. For reserves, the figures are the percentage by which the present value of the subsequent paid claim runoff exceeds the held reserve for the particular year-end. A positive number indicates a deficiency, and a negative number indicates a redundancy in the reserves. For premiums, the figures are the percentage by which the present value of the claim payments exceeds the loss portion of the premium for the particular accident year. (The loss portion of the premium is calculated by applying the complement of the expense ratio to the full premium.) A positive number indicates a deficiency, and a negative number indicates a redundancy (profit) in the premiums.
(11)	These are the simple averages of the figures in Columns (1) through (10).
(12)	These are the weighted averages of the figures in Columns (1) through (10), where the weights for each year are the percentage of the nominal losses that are actually paid as of December 31, 1991.
(13)	These are the simple standard deviations of the figures in Columns (1) through (10). The figures labeled Primary, Reinsurance, and Industry "Total" are the weighted average of the individual line standard deviations in the column. (The weights are the total reserves and the total premium for the ten year period for each line.) The corresponding figures labeled "Composite" reflect direct calculations on data summarized to that level.
(14)	These are the weighted standard deviations, calculated in a manner consistent with the weighted mean.

Exhibit 2
Sheet 1

Risk-Based Capital - Analysis of "Company" Reserve Risk

Present Value Reserve Deficiency (Redundancy) as Percentage of Held Reserves
Year-End 1985 Reserves

	All Companies					Large Companies					Small Companies				
	Number of Companies	Simple Average	Standard Deviation	Weighted Average	Weighted Deviation	Number of Companies	Simple Average	Standard Deviation	Weighted Average	Weighted Deviation	Number of Companies	Simple Average	Standard Deviation	Weighted Average	Weighted Deviation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Homeowners/Farmowners	394	-7.0%	40.0%	-9.0%	23.0%	21	-10.0%	11.0%	-9.0%	10.0%	373	-7.0%	41.0%	-10.0%	35.0%
Private Passenger Auto Liability	360	7.0%	45.0%	-10.0%	14.0%	71	-7.0%	19.0%	-10.0%	12.0%	289	10.0%	49.0%	-4.0%	26.0%
Commercial Auto Liability	300	-2.0%	49.0%	-12.0%	14.0%	38	-12.0%	11.0%	-12.0%	9.0%	262	-1.0%	52.0%	-11.0%	28.0%
Workers Compensation	281	-3.0%	45.0%	-12.0%	15.0%	57	-10.0%	18.0%	-13.0%	14.0%	224	-1.0%	49.0%	-6.0%	34.0%
Commercial Multiperil	342	-1.0%	55.0%	-15.0%	18.0%	35	-16.0%	15.0%	-16.0%	12.0%	307	1.0%	57.0%	-9.0%	37.0%
Products Liability	147	-7.0%	64.0%	-21.0%	29.0%	22	-20.0%	30.0%	-22.0%	25.0%	125	-5.0%	68.0%	-17.0%	51.0%
General Liability	412	-16.0%	48.0%	-21.0%	20.0%	48	-21.0%	21.0%	-21.0%	17.0%	364	-15.0%	51.0%	-19.0%	39.0%
Composite	416	-16.0%	48.0%	-21.0%	18.0%	55	-24.0%	18.0%	-21.0%	15.0%	361	-15.0%	51.0%	-18.0%	40.0%
Medical Malpractice	134	6.0%	61.0%	-22.0%	26.0%	40	-13.0%	38.0%	-23.0%	25.0%	94	15.0%	67.0%	0.0%	38.0%
Special Liability	123	-1.0%	54.0%	-14.0%	21.0%	9	-17.0%	15.0%	-17.0%	14.0%	114	0.0%	56.0%	-11.0%	26.0%
2-Year Line Composite	489	3.0%	58.0%	-2.0%	28.0%	42	0.0%	30.0%	2.0%	23.0%	447	3.0%	60.0%	37.0%	63.0%
International Primary	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Primary Total					**17.7%**			**19.6%**							
Primary Composite	**756**	**-7.0%**	**40.0%**	**-14.0%**	**14.0%**	**177**	**-14.0%**	**23.0%**	**-14.0%**	**13.0%**	**579**	**-5.0%**	**44.0%**	**-9.0%**	**31.0%**
Property Reinsurance (A&C)	61	-7.0%	50.0%	-11.0%	33.0%	6	-1.0%	38.0%	-10.0%	34.0%	55	-7.0%	51.0%	-14.0%	28.0%
Casualty Reinsurance (B)	75	-13.0%	37.0%	-27.0%	18.0%	20	-29.0%	17.0%	-30.0%	14.0%	55	-7.0%	40.0%	-5.0%	28.0%
Casualty Reinsurance (D)	48	0.0%	53.0%	-24.0%	24.0%	12	-9.0%	38.0%	-25.0%	21.0%	36	3.0%	57.0%	0.0%	55.0%
International Reinsurance	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Reinsurance Total					**21.7%**			**27.5%**							
Reinsurance Composite	**92**	**-10.0%**	**44.0%**	**-25.0%**	**19.0%**	**32**	**-24.0%**	**19.0%**	**-27.0%**	**14.0%**	**60**	**-3.0%**	**51.0%**	**0.0%**	**42.0%**
Industry Total					**18.0%**			**20.4%**							
Industry Composite	**897**	**-7.0%**	**44.0%**	**-15.0%**	**15.0%**	**202**	**-15.0%**	**23.0%**	**-15.0%**	**13.0%**	**695**	**-5.0%**	**48.0%**	**-7.0%**	**36.0%**

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Exhibit 2
Sheet 2

Risk-Based Capital - Analysis of "Company" Underwriting Risk

Present Value Premium Deficiency (Redundancy) as Percentage of Loss and LAE Portion of Premium
1985 Accident Year

	All Companies					Large Companies					Small Companies				
	Number of Companies	Simple Average	Standard Deviation	Weighted Average	Weighted Deviation	Number of Companies	Simple Average	Standard Deviation	Weighted Average	Weighted Deviation	Number of Companies	Simple Average	Standard Deviation	Weighted Average	Weighted Deviation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Homeowners/Farmowners	437	-0.3%	33.7%	-0.3%	11.7%	51	-1.8%	13.2%	-0.3%	10.3%	386	-0.3%	35.2%	1.2%	19.1%
Private Passenger Auto Liability	367	6.4%	43.4%	-0.1%	10.5%	69	2.5%	11.8%	-0.1%	9.2%	298	6.4%	47.3%	2.5%	23.7%
Commercial Auto Liability	314	-2.7%	52.9%	0.1%	21.5%	31	1.6%	14.3%	1.6%	15.7%	283	-4.1%	55.8%	-4.1%	34.3%
Workers Compensation	278	-5.0%	42.6%	-0.1%	14.6%	46	-1.3%	15.8%	1.1%	12.2%	232	-5.0%	46.3%	-3.8%	28.0%
Commercial Multiperil	377	-1.4%	71.5%	0.2%	19.1%	36	1.7%	14.3%	0.2%	14.3%	341	-1.4%	74.7%	-3.0%	35.0%
Products Liability	162	-14.9%	79.7%	0.0%	43.2%	9	10.8%	39.2%	14.9%	36.5%	153	-16.2%	81.1%	-14.9%	44.6%
General Liability	430	-11.3%	65.5%	-0.4%	32.7%	25	2.3%	30.0%	1.0%	31.4%	405	-12.7%	66.8%	-4.5%	39.6%
Composite	434	-11.5%	64.0%	-0.6%	30.0%	28	0.8%	24.5%	2.1%	27.2%	406	-12.8%	66.7%	-6.0%	39.5%
Medical Malpractice	110	7.0%	77.3%	-0.1%	23.8%	12	-2.5%	17.8%	-3.7%	13.1%	98	8.2%	80.9%	7.0%	34.5%
Special Liability	124	11.5%	53.2%	-0.2%	31.6%	10	-3.5%	23.3%	-5.2%	30.0%	114	13.1%	54.9%	6.5%	34.9%
2-Year Line Composite	573	-5.0%	53.7%	3.3%	22.0%	94	3.3%	31.7%	3.3%	17.9%	479	-6.3%	57.9%	-2.2%	39.9%
International Primary	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Primary Total			**50.6%**		**17.9%**			**19.8%**		**14.8%**			**54.0%**		**31.6%**
Primary Composite	**820**	**-5.9%**	**38.2%**	**0.9%**	**13.6%**	**191**	**-1.8%**	**21.8%**	**0.9%**	**10.9%**	**629**	**-7.3%**	**42.3%**	**-4.6%**	**32.7%**
Property Reinsurance (A&C)	67	-13.2%	52.1%	0.1%	32.0%	6	-2.5%	13.4%	5.5%	14.7%	61	-14.6%	53.4%	-11.9%	46.7%
Casualty Reinsurance (B)	74	5.5%	38.7%	0.1%	24.0%	14	0.1%	20.0%	-1.2%	21.4%	60	6.8%	41.4%	6.8%	30.7%
Casualty Reinsurance (D)															
International Reinsurance	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Reinsurance Total			**42.9%**		**26.5%**			**17.9%**		**19.3%**			**45.1%**		**35.7%**
Reinsurance Composite	**93**	**10.8%**	**77.4%**	**0.1%**	**33.4%**	**28**	**1.5%**	**18.7%**	**-1.2%**	**21.4%**	**65**	**14.8%**	**92.1%**	**13.5%**	**76.1%**
Industry Total			**50.3%**		**18.2%**			**19.8%**		**15.0%**			**53.7%**		**31.8%**
Industry Composite	**1021**	**-6.1%**	**49.0%**	**-0.6%**	**15.0%**	**215**	**-2.0%**	**21.8%**	**0.8%**	**12.3%**	**806**	**-7.4%**	**53.1%**	**-4.7%**	**39.5%**

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Notes to Exhibit 2

Column	Note
(1) to (15)	All figures shown are based on calculations presented in Appendix B.
(1) to (5)	These are the results for all company groups, excluding groups with immaterial (i.e., less than $50,000) reserves or premium in the line, and also excluding groups with anomalous or unusual Schedule P presentations.
(6) to (10)	These are the results for large groups, those with more than $50-million in reserves at year-end 1985 for the line, or more than $50-million in premium in calendar year 1985 for the line.
(11) to (15)	These are the results for small groups, those not qualifying as large under the criteria above.
(1), (6), (11)	These are the number of groups included in the experience for each line and the number in each sub-population.
(2), (7), (12)	For reserves, the figures are the percentage by which the average company's present value claim runoff exceeds their held reserve for year-end 1985. For underwriting, the figures are the percentage by which the average company's present value claim payments exceeds the loss and LAE portion of their premium for accident year 1985. In both cases, the figures are simple averages for the companies in each population.
(3), (8), (13)	These are the simple standard deviations of the individual group results about the average. The figures labeled Primary, Reinsurance and Industry "Total" are the weighted average of the individual line standard deviations in the column. The corresponding figures labeled "composite" reflect direct calculations on data summarized to that level.
(4), (9), (14)	These are the weighted averages of the individual company group results for the line. For reserves, the weights are the year-end 1985 held reserves for the line of each group. For underwriting, the weights are the 1985 earned premium for the line of each group.
(5), (10), (15)	These are the weighted standard deviations, calculated in a manner consistent with the weighted averages.

Risk-Based Capital - Analysis of Reserve Risk

Summary of Risk Measures and Calculation of Total Risk Funding Requirements

	"Industry" Reserve Risk				"Company" Reserve Risk				Total	Required Total Funding (Percent of Expected PV Losses)		
	Standard *Deviation*	Weighted *Std. Dev.*	50 / 50 *Line/Industry*	Selected *Std. Dev.*	Large *Std. Dev.*	Weighted *Std. Dev.*	50 / 50 *Line/Industry*	Selected *Std. Dev.*	Reserve *Risk*	*3% EPD*	*2% EPD*	*1% EPD*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Homeowners/Farmowners	6.2%	6.6%	7.6%	7.6%	11.0%	23.0%	20.5%	20.5%	21.9%	117.9%	124.1%	134.1%
Private Passenger Auto Liability	2.8%	3.0%	5.8%	5.8%	19.0%	14.0%	16.0%	16.0%	17.0%	110.7%	115.4%	123.0%
Commercial Auto Liability	*4.4%*	*4.1%*	*6.4%*	*6.4%*	*11.0%*	*14.0%*	*16.0%*	*16.0%*	*17.2%*	*110.9%*	*115.7%*	*123.4%*
Workers Compensation	6.5%	6.9%	7.8%	7.8%	18.0%	15.0%	16.5%	16.5%	18.3%	112.4%	117.5%	125.6%
Commercial Multiperil	9.6%	9.2%	8.9%	8.9%	15.0%	18.0%	18.0%	18.0%	20.1%	115.1%	120.8%	129.8%
Products Liability	*19.1%*	*17.5%*	--	*13.0%*	*30.0%*	*29.0%*	--	*18.8%*	*22.9%*			
General Liability	16.3%	15.4%	--	12.0%	21.0%	20.0%	--	17.8%	21.5%			
Composite	16.7%	15.7%	12.2%	--	18.0%	18.0%	18.0%	--				
Medical Malpractice	11.7%	12.8%	10.8%	10.8%	38.0%	26.0%	22.0%	16.0%	19.3%			
Special Liability	3.8%	4.1%	6.4%	6.4%	15.0%	21.0%	19.5%	19.5%	20.5%	115.8%	121.6%	130.9%
2-Year Line Composite	6.9%	3.6%	6.1%	6.1%	30.0%	28.0%	23.0%	23.0%	23.8%	121.2%	128.0%	139.0%
International Primary	6.5%	5.9%	7.3%	7.8%	--	--	--	20.0%	21.5%	117.3%	123.3%	133.1%
Primary Total	**8.2%**	**8.0%**	**8.3%**	**8.3%**	**19.6%**	**17.7%**	**17.9%**	**17.3%**	**19.4%**	**114.2%**	**119.6%**	**128.3%**
Primary Composite	**3.6%**	**3.8%**		**3.8%**	**23.0%**	**14.0%**		**14.0%**	**14.6%**			
Property Reinsurance (A&C)	16.4%	17.3%	13.0%	11.0%	38.0%	33.0%	25.5%	23.0%	25.5%	124.1%	131.5%	143.5%
Casualty Reinsurance (B)	*15.5%*	*14.7%*	*11.7%*	*12.2%*	*17.0%*	*18.0%*	*18.0%*	*19.4%*	*22.9%*	*119.7%*	*126.2%*	*136.8%*
Casualty Reinsurance (D)	13.6%	12.8%	10.8%	12.2%	38.0%	24.0%	21.0%	19.4%	22.9%	119.7%	126.2%	136.8%
Composite	16.8%	15.6%	12.2%	--	--	--	--	--				
International Reinsurance	12.6%	13.4%	11.1%	7.8%	--	--	--	20.0%	21.5%	117.3%	123.3%	133.1%
Reinsurance Total	**16.7%**	**15.8%**	**12.2%**	**12.1%**	**27.5%**	**21.7%**	**19.9%**	**19.7%**	**23.1%**	**120.1%**	**126.6%**	**137.3%**
Reinsurance Composite	**14.0%**	**13.1%**		**13.1%**	**19.0%**	**19.0%**		**19.0%**	**23.1%**			
Industry Total	**9.0%**	**8.7%**	**8.7%**	**8.7%**	**20.4%**	**18.0%**	**18.0%**	**17.6%**	**19.7%**	**114.7%**	**120.3%**	**129.2%**
Industry Composite	**4.5%**	**4.7%**		**4.7%**	**23.0%**	**15.0%**		**15.0%**	**15.7%**			

Exhibit 3
Sheet 2

Risk-Based Capital - Analysis of Underwriting Risk

Summary of Risk Measures and Calculation of Total Risk Funding Requirements

	"Industry" Underwriting Risk				"Company" Underwriting Risk				Total	Required Total Funding (Percent of Expected PV Losses)		
	Standard Deviation	Weighted Std. Dev.	50 / 50 Line/Industry	Selected Std. Dev.	Large Std. Dev.	Weighted Std. Dev.	50 / 50 Line/Industry	Selected Std. Dev.	U/W Risk	3% EPD	2% EPD	1% EPD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Homeowners/Farmowners	8.8%	8.4%	9.3%	17.0%	13.2%	11.7%	15.0%	23.0%	28.6%	129.9%	138.4%	152.4%
Private Passenger Auto Liability	4.8%	5.1%	7.6%	7.6%	11.8%	10.5%	14.4%	14.4%	16.3%	109.6%	114.2%	121.4%
Commercial Auto Liability	13.2%	14.2%	12.2%	12.2%	14.3%	21.5%	19.8%	19.8%	23.3%	120.2%	126.8%	137.6%
Workers Compensation	7.6%	8.2%	9.1%	9.1%	15.8%	14.6%	16.4%	16.4%	18.8%	113.1%	118.4%	126.8%
Commercial Multiperil	20.0%	21.2%	15.7%	15.7%	14.3%	19.1%	18.7%	18.7%	24.4%	122.2%	129.2%	140.6%
Products Liability	19.2%	21.0%	--	16.8%	39.2%	43.2%	--	24.9%	30.0%			
General Liability	22.5%	24.2%	--	16.8%	30.0%	32.7%	--	23.9%	29.2%			
Composite	21.8%	23.5%	16.8%	--	24.5%	30.0%	24.1%	--				
Medical Malpractice	17.3%	18.6%	14.3%	14.3%	17.8%	23.8%	21.0%	21.0%	25.4%			
Special Liability	10.4%	10.7%	10.4%	10.4%	23.3%	31.6%	24.9%	24.9%	27.0%	126.8%	134.7%	147.7%
2-Year Line Composite	4.9%	5.0%	7.6%	11.0%	31.7%	22.0%	20.1%	20.1%	22.9%	119.7%	126.2%	136.7%
International Primary	18.6%	18.0%	14.1%	15.2%	--	--	--	22.0%	26.7%	126.4%	134.2%	147.1%
Primary Total	**9.1%**	**9.5%**	**9.8%**	**11.6%**	**19.8%**	**17.9%**	**18.1%**	**18.9%**	**22.2%**	**119.0%**	**125.4%**	**135.7%**
Primary Composite	**5.6%**	**5.8%**		**5.8%**	**21.8%**	**13.6%**		**13.6%**	**14.8%**			
Property Reinsurance (A&C)	23.3%	23.9%	17.0%	23.0%	13.4%	32.0%	25.1%	25.1%	34.0%	141.0%	151.6%	169.5%
Casualty Reinsurance (B)	23.5%	25.5%	17.8%	17.8%	20.0%	24.0%	21.1%	21.1%	27.6%	128.0%	136.1%	149.6%
Casualty Reinsurance (D)	20.6%	20.1%	15.1%	--	--	--	--	--				
Composite	19.1%	21.0%	15.6%	--	--	--	--	--				
International Reinsurance	22.1%	22.7%	16.4%	15.2%	--	--	--	22.0%	26.7%	126.4%	134.2%	147.1%
Reinsurance Total	**20.0%**	**21.7%**	**15.9%**	**19.4%**	**17.9%**	**26.5%**	**22.4%**	**22.3%**	**29.6%**	**132.0%**	**140.9%**	**155.8%**
Reinsurance Composite	**18.8%**	**20.5%**		**20.6%**	**18.7%**	**33.4%**		**33.4%**	**39.1%**			
Industry Total	**9.6%**	**10.1%**	**10.1%**	**11.9%**	**19.8%**	**18.2%**	**18.2%**	**19.0%**	**22.5%**	**119.4%**	**125.9%**	**136.4%**
Industry Composite	**6.2%**	**6.5%**		**6.5%**	**21.8%**	**15.0%**		**15.0%**	**16.3%**			

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Notes to Exhibit 3

Column	Note
(1)	These figures are taken from Exhibit 1, Column (13).
(2)	These figures are taken from Exhibit 1, Column (14).
(3)	These are the average of the figure for the line in Column (2) and the figure for the industry total in Column (2). This inherently dampens the variation in by-line results, reflecting the lack of full credibility that can be attached to the individual line data.
(4)	These are the selected standard deviations for "industry" risk.
(5)	These figures are taken from Exhibit 2, Column (8).
(6)	These figures are taken from Exhibit 2, Column (5).
(7)	These are the average of the figure for the line in Column (6) and the figure for the industry total in Column (6).
(8)	These are the selected standard deviations for "company" risk.
(9)	The total risk for each line is calculated by taking the square root of the sum of the squares of the figures in Columns (4) and (8).
(10), (11), (12)	These are calculated using a lognormal distribution. The coefficient of variation of the distribution is assumed to be the total risk measure in Column (9). The figures are the ratio to the mean that reduces the expected cost of claims above that ratio to the percentage shown at the top of the column.

Exhibit 4
Sheet 1

Risked-Based Capital - Claims-Made vs. Occurrence Risk

Summary of Risk Measures and Calculation of Total Risk Funding Requirements

		Reserve Risk						Underwriting Risk					
					Required Total Funding (Percent of Expected PV Losses)						Required Total Funding (Percent of Expected PV Losses)		
		Historical Mix	Selected Relativity	Total Risk	3% EPD	2% EPD	1% EPD	Historical Mix	Selected Relativity	Total Risk	3% EPD	2% EPD	1% EPD
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Products Liability -	Claims-Made	0.09	0.80	18.6%	112.9%	118.1%	126.5%	0.12	0.80	24.6%	122.5%	129.6%	141.2%
	Occurrence	0.91	1.00	23.3%	120.2%	126.9%	137.7%	0.88	1.00	30.8%	134.2%	143.5%	159.0%
	Composite	1.00	0.98	22.9%	--	--	--	1.00	0.98	30.0%	--	--	--
General Liability -	Claims-Made	0.04	0.80	17.3%	111.0%	115.9%	123.6%	0.07	0.80	23.7%	121.0%	127.7%	138.8%
	Occurrence	0.96	1.00	21.6%	117.5%	123.7%	133.6%	0.93	1.00	29.6%	131.9%	140.8%	155.6%
	Composite	1.00	0.99	21.5%	--	--	--	1.00	0.99	29.2%	--	--	--
Medical Malpractice -	Claims-Made	0.34	0.80	16.6%	110.0%	114.6%	122.0%	0.54	0.80	22.8%	119.4%	125.9%	136.4%
	Occurrence	0.66	1.00	20.7%	116.1%	121.9%	131.3%	0.46	1.00	28.5%	129.6%	138.1%	152.1%
	Composite	1.00	0.93	19.3%	--	--	--	1.00	0.89	25.4%	--	--	--

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Exhibit 4
Sheet 2

Risked-Based Capital - Claims-Made vs. Occurrence Reserve Risk

Indicated Medical Malpractice Loss Development Ratios
Claims-Made vs. Occurrence
(thousands)

	Composite *			Claims-Made			Non Claims-Made		
Accident Year	Initial Incurred Loss & LAE	Current Incurred Loss & LAE	Ratio	Initial	Current	Ratio	Initial	Current	Ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1982	$815,636	$894,943	1.097	$474,438	$406,353	0.856	$341,197	$488,590	1.432
1983	938,348	1,112,720	1.186	579,553	559,487	0.965	358,795	553,233	1.542
1984	1,080,338	1,239,837	1.148	639,019	646,006	1.011	441,319	593,831	1.346
1985	1,410,165	1,435,803	1.018	835,582	770,486	0.922	574,583	665,317	1.158
1986	1,782,508	1,481,340	0.831	1,124,093	861,601	0.766	658,415	619,739	0.941
1987	1,929,778	1,522,023	0.789	1,414,713	1,080,410	0.764	515,065	441,613	0.857
1988	1,977,188	1,668,878	0.844	1,540,351	1,260,153	0.818	436,837	408,725	0.936
1989	2,083,910	1,833,491	0.880	1,608,752	1,430,285	0.889	475,158	403,206	0.849
1990	2,156,834	2,051,294	0.951	1,678,813	1,571,209	0.936	478,021	480,085	1.004
Average Loss Development			0.972			0.881			1.118
Std. Dev. of Loss Development			0.147			0.087			0.262
Indicated Relativity of Claims-Made Risk to Occurrence Risk						33%			100%

* Based on data of 37 PIAA companies, St. Paul, and Medical Protective.

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Exhibit 4
Sheet 3

Risked-Based Capital - Claims-Made vs. Occurrence Underwriting Risk

Indicated Medical Malpractice Loss Ratios
Claims-Made vs. Occurrence
(thousands)

	Composite *			Claims-Made			Non Claims-Made		
Accident Year	Incurred Loss & LAE	Earned Premium	Loss Ratio	Incurred	Premium	Ratio	Incurred	Premium	Ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1982	$940,231	$715,556	1.314	$429,219	$420,385	1.021	$511,012	$295,171	1.731
1983	1,169,362	805,734	1.451	589,324	482,708	1.221	580,038	323,026	1.796
1984	1,312,779	959,131	1.369	681,586	597,609	1.141	631,193	361,522	1.746
1985	1,529,401	1,309,571	1.168	815,290	774,688	1.052	714,111	534,883	1.335
1986	1,565,620	1,836,875	0.852	918,954	1,149,284	0.800	646,666	687,591	0.940
1987	1,636,043	2,196,021	0.745	1,170,418	1,635,345	0.716	465,625	560,676	0.830
1988	1,802,596	2,363,521	0.763	1,371,846	1,833,811	0.748	430,750	529,710	0.813
1989	1,967,383	2,304,225	0.854	1,538,983	1,769,100	0.870	428,400	535,125	0.801
1990	2,194,585	2,124,518	1.033	1,688,609	1,654,433	1.021	505,976	470,085	1.076
Average Loss Development			1.061			0.954			1.230
Std. Dev. of Loss Development			0.274			0.178			0.429
Indicated Relativity of Claims-Made Risk to Occurrence Risk						41%			100%

* Based on data of 37 PIAA companies, St. Paul, and Medical Protective.

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Notes to Exhibit 4

Column	Note
Sheet 1: (1), (7)	The historical mixes represent an estimate of the proportion of the experience over the last ten years that was written on each policy form. The former reflects the historical mix of reserves; the latter reflects the historical mix of premiums.
Sheet 1: (2), (8)	These are selected based on the data on Sheets 2 and 3, and reference to the risk factors for the other lines of business in Exhibit 3.
Sheet 1: (3), (9)	The policy form factors reflect the selected relativity and the historical mix, and balance to the composite risk factor, which is calculated in Exhibit 3.
Sheet 1: (4) - (6) and (10) - (11)	These have been calculated in a manner analogous to Columns (10) to (12) of Exhibit 3.

Exhibit 5
Sheet 1

Risk-Based Capital - Reserve Risk

Summary of Funding Requirements and Calculation of Net RBC Charges Applicable to Reserves

		Required Total Funding (Percent of Expected PV Losses)			Loss & LAE Reserve Funding (Percent of Expected PV Losses)				Indicated RBC Funding Charge Applicable to Reserves		
		3% EPD	2% EPD	1% EPD	5% Disc. Factors	Full Value Funding	Sel. Implicit Discount	Sel. Res. Funding	3% EPD	2% EPD	1% EPD
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Homeowners/Farmowners		117.9%	124.1%	134.1%	0.928	107.8%	40.0%	104.5%	12.8%	18.7%	28.3%
Private Passenger Auto Liability		110.7%	115.4%	123.0%	0.918	108.9%	40.0%	105.2%	5.3%	9.7%	16.9%
Commercial Auto Liability		110.9%	115.7%	123.4%	0.901	111.0%	40.0%	106.3%	4.3%	8.8%	16.1%
Workers Compensation		112.4%	117.5%	125.6%	0.850	117.6%	40.0%	109.9%	2.3%	6.9%	14.3%
Commercial Multiperil		115.1%	120.8%	129.8%	0.882	113.4%	40.0%	107.6%	7.0%	12.2%	20.6%
Products Liability -	Claims-Made	112.9%	118.1%	126.5%	0.875	114.3%	40.0%	108.1%	4.4%	9.2%	17.0%
	Occurrence	120.2%	126.9%	137.7%	0.815	122.7%	40.0%	112.5%	6.9%	12.8%	22.4%
General Liability -	Claims-Made	111.0%	115.9%	123.6%	0.885	113.0%	40.0%	107.4%	3.3%	7.9%	15.1%
	Occurrence	117.5%	123.7%	133.6%	0.825	121.2%	40.0%	111.7%	5.2%	10.7%	19.6%
Medical Malpractice -	Claims-Made	110.0%	114.6%	122.0%	0.845	118.3%	40.0%	110.3%	-0.2%	3.9%	10.7%
	Occurrence	116.1%	121.9%	131.3%	0.765	130.7%	40.0%	116.4%	-0.3%	4.7%	12.8%
Special Liability		115.8%	121.6%	130.9%	0.897	111.5%	40.0%	106.6%	8.6%	14.1%	22.8%
2-Year Line Composite		121.2%	128.0%	139.0%	0.966	103.5%	40.0%	102.1%	18.7%	25.4%	36.2%
International		117.3%	123.3%	133.1%	0.859	116.4%	40.0%	109.2%	7.4%	12.9%	21.8%
Property Reinsurance (A&C)		124.1%	131.5%	143.5%	0.914	109.4%	40.0%	105.4%	17.7%	24.7%	36.1%
Casualty Reinsurance (B)		119.7%	126.2%	136.8%	0.751	133.2%	40.0%	117.6%	1.8%	7.3%	16.4%
Casualty Reinsurance (D)		119.7%	126.2%	136.8%	0.710	140.8%	40.0%	121.1%	-1.1%	4.2%	13.0%

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Risk-Based Capital - Underwriting Risk

Summary of Funding Requirements and Calculation of RBC Charges Applicable to Written Premiums

		Required Total Funding			Premium Funding (Percent of Expected PV Losses)					Indicated RBC Funding Charge Applicable to Written Premium				
		3%	2%	1%	Underwriting Expense Ratio	Selected Profit Margin	Expected Loss Ratio	Unearned Premium Funding	Written Premium Funding	Unearned Premium Weight	Written Premium Weight	3% EPD	2% EPD	1% EPD
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Homeowners/Farmowners		129.9%	138.4%	152.4%	31.8%	1.5%	66.7%	134.0%	102.2%	0.50	1.00	17.1%	25.6%	39.6%
Private Passenger Auto Liability		109.6%	114.2%	121.4%	23.9%	1.5%	74.6%	123.4%	102.0%	0.35	1.00	2.1%	6.7%	14.0%
Commercial Auto Liability		120.2%	126.8%	137.6%	30.1%	1.5%	68.4%	131.5%	102.2%	0.35	1.00	9.6%	15.7%	25.7%
Workers Compensation		113.1%	118.4%	126.8%	17.9%	1.5%	80.6%	116.7%	101.9%	0.35	1.00	8.1%	13.8%	23.0%
Commercial Multiperil		122.2%	129.2%	140.6%	37.1%	1.5%	61.4%	142.7%	102.4%	0.45	1.00	6.5%	12.7%	22.8%
Products Liability -	Claims-Made	122.5%	129.6%	141.2%	26.0%	1.5%	72.5%	126.0%	102.1%	0.40	1.00	13.8%	21.0%	32.8%
	Occurrence	134.2%	143.5%	159.0%	26.0%	1.5%	72.5%	126.0%	102.1%	0.40	1.00	25.7%	35.1%	50.9%
General Liability -	Claims-Made	121.0%	127.7%	138.8%	26.7%	1.5%	71.8%	126.9%	102.1%	0.40	1.00	11.9%	18.6%	29.8%
	Occurrence	131.9%	140.8%	155.6%	26.7%	1.5%	71.8%	126.9%	102.1%	0.40	1.00	22.8%	31.8%	46.7%
Medical Malpractice -	Claims-Made	119.4%	125.9%	136.4%	15.9%	1.5%	82.6%	114.6%	101.8%	0.45	1.00	16.3%	24.1%	36.7%
	Occurrence	129.6%	138.1%	152.1%	15.9%	1.5%	82.6%	114.6%	101.8%	0.45	1.00	28.5%	38.7%	55.5%
Special Liability		126.8%	134.7%	147.7%	39.9%	1.5%	58.6%	148.0%	102.6%	0.40	1.00	9.2%	15.7%	26.4%
2-Year Line Composite		119.7%	126.2%	136.7%	27.4%	1.5%	71.1%	127.8%	102.1%	0.45	1.00	9.9%	16.6%	27.4%
International		126.4%	134.2%	147.1%	26.2%	1.5%	72.3%	126.2%	102.1%	0.50	1.00	17.6%	26.1%	40.1%
Property Reinsurance (A&C)		141.0%	151.6%	169.5%	25.1%	1.5%	73.4%	124.8%	102.0%	0.35	1.00	32.7%	43.2%	61.0%
Casualty Reinsurance (B)		128.0%	136.1%	149.6%	25.1%	1.5%	73.4%	124.8%	102.0%	0.35	1.00	19.9%	27.9%	41.3%
Casualty Reinsurance (D)														

Notes to Exhibit 5

Column	Note
(1), (2), (3)	These figures are taken from Exhibit 3, Columns (10), (11), and (12), respectively. The claims-made and occurrence figures are taken from Exhibit 4.
Sheet 1: (4)	These are discount factors calculated using a 5% interest rate and IRS payment pattern methodology, applied to 1991 industry Schedule P data.
Sheet 1: (5)	This is the inverse of Column (4), and reflects the funding provided by full value reserves as a percentage of expected present value losses.
Sheet 1: (6)	Based on the ten years of experience reviewed, industry reserves are biased on the low side. This "implicit discounting" absorbs roughly 40% of the full value discount.
Sheet 1: (7)	The figures reflect the funding inherent in reserves that are implicitly discounted by the amount in Column (6). $(7) = 1/[1-(1-(4)) \times (1-(6))]$
Sheet 1: (8), (9), (10)	The figures represent the RBC funding required to achieve the target total funding, after account is taken of the reserve funding in Column (7). Most importantly, they are expressed as a percentage applicable to reserves, and *not* a percentage of expected present value losses. $(8) = [(1)-(7)]/(7)$ $(9) = [(2)-(7)]/(7)$ $(10) = [(3)-(7)]/(7)$
Sheet 2: (4)	These are industry underwriting expense ratios, as reported in the 1991 Insurance Expense Exhibit.
Sheet 2: (5)	Based on the ten years of experience reviewed, industry rates are biased by approximately 1.5% above expected present value costs.

Notes to Exhibit 5 (cont'd)

Column	Note
Sheet 2: (6)	This is the balance of the premium after deducting the underwriting expenses in Column (4) and the profit margin in Column (5). $(6) = (1-(4)-(5))$
Sheet 2: (7)	The figures reflect the funding inherent in the unearned premium reserve, under the assumption that 2/3 of underwriting expenses are prepaid. The figures are percentage of expected present value losses. $(7) = [(1-1/3 \bullet (4))]/(6)$
Sheet 2: (8)	The figures reflect the funding inherent in the written premium as a percent of expected present value losses. $(8) = [(1-(4))]/(6)$
Sheet 2: (9), (10)	The total funding must account for the current unearned premium and the next years written premium. The unearned premium is assumed to be the portion of the annual written premium shown in Column (9).
Sheet 2: (11), (12), (13)	The figures reflect the RBC funding required to achieve the target total funding for underwriting risk, after account is taken of the premium funding in Columns (7) and (8). Most importantly, the figures are expressed a percentage applicable to written premium *only*, and not as a percentage of expected present value losses. $(11) = [[((9)+(10)) \times (1)] - [(9)\times(7)+(10)\times(8)]] \times (6)$ $(12) = [[((9)+(10)) \times (2)] - [(9)\times(7)+(10)\times(8)]] \times (6)$ $(13) = [[((9)+(10)) \times (3)] - [(9)\times(7)+(10)\times(8)]] \times (6)$

Primary Insurers - Implied Premium-to-Surplus Ratios

		NAIC			Academy Task Force Analysis					
				Worst	Expected Policyholder Deficit			Benchmark		
		1989	1990	Year	3%	2%	1%	3:1	1:1	Selected
Homeowners/Farmowners		10.53	10.93	6.43	5.41	3.66	2.39	3.00	1.00	3.45
Private Passenger Auto Liability		4.12	3.86	8.52	11.18	6.75	3.92	3.00	1.00	6.18
Commercial Auto Liability		2.59	2.31	3.11	6.80	4.26	2.57	3.00	1.00	3.71
Workers Compensation		8.64	8.85	10.36	7.30	4.29	2.42	3.00	1.00	3.65
Commercial Multiperil		2.17	2.07	3.42	7.11	4.41	2.67	3.00	1.00	3.96
Products Liability:	Claims-Made				6.25	3.91	2.39	3.00	1.00	3.59
	Occurrence				2.37	1.44	0.87	3.00	1.00	1.27
	Composite	1.22	0.85	0.76	2.16	1.40	0.87	2.56	0.98	1.25
General Liability:	Claims-Made				5.69	3.57	2.14	3.00	1.00	3.11
	Occurrence				2.93	1.85	1.12	3.00	1.00	1.63
	Composite	1.56	1.09	1.22	2.93	1.98	1.24	2.71	0.99	1.75
Medical Malpractice:	Claims-Made				5.58	3.45	1.86	3.00	1.00	2.94
	Occurrence				3.03	1.68	0.78	3.00	1.00	1.31
	Composite	1.00	0.68	3.10	3.26	2.32	1.29	2.54	0.97	1.98
Special Liability		2.34	3.89	6.07	5.56	3.97	2.61	3.00	1.00	3.67
2-Year Line Composite		27.01	38.79	38.79	8.88	5.56	3.45	3.00	1.00	5.14
International Primary		2.52	1.73	5.96	4.19	2.75	1.74	3.00	1.00	2.48
Primary Line Composite		4.95	4.23	6.84	7.42	4.59	2.78	3.18	1.06	4.13
Property Reinsurance (A+C)		1.90	1.03	2.00	2.53	1.91	1.35	3.04	1.01	1.80
Casualty Reinsurance:	(B)	0.84	0.93	2.04	4.05	2.64	1.54	3.86	1.27	2.30
	(D)									
	Composite	0.27	0.38	0.81	2.50	1.68	0.86	1.67	0.57	1.41
International Reinsurance										
Reinsurance Line Composite		0.40	0.53	1.16	2.71	1.82	1.02	2.08	0.71	1.58
Industry Composite		4.71	4.09	6.69	7.36	4.56	2.76	3.18	1.06	4.10

[PRIMARY.XLW]Premium to Surplus Results 2/18/93

Exhibit 6
Sheet 2

Reinsurers - Implied Premium-to-Surplus Ratios

		NAIC		Worst	Academy Task Force Analysis					
					Expected Policyholder Deficit			Benchmark		
		1989	1990	Year	3%	2%	1%	3:1	1:1	Selected
Homeowners/Farmowners		10.46	10.89	6.46	5.37	3.63	2.36	2.97	0.99	3.41
Private Passenger Auto Liability		4.16	3.92	8.41	11.14	6.90	4.04	3.05	1.02	6.34
Commercial Auto Liability		2.66	2.39	3.09	6.82	4.38	2.68	3.12	1.05	3.85
Workers Compensation		6.03	6.08	6.53	5.22	3.12	1.74	2.12	0.71	2.60
Commercial Multiperil		2.57	2.46	3.68	8.18	5.04	3.03	3.30	1.09	4.54
Products Liability:	Claims-Made				3.66	2.36	1.42	1.61	0.56	2.09
	Occurrence				0.92	0.62	0.39	0.96	0.42	0.55
	Composite	0.51	0.36	0.32	0.94	0.63	0.40	0.98	0.43	0.56
General Liability:	Claims-Made				5.43	3.52	2.14	2.99	1.01	3.09
	Occurrence				2.81	1.83	1.13	2.88	1.02	1.62
	Composite	1.64	1.13	1.27	3.18	2.07	1.28	2.93	1.02	1.83
Medical Malpractice:	Claims-Made				5.06	3.55	2.19	3.93	1.40	3.24
	Occurrence				2.63	1.86	1.05	3.21	1.44	1.61
	Composite	1.29	0.95	3.77	4.03	2.85	1.70	3.81	1.43	2.55
Special Liability		2.13	3.43	5.14	4.00	2.82	1.85	2.27	0.76	2.57
2-Year Line Composite		12.29	22.88	22.88	6.25	4.27	2.79	2.80	0.94	3.92
International Primary										
Primary Line Composite		4.38	3.91	5.07	5.64	3.65	2.29	3.00	1.01	3.29
Property Reinsurance (A+C)		1.87	1.21	2.40	2.51	1.89	1.34	3.00	1.00	1.77
Casualty Reinsurance:	(B)	0.88	0.99	2.10	4.13	2.71	1.60	4.06	1.33	2.37
	(D)									
	Composite	0.56	0.70	1.51	3.66	2.39	1.33	3.00	1.00	2.05
International Reinsurance		2.62	1.81	3.95	4.82	3.24	2.08	3.00	1.00	2.97
Reinsurance Line Composite		0.67	0.81	1.78	3.46	2.29	1.35	3.10	1.02	2.01
Industry Composite		1.10	1.28	2.54	4.27	2.77	1.67	3.14	1.04	2.45

[REINS.XLW]Premium to Surplus Ratios 2/18/93

Net Risk-Based Capital Reserve Charges

		NAIC		Academy Task Force Analysis						
				Worst	Expected Policyholder Deficit			Benchmark		
		1989	1990	Year	3%	2%	1%	3:1	1:1	Selected
Homeowners/Farmowners		0.092	0.086	0.065	0.128	0.187	0.283	0.211	0.635	0.210
Private Passenger Auto Liability		0.104	0.121	-0.096	0.053	0.097	0.169	0.170	0.520	0.110
Commercial Auto Liability		0.133	0.172	0.001	0.043	0.088	0.161	0.141	0.435	0.110
Workers Compensation		-0.036	0.005	-0.154	0.023	0.069	0.143	0.116	0.365	0.090
Commercial Multiperil		0.287	0.305	0.117	0.070	0.122	0.206	0.158	0.490	0.140
Products Liability:	Claims-Made				0.044	0.092	0.170	0.156	0.470	0.110
	Occurrence				0.069	0.128	0.224	0.065	0.207	0.150
	Composite	0.174	0.253	0.287						
General Liability:	Claims-Made				0.033	0.079	0.151	0.116	0.364	0.100
	Occurrence				0.052	0.107	0.196	0.072	0.241	0.130
	Composite	0.174	0.253	0.212						
Medical Malpractice:	Claims-Made				-0.002	0.039	0.107	0.083	0.255	0.060
	Occurrence				-0.003	0.047	0.128	0.032	0.109	0.070
	Composite	0.148	0.255	-0.093						
Special Liability		0.104	0.056	-0.109	0.086	0.141	0.228	0.167	0.534	0.160
2-Year Line Composite		0.109	-0.074	-0.043	0.187	0.254	0.362	0.218	0.654	0.280
International Primary		0.050	0.080	0.057	0.074	0.129	0.218	0.136	0.422	0.150
Primary Line Composite										
Property Reinsurance (A+C)		0.370	0.315	-0.034	0.177	0.247	0.361	0.168	0.525	0.280
Casualty Reinsurance:	(B)	0.388	0.348	0.128	0.018	0.073	0.164	0.067	0.236	0.100
	(D)	0.592	0.368	0.183	-0.011	0.042	0.130	0.067	0.236	0.060
International Reinsurance		0.050	0.245	0.200	0.074	0.129	0.218	0.172	0.525	0.150
Reinsurance Line Composite										
Industry Composite										

[BACKUP.XLW]Net RBC Reserve Charges 2/18/93

Exhibit 6
Sheet 4

Net Risk-Based Capital Written Premium Charges

		NAIC		Worst	Academy Task Force Analysis					
					Expected Policyholder Deficit			Benchmark		
		1989	1990	Year	3%	2%	1%	3:1	1:1	Selected
Homeowners/Farmowners		0.076	0.073	0.147	0.171	0.256	0.396	0.317	0.953	0.270
Private Passenger Auto Liability		0.198	0.203	0.100	0.021	0.067	0.140	0.255	0.780	0.070
Commercial Auto Liability		0.297	0.302	0.282	0.096	0.157	0.257	0.211	0.653	0.170
Workers Compensation		0.063	0.057	0.008	0.081	0.138	0.230	0.174	0.548	0.150
Commercial Multiperil		0.217	0.219	0.228	0.065	0.127	0.228	0.237	0.735	0.140
Products Liability:	Claims-Made				0.138	0.210	0.328	0.234	0.705	0.220
	Occurrence				0.257	0.351	0.509	0.098	0.311	0.370
	Composite	-0.001	0.157	0.169						
General Liability:	Claims-Made				0.119	0.186	0.298	0.173	0.546	0.200
	Occurrence				0.228	0.318	0.467	0.108	0.362	0.330
	Composite	0.006	0.164	0.259						
Medical Malpractice:	Claims-Made				0.163	0.241	0.367	0.124	0.383	0.250
	Occurrence				0.285	0.387	0.555	0.048	0.164	0.400
	Composite	0.458	0.479	0.184						
Special Liability		0.392	0.217	0.110	0.092	0.157	0.264	0.251	0.801	0.170
2-Year Line Composite		-0.044	-0.036	-0.004	0.099	0.166	0.274	0.327	0.981	0.180
International Primary		0.354	0.496	0.100	0.176	0.261	0.401	0.203	0.633	0.280
Primary Line Composite										
Property Reinsurance (A+C)		0.289	0.645	0.363	0.327	0.432	0.610	0.252	0.788	0.450
Casualty Reinsurance:	(B)	0.334	0.294	0.264	0.199	0.279	0.413	0.101	0.354	0.290
	(D)									
International Reinsurance		0.354	0.437	0.073	0.176	0.261	0.401	0.258	0.788	0.280
Reinsurance Line Composite										
Industry Composite										

[BACKUP.XLW]Net RBC WP Charges 2/18/93

Exhibit 6
Sheet 5

Net Risk-Based Capital Unearned Premium Charges

		NAIC		Academy Task Force Analysis						
				Worst	Expected Policyholder Deficit			Benchmark		
		1989	1990	Year	3%	2%	1%	3:1	1:1	Selected
Homeowners/Farmowners		-0.242	-0.245	-0.065	0.000	0.000	0.000	0.000	0.000	0.000
Private Passenger Auto Liability		-0.041	-0.036	-0.059	0.000	0.000	0.000	0.000	0.000	0.000
Commercial Auto Liability		-0.004	0.001	0.081	0.000	0.000	0.000	0.000	0.000	0.000
Workers Compensation		-0.116	-0.122	-0.111	0.000	0.000	0.000	0.000	0.000	0.000
Commercial Multiperil		-0.154	-0.152	-0.019	0.000	0.000	0.000	0.000	0.000	0.000
Products Liability:	Claims-Made				0.000	0.000	0.000	0.000	0.000	0.000
	Occurrence				0.000	0.000	0.000	0.000	0.000	0.000
	Composite	-0.261	-0.103	-0.004						
General Liability:	Claims-Made				0.000	0.000	0.000	0.000	0.000	0.000
	Occurrence				0.000	0.000	0.000	0.000	0.000	0.000
	Composite	-0.261	-0.103	0.081						
Medical Malpractice:	Claims-Made				0.000	0.000	0.000	0.000	0.000	0.000
	Occurrence				0.000	0.000	0.000	0.000	0.000	0.000
	Composite	0.299	0.320	0.078						
Special Liability		-0.007	-0.182	-0.156	0.000	0.000	0.000	0.000	0.000	0.000
2-Year Line Composite		-0.318	-0.310	-0.187	0.000	0.000	0.000	0.000	0.000	0.000
International Primary		0.092	0.234	-0.075	0.000	0.000	0.000	0.000	0.000	0.000
Primary Line Composite										
Property Reinsurance (A+C)		0.038	0.394	0.196	0.000	0.000	0.000	0.000	0.000	0.000
Casualty Reinsurance:	(B)	0.083	0.043	0.097	0.000	0.000	0.000	0.000	0.000	0.000
	(D)									
International Reinsurance		0.092	0.175	-0.167	0.000	0.000	0.000	0.000	0.000	0.000
Reinsurance Line Composite										
Industry Composite										

[BACKUP.XLW]Net RBC UPR Charges 2/18/93

Net Risk-Based Capital

	NAIC		Academy Task Force Analysis						
			Worst	Expected Policyholder Deficit			Benchmark		
	1989	1990	Year	3%	2%	1%	3:1	1:1	Selected
Primary Insurers									
Investment RBC	15,454,146	15,716,302	14,946,067	14,836,645	15,510,912	16,676,157	16,283,849	21,429,224	15,709,684
Credit	958,698	958,698	958,698	958,698	958,698	958,698	958,698	958,698	958,698
Reinsurance Credit	4,992,792	4,992,792	4,992,792	4,992,792	4,992,792	4,992,792	4,992,792	4,992,792	4,992,792
Reserve RBC	33,777,683	40,617,103	16,837,565	14,231,260	28,183,669	50,668,424	36,157,514	112,666,440	33,709,787
Underwriting RBC	24,303,855	26,931,961	21,482,484	19,369,531	32,693,791	54,205,268	52,651,706	160,930,766	34,948,016
Total	79,487,174	89,216,856	59,217,605	54,388,926	82,339,861	127,501,339	111,044,559	300,977,920	90,318,976
Covariance	(34,914,607)	(37,851,930)	(27,838,320)	(25,856,358)	(36,295,693)	(51,344,472)	(45,006,648)	(103,321,846)	(39,125,406)
Net Risk Based Capital	44,572,568	51,364,926	31,379,285	28,532,568	46,044,168	76,156,867	66,037,910	197,656,074	51,193,570
Reinsurers									
Investment RBC	1,697,654	1,672,613	1,561,847	1,482,848	1,527,335	1,609,073	1,513,052	1,670,951	1,544,417
Credit	62,670	62,670	62,670	62,670	62,670	62,670	62,670	62,670	62,670
Reinsurance Credit	823,824	823,824	823,824	823,824	823,824	823,824	823,824	823,824	823,824
Reserve RBC	11,627,325	9,620,933	3,984,254	1,282,624	3,013,934	5,940,056	2,946,783	9,781,503	3,788,717
Underwriting RBC	2,979,241	3,512,284	2,962,746	2,311,199	3,345,979	5,057,678	2,553,205	8,088,256	3,513,805
Total	17,190,713	15,692,323	9,395,340	5,963,165	8,773,741	13,493,300	7,899,534	20,427,203	9,733,433
Covariance	(5,044,487)	(5,288,390)	(4,142,500)	(2,843,089)	(3,959,044)	(5,491,400)	(3,650,534)	(7,597,507)	(4,287,512)
Net Risk Based Capital	12,146,226	10,403,933	5,252,840	3,120,076	4,814,696	8,001,900	4,249,000	12,829,696	5,445,921
Total Industry									
Investment RBC	17,151,800	17,388,915	16,507,914	16,319,493	17,038,246	18,285,230	17,796,901	23,100,175	17,254,101
Credit	1,021,367	1,021,367	1,021,367	1,021,367	1,021,367	1,021,367	1,021,367	1,021,367	1,021,367
Reinsurance Credit	5,816,616	5,816,616	5,816,616	5,816,616	5,816,616	5,816,616	5,816,616	5,816,616	5,816,616
Reserve RBC	45,405,008	50,238,036	20,821,819	15,513,884	31,197,602	56,608,480	39,104,297	122,447,943	37,498,504
Underwriting RBC	27,283,096	30,444,244	24,445,229	21,680,730	36,039,769	59,262,946	55,204,911	169,019,022	38,461,821
Total	96,677,888	104,909,179	68,612,945	60,352,092	91,113,602	140,994,640	118,944,093	321,405,123	100,052,409
Covariance	(39,959,094)	(43,140,319)	(31,980,820)	(28,699,447)	(40,254,737)	(56,835,872)	(48,657,182)	(110,919,353)	(43,412,918)
Net Risk Based Capital	56,718,794	61,768,859	36,632,125	31,652,644	50,858,865	84,158,768	70,286,911	210,485,770	56,639,491
Industry Premium	223,243,202	223,243,202	223,243,202	223,243,202	223,243,202	223,243,202	223,243,202	223,243,202	223,243,202
Industry Premium-to-Surplus Ratio	3.94	3.61	6.09	7.05	4.39	2.65	3.18	1.06	3.94

{BACKUP.XLW}Summary of RBC 2/18/93

REPORT ON COVARIANCE METHOD FOR PROPERTY-CASUALTY RISK-BASED CAPITAL

Actuarial Advisory Committee to the NAIC P/C Risk-Based Capital Working Group

Report on Covariance Method for Property-Casualty Risk-Based Capital

from the

Actuarial Advisory Committee to the NAIC P/C Risk-Based Capital Working Group

February 26, 1993

Introduction

The Actuarial Advisory Committee to the NAIC Property/Casualty Risk-Based Capital Working Group has developed a recommended method for treating *covariance*. Our technique combines the separately-determined RBC amounts for all of the risk elements, assuming that everything bad doesn't occur at once. The proposal is based on data analysis as much as possible and, we believe, sound judgment otherwise. We have included results from our recent extensive analysis of underwriting risk over 1982-91, from testing on individual companies and from comments on earlier proposals.

This report is organized as follows:

Recommendation	A brief description of the proposed covariance formula; subsequent sections describe its rationale.
Conceptual Background	Discusses why a covariance adjustment is needed. The effect of statistical independence, correlation and the role of diversification. The square root rule.
Selecting Independent RBC Categories	Determines which asset, credit and underwriting risk elements are treated as independent, and thus reduce total RBC.
Correlation Between Lines of Business	Develops simplified covariance formula for diversification by line: the concentration adjustment.
Treatment of Affiliates	Shows why affiliate ownership must be treated differently from other equities in covariance formula.
Numerical Example of Covariance Formula	Illustrates the proposed formula with a simple set of numbers for the inputs.
Exhibits	Provides additional detail supporting the analysis.
Appendix	Provides theoretical background for covariance method.

Recommendation

For treatment of covariance between risks in the RBC calculation, we recommend the following formula to combine the RBC for independent risk categories:

$$\textbf{Total Company RBC} = R_1 + \sqrt{[R_2]^2 + [R_3]^2 + \ldots + [R_7]^2}.$$

The variables in the formula are RBC amounts for seven categories:

RBC Amount	*Risk Category (RBC is added for all items in category)*
R_1	Assets: Stock (common and preferred) of U.S. P/C insurance affiliates
R_2	Assets: Equities *excluding* P/C insurance affiliates
R_3	Assets: Fixed income items
R_4	Credit risk
R_5	Loss & LAE reserve and reserve growth risk, *adjusted for concentration*
R_6	Premium risk and premium growth risk, *adjusted for concentration*
R_7	Size risk

The above concentration-adjusted reserve and premium RBC amounts are

Adjusted Reserve RBC = RBC x [0.7 + (0.3 x Reserve Concentration)].

Adjusted Premium RBC = RBC x [0.7 + (0.3 x Premium Concentration)].

The purpose of the concentration adjustment is to allow for the effect of diversification between lines of business. The reserve concentration is the ratio of the reserve for the largest single line to the reserve for all lines. The premium concentration is a parallel calculation. The specific concentration formula is provided in the section of this report that discusses correlation between lines.

The special treatment of property-casualty affiliate RBC (removed from the equities category and denoted by R_1) outside the square root is to avoid applying the covariance adjustment more than once to an insurer. Otherwise RBC can be severely understated. To further address the affiliate covariance problem, we recommend that the insurer have the ***option of consolidating affiliates*** in determining total RBC.

In establishing a risk-based capital formula, a sensible, basic approach is to set the capital requirement for each risk element so that the insurer will be reasonably safe from insolvency due to that particular risk element alone. However, the *total RBC* for an insurer should generally be *less than* the simple sum of the RBC amounts for each risk element.

Diversification is responsible for this reduction to total RBC. Most insurers write several lines of business. It is unlikely that all lines will have adverse results at the same time: for example, property catastrophes are independent of liability losses and adverse workers' compensation reserve development does not always correspond to like movement in auto liability reserves. Similarly, many insurers have a broad portfolio of assets including stocks, bonds and real estate. Often the stock and bond markets will move in opposite directions at the same time, offsetting an adverse impact in one area. Thus, an insurer can reduce its chance of insolvency by diversifying its risk across underwriting and asset categories.

For two items, whose future values are uncertain, to have values unrelated to each other is called *statistical independence*. When two risk elements are independent, an adverse movement in one risk item will correspond, with equal likelihood, to either a positive or negative movement in the other. Clearly, when risk elements are independent, there is less total risk than if they are correlated. Statistical independence, which gives rise to the "law of large numbers", is the cornerstone of insurance. The more independent events insured, the more likely that adverse outcomes will be offset by favorable results.

On the other hand, if the risk elements are perfectly correlated, then the total RBC is the sum of the separate RBC amounts : for example, if loss reserves and stocks had 100% correlation, then an adverse development in loss reserves will always be accompanied by an equally adverse result in the stock market. Note that correlation is a measure of covariance, the ability of two variables to move together (i.e., to "co-vary"). Hence the general technique for combining RBC amounts has become known as the "covariance" adjustment.

As indicated in our *Conceptual Framework* document, a practical mathematical technique for recognizing independence of events computes their total RBC as the *square root of* *the sum of the squares of the individual RBC amounts.* We call this the "square root rule." The Life/Health Risk-Based Capital formula, adopted in 1992, also has a square root rule for combining RBC for separate risk elements. The Appendix develops the theory underlying the square root rule and discusses correlation in greater detail.

Perhaps the most important benefit of a risk-based capital program is to motivate insurers to "do the right thing." This proposal encourages *diversification*, both for investment portfolios and underwriting lines of business. We firmly believe that prompting insurers to spread their risk will be a major benefit to policyholders from a properly-designed RBC approach.

It is as important to recognize the degree of correlation between risk elements as it is to recognize the risk of any individual items. Ignoring the covariance adjustment to RBC could substantially harm a well-diversified insurer.

Selecting Independent RBC Categories

In order to establish a practical application of the square root rule, one must select a limited number of independent risk categories, recognizing that few risk elements are either truly independent of all others or are perfectly correlated with them. In some cases where there was a perceived independence or correlation between risk elements (e.g., reinsurance credit risk and loss reserve risk) we chose to ignore the relationship because the correlation was weak or the items were rather small for a typical insurer, and thus the effect on total RBC was minor.

Exhibit 1 shows that the square root rule tends to overstate the true amount of RBC for independent risk elements. Thus, if risk elements are almost independent (i.e., are weakly correlated), which is likely in practice, then the square root rule will be an even better approximation. See Exhibit 2 (discussed below) for an example of this.

Asset vs. Underwriting Risk

In general, we felt that non-insurance asset risk (including credit risk) was independent of underwriting risk (reserves, premium, size and growth risk). A notable exception is the relationship between bond duration and reserve duration (the interest rate risk); we will provide a separate recommendation on this topic.

Independent Asset Categories

The major asset categories likely to produce enough RBC for a material covariance reduction if independent are stocks, bonds and ceded reinsurance. We believe that ceded reinsurance risk is largely independent of the other assets since we could find no a priori reason why reinsurance defaults should be highly correlated with investment returns (rather, they should be related to adverse underwriting performance).

As indicated in Exhibit 2, based on long-term historical data, the correlation between stock and bond returns is a rather weak 14%. Ignoring the correlation understates combined RBC by a maximum of about 6%. However, the square root rule itself is an approximation that *overstates* RBC, so the errors tend to cancel. Thus, it is reasonable to use the simple square root rule and to assume no correlation between stocks and bonds.

Independent Underwriting Categories

The major underwriting risk categories are loss & LAE reserves, premiums, growth and size (both reserves and premiums).

Based on our extensive study of underwriting risk, we have concluded that reserve and written premium risk are not very well correlated. Here we define risk as the volatility (standard deviation) of the present value of reserve or premium deficiency. The reserve deficit is measured at the end of each year, while the premium shortfall is determined in the *following* year. Note that, at any point in time, the risk in premiums is related to upcoming exposure, since premium adequacy for the evaluation year is already incorporated in the reserve RBC.

Exhibit 3 shows that, from 1982 to 1991, the industry all-lines composite premium and reserve risk elements had only a 26% correlation. In fact, many of the individual lines show a negative association. However, because the historical period includes only one complete underwriting cycle (the next one may behave differently), one must be careful not to attach much credibility to the correlation of any particular line. Thus, we have included a correlation measure that weights each line equally with the all-lines composite. Also, Exhibit 3 shows that the number of years between the worst premium and reserve deficiency varies dramatically by line; with a strong premium/reserve correlation these would all be the same. Since the correlation is weak, and the square root rule overstates RBC, for the sake of simplicity, we have treated these two components as being independent.

Based on our judgment, we have determined that reserve growth risk is highly correlated with reserve risk, and therefore have included it with the reserve RBC category. Similarly, the premium growth risk is put with the premium risk.

Also, we believe that size risk is independent of either reserves or premium, but premium and reserve size risk are highly correlated. Thus, size risk for both should be a single independent RBC category.

Correlation Between Lines of Business

Our underwriting risk analysis has provided a way to measure the covariance between lines of business (an earlier proposal was based on judgment). To simplify the formula while recognizing the relationship between lines within loss reserve and written premium risk categories, we have developed an adjustment that depends on the *concentration* by line of business. It is applied separately to loss & LAE reserves and to written premiums:

Adjusted Reserve or Premium RBC = RBC x [0.7 + 0.3 x Concentration],

where

$$\textbf{Reserve Concentration} = \frac{\text{Loss\&LAE reserve for largest line (Page 10 /[Col 5 + 6])}}{\text{Total loss \& LAE Reserve}}$$

$$\textbf{Premium Concentration} = \frac{\text{Net Premium Written for largest line (Page 8 /Col 4)}}{\text{Total Net Premium Written}}.$$

The concentration adjustment reduces the RBC for insurers having a diversified book of business: a monoline insurer would get no reduction to its RBC, but the average insurer (about 30% concentration in both Workers Compensation reserves and PP Auto Liability premium) would get around a 20% reduction (before applying the square-root calculation). The reduction is limited to 30%.

Exhibit 4 derives the concentration adjustment from the average correlation between results for the Schedule P lines of business. We used P/C industry data from 1982-1991 for this analysis. For both reserves and premium, the average correlation between lines is about 40%, a number too low to lump all lines into a single independent category without adjustment, and too high to require independent line categories (to do this would greatly complicate the formula, anyway). Therefore we recommend this intermediate path of using the concentration adjustment.

Treatment of Insurance Affiliates

When the RBC for holding an affiliate is the ownership percentage of the affiliate's RBC, one cannot assume that this asset risk is independent of the other RBC categories. To illustrate, if an insurer creates a subsidiary that is a scaled-down version of the original company, then the results of the sub will be perfectly correlated with that of the parent. Thus, the square root rule should not apply: using it for affiliate RBC applies the covariance reduction *twice* (or more, if there are several layers of ownership), when only once is warranted. Exhibit 5 illustrates this point.

In Case 1, the original insurer (now the consolidated group) carves out a subsidiary one-third the size of the group. The group's RBC is $3,699—which should be identical to the parent's RBC, since the risk of the entire enterprise cannot change by shifting its assets and liabilities back and forth between sub and parent. The sub's RBC is $1,233, which is one-third of the group RBC. This is proper, because the sub is identical to the group, but a third its size.

Including the sub's RBC "inside" the square root (Cov-Adjusted Total 1) gives $2,757 for the Parent's RBC—an amount 25% too low. However, placing the sub's RBC "outside" the square root (Cov-Adjusted Total 2), which assumes that the sub's results depend on the parent's results, yields the correct RBC for the parent.

A third, theoretically correct treatment of affiliate covariance (Cov-Adjusted Total 3) is to consolidate the six independent RBC categories (R_2 through R_7) for parent and affiliates and then apply the square root rule to the six consolidated RBC categories. This gives the RBC of the consolidated insurer—a result that doesn't depend on the ownership structure.

Case 2 shows that only the consolidation method works when the sub is *not a proportionate scaling* of the parent. Here the "inside" method still produces a very low parent RBC, but the "outside" formula gives slightly (by 3%) too much parent RBC. Note that the "inside" formula will *always* give a parent RBC that is too low and the "outside" version will *always* give the correct or higher (although not by much for typical affiliates) parent RBC.

Because the "outside" formula is much easier to use than consolidation in calculating RBC, we recommend it for computing a company's total RBC. However, we also recommend that the insurer have the *option* of consolidating (up to the ownership level) all affiliates in determining total RBC.

Treatment of life insurance subsidiaries is difficult, since there is some correlation with P/C parent results through asset risk. But, we believe that, overall, life affiliates are more independent than dependent, and thus their RBC should be included with equities (R_2) "inside" the square root.

Illustrative Example Using Covariance Formula

Exhibit 6 illustrates the calculation of our recommended RBC covariance method: suppose that a hypothetical insurer owning a subsidiary has the following amounts of RBC by risk category before the covariance calculation:

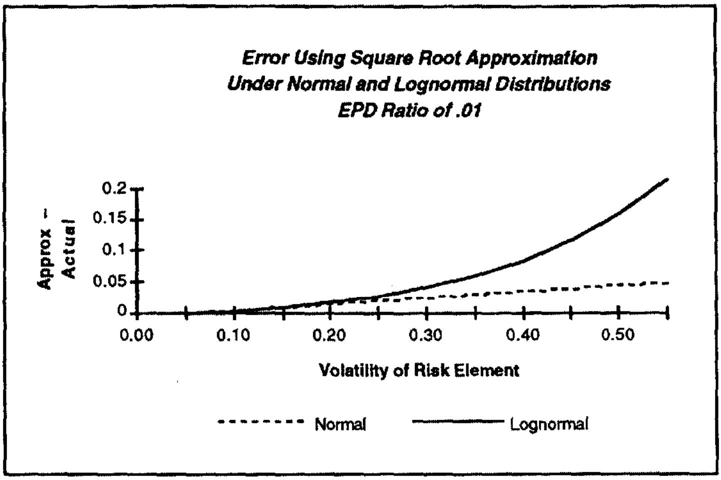
	Parent	*Subsidiary*
Affiliate ownership	$100	$0
Equities	200	60
Fixed income assets	100	0
Credit risk	50	0
Reserve risk	300	90
Premium risk	200	30
Size risk	50	0

The reserve and premium concentrations are 50%, and 40% respectively for both parent and sub. Thus, the sub's RBC is $100 (see Exhibit 6b) and the parent's RBC is $543 (from Exhibit 6a) using the recommended square root rule with the affiliate RBC added after the square root is taken. Applying the consolidation option reduces the insurer's RBC slightly to $542.

Exhibit 1

Error in Using Square Root Approximation

The square root rule approximates the true amount of capital required when two risk elements are independent. The graph below shows the error in this simplification under either the normal or lognormal probability distribution, for two equal-sized independent risk elements having the same standard deviation.



The volatility of the risk element is the ratio of the standard deviation to the mean. The solvency standard chosen for this comparison is an expected policyholder deficit ratio of 1%. The EPD ratio is the average insolvency cost per dollar of obligation to policyholders. This idea is developed in our Conceptual Framework document.

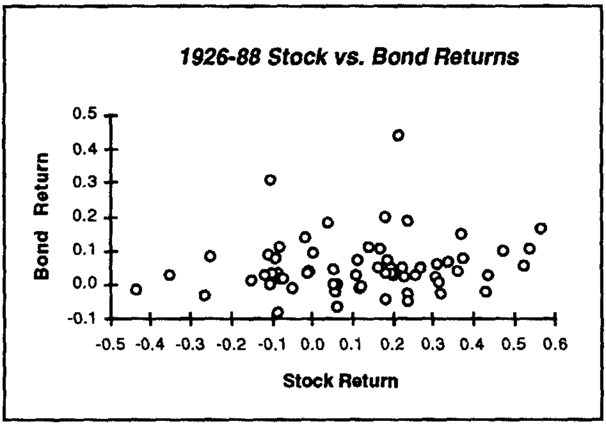
The error is defined as the approximated ratio minus the true ratio of capital to the risk element. Since the error is positive, the square root rule *overstates* the true amount of RBC, assuming that the risk elements have these probability distributions (we believe that these are reasonable choices for most RBC items).

For details on the error calculation and derivation of the square root rule, see the Appendix.

Exhibit 2

Stock vs. Bond Correlation

The scatter diagram below depicts the 1926-1989 stock and bond returns (based on Ibbotson & Associates data). The correlation between them is 14%.



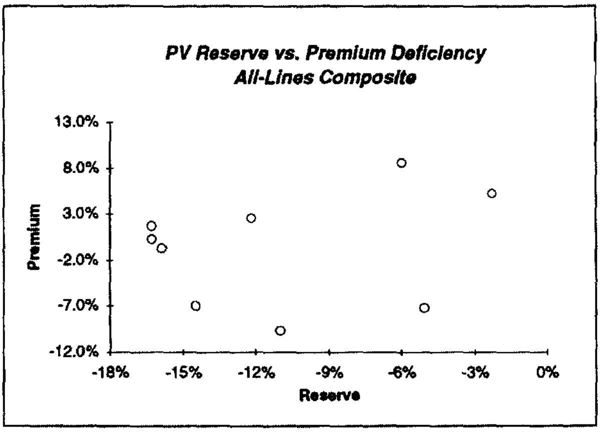
Using the square root rule and incorporating the correlation, the combined RBC for these two risk elements is $C = \sqrt{C_S^2 + C_B^2 + 2(.14)C_S C_B}$,where C_B and C_S are the RBC amounts for stocks and bonds. The maximum error in assuming a zero correlation is a 6.3% understatement of the total RBC, occurring when stock and bond RBC are equal. For an 8-to-1 ratio of stock to bond RBC, the error is only 1.7%.

However, the square root rule itself is an approximation that tends to *overstate* the amount of RBC needed (see Exhibit 1). For example, assume a 1% expected insolvency cost, a normal distribution for asset variability and annual standard deviations of 5% for bond annual returns and 15% for stocks (based on the Ibbotson data). *Including* the above effect of omitting the correlation, the square root rule still overstates the true RBC. The maximum overstatement, occurring with equal amounts of stocks and bonds is 2.3% of the assets. The net overstatement is 3.8% for the lognormal distribution.

Recognizing the above offsetting factors and the importance of simplicity, it is reasonable to use the simple square root rule, assuming no correlation between stocks and bonds.

Exhibit 3

Correlation Between Present Value of Reserve and Premium Deficiency 1982-91 U. S. P/L Industry Results



	Correlation*		Worst-Year
	Raw Value	Weighted	Gap**
Homeowners	-0.14	0.06	7
PP Auto Liab	0.81	0.54	-1
Comm Auto Liab	0.24	0.25	-2
Workers Comp	0.64	0.45	-7
CMP	0.56	0.41	0
Products Liability	0.59	0.42	1
Other Liability ex PL	0.66	0.46	0
Med Mal	0.76	0.51	-2
Special Liability	-0.35	-0.05	-5
Comb 2-Yr Lines	0.38	0.32	-8
International	-0.53	-0.14	4
Property Reins AC	-0.33	-0.04	-5
Casualty Reins B	0.52	0.39	-1
Casualty Reins D	-0.31	-0.02	-2
Reins Intl	-0.07	0.10	-1
All-Lines Composite	**0.26**	**0.26**	**-1**

*Year-end resv deficiency vs. following year prem deficiency. Weighted value uses 50% all-lines average and 50% raw value.

**[Year of worst prem deficiency] - [year of worst resv def] - 1. Perfect correlation would be zero.

Exhibit 4a
Calculating the Concentration Adjustment

For this analysis, we used the data underlying our proposed reserve and premium RBC factors. We have segmented the risk into an industry component, which measures year-to-year variation for all companies, and a company component, which measures variation within a year between all companies. These two risks are assumed to be independent, so their total is computed using a square root rule.

Exhibit 4b summarizes the calculation of the average correlation between lines (ρ in the exhibit) for reserves: it is about 42%. Here we have used the 1985 (a representative year for the period used) reserve volume to weight the line results.

Exhibit 4c performs a parallel calculation for premium, giving an average correlation of about 43%.

We have rounded both of the correlation measures to 40%. Translating the correlations to a concentration adjustment assumes that

(1) the insurer has n lines of business of equal size with concentration
$C = 1/n$ = [volume of the largest line] ÷ [total volume] and

(2) the RBC is the same for each line.

Assumption (1) overstates RBC and (2) understates RBC, so the net effect is nearly exact.

Thus, the concentration adjustment factor is $\sqrt{\rho + (1-\rho)\times C}$,

or approximately $\sqrt{\rho} + (1-\sqrt{\rho})\times C$.

Using $\rho = 0.40$ for both reserves and premium, we get $\sqrt{\rho} = 0.63$; to compensate for the small correlation between reserves and premiums, we have boosted this to 0.70 in the proposed formula:

Adjusted reserve or premium RBC = [.7 + (.3 x *C*)] x [*unadjusted RBC*].

Exhibit 4b

Correlation Between Lines: 1982-91 U. S. P/L Industry Loss & LAE Reserves

Line of Business	1985 Volume	Std Dev of Deficiency Company	Industry	Total
	V_i	sc_i	sd_i	st_i
Homeowners	4,999	23.0%	6.2%	23.8%
PP Auto Liab	28,015	15.0%	2.8%	15.3%
Comm Auto Liab	9,216	14.0%	4.4%	14.7%
Workers Comp	31,254	14.0%	6.5%	15.4%
CMP	9,813	18.0%	9.6%	20.4%
Other Liability ex PL	18,263	20.0%	16.3%	25.8%
Products Liability	4,496	29.0%	19.1%	34.7%
Med Malpractice	11,281	26.0%	11.7%	28.5%
Special Liability	1,591	21.0%	3.8%	21.3%
Comb 2-Yr Lines	11,295	28.0%	6.9%	28.8%
International	88	30.0%	6.5%	30.7%
Property Reins AC	1,387	33.0%	16.4%	36.9%
Casualty Reins B	5,394	18.0%	15.5%	23.8%
Casualty Reins D	6,910	24.0%	13.6%	27.6%
Reins International	17	30.0%	12.6%	32.5%
Total	144,019			
Average $\sigma_A = \left(\sum sx_i V_i\right)/\left(\sum V_i\right)$*	σ_A	**18.9%**	**8.7%**	**21.2%**
				$st_i = \sqrt{sc_i^2 + sd_i^2}$

All-Lines Composite	σ_C	**14.0%**	**4.5%**	**14.7%**
Independent Std Dev $\sigma_I = \sqrt{\sum [sx_i V_i]^2} / \left(\sum V_i\right)$*	σ_I	**6.2%**	**3.1%**	**6.9%**
Correlation Coefficient $\rho = \left(\sigma_C^2 - \sigma_I^2\right)/\left(\sigma_A^2 - \sigma_I^2\right)$	ρ	**49.1%**	**16.5%**	**42.1%**

*where "x" denotes "*c*", "*d*" or "*t*"

Exhibit 4c

Correlation Between Lines: 1982-91 U. S. P/L Industry Premium

Line of Business	1985 Volume	Std Dev of Deficiency Company	Industry	Total
	V_i	sc_i	sd_i	st_i
Homeowners	13,843	11.7%	8.8%	14.6%
PP Auto Liab	26,439	10.5%	4.8%	11.5%
Comm Auto Liab	6,485	21.5%	13.2%	25.2%
Workers Comp	15,889	14.6%	7.6%	16.5%
CMP	9,592	19.1%	20.0%	27.7%
Other Liability ex PL	6,927	32.7%	22.5%	39.7%
Products Liability	1,327	43.2%	19.2%	47.3%
Med Malpractice	2,262	23.8%	17.3%	29.4%
Special Liability	1,906	31.6%	10.4%	33.3%
Comb 2-Yr Lines	37,188	22.0%	4.9%	22.5%
International	39	25.0%	18.6%	31.2%
Property Reins AC	1,430	32.0%	23.3%	39.6%
Casualty Reins B	2,791	24.0%	23.5%	33.6%
Casualty Reins D	3,881	30.0%	17.1%	34.5%
Reins International	16	25.0%	22.1%	33.4%
Total	130,015			
Average $\sigma_A = \left(\sum sx_i V_i\right)/\left(\sum V_i\right)*$	σ_A	**18.8%**	**9.5%**	**21.5%**
				$st_i = \sqrt{sc_i^2 + sd_i^2}$
All-Lines Composite	σ_C	**14.0%**	**6.2%**	**15.3%**
Independent Std Dev $\sigma_I = \sqrt{\sum [sx_i V_i]^2}/\left(\sum V_i\right)*$	σ_I	**7.5%**	**3.1%**	**8.1%**
Correlation Coefficient $\rho = \left(\sigma_C^2 - \sigma_I^2\right)/\left(\sigma_A^2 - \sigma_I^2\right)$	ρ	**47.1%**	**35.8%**	**42.6%**

*where "x" denotes "c", "d" or "t".

Exhibit 5

Covariance Calculation for Insurance Affiliates Alternative Versions

Case 1: **Parent and Sub have Proportionate RBC**	*RBC Amount*		
	Consolidated Group	**Subsidiary**	**Parent**
Affiliate Stock (RS)	0	0	1,233
Bonds (RB)	1,200	400	800
Reserves (RR)	3,000	1,000	2,000
Premium (RP)	1,800	600	1,200
Total* Before Covariance Reductio	6,000	2,000	5,233

				Error
Cov-Adjusted Total 1 $=\sqrt{RS^2+RB^2+RR^2+RP^2}$	**3,699**	**1,233**	**2,757**	**-25%**
Cov-Adjusted Total 2 $=RS+\sqrt{RB^2+RR^2+RP^2}$	**3,699**	**1,233**	**3,699**	**0%**
Cov-Adjusted Total 3 *[Parent RBC = Consolidated RBC]*	**3,699**	**1,233**	**3,699**	**0%**

Case 2: **Parent and Sub have Nonproportionate RBC**	*RBC Amount*		
	Consolidated Group	**Subsidiary**	**Parent**
Stock (RS)	0	0	2,475
Bonds (RB)	1,200	360	840
Reserves (RR)	3,000	2,100	900
Premium (RP)	1,800	1,260	540
Total Before Covariance Reduction	6,000	3,720	4,755

				Error
Cov-Adjusted Total 1	**3,699**	**2,475**	**2,817**	**-24%**
Cov-Adjusted Total 2	**3,699**	**2,475**	**3,820**	**3%**
Cov-Adjusted Total 3	**3,699**	**2,475**	**3,699**	**0%**

*For simplicity, this example excludes RBC for equities, credit risk and size.

Exhibit 6a

Example of Covariance Calculation for Risk-Based Capital Separate Treatment of Affiliate RBC

A: Summary Calculation				Squared
		Base	Adjusted	Adjusted
Risk Element		RBC	RBC	RBC
Equities excl P/C Affiliates	R2	250	250	62,500
Fixed Income	R3	50	50	2,500
Credit	R4	50	50	2,500
Reserves & Resv Growth	R5	400	**340**	115,600
Premium & Prem Growth	R6	140	**115**	13,179
Size (Reserve & Premium)	R7	10	10	100
Subtotal		**900**	815	196,379
Square Root				**443**
P/C Affiliate Stock	R1	**100**		**100**
Total		**1,000**		**543**

B: Adjusted Underwriting RBC Calculation

		Base RBC	Adjusted RBC
(1)	Reserves & Resv Growth	400	**340**
(2)	Premium & Prem Growth	140	**115**
(3)	Reserve Concentration	0.500	
(4)	Reserve Conc Adjustment	**0.850**	
(5)	Premium Concentration	0.400	
(6)	Premium Conc Adjustment	**0.820**	

Notes

(1) Adjusted RBC = Base RBC x (4).
(2) Adjusted RBC = Base RBC x (6).
(3) Ratio of largest line net Loss & LAE reserve to total all lines reserve.
(4) Equals .7 + .3 x (3).
(5) Ratio of largest line net premium earned to total all lines NPE.
(6) Equals .7 + .3 x (5).

Exhibit 6b

Example of Covariance Calculation for Risk-Based Capital Consolidation Method

A: Calculation For Subsidiary

Risk Element		Base RBC	Adjusted RBC	Squared Adjusted RBC
Equities excl P/C Affiliates	R2	60	60	3,600
Fixed Income	R3	0	0	0
Credit	R4	0	0	0
Reserves & Resv Growth	R5	90	**77**	5,852
Premium & Prem Growth	R6	30	**25**	605
Size (Reserve & Premium)	R7	0	0	0
Total		**180**	161	10,057
Square Root				**100**
Reserve Conc Adjustment		**0.850**		
Premium Conc Adjustment		**0.820**		

B: Consolidated Calculation

Risk Element		Base RBC*	Adjusted RBC	Squared Adjusted RBC
Equities excl P/C Affiliates	R2	310	310	96,100
Fixed Income	R3	50	50	2,500
Credit	R4	50	50	2,500
Reserves & Resv Growth	R5	490	**417**	173,472
Premium & Prem Growth	R6	170	**139**	19,432
Size (Reserve & Premium)	R7	10	10	100
Total		**1,080**	976	294,105
Square Root				**542**
Reserve Conc Adjustment		**0.850**		
Premium Conc Adjustment		**0.820**		

***Sum of Subsidiary RBC (above) and Parent RBC (Exhibit 6a)**

Appendix

CORRELATION AND INDEPENDENCE OF RISK ELEMENTS

Excerpted from

"Risk Measurement for Property-Liability Risk-Based Capital Applications"

by Robert P. Butsic

1992 Casualty Actuarial Society Discussion Paper Program.

Having demonstrated how risk-based capital for each risk element can be calculated separately by treating each element as a mini-insurer, we now need a way to *combine* the risk capital for the separate elements. As shown next, we cannot simply add their required capital amounts together unless the risk elements are highly correlated with the proper sign.

A Numerical Illustration

For example, suppose that we have a line of business with riskless assets and risky losses, which can have only two possible realizable values. The values and their probabilities are given below. The desired EPD (expected policyholder deficit) ratio is 1%. The risk-based capital needed for this degree of protection is easily calculated at $2,900:

Single Line	Asset Amount	Loss Amount	Probability	Claim Payment	Deficit
	6,900	2,000	.6	2,000	0
	6,900	7,000	.4	6,900	100
Expected Value	6,900	4,000		3,960	**40**
Capital:		2,900			
Capital / Loss:		.725			
EPD Ratio:		**.01**			

Now suppose that we have another line of business with an identical loss distribution, but directly correlated with the first: if a $2,000 loss amount occurs for the first line, the same amount occurs for the second line; similarly, a $7,000 amount will occur concurrently for both lines. The effect of combining the two lines is the same as if we now had a single line twice as large as the original single line:

Two Correlated Lines	Asset Amount	Loss Amount	Probability	Claim Payment	Deficit
	13,800	4,000	.6	4,000	0
	13,800	14,000	.4	13,800	200
Expected Value	13,800	8,000		7,920	**80**
Capital:		5,800			
Capital / Loss:		.725			
EPD Ratio:		**.01**			

Now suppose that the two lines are statistically *independent*: the value of the loss for one line does not depend on the value for the other. Then we have the following possible total losses with their associated probabilities:

Amount		Probability	
4,000	= 2,000 + 2,000	**.36**	= (.6)(.6)
9,000	= 2,000 + 7,000 or 7,000 + 2,000	**.48**	= (.6)(.4) + (.4)(.6)
14,000	= 7,000 + 7,000	**.16**	= (.4)(.4)

Adding the two $2,900 risk-based capital amounts and using the above combined losses and probabilities, we can determine the EPD for the total of the two lines:

Two Independent Lines	Asset Amount	Loss Amount	Probability	Claim Payment	Deficit
	13,800	4,000	0.36	4,000	0
	13,800	9,000	0.48	9,000	0
	13,800	14,000	0.16	13,800	200
Expected Value	13,800	8,000		7,968	**32**
Capital:		5,800			
Capital/Loss:		.725			
EPD Ratio:		**.004**			

Notice that the $32 expected deficit for the combined lines is less than the sum of the individual expected deficits ($80). This produces a 0.4% protection level, compared to the 1% value for the separate pieces. To reach the same 1% level as before, we need *less* capital than obtained by adding the separate amounts of risk-based capital:

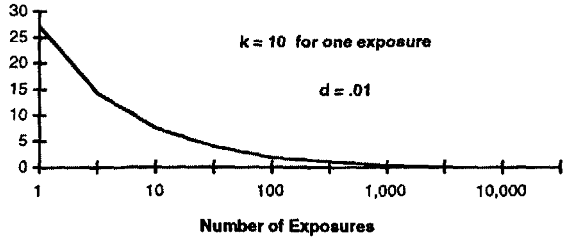
Two Independent Lines	Asset Amount	Loss Amount	Probability	Claim Payment	Deficit
	13,500	4,000	0.36	4,000	0
	13,500	9,000	0.48	9,000	0
	13,500	14,000	0.16	13,500	500
Expected Value	13,500	8,000		7,920	**80**
Capital		5,500			
Capital/Loss		**.687**			
EPD/Loss		**.01**			

As shown here, we only need $5,500 in capital, which is $480 less than the $5,980 needed when the losses are correlated. The capital ratio to loss drops from .725 to .687.

The reason for the reduced capital requirement through independence of risk elements is the *law of large numbers*. The spread of realizable values (relative to their mean) is reduced when independent elements are combined. The following graph depicts the diminishing capital needed to provide a 1% protection level for losses arising from independent normal exposures (having a standard deviation to mean ratio (k) of 10 for a single exposure):

Figure 1

Capital / Loss For Independent Normal Exposures



This illustrates that if losses are truly independent of each other, a small line of business will need a relatively large amount of capital, while a larger one requires much less capital. In reality, however, there is a limit to the risk reduction allowed by the law of large numbers. The mean or other parameters of the loss distribution are rarely known with certainty, introducing *systematic*, or parameter risk affecting all exposures. Thus, an insurer with a very large homogeneous book of business will still be subject to considerable uncertainty, and consequent capital needs.

Correlation Under the Normal Distribution

Although the preceding numerical example illustrates the capital reduction due to independence of risk elements, one must be careful not to generalize regarding the degree of reduction.[1] More robust conclusions can be reached by analyzing a continuous probability model, such as the normal distribution.

The normal distribution has the important property that sums of normal random variables are themselves normal random variables with additive means and easily-computed variances. For two assets (A_1 and A_2), two liabilities (L_1 and L_2), or an asset and a liability (A and L), we have

[1]For example, using a 10% EPD Ratio, the capital requirement drops to $2,000 for the single line of business. The *combined* capital need drops to $1,000 for the two independent lines—less capital than for a single line. This effect is due to using a discrete probability distribution with a limited range of outcomes.

	Mean	Variance
Two Assets	$A = A_1 + A_2$	$\sigma^2 = \sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2$
Two Liabilities	$L = L_1 + L_2$	$\sigma^2 = \sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2$
Asset and Liability	$C = A - L$	$\sigma^2 = \sigma_A^2 + \sigma_L^2 - 2\rho\sigma_A\sigma_L$

Here σ_1 and σ_2 denote the standard deviations of risk elements 1 and 2 (either assets or liabilities) and σ the total SD of combined risk elements (for assets minus liabilities, the SD of the capital). For the asset and liability combination, σ_A is the total asset SD and σ_L the total liability SD. The correlation coefficient between risk elements is ρ.

With perfect positive correlation ($\rho = 1$), we have $\sigma = \sigma_1 + \sigma_2$ for risk elements on the same side of the balance sheet or $\sigma = \sigma_A - \sigma_L$ for assets and liabilities. With perfect negative correlation ($\rho = -1$), $\sigma = \sigma_1 - \sigma_2$ and $\sigma = \sigma_A + \sigma_L$. When the elements are independent, $\rho = 0$, and thus $\sigma = \sqrt{\sigma_1^2 + \sigma_2^2}$ and $\sigma = \sqrt{\sigma_A^2 + \sigma_L^2}$ for the two cases.

The formula for the EPD ratio with normally distributed combined risk elements is identical to that for individual elements as presented earlier:

$$d = \frac{D}{L} = k\,\varphi\left(\frac{-c}{k}\right) - c\,\Phi\left(\frac{-c}{k}\right).$$

Here c is the capital to loss, k is the total standard deviation divided by the total expected loss L, D is the total expected policyholder deficit, $\varphi(\bullet)$ and $\Phi(\bullet)$ are the respective standard normal density and cumulative distribution functions. The lognormal EPD ratio for combined risk elements is identical to the earlier formula for the separate risk elements.

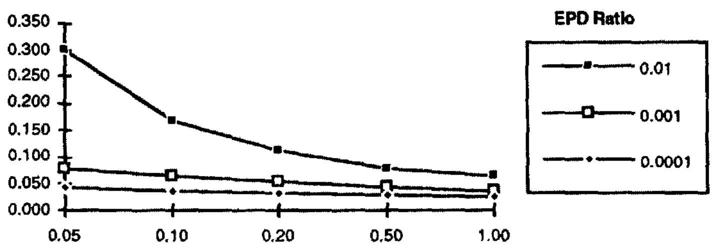
As indicated earlier, for the normal and lognormal distributions the relationship between c and k is approximately linear for a fixed EPD ratio d. Since $c = -d$ when $k = 0$ (no risk), we have $c \cong ak - d$ for some constant a. Under the assumption that we desire a high level of protection (d less than 1% or so), we can further simplify the relationship to $c \cong ak$.

Since the total capital C equals cL and the total SD σ equals kL, it follows that if $c = ak$, then $C = akL = a\sigma$. Therefore, the risk-based capital for the total of separate risk elements is proportional to their combined standard deviation. Risk capital for perfectly correlated items can be added (or subtracted, depending on whether the correlation is positive or negative or whether the items are on the same side of the balance sheet). Risk capital for independent (and partially correlated items) can be combined according to the square root of the sum of the squares of their standard deviations, plus twice the product of their SD's and the correlation coefficient.We will refer to this as the *square root* rule.

The graph below shows the relative error in using the square root rule, for two independent risk elements of the same size and standard deviation:

Figure 2

Relative Error Using Square Root Rule
for Equal Independent Normal Risk Elements



This graph shows that the error decreases as the EPD ratio decreases and as the risk increases. For a reasonable (i.e., .001) protection level, the error is less than 10%. To illustrate, suppose that we have two independent lines of business each with a \$1,000 expected loss and \$200 SD. For a .001 EPD ratio, each requires \$438 of capital in isolation. When the lines are combined, Equation (6) produces a capital ratio of .292, or \$584 in capital when applied to the \$2,000 expected total losses. The square root rule produces \$619 = $438\sqrt{2}$, which is about 6% more than the exact calculation[2] yields.

[2]Because the error in using the square root for the normal and lognormal distributions overstates the combined amount of capital needed, a closer fit could be had by using a root higher than two. For instance, in the normal example given, using a 2.4th root (.42 power) gives an exact result.

A parallel calculation using the lognormal distribution shows a 15% error: the true required capital is \$694, compared to \$800 indicated by the square root rule.[3]

The square root rule can be extended to incorporate more than two risk elements. The total capital C is a function of the individual element risk capital amounts C_i and the separate correlation coefficients between each pair of n risk elements (note that the sign of the correlation coefficient depends on which side of the balance sheet the two items reside):

$$C = \left[\sum_{i=1}^{n} C_i^2 + \sum_{i \neq j}^{n} \rho_{ij} C_i C_j \right]^{\frac{1}{2}}.$$

Practical Application of Correlated and Independent Risk Elements

The preceding analysis has shown the effect of correlation between risk elements. Some examples of balance sheet items having varying degrees of correlation are presented in the table below:

Correlation	**Asset/ Asset**	**Liability/ Liability**	**Asset/ Liability**
Positive	Common Stock/ Preferred Stock Common Stock/ Bonds	Loss Reserve/ LAE Reserve	Bonds/ Loss Reserve
Zero	Cash/ Real Estate	Liability Loss Reserve/ Property Unearned Premium Reserve	Common Stock/ Unearned Premium Reserve
Negative	Common Stock/ Put Options	Loss Reserve/ Income Tax Liability Loss Reserve/ Dividend Reserve	Property-Liability Stock/ Loss Reserve Reinsurance Recoverable/ Loss Reserve

[3]The higher capital amounts are a consequence of thicker tail of this distribution, compared to the normal distribution. For the lognormal model, the error increases with increasing risk (k).

In general, reinsurance transactions create a high degree of correlation between ceding and assuming parties. Ownership of insurance subsidiaries (affiliates) or stock also produces highly correlated values. Where it is difficult to determine the numerical correlation between items, a practical approach would be to judgmentally peg the correlation at zero, 1 or −1, whichever is closest to the perceived value.

We can demonstrate the effect of independent and correlated risk elements by constructing a numerical example. The table below shows risk elements from a hypothetical insurer's balance sheet at market values. The capital ratios assume a .001 EPD ratio and are based roughly on empirical data.

	Amount	Capital Ratio	RBC
Stock	200	0.30	60
Bonds	1000	0.05	50
Affiliates	100	0.30	30
Loss Reserve	800	0.40	320
Property UPR	100	0.10	10
Total			**470**

The 30% stock capital factor arises from using the 16.6% standard deviation of 1946 to 1989 annual returns from Ibbotson and Associates (1990). Based on the same source, we have used a 6% annual SD for bonds (the corporate bond SD is 9.8% for a 20-year maturity; adjusting for a more typical property-liability insurer's duration gives a lower value), producing an approximate 5% capital ratio. The loss reserve capital ratio is based on a study of loss ratio variation by Derrig[4] (1986). We have assumed that the affiliate stock risk is the same as for general non-insurance stock, that all the risk elements are lognormally distributed and that the EPD's are discounted at an 8% riskless interest rate. In the loss reserve (equal to the present value of the expected payments), we have also included the loss expenses and the liability portion of losses arising from the unearned premiums.

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[4]Derrig used a sample of Workers' Compensation and Private Passenger Auto loss ratios from 51 insurers over the period 1976-1985 (since calendar-year losses were used, the variance should be similar to that for loss reserves). The combined annual variance was .059, which we have judgmentally reduced to .045 reflecting a greater variance in the unpaid loss tail; the variance is lowered when the loss is brought to present value. This produces a capital ratio (to the discounted loss) of about 0.40. Notice that a further adjustment would be needed to convert the capital factor for application to an *undiscounted* loss reserve: using an 18% reserve discount, the required *statutory* surplus is (1 + .40)(1 - .18) - 1 = .15 times the undiscounted reserve.

The sum of the separate risk-based capital amounts is $470. This value assumes that *all* items are fully correlated, ignoring any independence or partial covariance between the items. Now assume that only the following pairs of elements are correlated:

		Correlation Coefficient
Stock	Bonds	0.2
Stock	Affiliates	1.0
Bonds	Affiliates	0.2
Bonds	Loss Reserve	0.4
Affiliates	Loss Reserve	-1.0

The property UPR is independent of all other items. Notice that the bonds/reserve correlation coefficient is positive due the parallel change in value from interest rate movements; since these two items are on opposite sides of the balance sheet, this means that their joint movement will *reduce* total risk.[5] Similarly, the negative sign of the affiliates/reserve correlation coefficient indicates that these opposing items will *increase* total risk when combined.

Applying Equation (7), we have the sum of the squares of the separate risk capital amounts equal to 109,500. The sum of the cross products (each of the above pairs appears twice) of the capital amounts times their correlation coefficients equals 11,800. Thus the approximate total risk capital is $\$348 = \sqrt{121{,}300}$. If all the risk elements were independent, the total required capital would be only $\$331 = \sqrt{109{,}500}$.

The impact of the bond/reserves covariance can be found by setting the correlation coefficient to zero: here the total risk capital increases to $366. Thus, the effect of their correlation is to reduce required capital by $18. Similarly, if the affiliate and reserves values were independent, the required capital would drop by $28 to $320.

A more sophisticated RBC calculation would divide the risk elements into additional categories and might include a provision for the value of future business.

[5]The correlation methodology provides a means of allowing for matching of asset and liability durations. If the durations of fixed maturity assets and loss payments were equal, and the movements in value were due solely to interest rate fluctuations, then a (negative) 100% correlation coefficient would be appropriate.

STATUTORY RETURNS ON SURPLUS AND THE COST OF EQUITY CAPITAL

Sholom Feldblum

STATUTORY RETURNS ON SURPLUS
AND THE COST OF EQUITY CAPITAL

Biography

Sholom Feldblum is an Associate Actuary with the Liberty Mutual Insurance Company in Boston, Massachusetts. He was graduated from Harvard University in 1978 and spent the next two years as a visiting fellow at the Hebrew University in Jerusalem. He became a Fellow of the CAS in 1987, a CPCU in 1986, an Associate of the SOA in 1986, and a member of the American Academy of Actuaries in 1989. In 1988, while working at the Allstate Research and Planning Center in California, he served as President of the Casualty Actuaries of the Bay Area and as Vice President of Research of the Northern California Chapter of the Society of CPCU. In 1989, he served on the CAS Education and Testing Methods Task Force. He is presently a member of the CAS Syllabus Committee, the CAS Committee on Review of Papers, the Advisory Committee to the NAIC Casualty Actuarial (EX5) Task Force, and the Actuarial Advisory Committee to the NAIC Risk Based Capital Task Force, and he is the quarterly review editor for the *Actuarial Review*. Previous papers of his have appeared in *Best's Review*, the *CPCU Journal*, the *Proceedings of the Casualty Actuarial Society*, the *Actuarial Digest*, the *CAS Forum*, and the *CAS Discussion Paper Program*.

Abstract

The statutory return on surplus for the insurance industry has averaged slightly over 10% during the 1970's and 1980's. Estimates of the cost of equity capital during the same period have averaged about 16%.

The cost of capital and the firm's accounting return may differ for various reasons. For instance, company growth may depress the statutory return on surplus in several ways. First, acquisition and underwriting costs are expensed when incurred, but no recognition is given to the "equity" in the unearned premium reserve (the "deferred acquisition costs"). If the insurer is growing, this equity increases over time, statutory earnings may be understated, and the return on surplus may be depressed.

Second, loss and loss adjustment expenses are held at undiscounted values on the statutory balance sheet. If the insurer is growing, the "unrecognized interest discount" in the loss reserves increases over time, statutory earnings may be understated, and the return on surplus may be depressed.

These two effects account for about 2.16 points of return, or slightly over a third of the discrepancy between the statutory return on surplus and the cost of equity capital. These adjustments to statutory returns allow a more accurate assessment of insurer profitability.

STATUTORY RETURNS ON SURPLUS AND THE COST OF EQUITY CAPITAL

Insurers' returns on surplus have been used to measure profitability by state regulators, consumer activists, and company managers. Several aspects of insurance accounting have raised questions about the usefulness of this measure. In particular, the industry's statutory return on surplus has been consistently lower than financial estimates of the cost of equity capital, another measure of company profitability.

Part of the difference stems from the interaction of company growth with two facets of statutory accounting: the non-recognition of the "equity" in the unearned premium reserve and the undiscounted estimates of loss and loss adjustment expense reserves. This paper estimates the effects of these two accounting practices on the reported returns on surplus.

The discrepancy between accounting and financial estimates has implications for policy pricing. Some state regulators, as in California, have used historical accounting data to determine an allowable return on equity for insurers. These returns may be used in financial models to set premium rates for subsequent policy years. The use of unadjusted statutory returns may lead to inadequate premium rates.

Statutory Return on Surplus

The A. M. Best Corporation aggregates Annual Statement figures reported by each insurer into industry totals. The all lines combined operating margins have averaged 5.27% from 1970 through 1990, as shown below.

Exhibit 1: Operating Margins and Premium to Surplus Ratios

Year	Operating Margin	Prem:Surp Ratio	Year	Operating Margin	Prem:Surp Ratio	Year	Operating Margin	Prem:Surp Ratio
70	4.97	2.12	77	10.06%	2.49	84	-3.14%	1.86
71	9.25	1.87	78	10.90	2.33	85	-4.34	1.92
72	9.91	1.65	79	9.18	2.15	86	3.19	1.88
73	7.59	1.99	80	8.24	1.85	87	7.06	1.86
74	2.20	2.78	81	7.14	1.86	88	7.96	1.71
75	-0.67	1.52	82	4.52	1.72	89	4.89	1.56
76	4.21	2.47	83	2.47	1.67	90	5.11	1.58
Average (1970-1990):							5.27	1.94

The operating margin encompasses all sources of revenue, including investment income on both capital and policyholder supplied funds. To convert the return on sales (operating margin) to a return on surplus, one must multiply by the premium to surplus ratio. The ratio of written premium to consolidated surplus has averaged 1.94 over this period, yielding an average return on surplus of 10.2%.[1]

Unearned Premium Reserve

Proper measurement of insurance income requires a matching of revenues (e.g., premiums) with expenditures (e.g., losses and expenses).

- *Earned Premiums:* Insurance premiums are generally booked at the inception of the policy period, before services have been rendered by the insurer. To match revenues and expenditures, premiums booked in one accounting period that provide for insurance coverage in a subsequent accounting period are held as "unearned premium reserves" on the liability side of the balance sheet. Earned premiums are the premiums booked minus the change in the unearned premium reserve.

- *Incurred Losses:* In most lines of business, losses and loss adjustment expenses are incurred evenly over the policy period. Incurred losses enter the income statement as the unearned premium liability runs off – that is, as the premium is earned.

- *Expenses:* Underwriting and acquisition expenses are incurred primarily at policy inception, and they enter the statutory income statement at that time, before the premium is earned. Thus, some underwriting and acquisition expenses are double counted in the earnings statement at policy inception: once as expenditures and once in the unearned premium reserve. The reserve runs off evenly over the policy period, so these expenses are counted only once at the expiration date.

GAAP and federal income tax accounting avoid this double counting of expenses. GAAP requires that a "deferred acquisition cost" asset be set up to amortize "costs that vary with and are primarily related to the acquisition of new and renewal insurance contracts" (FASB [1982], §28; AICPA [1990]). The "revenue offset" provision of the 1986 federal income tax amendments adds 20% of the statutory unearned premium reserve to income (Gleeson and Lenrow [1987]; Almagro and Ghezzi [1988]).

The treatment of underwriting and acquisition expenses in statutory statements affects the reported return on equity in two ways:

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[1] See Best's [1991]: Operating margins are from "% to Net Prem Earned" column of "Industry Operating Results" (page 124); policyholders' surplus [consolidated] from "Major Contributions to Investments" (page 124); net premiums written [not consolidated] from "total" column of "Aggregates of the Property-Casualty Business" (page 132). Consolidation affects assets and surplus, but not premiums written; unconsolidated figures show lower premium to surplus ratios. The averages are arithmetic averages. For operating results, some analysts would use the geometric average, which is slightly lower; see Panning [1987].

GAAP financial statements, showing GAAP equity, are not published by most mutual insurers and privately held firms; industry aggregates are not available even for publicly traded companies.

- Statutory surplus is generally less than GAAP equity, causing the return on surplus to be higher than the return on equity.[2]

- The change in the "equity" in the unearned premium reserve during the accounting period causes statutory income to differ from GAAP income. A growing insurer has a larger unearned premium reserve at the end of the accounting period than at the beginning. The "equity" in the reserve increases, statutory income is depressed, and the return on surplus is lower than the return on equity.

The net result of these two effects depends on

- the relative sizes of policyholders' surplus and the unearned premium reserve, and
- the growth rate of the company (see below).

Loss Reserve Discounting

Statutory accounting generally uses undiscounted values for Property/Casualty loss and loss adjustment expense reserves.[3] The IRS has used discounted loss reserves since 1987. GAAP accounting follows statutory practices, though the Financial Accounting Standards Board is now reconsidering this issue (FASB [1990]).

Again, there are two effects on the reported return on surplus:

- By raising liabilities, undiscounted reserves lower surplus and increase reported returns.[4]

- Both statutory and GAAP income are affected by the change in the unrecognized interest discount in loss reserves during the accounting period. A growing insurer generally has larger loss reserves at the end of the accounting period than at the beginning. As the unrecognized interest discount in the reserve increases, statutory income is depressed, and

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[2] Rosenthal [1989] estimates that average GAAP equity is 25% greater than statutory surplus for Property/Casualty insurers.

[3] Loss reserve discounting is permitted in statutory financial statements (1) for certain Medical Malpractice carriers (Yow, *et al.* [1990]), (2) in certain jurisdictions (e.g., MASSACHUSETTS INSURANCE CODE, §12, "Computation of Reserves of Liability Companies," paragraph 2: "For all compensation claims under policies written more than three years prior to [the Statement] date, the present values at four per cent interest of the determined and the estimated future payment"), and (3) when permission to discount is granted by the State Insurance Department.

[4] Butsic [1990] estimates that discounting loss reserves raises equity by 20%. Lowe and Philbrick [1985] estimate that discounting reduces loss reserves by 15%, though they do not quantify the effect on surplus.

the return on surplus is lower than the return on economic net worth.[5]

The Cost of Equity Capital

Financial analysts consider the returns received by equityholders for the use of their funds. Accounting data, such as net income and policyholders' surplus, are used primarily by company management. Market data, such as stock prices and dividends, are used by investors.[6]

Two common procedures for estimating the cost of equity capital are the Dividend Growth Model (DGM) and the Capital Asset Pricing Model (CAPM). The Dividend Growth Model directly estimates the cost of equity capital, but it requires assumptions about future dividend payments. The CAPM relies on historical data, but its theoretical foundations are disputed by some analysts.

The Dividend Growth Model

What determines the prices of stocks? The stock certificate is a piece of paper, with no intrinsic worth. In a free market, of course, its value is determined by the forces of supply and demand: what others are willing to pay for it. But this only begs the question: What determines how much others are willing to pay for the stock certificate?

A stock certificate is a financial asset, like a bond. The worth of a bond is determined by the cash payments to the owner: semiannual coupons and the par value at maturity. At any time, the worth of a bond is the present value of these future cash payments.

A stock has three differences from a bond.

- First, the stock never matures: there are periodic dividends, but no "repayment of principal at maturity."
- Second, the dividend payments are less certain. If the firm faces financial difficulties, it may eliminate or reduce a dividend payment. If it earns unusually large profits one year, it may provide a larger dividend.
- Third, bond coupons have fixed amounts. Stock dividends are not fixed in nominal terms, but generally grow with monetary inflation and with the earnings of the firm.

If we knew the amounts of all future dividend payments, we could estimate the price of the stock

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[5] "Economic net worth" denotes net worth as an economist might value a company. Kischuk [1986] defines "economic value" as "the present value of free cash flow, discounted using the company's cost of capital. Similarly, Woll [1987] examines insurance company profitability with "Expected Value Accounting," using present values of premium, loss, and expense cash flows. Economic net worth is closer to the market value upon which financial returns are evaluated than is the book value of either statutory or GAAP accounting.

[6] On the cost of equity capital for insurers, see Haugen and Kronke [1971], Quirin and Waters [1975], Lee and Forbes [1980], and Cummins [1992].

as the present value of the future cash flows. The actual future dividends are uncertain, but we can use historical experience to forecast them. To determine present values, we must know the appropriate discount rate, which is the opportunity cost of equity capital. So if we know the current price, and we forecast future dividends, we can solve for the discount rate.[7]

Forecasting future dividends is a difficult task. To simplify, assume that the firm's earnings, assets, dividends, and stock price are all increasing at a constant rate. This growth rate, in combination with the dividend to price ratio, determines the cost of equity capital.

For example, suppose a firm is growing 10% per annum, its stock price increases at the same rate, and it pays an annual dividend at the end of each year equal to 5% of its stock price. What is the return to the equity holders in this firm?

Imagine an investor who buys a share of common stock for $100 on January 1, receives the dividend on December 31, and then sells the stock. (The $100 price is arbitrary; any price gives the same result.) On December 31, the stock price is $110 (10% per annum capital appreciation), and the dividend is $5.50. The annual return to the investor, or the cost of equity capital, is ($10 + $5.50) / $100, or 15.5% (Butters, et al. [1981], page 140).

Derivation of the DGM

In mathematical terms, let

- K be the cost of equity capital,
- D be the stockholder dividend at the end of the previous year,
- P be the stock price at the beginning of the year, and
- G be the anticipated (uniform) growth rate of stockholder dividends.

We assumed above that all financial characteristics of the firm, such as earnings, assets, stock price, and dividends, are growing at the same rate. This is the common situation, since dividends can not grow indefinitely if earnings do not keep pace. The mathematical derivation, though, needs only the growth rate of dividends (hence the name Dividend Growth Model).

On January 1, the investor pays P for the stock. If the firm grows 100G% per annum, he can sell the stock on December 31 for (P)(1 + G). In addition, he receives the stockholder dividend on December 31. The dividend the previous year was D, so this year it will be (D)(1 + G). The return to the investor, or the cost of equity capital, is

$$\{ (P)(1 + G) + (D)(1 + G) - P \} / P, \text{ or}$$

$$K = (D/P)\ (1 + G)\ +\ G.$$

A more rigorous derivation examines only future cash flows, the stockholder dividends. The price of the stock equals the present value of future returns. If dividends are growing at

[7] On the Dividend Growth Model, see Gordon and Shapiro [1956], Sharpe and Alexander [1990], chapter 16, Weston and Copeland [1986].

100G% per annum, the future returns are $D(1+G)$ in one year's time, $D(1+G)^2$ another year later, and so forth. Discounting these at the cost of equity capital ("K"), we obtain

$$P = D(1+G)/(1+K) + D(1+G)^2/(1+K)^2 + D(1+G)^3/(1+K)^3 + \ldots$$

Now $(x + x^2 + x^3 + \ldots) = x/(1-x)$ for positive $x < 1$. If dividends are positive, $K > G$, so

$$P = D \{ (1+G)/(1+K) \} / \{ 1 - [(1+G)/(1+K)] \}.$$

Simplifying this expression gives

$$P = D (1 + G) / (K - G), \text{ or}$$
$$K = (D/P) (1 + G) + G.$$

Both parameters of the dividend growth model, the ratio of stockholder dividend to stock price (or "dividend yield") and the anticipated dividend growth rate, are calculated or projected by investment firms for the major publicly traded stock companies. The dividend yield is generally stable from year to year. It now averages between 4% and 4.5% for Property-Liability insurers.

The anticipated dividend growth rate is a subjective estimate, for which investment firms provide differing forecasts.[8] Value Line's average projected rate for Property/Casualty insurers was 11% in 1989, implying a cost of equity capital of 16% [= (4.5%)(1.11) + 1.11].

Capital Asset Pricing Model

The Dividend Growth Model works best in an unchanging environment: inflation remains level, the firm grows steadily, and the economy expands slowly. If inflation accelerates suddenly, the economy enters a recession, or the firm's book of business changes rapidly, the Dividend Growth Model may not provide reasonable forecasts.

Consider the effects of inflation. If inflation accelerates, and investors seek the same return in inflation-adjusted dollars, then the *nominal* cost of equity capital will rise. But so will the nominal costs of other financial instruments, such as the coupon rate on bonds, or the mortgage rate on home loans.

Few pricing actuaries try to forecast future inflation or economic conditions. Instead, they seek a relationship between the cost of equity capital and some steady and accessible index. The Capital Asset Pricing Model (CAPM) provides such a relationship.

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[8] One cause of this is that the growth rate of a firm is inversely related to the dividend yield: "growth stocks" pay low dividends, whereas "income stocks" pay higher dividends but grow more slowly. The Dividend Growth Model is not suitable for an individual firm changing its business strategy and operations. It is more appropriate for industry average growth rates and dividend yields.

Price Fluctuation

The Capital Asset Pricing Model presumes that there are two types of influences on common stock price fluctuations. Some price changes are peculiar to the specific firm. For instance, the stock price for an oil company may increase if the company discovers an untapped oil source. Similarly, the stock price of an auto manufacturer may drop if its employees declare a strike.

A second influence on the prices of individual stocks is the movement in the stock market as a whole. During a "bull market," the prices of most stocks increase. The prices of some stocks are highly responsive to market movements: if the market as a whole goes up 12%, the prices of these stocks may increase 15%. The prices of other stocks are less responsive, and may increase only 10% during this period.

Price fluctuations that are peculiar to individual firms are referred to as *firm-specific, unsystematic*, or *diversifiable* risk. Price movements that reflect overall market returns are termed *systematic* or *undiversifiable* risk. The Capital Asset Pricing Model hypothesizes that

- The *expected* return from a common stock is related only to the stock's systematic risk;
- The difference between the *expected* return from a common stock and the return on a risk-free security is proportional to the firm's systematic risk; and
- The systematic risk and the factor of proportionality are relatively constant over time.[9]

Formally, the Capital Asset Pricing Model posits the following relationship:

$$R = R_f + \beta\,(R_m - R_f),$$

where R is the expected return on a given stock,
R_f is the risk free rate, such as the rate on Treasury bills,
R_m is the overall market return, and
β quantifies the undiversifiable or systematic risk associated with this stock.

The "market risk spread," or $(R_m - R_f)$, has averaged about 8.6 percentage points over the past 60 years, if R_f is the return on short term Treasury bill.[10] The β parameters, which reflect

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[9] See Sharpe [1970] and Lintner [1965]. Good introductions to the CAPM are Weston and Copeland [1986], chapters 16 and 17, Brealey and Myers [1988], chapter 9, or Cohen, Zinberg, and Zeikel [1982], pp. 143-241. For application of these concepts to insurance returns, see Williams [1983] and Cooper [1974].

[10] This figure uses the arithmetic average of the difference between stock returns and the return on Treasury bills. The averages from 1926 to 1986 are 12.12% for stock returns and 3.51% for T-Bills, for a difference of 8.61% (Sharpe and Alexander [1990], pages 5-6). Other analysts, such as Cox and Griepengrog [1988] and Quirin and Waters [1975], use

systematic risk, are estimated from historical data, and have averaged about unity for most Property/Liability insurers.

In sum, the Capital Assets Pricing Model estimates that the cost of equity capital for Property/Liability insurers is about 8.6 percentage points higher than the return on Treasury bills. The Treasury bill returns are readily available, and they closely track monetary inflation, economic prosperity, and other external conditions that affect the cost of capital.

Return on Surplus and the Cost of Equity Capital

For 1970 through 1990, the return on Treasury bills averaged between 7.5% and 8%, implying a cost of equity capital of about 16%, considerably higher than the statutory return on surplus of 10%. Insurers have argued that a 16% return on equity is needed to attract equity capital. Critics of the insurance industry have retorted that statutory experience shows 10% to be a reasonable return on surplus.[11]

During individual years, accounting returns on surplus are influenced by movements in underwriting cycles, reserve strengthening or weakening, and (for some definitions) the realization of capital gains and losses. Financial returns are affected by interest rate fluctuations and stock market changes. In the short run, the insurer's accounting return will diverge from the investor's financial return.

But if accounting returns are consistently lower than the opportunity cost of capital, as the historical experience implies, equityholders might withdraw their funds from the insurance industry and invest them elsewhere (Balcarek [1968]; Plotkin [1967]). Yet the opposite has occurred: despite low returns and unfavorable regulation in many states, the industry raised $32 billion in public stock and bond offerings from January 1985 through June 1987 (Matison [1987]).

Company Growth and Investment Income

Accounting statements combine investment income from past writings with underwriting income from the present book of business. If the company's growth exceeds its investment

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geometric averages, not arithmetic averages. The geometric averages are 9.98% for stock returns and 3.45% for T-Bills, for a difference of 6.53%. See Ibbotson and Sinquefield [1982], pages 57-61, for further discussion of when to use each type of average.

[11] See, for example, NAIC [1984], who infer from the low returns manifest in accounting statements that insurance is a low risk industry: "The property/casualty industry earned a below-average rate of return for most years since 1929. . . [This is] inconsistent with claims that the property/casualty industry is of above-average risk. . . . it seems valid to point to the historical returns as evidence of the industry's relative risk." Similarly, upon reviewing these historical returns for 1973 through 1987, the California Department of Insurance decided that for implementing the rate rollback provisions of Proposition 103, 11.2% was an appropriate return on surplus.

yield, then investment income from past writings is less than the expected investment income from the present book. The effect on operating margins is the product of three terms:

$$(G - Y)(Y)(K)$$

where

G = the growth rate in invested assets derived from insurance operations,
Y = the after tax investment yield (including capital gains and losses), and
K = the lag between premium collection and loss payment, or the "funds generating factor" (Kahane [1978]; Fairley [1979]).

One may use annual growth in premiums written, assets, or reserves to estimate the growth rate ("G"). Premium volume changes are distorted by underwriting cycle fluctuations and different growth patterns in losses and expenses (only the former correspond to invested assets). Loss reserve changes are influenced by industry wide strengthening and weakening. Asset changes are influenced by paid in capital, stock offerings, and capital market fluctuations.

The 1970-1990 annual growth rates in these three indices are 10.0% for premiums written, 12.3% for assets, and 14.3% for reserves. We select 12% as an average growth rate.[12]

The expected after tax investment yield is difficult to ascertain because of the large capital gains in the mid to late 1980's stock market and the federal income tax revisions in 1986. During 1985–1988, for instance, insurers showed an average investment yield of 7.0% and an average investment gain (realized capital gains, unrealized capital gains, and other gains) of 2.2%, for a total pretax return of 9.2% (Best's [1990], pages 51, 59). The economic prosperity and the stock market growth during these years contributed to this high return. Current yields are lower, though this reflects the recession and the low interest rates of the early 1990's. We select 6% as the long-term average after tax return.

The value of K is increasing as the percent of business in the long-tailed commercial liability lines grows. We select 2.5 for the value of K.[13]

Thus, Y = 6%, (G – Y) = 6%, K = 2.5, and the product of these three terms is 0.9%. This product may be interpreted as follows: investment income received now is derived from premiums collected two and a half years ago. Since there is a 6% difference (G – Y) between

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[12] The loss reserve growth rate reflects the lengthening payment lags in addition to growth in incurred losses. Asset growth was particularly high from 1984 to 1989 (13.8% per annum) reflecting stock and bond returns in addition to premium growth.

[13] This is Noris's [1985] estimate of the 1983 liability duration for an insurance portfolio of Automobile Liability, Automobile Physical Damage, Workers' Compensation, Multi-Peril, and General Liability, weighted in the same proportion as the overall industry portfolio. The lag between premium collection and loss occurrence lengthens this figure. The inclusion of the property lines of business and the effects of cash flow and installment premium payment plans shortens this lag. See also Woll [1987].

- the growth in invested assets due to growth in reserves and premium volume, and
- the growth in invested assets due to after tax compounding of the investment yield,

the expected investment income stems from an asset base 15% greater (= 6% x 2.5) than the asset base that produced the investment returns in the current year. With an investment yield of 6% per annum (Y), one must add 15% x 6% to the actual investment income to derive expected investment income from current operations.[14]

An Illustration

A simple illustration should clarify this phenomenon. Choose Y = 5%, G = 15%, and K = 2 years. Moreover, suppose that

- premiums are collected and losses are paid on July 1 of each year,
- premiums are $1 million on July 1, 1990,
- losses are paid two years after the receipt of premiums, and
- there are no expenses or taxes.

To simplify, we use cash basis accounting for investment returns with annual dividends or coupons.

In 1990, $1 million of premium is collected and the appropriate unearned premium and loss reserves are set up. No expenses are incurred, so the $1 million is invested at 5% per annum to yield $50,000 in 1991 and $52,500 in 1992, when the claims are paid.

In 1991, premiums are $1.15 million. The investment income received from these assets in 1992 is $57,500. In 1992, premiums are $1,322,500, though no investment income on these assets is received until 1993.

[14] I am indebted to Robert Butsic for pointing out this phenomenon to me, and to Len Gershun and Gabriel Baracat for explaining its relationship to the difference between the growth rate and the rate of return (Butsic [1990], as well as Bingham [1992]). Similarly, Cummins and Chang [1983], pages 561-564, note that when the company growth rate exceeds the investment return, an accounting model may overstate the expected investment return.

Exhibit 2: Company Growth and Investment Income ($000)

	1990	1991	1992	1993	1994
Premium written	1,000.0	1,150.0	1,322.5	–	–
Investment income: on '90 premium	0	50.0	52.5	0	0
on '91 premium	0	0	57.5	60.4	0
on '92 premium	0	0	0	66.1	69.4
Total investment income received	–	–	110.0	–	–
Present value of future investment income	–	–	126.0	–	–

The present value of the investment income to be received in future years on the assets derived from 1992 premiums is

$$(\text{Assets} \times 0.05) / (1.05) + (\text{Assets} \times 1.05 \times 0.05)/(1.05 \times 1.05).$$

For assets of $1,322,500, this present value is $125,952. The actual investment income received in 1992 is $110,000, for a difference of $15,952, or 1.2% of premium. The estimate provided by (G - Y) (Y) (K) is (0.15 - 0.05)(0.05)(2) = 1%.[15]

Company Growth and the Unearned Premium Reserve

Business growth also increases the "equity" in the unearned premium reserve. [The "equity" is the deferred underwriting and acquisition expenses incurred and paid at policy inception and still unamortized on GAAP balance sheets.] Since deferred acquisition costs may not be capitalized in statutory financial statements (that is, the "equity" is not recognized), the increase in the equity is double counted in the income statement: once as an expense and once as a reserve addition. The effect on the operating ratio equals the ratio of the increase in the equity to earned premium, or

$$\frac{\text{Change in Equity}}{\text{Earned Premium}} = \frac{\text{(Growth Rate)(Unearned Prem Reserve)}}{\text{(Earned Premium)}} \times \frac{\text{(Equity)}}{\text{(Unearned Premium Reserve)}}$$

For 1970 through 1990, premiums have been growing at about 10% per annum. The ratio of unearned premium reserves to earned premium for all lines combined has been about 38.4% for 1977 through 1990, as shown in Exhibit 3. Before 1987, the ratio was about 40%; the

[15] The cash basis accounting used to simplify the example slightly overstates the discrepancy between actual and expected investment income.

decrease since then is due to the 1986 Federal Income Tax amendments.[16]

Exhibit 3: Earned Premium and Unearned Premium Reserves ($000,000)

Year	Unearned Premium Reserve	Earned Premium	Ratio
1978	31,367	78,738	39.8%
1979	34,561	86,917	39.8
1980	36,391	86,917	41.9
1981	38,194	97,465	39.2
1982	40,187	102,005	39.4
1983	42,303	107,224	39.5
1984	45,832	115,010	39.9
1985	56,850	133,342	42.6
1986	67,374	166,381	40.5
1987	72,302	188,989	38.3
1988	76,831	199,978	38.4
1989	79,941	206,669	38.7
1990	82,561	215,953	38.2
Average			39.8%

A rough estimate of the equity in the unearned premium reserve may be derived from Insurance Expense Exhibit data. Some expenses, such as commission, other acquisition expenses, and state premium taxes, are incurred when the policy is written. Other expenses, such as underwriting and administrative costs, are incurred partly when the policy is written and partly when the coverage is in force. The statutory procedure for estimating the equity in the unearned premium reserve, as described in the notes to the Insurance Expenses Exhibit, uses the ratio

$$\frac{\text{commission + other acquisition expenses + taxes, licenses, \& fees + (0.5)(general expenses)}}{\text{written premium}}$$

Industry expense data for 1990 provides the following figures in millions of dollars (Best's

[16] The ratio of unearned premium reserves to earned premium is available from Annual Statement data as page 3, line 9 divided by page 4, line 1. Until 1987, the full unearned premium reserve was an offset to taxable income. Since the timing of premium bookings had no effect on federal income taxes, many insurers even booked advance premiums, with an offsetting entry to unearned premium reserves. The revenue offset provision of the 1986 tax amendments allows only 80% of unearned premium reserves as an offset to taxable income. Booking premium more quickly increases federal income taxes. Insurers now avoid booking advance premiums, and they are shifting to premium payment plans and policy terms that allow later booking of written premium. For statutory accounting practices on the recording of certain premiums when billed or collected, see the minutes of the NAIC Emerging Issues (EX4) Working Group of June 4, 1990, and December 3, 1990.

[1991], pages 90-91, column 34, lines 2, 5, 6, 7, and 8:

$$\frac{24{,}598 + 12{,}994 + 6{,}972 + (0.5)(12{,}267)}{217{,}825} = 23.3\%.$$

The effect on statutory operating ratios caused by the double counting of acquisition expenses is

$$(0.100)\ (0.398)\ (0.233) = 0.93\%.$$ [17]

The combined effect of company growth on premium and loss reserves is 1.83 points of operating ratio. With a premium to surplus ratio of 1.94, this is 3.55 points of the return on surplus.

As noted earlier, the valuation of loss reserves at undiscounted amounts and the expensing of underwriting and acquisition costs when they are incurred decrease statutory surplus and raise the reported return on surplus. Loss reserve adequacy has the opposite effect. Lowe and Philbrick [1985] suggest that insurers implicitly discount their reserves, since they estimate an aggregate industry reserve deficiency about equal to the unrecognized interest discount.[18] Loss reserve discounting and reserve adequacy have opposite effects on the difference between the accounting return on surplus and the cost of equity capital.

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[17] NAIC [1984], Exhibits 8-5, 8-5, and A.8-3, show an average increase in prepaid expenses as a percentage of earned premiums of 0.7% for 1962 through 1981. Anderson [1972] models the effects of business growth on statutory earnings statements and concludes that "the prepaid acquisition expense adjustment can have a very significant effect on net income . . . especially . . . during periods of rapid growth and for firms issuing policies with longer durations" (page 207). See particularly the "Percent Return on Net Worth" columns in his Table 5 on page 209. Anderson uses an after-tax investment return of about 2%: his financial portfolio is two thirds bonds and one third stocks: three quarters of the bonds are tax exempt; and yields are 2% per annum for bond interest, 2% for stock dividends, and 3% for stock capital gains. For policies with annual terms (Anderson's "liability" rows), an increase in company growth from 5% per annum to 10% per annum has no effect on the "adjusted" return on net worth, but it reduces the statutory return on net worth from 6.01% to 5.56%. This difference is caused primarily by the change in the equity in the unearned premium reserve and to a lessor extent by the recording of reserves at undiscounted values. (See Anderson's Table 4 on page 208, columns "Prepaid Acquisition Expenses Adjustment" and "Excess Loss Reserve Adjustment.") Anderson also estimates the effect of not including unrealized capital gains and losses in the statutory earnings statement; see the "Unrealized Stock Appreciation Adjustment" in his Table 4 and the "Total Basis Percent Return on Net Worth" in his Table 5. The fluctuating stock market movements in the 1980's and the varying company strategies on realization of capital gains make these effects difficult to model.

[18] Lowe and Philbrick were writing at the nadir of the underwriting cycle, when industry loss reserves are weak. However, Cholnoky and Cohen [1989] and ISO [1989] find similar reserve deficiencies at year end 1988, the apex of the cycle.

The non-recognition of the equity in the unearned premium reserve lowers statutory surplus. In 1990, the industry reported unearned premium reserves of $82,561 million and policyholders' surplus of $138,401 million. The IEE estimate of the equity in the unearned premium reserve (23.3%) is $19,237 million, or 13.9% of surplus. Thus, the statutory return on surplus is understated by 2.16 points (= 3.55 – 1.39).

Other Factors

Company growth accounts for only a part of the disparity between accounting returns on surplus and estimates of the cost of capital. Several other items affect the statutory return on surplus.

1. Mutual and Stock Carriers The industry wide operating returns include both mutual and stock company experience, whereas the cost of capital estimates use only publicly traded stock company data. Differences between mutual and stock companies in (a) premium to surplus ratios, (b) operating profitability, and (c) dividends to policyholders affect the comparability of the accounting returns with the cost of capital estimates.

(a) Premium to Surplus Ratios: The premium to surplus ratio for stock companies was lower than the corresponding ratio for mutuals from 1969 to 1982, higher from 1983 to 1988, and lower from 1989 to 1990.[19] Using stock company figures would not give a substantially different accounting return on surplus.

(b) Operating Profitability: Stock companies have shown poorer underwriting performance than mutuals or reciprocals during the past 10 years. The 1981 to 1990 all lines underwriting ratios were –9.4% for stock companies, –7.0% for mutuals, and –5.5% for reciprocals.[20] If stock company figures are used for the accounting return on surplus, the average is slightly lower, increasing the disparity with the financial cost of capital.

(c) Policyholder Dividends: Most mutuals provide larger policyholder dividends than stock companies do. In 1990, the ratio of policyholder dividends to premiums earned was 0.9% for stock companies and 1.2% for mutuals (Best's [1991], pages 5 and 7). Mutuals are owned by their policyholders, so the policyholder dividend of a mutual is similar to the combined

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[19] The 1990 ratios of net premium written to policyholders' surplus were 1.208 for stock companies, 1.290 for mutuals, 1.685 for reciprocals, 0.707 for Lloyds organizations, and 1.264 for all insurers combined. These ratios use unconsolidated surplus figures, with no eliminations for interownership, and therefore differ from the 1.95 premium to surplus ratio cited above; see Best's [1991], page 132. A more thorough analysis would examine the premium to surplus ratios for major insurers, some of whom (e.g., State Farm) have unusually high or low ratios.

[20] Best's [1991], pages 141, 145, and 147. A more careful analysis would examine the underwriting ratios by line of business, since mutual company insurance portfolios are weighted toward the Personal Lines, which produce less investment income, whereas stock company insurance portfolios are weighted toward the Commercial Lines, which produce more investment income; see Roth [1992], pages 457-458.

policyholder and stockholder dividends of a stock company.[21] Using stock company dividend experience would raise the accounting return on surplus by about 1 percentage point.

2. Unrealized capital gains: Unrealized capital gains and losses are a direct charge or addition to surplus; they do not pass through the statutory earnings statement. This treatment generally depresses the statutory return on surplus when business volume is growing or when the industry's financial portfolio is shifting to common stocks. The lack of a deferred tax liability for the unrealized gains in statutory financial statements partially offsets this. (GAAP equity incorporates the deferred tax liability; see Berthoud [1988].) The combined effect depends on the growth rate of unrealized capital gains and the relation between realized and unrealized gains. If unrealized gains are stable from year to year and are offset by realized capital gains, the earnings statement is not significantly affected by inclusion or exclusion of unrealized gains, whereas the surplus account is depressed by the exclusion of the deferred tax liability. Conversely, if unrealized gains are increasing rapidly enough from year to year, the effect on the earnings statement is greater than the effect on surplus.[22]

3. Amortized bond values: Statutory accounting uses amortized values for bonds in good standing, raising their values above market during periods of increasing interest rates. This effect was great in the 1970's and early 1980's, though it has subsided in recent years, as interest rates have become more stable and as old bonds mature.

Amortization of bonds affects both reported earnings and surplus. As interest rates rise, the market value of bonds declines (Bierwag, Kaufman, and Toevs [1983]). Statutory accounting, which uses amortized values for bonds, shows no effect on either earnings or surplus. Market value accounting shows an earnings loss and a decline in surplus. The earnings loss reduces the reported return, and the decline in surplus increases the reported return. Unless there is a continual increase or decrease in interest rates, however, these effects are temporary.

Conclusion

The reported return on surplus of 10% is understated because of the interaction of company growth with statutory accounting practices. The 2.2% adjustment for growth, along with other needed adjustments (e.g., policyholder dividends, valuation of bonds), allows a more accurate assessment of accounting returns.

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[21] Cf. the federal income tax procedure of dividing mutual life insurance company dividends between "policyholders as owners" and "policyholders as customers" (Saunders [1989]). On the "ownership" of mutual insurance companies, see Leckie [1979] and Trowbridge, Leckie, Margolin, and Roberts [1979].

[22] NAIC [1984] calculates a 20-year average (1963-1982) of unrealized capital gains and losses as a percentage of mean total assets of 0.07%, with wide fluctuations from year to year; see Exhibit 8-4. Roth [1992] calculates the return on surplus as (the change in statutory surplus, plus stockholder dividends, less paid-in capital) divided by (beginning surplus), thereby avoiding the statutory income statement. This includes unrealized capital gains and losses, and Roth shows larger returns for the 1980's than shown in Exhibit 1 above.

This paper does not address the normative issues, such as: What is an appropriate return for insurers? Are insurers over- or under-earning? Should government agencies regulate insurers' profitability? In the past, the discrepancies between the accounting and financial rates of return have hampered objective consideration of these normative issues. Once the insurance industry's historical return has been properly quantified, these questions can be more fully examined.

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DISCUSSION OF "THE COMPETITIVE MARKET EQUILIBRIUM RISK LOAD FORMULA FOR INCREASED LIMITS RATEMAKING," BY GLENN MEYERS

Howard C. Mahler

Discussion by Howard C. Mahler

"The Competitive Market Equilibrium Risk

Load Formula for Increased Limits Ratemaking"

Yet another fine paper by Glenn Meyers will appear in PCAS 1991. In it Glenn derives a formula for risk loadings per (expected) occurrence; the risk loading R is proportional to the (partial) derivitative of the Variance with respect to the number of occurrences n.

$$R \propto \frac{\partial \text{ Variance}}{\partial n}$$

This result follows directly from his assumption that each insurer will maximize its collected risk load subject to a constraint on the total variance of its book of business.[1]

Maximize Rn subject to the constraint:

$$\text{Variance} = A^2$$

The solution[2] via the method of Lagrange multipliers is:

$$\frac{\partial (Rn - \lambda\text{Variance} + \lambda A^2)}{\partial n} = 0$$

$$R = \lambda \frac{\partial \text{ Variance}}{\partial n}$$

$$R \propto \frac{\partial \text{ Variance}}{\partial n}$$

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[1]If some other type of constraint were chosen which depended on something other than the total variance (or standard deviation), a different formula for the risk load would follow.

[2]The author shows that one can average the (expected) number of occurrences n over the insurers writing the given line/limit combination. The author refers to this average as $\bar{n}$.

The author breaks the variance into two pieces, process risk and parameter risk. As is usual, the process risk varies with n, while the parameter risk varies with n^2. In the author's matrix notation:

$$\text{Variance} = n^T U + n^T V n$$

The first term quantifies process risk, while the second term quantifies parameter risk. Therefore,

$$\frac{\partial \text{ Variance}}{\partial n} = U + 2Vn$$

Therefore,

$$R \;\alpha\; U + 2Vn$$

which is the author's equation 5.6.

It should be noted that this differs from the usual variance based risk loadings. First, it considers parameter variance as well as process variance. Second, the parameter variance enters multiplied by n, a measure of size.[3,4] One still has to select the proportionality constant for the risk load. The author suggests looking at average risk loads in the insurance market.

The ideas in this paper are being applied by Glenn in the calculation of I.S.O Increased Limits Factors. This has stirred up some controversy, which was discussed at the March 1992 CAS Seminar on Ratemaking.

In any case, this paper is a very significant step forward in the theory of risk loads.

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[3]These two features are analogous to those found in the computation of credibilities. See for example, the discussion of parameter uncertainty in H.C. Mahler, Discussion of G.G. Meyers, "An Analysis of Experience Rating", PCAS LXXIII, 1987.

[4]The proposed risk loading does not depend on the size of the particular insurer. (It does depend on the average amount of the particular line/limit combination written by all insurers.)

CONSISTENCY OF RISK LOADED PREMIUMS

John M. Cozzolino

Consistency of Risk Loaded Premiums

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ABSTRACT

The meaning of consistency of increased limit factors (ILF) is reconsidered and a new test of the consistency condition is proposed. It is shown that the three major measures of risk satisfy the new consistency test with no restrictions. The problems of specifying consistent risk-loaded rates for high limits are discussed and a revised subtraction formula is given for the case where risk is measured by the certainty equivalent of an exponential utility function. Risk "profile" curves are suggested as a method to emphasize the objective aspects of risk load. A new practical meaning is suggested for the old consistency condition.

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INTRODUCTION

The paper begins with the statement of two different types of consistency which are discussed in the literatures of utility theory and the literature of layer pricing, as discussed in [2] by Miccolis. The meaning of the consistency test is reconsidered and a new test is proposed. The new consistency test is shown not to impose any limitations upon either utility, variance or standard deviation as measures of risk. It is suggested that the error in the old consistency test is caused by the assumption that the rate for a excess layer can be found by subtraction of the corresponding two rates for ground-up covers. This subtraction rule is a problem for risk-loaded rates but not for expected value rates. Miccolis showed the rate reduction due to layer splitting. It is shown similarly here for exponential utility.

The next part of the paper provides a new formula for the premium of an excess layer when the measure of risk employed is Risk Adjusted Cost. The paper suggests that the old test for consistency is useful for detecting cases where the layer being tested ought to be split so that a lower pricing can be achieved.

Finally, the paper provides a formal proof in appendix I of the new formula. It gives a separate discussion of the application of the exponential utility functions in appendix II. The last part, appendix III, is a lengthy illustration of the use of the exponential utility functions and a comparison with the variance measure of risk shown by Miccolis.

Having provided a complete road map for the parts of the paper, I now add one point which helps complete the connection. The research began with the goal of applying utility to the task of calculating risk loads. Consistency was realized to be a roadblock. Therefore the formal content of the paper begins with consistency.

THE CONCEPT OF RISK LOAD

The uncertainty in the cost of insurance is its distinctive feature. Furthermore, different insurance products have different degrees of cost uncertainty, and therefore different degrees of risk to the insurer. In particular, policies with different upper limits of insurance coverage have very different degrees of risk in spite of their similarity in the type of risk. One idea of a risk load can be expressed as that amount which when added to the pure premium of each policy makes a risk averse insurance company indifferent between the alternatives which the buyer might select. Another, perhaps more fundamental purpose for the risk load is to create an "adequate" rate which holds the chance of insolvency down to an acceptable level . If the business of insurance had to exist on only expected value rates, the nature of the business would be much like gambling, where the outcomes are prone to runs of both good and bad luck. Management skills would matter little compared to the role of luck. A risk-load improves the chance of solvency by giving a positive expected growth rate to the surplus, which is the cushion against insolvency.

CONSISTENCY

There are two kinds of consistency, whose discussion would logically fit within this topic; the consistency of Increased Limits Factors (ILF's) and the consistency of choice under uncertainty are both relevant. The first is defined in the paper by Miccolis [2]. The second is in the literature of Utility Theory.

Consistency of risk loads among lines

Some would say that the risk load for automobile liability ought to be less than the risk-load for products liability. Such comparisons are based upon intuition about which things are more risky than others. Utility theory, a structure based upon axioms of consistency, is designed to give consistency of rankings by risk. Variance, as a measure of risk, may not give this kind of consistency and standard deviation also could fail in some situations. Among these later two risk load choices, variance is more likely to give this kind of consistency because it has a closer relationship to a utility function than does standard deviation. Pratt [3] shows that variance is the first order approximation to certainty equivalent when variance is small.

Consistency of increased limits factors

Risk loads, as discussed by Miccolis in his 1977 PCAS paper [2], and by Sheldon Rosenberg in his review of that paper, is the subject of our interest here. All risk load methods, including utility, variance, and standard deviation, can be inconsistent, but it happens less often for standard deviation. Standard deviation increases less rapidly as a function of loss size than does the variance which is the expectation of loss size squared. Therefore one would expect this statement is true also for policy limit which is the top loss size in the expectation integral. One purpose of this paper is to question wherein it is wrong for a rating bureau to publish rates which are inconsistent. What was the original motivation for the concern with consistency and what role does it play today? An example from the Rosenberg discussion of the Miccolis paper is presented next. All policies in this example have a $250,000 aggregate limit.

The table giving "Increased Limits Factors" for various per occurrence limits follows:

TABLE 1

P.O. LIMIT*	ILF
$25,000	2.00
$50,000	2.25
$100,000	2.80
$250,000	3.20

* DENOTES PER OCCURRENCE LIMIT

The test for inconsistency examines the ratio of the differences in ILFs to the differences in limits. It shows that the ratio based upon the change from the $25,000 to the $50,000 limits is .01. This is computed as the ratio of (2.25-2.00) to the difference (50-25). The scale factor change of leaving off the factor of one thousand in the premium figures does not matter if done consistently. A similar calculation also shows that the corresponding ratio based upon the change from the $50,000 to the $100,000 limits is .011. This is the ratio of (2.80-2.25) to (100-50). Such an increase in the ratio identifies the condition of inconsistency. While this test is simple, the meaning is not so clear. It is not clear why this ratio ought to be declining. One possible motivation is to think of the premium difference as the price of coverage for the layer going from the lower limit to the higher limit. Perhaps it is testing the condition that the price per unit of coverage declines as the layer is moved up the loss size scale. Where this motivation would be wrong is that the proper price of a layer of coverage is not the difference in premiums, when the premiums include a risk-load. One purpose of this paper is to revisit this idea of inconsistency and to suggest that it is no longer relevant.

It will be shown that a new statement of the condition of consistency is almost always true for rates which are calculated based upon a probability distribution. This paper does suggest an important warning to those who base rates for excess layers upon differences computed from tables of risk-loaded increased limits factors. I suggest that the reason behind inconsistency is half forgotten, and no longer relevant. Miccolis gives an example of inconsistencies on page 33. He wrote "The marginal premium per $1000 of coverage should decrease as the limit of coverage increases. If not, this implies negative probabilities." Miccolis shows that consistency is a property obeyed by expected value premiums; he does not claim that it is a property of risk-load based premiums. Apparently, consistency is a test of whether the increased limits factors are based upon the use of a probability distribution. If the risk-loaded premium would necessarily obey the consistency test, then Miccolis would likely have shown it! His work on the risk reduction due to layering suggests that an inequality condition exists instead. This will be discussed later.

THE NEW CONSISTENCY TEST

What ought to be true is that the cost of a layer be a decreasing function of its starting (attachment) point. A higher layer ought not cost more than a lower layer when both have the same width. This will be shown to be true for any probability distribution and for any utility function of loss. If true, for a layer of any fixed size, then the price of the layer per unit of coverage will also decline because the division by size of the layer merely scales the function. The reason that this is so generally true is that the insurer pays something (all or part) for all losses above the attachment point. The higher the attachment point, the fewer losses get that high. Miccolis states essentially the same thing at the top of page 34. The sentence "Aside from the mathematical interpretation of this consistency test, it has a very practical meaning. In general, it does not make sense to the insurance buyer to have to pay more for each additional $1000 of coverage since the probability of losses larger than some limit should be less than for a lower limit."

PROOF OF THE NEW CONSISTENCY

Let's begin with the basic formulas for expected loss, risk adjusted cost, and the variance (actually the second moment) for the case where the frequency is assumed to follow the Poisson distribution. The symbol F represents frequency; it is the parameter of the Poisson distribution, and is also the mean number of claims. Here the f(x) is the density function for the severity distribution. F(x) is the integral of the density, called the cumulative distribution function. Let U(x) be an increasing function of the individual loss size x. Consider a layer which starts at an attachment point "a", and has size "h". The largest loss completely covered is of size (a+h). Let U(x) be an increasing function of the individual loss size x. The expected value of U(X) will be denoted EU. It is found as:

$$EU = U(0)\times\int_0^a f(x)dx + \int_a^{a+h} U(x-a)f(x)dx + U(h)\times\int_{a+h}^{\infty} f(x)dx \quad (1)$$

The first integral is just F(a). It represents all the cases of individual loss where the loss is less than the attachment point. The second integral counts all loss cases within the insured layer, and the third integral counts losses above the limit. The expression for EU is a function of the attachment point, a, and the layer width, h. Those variables also appear in the limits of the three integrals, as well as in the integrand of the middle integral. We are interested in the derivative of the function EU with respect to the attachment point a. The result is:

$$\frac{\partial EU(a,a+h)}{\partial a} = -\int_{a}^{a+h} U'(x-a)f(x)dx \qquad (2)$$

From the formula for the derivative of definite integrals, one finds that all the terms coming from derivatives of the limits of integration happen to cancel each other. The remaining term, as shown above is the integral of the derivative of the former integrand. The negative sign in front results from the derivative of the argument of the function evaluated at (x-a) with respect to a. The U prime (U'(x)) stands for the derivative of the function U with respect to its argument. If and only if this derivative is positive, then the derivative of the function EU with respect to a is negative, and this is so for all positive values of h. To interpret this result, consider first the case where the function U(x) is just x itself.

$$EL = F * \left\{ \int_{a}^{a+h} (x-a) f(x) dx + h (1 - F(a+h)) \right\} \qquad (3)$$

The expected aggregate loss from this layer is equation (3). When the function U(x) is the exponential function exp(rx), then the Risk Adjusted Cost, which is the risk loaded Premium based upon exponential utility with risk aversion level r, is given by the

$$RAC(a, a+h) = (F/r) x \left\{ \int_{0}^{a} e^{0} f(x) dx - 1 + \int_{a}^{a+h} e^{r*(x-a)} f(x) dx + e^{(r*h)} * (1 - F(a+h)) \right\} \qquad (4)$$

Its derivative with respect to a is a negative quantity, as shown in (5).

$$\frac{\partial RAC}{\partial a} = -F * \left[\int_{a}^{a+h} e^{r*(x-a)} * f(x) dx \right] \qquad (5)$$

Thus the result is that the risk loaded premium for the layer is a decreasing function of the attachment point, a, for any positive value of h. The "new" consistency is true for all exponential utility functions regardless of the degree of positive risk aversion. With regard to variance as a measure of risk, it is well known that for Poisson frequency, the variance of the aggregate loss distribution is equivalent to the expected frequency multiplied bythe second noncentral moment of the severity distribution. When the function U(x) is x squared, the result is:

$$VAR(a, a+h) = F x \left\{ \int_{a}^{a+h} (x-a)^2 f(x) dx + h^2 x (1 - F(a+h)) \right\} \qquad (6)$$

This function also fits into the pattern of the first two cases and will have a negative first derivative. Thus we can conclude that the premium for an excess layer, which contains a risk load based upon variance or upon exponential utility with non-negative risk aversion, is a decreasing function of its attachment point regardless of the size of the width of the layer, h. Therefore, the "new" consistency holds, with no restrictive conditions, for both variance and for exponential utility. The condition is likely to be true also for other utility functions and for the standard deviation. The only condition upon the function is that it be an increasing function; this is also required of a function for it to be a utility function. However, the starting point for this proof, equation (1), which is essentially the expected utility on a per occurrence basis, while true for exponential utility and for variance, may not be true for other utility functions. Equation (8) is the real starting point. Apparently all of these possible bases for risk load will give premiums which have decreasing premium per unit of coverage as the attachment point is moved up the loss size scale.

CONCLUSIONS ABOUT CONSISTENCY

The result of this analysis so far is the conclusion that the old definition of consistency is flawed in the way it has been applied. In the case of risk-loaded premiums for excess layers, it must be replaced by the new definition and the new test for consistency. Perhaps the old consistency should be forgotten because its reason for existence is wrong when the pricing includes a risk-load. Its practical meaning to many is just that the premium increases "too fast" as a function of the limit. It survives, giving the appearance of precision, but serving only as a vague condition for the expression of "too fast". Another view of the use of the inconsistency condition is that it may be useful to detect situations where one carrier ought not to price so wide a layer because the price can easily be reduced by splitting that layer into two or more layers. It would detect some such situations, but would it detect all such? Which ought to be detected?

RISK REDUCTION DUE TO LAYERING

The more positive thrust of the Miccolis paper is to show the risk reduction due to layering of coverage. For risk-loaded ratemaking, we have an inequality in risk-loaded premiums. It is:

$$P(x,y) \geq P(x,z) + P(z,y) \quad \text{for } x < z < y \qquad (7)$$

The inequality simply says that the premium for the coverage from x to y is more expensive than the coverage structured into two layers; the first layer is from x to z and the second layer is from z to y. An important condition is that the two layers are not insured by the same insurer. The spreading, or subdividing of risk would not then be achieved. This is fundamental for risk reduction to exist. Often, we will consider that the two insurers writing the two layers have the same risk aversion. This is not necessary, but might be convenient for illustrations.

IMPLICATIONS FOR PRICING

The most important conclusion is that there does not exist a unique risk-loaded price of coverage between X, and Y, unless you define it as the coverage provided by only one policy and only if the degree of risk aversion is fixed. Once layering is allowed, the premium depends upon the layer details. There are some implications here for the pricing operations of both insurers and reinsurers. The problems raised for a rating bureau are larger because of some uncertainty about how its products will be used by its member companies. Some alternative choices for a rating bureau are the following:

1. No Risk Load-Compute increased limits factors based upon expected value. This would give rates for excess layers also since the differences are correct for excess layers when there is no risk-load. This will not satisfy those who believe that risk-load is very important to the stability of the industry and that rating bureaus ought to maintain their practice of including it.

Objectively, the function of computing risk load fits within the function of the rating bureau because that calculation is dependent upon the historic loss data from which the degree of variability is measured. Without this measurement of actual variability, the risk-load would be entirely subjective and its theoretical connection to rate adequacy would not be easily demonstrable.

2. Publish risk-loaded ILF tables and also publish risk-loaded excess layer rates for some commonly used layers. This would be popular and would bring out the fact that layer premiums cannot be calculated by subtraction, but it could give rise to some cases of old inconsistency. This appearance of old inconsistency is considered undesirable even if the meaning of old consistency is not what it was previously thought to be.

3. Assume Standard Layers-There could be layer breakpoints at every limit which is a whole number of half-million dollar units, for example. This would probably eliminate the occurrence of old inconsistency. If the use of half-million dollar layers did not achieve this elimination, then there would be some layer sizes which would accomplish this. Another point for discussion is whether there is a limit as the process of layer subdivision is carried to the extreme of infinitely many layers of infinitesimal width. This is somewhat similar to the case of fractional participation, the fundamental basis for pro rata forms of insurance, as well as for most forms of risk sharing of investment projects. Paul Samuelson discussed the limits of risk sharing in 1963 (4). In "Risk and Uncertainty: A Fallacy of Large Numbers", his simple and elegant argument showed that the value of a small share approaches its expected value as the share gets very small.

The same argument works also for layers just as it does for shares. A layer of coverage of size dx in excess of the attachment point x can be evaluated using a series expansion for the utility function as was shown in (3) by Pratt. With the expected value as the limit of subdividing, an interesting question would be how close to this limit does the industry operate. Those familiar with the costly nature of reinsurance brokerage would be inclined to believe that the practical world of insurance operates at significantly different rates than the expected value rates except during the extremes of the soft market. Then the extreme competition does exist and drives the rates even lower than expected value rates. In other words, the limit of expected value pricing does not seem highly relevant in light of the actual behavior.

LAYER RATES BY SUBTRACTION PLUS DIVISION

Let us now concentrate upon computing the risk loaded premium for an excess layer, but using exponential utility in place of variance. The risk adjusted cost, RAC, is the certainty equivalent defined in the theory of utility but specialized here to the family of all exponential utility functions. Cozzolino [1978], "A Method for the Evaluation of Retained Risk", shows that for a Poisson frequency with parameter F and a risk aversion level denoted by r, the RAC, which represents a risk loaded premium, can be found from equation 8.

$$\mathrm{RAC} = \frac{F}{r} \times \left[e^{(r * \mathrm{RAS})} - 1 \right] \qquad (8)$$

The expression RAS stands for the Risk Adjusted Severity and it is computed from the severity distribution according to the formula:

$$RAS = \frac{1}{r} * LN\left[\int_0^{\infty} e^{r \times l} f(l) dl \right] \qquad (9)$$

Here, LN stands for the natural logarithm. The result of the above two expressions is the simpler expression, equation (10) which will be the basis of the subsequent equations.

$$RAC = \frac{F}{r} \times \left\{ \int_0^{\infty} e^{r \times l} f(l) dl \quad -1 \right\} \qquad (10)$$

RAC is the "certainty Equivalent" of utility theory. It is the premium for the risk represented by the severity probability distribution f(l), in combination with the Poisson frequency with parameter F. Notice that F appears only as a multiplicative factor. RAC/F then represents a rate. The next step is to study this in more detail. The symbol l represents the individual loss from the severity distribution. The symbol L represents the loss to the insurer if he insures the layer from x to y. An alternative description is that there is coverage of amount (y-x) in excess of x, also called the attachment point. Thus L is a function of l, and of x, and of y. It is shown in equation 11.

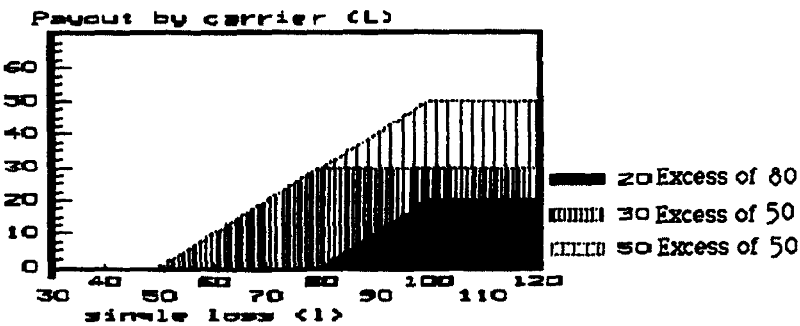
$$L(l,x,y) = \begin{cases} = 0 & \text{for } 0 < l \leq x \\ = (l-x) & \text{for } x < l \leq y \\ = (y-x) & \text{for } y < l < \infty \end{cases} \qquad (11)$$

It can easily be shown that such payout functions are additive. Thus the claim is that:

$$L(l,x,y) = L(l,x,z) + L(l,z,y) \text{ for all } z \text{ in } (x,y) \qquad (12)$$

The loss from the policy of amount (y-x) in excess of x can be expressed as the sum of the losses from two policies. They are the coverage of amount (z-x) in excess of x plus the coverage of amount (y-z) in excess of z. This can also be seen in terms of the graph of figure I which shows the three loss functions being discussed.

FIGURE I



In the example of the graph, the x value is 50, the y value is 100, and the z value chosen is 80. The sum of losses from the 30 excess of 50 plus the 20 excess of 80 equals the loss from the policy for

50 excess of 50. This is true at any individual loss size l, the abscissa of the graph.

With the loss function L now established, and its additivity demonstrated, we can now express the RAC equations in terms of L as follows:

$$RAC(x,y) = \frac{F}{r} * \left\{ \int_0^{\infty} e^{r*L} f(l)\,dl \quad -1 \right\} \qquad (13)$$

Note that the loss function specified in equation (11) is the L in equation (13). That is why the RAC is a function of both x, and y. The real working equation is with the definition of L(l,x,y) substituted into the last equation. It is given in equation (14). The additivity of the L loss function, equations 11, and 12, and the RAC equation (13), are all used in Appendix I to shows how to derive the last equation. Equation 14 can be further expressed in

$$RAC(x,y) = \frac{F}{r} * \left\{ e^{0} * \int_0^{x} f(l)\,dl + \int_x^{y} e^{r*(l-x)} f(l)\,dl \right. \qquad (14)$$
$$\left. + \quad e^{r*(y-x)} \int_y^{\infty} f(l)\,dl \quad -1 \right\}$$

terms of the premium functions of the sub layers from x to z and from z to y. The final result is equation 15 which follows:

$$RAC(x,y) = RAC(x,z) + RAC(z,y) * e^{r*(z-x)} \qquad (15)$$

Equation 15 is the main result. It is a useful tool for layer pricing. Notice that when $r = 0$ it implies that additivity is corrrect in the case of premiums based upon expected value, since e to the zero power is unity. This corresponds to expected value pricing, and is in agreement with the Miccolis results. Notice that the factor r in the exponent is positive for a risk averse decision maker, and the factor (z-x) is also positive, so that the exponential factor in the second term of the equation is a positive number greater than one. Therefore, deletion of this exponential factor would decrease the right-hand side of the equation. The result is a fundamental inequality, stated first, without proof, as equation 7. It is equation 16. This inequality also shows, by turning it around algebraically, that the price of a layer, when computed by subtraction, is

$$RAC(x,y) > RAC(x,z) + RAC(z,y) \quad \text{for all } r > 0 \quad (16)$$

overestimated. This is shown by the following revised form of equation 16, shown next:

$$RAC(z,y) < RAC(x,y) - RAC(x,z) \quad \text{For any } x < z \text{ and any } z < y. \ (17)$$

The two premiums in the subtraction shown in equation 17 are for premiums for coverages in excess of attachment point x. More often, these terms would be representing ground up coverages and so x would then be zero. Since subtraction of risk loaded premiums gives an overestimate of the correct premium, we can turn equation 15 around to obtain a very useful correction form. It is equation 18.

$$RAC(z,y) = \left[\frac{RAC(x,y)-RAC(x,z)}{e^{r*(z-x)}}\right] \qquad (18)$$

This says that the premium computed by subtraction must be divided by a number greater than one to yield a correct result. The implication is that the correct answer is smaller than the answer obtained from subtraction. The difference,

$$\begin{aligned} &RAC\ (x,y)-RAC(X,Z)-\ RAC(Z,Y) \\ &= \text{RISK REDUCTION DUE TO SPLITING}\ (x,y) \qquad (19) \end{aligned}$$

is the risk reduction due to layering. This was first computed by Miccolis, shown on his p. 49, for variance as a measure of risk. How similar are the results? An example given by Miccolis is repeated here in appendix III so that the comparison can be seen.

CONCLUSIONS

An important implication of equation 18 is that there is no need for tables of increased limit factors for excess layers; the equation makes that information directly computable from the ground-up rates. It is interesting that the correction factor is not a function of the probability distribution but a function only of the risk aversion level and of the layer endpoints. All of the results shown so far which involve the family of exponential utility functions are valid for all risk aversion levels greater than or equal to zero. The user of these results should be aware, however, that for high enough risk aversion and/or high enough limits, the old inconsistency will always occur. This is not a manifestation of some obscure flaw in the theory of utility. Instead, it is simply a warning that layer splitting is essential to enable reasonable pricing. It simply demonstrates the need for layering the coverage, just as is usually done.

Experience with applications of utility analysis suggests that every company ought to have its own utility function which serves to represent the attitude toward risk of that company. Larger companies ought to be less risk averse than smaller companies, although the choice is the prerogative of management.

The risk aversion can also be determined in the same way that Miccolis used to determine the coefficient of variance for calculating risk load. This method was to set the coefficient to result in a 5% risk load for a policy with the basic limit. Utility theory is useful to improve the understanding of risk loads, their meaning, and their implications. It will probably be a useful tool to help insurance company actuaries develop pricing rules. Appendix II gives some of the considerations relevant for the decision of whether to use utility. However, for a rating bureau, utility theory is not a complete theory of insurance pricing. A current influence upon the developing ideas of industry risk-load is the changing ideas of the role of the service bureau. In response, the bureau can give the risk-load as a function of the risk aversion level so that the subjective aspect of risk-load, selection of the company's risk aversion level, is left to the insurer, while the objective part, determined from data, is recognized as an essential bureau function. The graph of the risk adjusted cost function, as a function of the risk aversion level, for all risk aversion levels is a simple way to do this. In fact, it can be shown that the RAC function, as a function of the risk aversion level, uniquely encodes all of the probability information contained in the loss distribution.

This property of the complete family of exponential utility functions is known from the theory of transforms. The transform is the same function as the expected utility. Therefore the risk profile curve, which is the graph of RAC as a function of the risk aversion level, is as objective a measure of risk as is possible. Increased limits pricing is an essential topic today in light of the increasing popularity of large risk retention by the buyer. The increased risk retained by the insurer is something which the industry must maintain a careful awareness of. The risk of writing a policy is a strongly increasing function of the limits of coverage. The understanding provided by the theory of utility is useful for both insurers and regulators.

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APPENDIX I: PROOF OF EQUATION 15

The starting points are equation 11, which defines the loss to the insurer who insures the excess layer from x to y, already denoted L(l,x,y), and the equation which gives the RAC for that layer. Our goal is to express it as a function of RAC(x,z) and RAC(z,y), which are the risk-loaded premiums of the two contiguous layers into which the (x,y) layer might be broken. Let us begin by applying the definitions to the sublayers. These are:

$$RAC(x,z) = \frac{F}{r} * \left\{ \int_0^x f(l)dl + \int_x^z e^{r*(l-x)} f(l)dl + e^{r*(z-x)} \int_z^\infty f(l)dl - 1 \right\} \tag{21}$$

and,

$$RAC(z,y) = \frac{F}{r} * \left\{ \int_0^z f(l)dl + \int_z^y e^{r*(l-z)} f(l)dl + e^{r*(y-z)} \int_y^\infty f(l)dl - 1 \right\} \tag{22}$$

The loss functions corresponding to these two layers are L(l,x,z) and L(l,z,y). These can be expressed in the same form as equation 11.

$$L(l,x,z) = \begin{cases} = 0 & \text{for } 0 < l < x \\ = (l-x) & \text{for } x < l < z \\ = (z-x) & \text{for } z < l < \infty \end{cases}$$

$$L(l,z,y) = \begin{cases} = 0 & \text{for } 0 < l < z \\ = (l-z) & \text{for } z < l < y \\ = (y-z) & \text{for } y < l < \infty \end{cases} \tag{23}$$

The next step in preparation is to write equation 12 which expresses the layer losses from each layer as the terms in each layer.

This will express the L(l,x,y) in terms of four loss size intervals rather than three.

Layer (x,y) Loss		Layer (x,z) Loss		Layer (z,y) Loss	
0	=	0	+	0	for $0 < l < x$
(l-x)	=	(l-x)	+	0	for $x < l < z$
(l-x)	=	(z-x)	+	(l-z)	for $z < l < y$
(y-x)	=	(z-x)	+	(y-z)	for $y < l < \infty$

The first step in the proof of equation 15 is to begin with equation 14 and to split the middle integral, which goes from x to y into two integrals corresponding to the layers of the table above. The result is:

$$RAC(x,y) = \frac{F}{r}*\left\{ \int_0^x f(l)dl + \int_x^z e^{r*(l-x)}f(l)dl - 1 \right\}$$

$$+ \frac{F}{r}*\left\{\left[e^{r*(z-x)}\right]\left[\int_z^y e^{r*(l-z)}f(l)dl + e^{r*(y-z)}\int_y^\infty f(l)dl\right]\right\}$$

The expression above for RAC(X,Y) has two curly brackets on its right hand side. The following expression can be added into the first bracket and balanced by subtraction within the second bracket.

$$e^{r*(z-x)}\int_z^\infty f(l)dl$$

The resulting equation appears as:

$$RAC(x,y) = \frac{F}{r}*\left\{ \int_0^x f(l)dl + \int_x^z e^{r*(l-x)}f(l)dl + \right.$$

$$\left. + \quad e^{r*(z-x)}\int_z^\infty f(l)dl \quad -1 \right\} +$$

$$+ \frac{F}{r}*\left\{\left[e^{r*(z-x)}\right]\right.$$

$$\left.\left[-\int_z^\infty f(l)dl + \int_z^y e^{r*(l-z)}f(l)dl + e^{r*(y-z)}\int_y^\infty f(l)dl\right]\right\}$$

The new negative term in the second bracket can be replaced by its equivalent value shown in the next equation:

$$-\int_z^{\infty} f(l)\,dl = -1 + \int_0^z f(l)\,dl$$

The equation for RAC(x,y) now looks like the following:

$$RAC(x,y) = \frac{F}{r} * \left\{ \int_0^x f(l)\,dl + \int_x^z e^{r*(l-x)} f(l)\,dl + e^{r*(z-x)} \int_z^{\infty} f(l)\,dl \quad -1 \right\} +$$

$$+ \frac{F}{r} * \left\{ \left[e^{r*(z-x)} \right] \left[\int_0^z f(l)\,dl + \int_z^y e^{r*(l-z)} f(l)\,dl + e^{r*(y-z)} \int_y^{\infty} f(l)\,dl - 1 \right] \right\}$$

At this point it is easy to recognize that we have equation 15:

$$RAC(x,y) = RAC(x,z) + RAC(z,y) * e^{r*(z-x)}$$

PERSPECTIVES IN THE APPLICATION OF UTILITY THEORY

There are two utility theories. The one used by economists to rationalize the purchase of possible market baskets of goods has nothing to do with risk. Many people, never exposed to the utility theory of risk, erroneously assume that they learned something about it in their required course in economics. Where would you have studied this relatively new risk theory? The theory of Von Neumann and Morgenstern is the one we are concerned with. It is a theory based upon three consistency axioms for choice among lotteries. The properties of the utility curve are derived from the axioms. There are several books which contain this theory, including references 1, 2, 8, 9, 10, 14, and 17 for example. There are several more under the subject name "Statistical Decision Theory". The book by Morris DeGroot, entitled "Optimal Statistical Decisions" is an excellent example and a fine pressentation of the derivation from the axioms.

Another perspective is that other applications areas exist in addition to insurance. Oil and gas exploration is another highly risky business. Some of those practitioners also apply utility theory and there is an extensive literature on risk. Operations research people often tended to be the users and trustees of the knowledge of utility theory in general, but the study of risk is rapidly growing, including new disciplines called risk management and risk analysis.

Another perspective is that the theory of utility has developed considerably over the years and there is now a general realization that the exponential family of utility functions is the simplest to apply. It is unique in its "portfolio property" which is additivity of the values of independent random variables. Without this, the complication of evaluating hundreds or thousands of "lotteries" would be insurmountable. With this type of function, the expected utility is essentially the moment generating function, which we know from probability theory, so the mathematics is already in place. Science usually begins with the simplest model, when the choice is available, proceeding to more complicated models only when experience reveals the need to do so. That is how we ought to proceed.

The family of exponential utilities is a one parameter family. The parameter is called the local risk aversion function, so named by John Pratt, who explored the properties of many functional forms of utility functions. The fact that this function is a constant for the exponential is often called the "wealth independence" property. It is reasonable to expect that every decision maker has their own individual risk aversion level, the parameter of the exponential. We can make the measurement of risk more objective by computing and showing the spectrum of certainty equivalent values for each possible risk aversion level from zero to infinity. This graph has been called the "Risk Profile Curve". Lotteries can be compared against each other by comparing their risk profile curves. Reference [5] gives the details of "Risk Profile Dominance". In practice we find that real decision makers want to know how they "ought to" behave regarding risk. Utility theory was not meant to answer that question. One widely accepted idea is the greater the wealth the smaller the risk aversion. When constructing a theory which involves a whole population of companies or individuals, we often find a Pareto distribution of wealth levels. A simple model for the population of risk aversions is that each individual's risk aversion level is the reciprocal of their wealth level.

In my experience, I was fairly successful in advising oil exploration companies when I recommended that their risk aversion level be taken as the reciprocal of their exploration budget. In many cases, individuals in positions of responsibility are found to be too risk averse compared to this guideline and the advice is often welcome news. Personality traits can influence this but probably ought not to.

Applying exponential utility theory is simple because you only need one number, the risk aversion level, to get started. For the application to risk loads, for example, we can determine the risk aversion level which gives the risk load of 5% for the basic limits policy. This will be illustrated in Appendix 3 which contains the example. In general, since only one parameter need be determined, one past decision is sufficient too determine the past risk aversion level. An alternative to uing the parameter r is provided by Van Slyke [18]. He recommends a risk tolerance type of parameter and calls it capacity, intending it to be measure of capacity. A model such as this would be very useful if it found general acceptance.

The interested reader ought to examine one general reference, such as [2] or [10], and the two papers by Pratt [13] and Samuelson [15].

The idea that the local risk aversion ought to be declining with wealth is appealing to many people and was first expressed by Kenneth Arrow. Reference [19] quickly assumes declining risk aversion with wealth. An alternative, but similar, hypothesis is that of population heterogeneity; all individuals in the population have different risk aversion levels.

The weatlthier individuals have the smaller risk aversion levels. Their risk aversion levels all remain constant. I think that this possibility needs empirical testing rather than debate because these two hypotheses are difficult to distinguish between. The simpler of the two models is that of population heterogeneity. This model as assumed by Lintner [12] in his early derivation of the capital asset pricing model.

An objection to exponential utility theory was expressed by Richard Woll in his review of the discussion paper by Cozzolino and Kleinman in the Discussion Paper Program of 1982. Woll states that "While the characteristic of constant risk aversion is extremely useful, ...,it provides no limit on the number of independent risks which a particular insurer might be willing to write, given no external constraints." In his next paragraph Woll states that "This implication of exponential utility flies in the face of the historical and intuitive notion that there is always some limit to the amount of business one is willing to write with a given amount of capital." This objection to exponential utility is less real than imagined because it is not the role of risk aversion to limit the amount of business written. The realistic nature of the limitation is the limitation of the capacity available to any insurer. Some think that capacity is not real, perhaps just a construct of the regulators. But another natural cause of limitation for any business is the finite nature of the stock of good opportunities available in the whole world. As an insurer trys to obtain more risks of a given type, the quality declines; the additional risks are not of the same quality. In that case of declining quality, risk aversion will also play a role; the lower quality of the marginal risk makes it more risky and so it fails to meet a constant cutoff.

In all businesses, there are very real limitations of the number of good prospects available. Much of the effort expended in many businesses is that of finding the opportunities worthy of investment.

If the utility function really had decreasing local risk aversion, then as the insurer takes more risks whose expected profit is positive, the insurer's risk aversion would decline and become less of a restriction on the acceptance of marginal risks. Perhaps this proves that the desired restriction is not the role of utility but rather the result of some other general aspect of business.

One last consideration; don't wait to find the "perfectly correct" utility curve before beginning to apply this methodology. Utility curves, like probability distributions, are never perfectly correct, although we can distinguish that some are better than others. As for wealth independence, if you think that the utility curve is changing over time, then you can reestimate the risk aversion periodically, perhaps annually, as is done for other financial parameters of business firms. Slow changes are easily handled this way.

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APPENDIX III

The Miccolis paper, "On the Theory of Increased Limits and Excess of Loss Pricing," is very complete but did not illustrate all of the capabilities it contains. The formula for the covariance between the excess loss of two adjacent layers was given (equation 39 of that paper) but it was not illustrated. The capability of computing the variance-based risk-loaded premiums for excess layers was illustrated.

The formula (equation 43 of that paper) was stated as a formula for the amount of risk reduction due to layering. In addition, it can be used to compute the correct variance-based, risk-loaded premium for an excess layer; it is also a formula for the correction of a premium determination by subtraction of ground-up rates. It seems useful to illustrate those here because the main purpose is to illustrate RAC-based risk-loaded premiums. The presence of variance-based risk-loads in the same paper is useful to allow comparisons.

Example A will be the Miccolis example of a lognormal severity distribution with the parameters μ equal to 8.9146, and σ equal to 1.7826. The mean frequency is given as 0.1 losses per year. This is a long-tailed distribution, appropriate for the medical malpractice loss of one doctor. The annual expected loss of this frequency and severity combination is \$3,644. The distribution of annual aggregate loss has a variance of 2.4181E09 squared dollars, and the standard deviation is \$49,174.

In example A, the formulas supplied by Miccolis for partial integral, partial mean, and partial noncentral second moment were used to produce the layer results shown in the following tables:

Table A-III-1

Layer Definitions Layer #	Start	Top	Frequency in Layer
1	$ 0	$ 25,000	0.075172
2	25,000	50,000	0.010569
3	50,000	100,000	0.007011
4	100,000	300,000	0.005343
5	300,000	500,000	0.000992
6	500,000	1,000,000	0.000614
7	1,000,000	1,300,000	0.000110
8	1,300,000	1,500,000	0.000043
9	1,500,000	2,000,000	0.000061
10	2,000,000	3,000,000	0.000047
11	3,000,000	4,000,000	0.000017
12	4,000,000	5,000,000	0.000008
13	5,000,000	7,500,000	0.000008
14	7,500,000	10,000,000	0.000003
15	10,000,000	15,000,000	0.000002
	Total Frequency =		0.10000

Table A-III-2

Layer #	Exp. Loss Freq in layer	above layer	Exp. Loss below & inc.	Exp. Loss zero to top	Exp. Loss Excess Layer
1	492.25	0.02483	492.25	1,112.92	1,112.92
2	373.81	0.01426	866.06	1,578.95	466.03
3	491.68	0.00725	1,357.74	2,082.39	503.44
4	881.85	0.00190	2,239.58	2,810.61	728.22
5	378.00	0.00091	2,617.59	3,073.40	262.78
6	418.45	0.00030	3,036.04	3,333.67	260.27
7	124.56	0.00019	3,160.60	3,404.62	70.95
8	59.97	0.00014	3,220.57	3,437.58	32.97
9	104.17	0.00008	3,324.74	3,492.80	55.21
10	112.64	0.00004	3,437.38	3,549.00	56.21
11	58.90	0.00002	3,496.28	3,576.42	27.42
12	35.62	0.00001	3,531.90	3,592.00	15.58
13	46.56	0.00000	3,578.46	3,610.32	18.32
14	21.99	0.00000	3,600.45	3,617.23	6.91
15	20.04	0.00000	3,620.49	3,620.49	3.26
Sum =	3,620.49				

Table A-III-3

(All variance figures have been divided by 1000)

Layer #	Variance Freq. in Layer	above layer	Variance below & incl.	Var of layer zero to top
1	6,229	0.024827	6,229	21,746
2	13,753	0.014258	19,982	55,627
3	35,873	0.007247	55,855	128,320
4	160,588	0.001903	216,442	387,751
5	147,215	0.000912	363,657	591,562
6	296,676	0.000298	660,334	957,964
7	141,951	0.000188	802,285	1,119,508
8	83,722	0.000145	886,007	1,211,530
9	180,154	0.000084	1,066,161	1,402,290
10	274,697	0.000037	1,340,858	1,675,739
11	203,442	0.000020	1,544,300	1,864,866
12	158,942	0.000012	1,703,242	2,003,755
13	282,726	0.000004	1,985,968	2,224,928
14	189,530	0.000002	2,175,498	2,343,264
15	242,625	0.000000	2,418,124	2,418,124
Total Var=	2,418,124			
Std. Dev. =	49,174.42			

The variance scaling was reversed before computing the standard deviation, in this and all similar tables.

The righthand column of the table above shows the variances of ground up layers (from zero to the tops of the numbered layers). The next thing of interest would be to show the variance of the excess loss for each numbered layer. If subtraction of ground-up layer variances were correct, the results would be just the differences of the successive numbers in that column, after the entry for the bottom layer. Subtraction results are shown in the next table after a correction determined by the Miccolis formula. The correction term is shown separately in the next column. The variance of the excess loss in the top layer is also useful in computing the correlation, shown in the next column, between the ground-up layer which excludes the top layer shown in the layer column and the top layer itself. The first entry here is for row 2 of the table; that represents the correlation between excess loss in layer one and excess loss in layer two. The third row is the correlation between excess loss in the combined first two layers and excess loss in the third layer counting up from the bottom.

Table A-III-4

Layer	Var of layer zero to top	Var/Excess Layer	Var Reduction	Correl of O,T w/top layer
1	21,746	21,746		
2	55,627	10,579	23,302	0.733945
3	128,320	22,349	50,344	0.691373
4	387,751	113,786	145,645	0.590111
5	591,562	46,140	157,671	0.583871
6	957,964	106,129	260,273	0.516184
7	1,119,508	19,651	141,894	0.515368
8	1,211,530	6,307	85,715	0.508690
9	1,402,290	25,115	165,644	0.473712
10	1,675,739	48,628	224,821	0.429720
11	1,864,866	24,613	164,514	0.404548
12	2,003,755	14,273	124,616	0.381568
13	2,224,928	38,012	183,161	0.331595
14	2,343,264	14,698	103,637	0.286408
15	2,418,124	9,674	65,187	0.216404

A risk charge of 5% of the expected value pure premium was used by Miccolis to as a standard to determine the coefficient of variance in the pricing formula. The coefficient was determined to be 2.559E-06. The following table gives the resulting premiums for all ground-up layers and all excess layers.

Table A-III-5

Lambda = 2.56E-06

Layer#	Exp. Loss zero to top	Exp. Loss Excess Layer	Premium zero to top	Premium Excess layer
1	$1,113	$1113	$1,169	$1,169
2	1,579	466	1,721	493
3	2,082	503	2,411	561
4	2,811	728	3,803	1,019
5	3,073	263	4,587	381
6	3,334	260	5,785	532
7	3,405	71	6,269	121
8	3,438	33	6,538	49
9	3,493	55	7,081	119
10	3,549	56	7,837	181
11	3,576	27	8,349	90
12	3,592	16	8,720	52
13	3,610	18	9,304	116
14	3,617	7	9,614	45
15	3,620	3	9,808	28

Table A-III-6

Percentage Risk Loads

Layer Definitions Layer #	Start	Top	Percent for zero to top	Percent for excess layer
1	$ 0	$ 25,000	4.76	4.76
2	25,000	50,000	8.27	5.49
3	50,000	100,000	13.62	10.20
4	100,000	300,000	26.09	28.56
5	300,000	500,000	33.00	31.00
6	500,000	1,000,000	42.37	51.06
7	1,000,000	1,300,000	45.70	41.48
8	1,300,000	1,500,000	47.42	32.87
9	1,500,000	2,000,000	50.68	53.79
10	2,000,000	3,000,000	54.72	68.89
11	3,000,000	4,000,000	57.16	69.67
12	4,000,000	5,000,000	58.81	70.10
13	5,000,000	7,500,000	61.20	84.15
14	7,500,000	10,000,000	62.37	84.48
15	10,000,000	15,000,000	63.09	88.37

This verifies the often stated opinion that the risk load is a larger fraction of the excess layer premium than it is of the primary premium. While it is also quite large for very high limits primary policies, those ground-up coverages in the top half of the list are not often written as single policies because of their high risk loads, which can be avoided by the common combination of primary plus excess covers. Excess layers, on the other hand, can be kept small to hold down their expected losses, but their percentage risk loads are still high because of their risk structure. A sufficiently thin excess layer approaches the risk characteristics of the Poisson distribution which has a long tail for the cases of small frequency.

The next example is similar to the first example; it has the same Poisson frequency but the severity is piece wise constant with constant density within each layer. The layers have the same frequency within the layer for each layer as for the lognormal, but the mean and variance within each layer will be somewhat different than for the lognormal. The main motive for this difference is to facilitate the calculation of the RAC within each layer. Based upon the lognormal, the RAC is difficult to compute because the moment generating function for the lognormal can only be expressed as a series expansion. The lognormal has all moments but the series is difficult to express in any simple form. In addition, the motive also exists to illustrate how easy the RAC is to compute when each layer is approximated as a rectangular density function.

EXAMPLE B

Table A-III-1 remains the same in the B example as in the A table, because the layer frequencies have been kept the same. But the layer mean (the mean of all aggregate loss from losses whose size is within that layer) is just the layer frequency multiplied by the average of the upper and lower endpoints of the layer. Because of the Poisson frequency within each layer, the variance of aggregate loss (the variance of the sum of all losses whose size is within that layer) is given as the frequency in that layer multiplied by the second non-central moment of the layer severity. The formulas for these and for the RAC within a layer are given at the end of this appendix.

The next five tables repeat the last five tables so the reader can see the size of the differences between the two models. The next two tables have some differences from their example A counterparts.

Table A-III-7

Layer #	Exp. Los in layer	Freq above in layer	Exp. Loss below & incl.	E. Loss for zero to top	Exp. Loss excess layer
1	$ 939.65	939.6542	$ 939.65	$1,560.32	$1,560.32
2	396.33	396.3317	1,335.99	2,048.88	488.56
3	525.85	525.8496	1,861.84	2,586.49	537.61
4	1,068.61	1,068.6149	2,930.45	3,501.48	914.99
5	396.72	396.7247	3,327.18	3,782.98	281.50
6	460.49	460.4910	3,787.67	4,085.30	302.31
7	126.41	126.4126	3,914.08	4,158.10	72.80
8	60.24	60.2403	3,974.32	4,191.33	33.24
9	106.13	106.1288	4,080.45	4,248.51	57.18
10	117.06	117.0581	4,197.51	4,309.13	60.62
11	60.11	60.1075	4,257.61	4,337.76	28.62
12	36.07	36.0670	4,293.68	4,353.78	16.03
13	48.58	48.5772	4,342.26	4,374.12	20.34
14	22.49	22.4920	4,364.75	4,381.53	7.41
15	20.97	20.9707	4,385.75	4,385.72	4.19
Sum =	$4,385.72				

Table A-III-8

(All variance figures have been divided by 1000)

Layer #	Variance Freq in Layer	Above Layer	Variance below & incl.	Var/Layer zero to top
1	15,661	0.024827	15,661	31,178
2	15,413	0.014258	31,074	66,718
3	40,899	0.007247	71,973	144,438
4	231,533	0.001903	303,506	474,815
5	161,996	0.000912	465,502	693,407
6	358,160	0.000298	823,662	1,121,292
7	146,199	0.000188	969,861	1,287,084
8	84,480	0.000145	1,054,341	1,379,865
9	186,989	0.000084	1,241,330	1,577,459
10	296,547	0.000037	1,537,877	1,872,758
11	211,807	0.000020	1,749,684	2,070,251
12	162,969	0.000012	1,912,654	2,213,166
13	307,655	0.000004	2,220,309	2,459,268
14	198,144	0.000002	2,418,453	2,586,218
15	265,628	0.000000	2,684,081	2,684,081
Sum =	2,684,081	(Scaled by E-04)		
Std. Dev. =	$ 51,808			

Table A-III-9

Layer	Var of Layer zero to top	Var of Excess Layer	Var Reduct By Layering	Correll of O,T with top layer
1	31,178	31,178		
2	66,718	11,113	24,428	0.615219
3	144,438	23,959	53,761	0.644774
4	474,815	147,378	182,999	0.610913
5	693,407	49,689	168,903	0.543396
6	1,121,292	125,573	302,312	0.508375
7	1,287,084	20,191	145,601	0.481853
8	1,379,865	6,361	86,420	0.476027
9	1,577,459	26,062	171,532	0.451003
10	1,872,758	52,817	242,482	0.419143
11	2,070,251	25,760	171,733	0.390379
12	2,213,166	14,692	128,224	0.367209
13	2,459,268	42,743	203,359	0.330303
14	2,586,218	15,841	111,109	0.281305
15	2,684,081	13,980	83,883	0.220475

The variance-based risk-loaded premiums for the B example are given in the next tables, with their percentages of risk load. The λ value used is that which gives the 5% risk load for the basic policy whose limit is $25,000.

Table A-III-10

Layer #	E. Loss for zero to top	Exp. Loss Excess Layer	Premium zero to top	Premium Excess Layer
1	$1,560	$1,560	$1,640	$1,640
2	2,049	489	2,220	517
3	2,586	538	2,956	599
4	3,501	915	4,717	1,292
5	3,783	282	5,557	409
6	4,085	302	6,955	624
7	4,158	73	7,452	124
8	4,191	33	7,722	50
9	4,249	57	8,285	124
10	4,309	61	9,102	196
11	4,338	29	9,636	95
12	4,354	16	10,017	54
13	4,374	20	10,667	130
14	4,382	7	11,000	48
15	4,386	4	11,254	40

Table A-III-11

Layer Definitions Layer #	Start	Top	% Risk-Load zero to top	% Risk-Load Excess Layer
1	$ 0	25,000	4.86	4.86
2	25,000	50,000	7.69	5.50
3	50,000	100,000	12.50	10.24
4	100,000	300,000	25.76	29.19
5	300,000	500,000	31.93	31.11
6	500,000	1,000,000	41.26	51.53
7	1,000,000	1,300,000	44.20	41.51
8	1,300,000	1,500,000	45.73	32.87
9	1,500,000	2,000,000	48.72	53.84
10	2,000,000	3,000,000	52.65	69.04
11	3,000,000	4,000,000	54.98	69.73
12	4,000,000	5,000,000	56.54	70.11
13	5,000,000	7,500,000	59.00	84.32
14	7,500,000	10,000,000	60.17	84.55
15	10,000,000	15,000,000	61.03	89.51

The differences between the examples A and B are now evident and are apparently minor, based on comparison of the two sets of 5 tables for each. The next series of tables will focus upon the differences between variance risk load and RAC, and upon the properties of RAC as a risk-loaded premium, all entirely based upon the B example.

The first idea to illustrate is that the risk aversion level can be selected on the same basis as the λ coefficient of variance was selected. The result is that the risk aversion level is $r = 4.93E\text{-}06$, also a very small number. The reciprocal of the risk aversion level will also be noted since this is sometimes called risk tolerance. For the stated risk aversion level the risk tolerance is $202,840 indicating a very small insurer. The set of premiums calculated by RAC for the ground-up policies is given in the next table.

Table A-III-12

Risk Aversion = 4.93E-06, Risk Tolerance = $202,840

Layer #	Policy Limit	E. Loss for zero to top	RAC of layer zero to top	% Risk-Load zero to top	Var Prem zero to top
1	$ 25,000	$1,560	$1,640	5.1	$1,640
2	50,000	2,049	2,225	8.6	2,220
3	100,000	2,586	2,995	15.8	2,956
4	300,000	3,501	5,307	51.6	4,717
5	500,000	3,783	7,292	92.8	5,557

The reason that the results are not given for the higher policy limits is that the premium becomes very large for the higher limits at this large risk aversion level. If an insurer is so risk averse that it requires a 5% risk load at a policy limit of $25,000, it is too risk averse to write policy limits of $500,000 or more. That conclusion seems reasonable in light of the fact that most small primary companies do not write high limits policies.

Another risk aversion level to consider is that which makes the premium for top policy limits as determined by RAC equal to that determined by variance with the same λ we have been using, 2.559E-06. This is .5682E-06 and it corresponds to a risk tolerance of $1,759,944.

Table A-III-13

Risk Aversion = 5.68E-07, Risk Tolerance = $1,759,944

Layer #	Policy Limit	E. Loss for zero to top	RAC of layer zero to top	% Risk-Load zero to top	Var Prem zero to top
1	25,000	1,560	1,569	0.6	1,640
2	50,000	2,049	2,068	0.9	2,220
3	100,000	2,586	2,628	1.6	2,956
4	300,000	3,501	3,642	3.9	4,717
5	500,000	3,783	3,994	5.3	5,557
6	1,000,000	4,085	4,447	8.1	6,955
7	1,300,000	4,158	4,586	9.3	7,452
8	1,500,000	4,191	4,660	10.1	7,722
9	2,000,000	4,249	4,813	11.7	8,285
10	3,000,000	4,309	5,058	14.8	9,102
11	4,000,000	4,338	5,264	17.6	9,636
12	5,000,000	4,354	5,468	20.4	10,017
13	7,500,000	4,374	6,154	28.9	10,667
14	10,000,000	4,382	7,200	39.1	11,000
15	15,0000,00	4,386	11,254	61.0	11,254

The next table shows the premiums for all excess layers. Also shown for perspective are the expected loss, the risk-load as a fraction of the premium, and the variance-based premium.This is at the same risk aversion level last used.

Table A-III-14

Risk Aversion = 5.682E-07, Risk Tolerance = $1,759,944

Start	Top	Exp. Loss Excess Layer	RAC of Excess Layer	Var Premium Excess Layer	Layer RI Load as
$0	25,000	1,560	1,569	1,640	0.5
25,000	50,000	489	492	517	0.6
50,000	100,000	538	544	599	1.2
100,000	300,000	915	958	1,292	4.5
300,000	500,000	282	296	409	4.9
500,000	1,000,000	302	341	624	11.4
1,000,000	1,300,000	73	79	124	7.6
1,300,000	1,500,000	33	35	50	5.3
1,500,000	2,000,000	57	65	124	12.4
2,000,000	3,000,000	61	79	196	22.9
3,000,000	4,000,000	29	37	95	23.5
4,000,000	5,000,000	16	21	54	23.9
5,000,000	7,500,000	20	40	130	49.1
7,500,000	10,000,000	7	15	48	49.7
10,000,000	15,000,000	4	14	40	69.6

Table A-III-15

Risk Aversion = 5.682E-07, Risk Tolerance = $1,759,944

Start	Top	Exp. Loss Excess Layer	RAC of Excess Layer	Var Premium Excess Layer	Layer RI Load as
$ 0	$ 25,000	$1,560	$1,640	$1,640	4.8
25,000	50,000	489	517	517	5.5
50,000	100,000	538	602	599	10.6
100,000	300,000	915	1,412	1,292	35.2
300,000	500,000	282	452	409	37.7
500,000	1,000,000	302	1,069	624	71.7
1,000,000	1,300,000	73	158	124	53.8
1,300,000	1,500,000	33	55	50	40.0
1,500,000	2,000,000	57	225	124	74.5
2,000,000	3,000,000	61	1,292	196	95.3
3,000,000	4,000,000	29	652	95	95.6
4,000,000	5,000,000	16	379	54	95.7
5,000,000	7,500,000	20	222,912	130	99.9
7,5000,000	10,000,000	7	86,181	48	99.9

In spite of the small size and high risk aversion represented in the table above, this insurer is able to write most of the excess layers evaluated. The premiums are excessively large for the top six layers. Apparently, risk sharing works very well, but there are enough larger insurers, with smaller risk aversion to write these excess layers at lower cost.

The "Risk Profile Curve is a graph of the RAC as a function of the risk aversion level. Here it is a graph as a function of the risk tolerance which is the reciprocal of the risk aversion. Risk tolerance is an amount of money and so may appear more meaningful."

Figure two is the risk profile curve for the top excess layer,which starts at 7.5 million dollars and runs to 15 million dollars. At low risk tolerance, the risk loaded premium is very large but then it declines, approaching the expected loss pure premium which is just $4.00.

FIGURE 1

Risk Profile Curve for Basic Policy

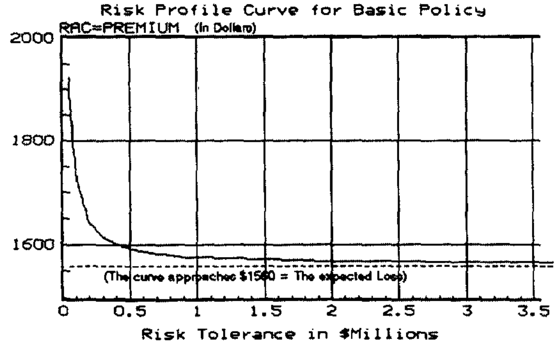
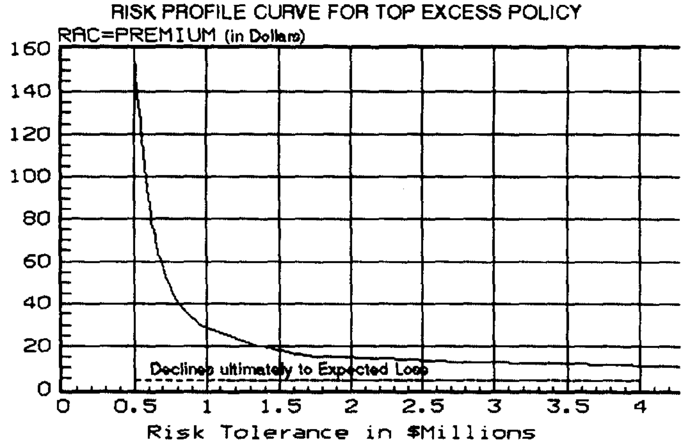


FIGURE 2

RISK PROFILE CURVE FOR TOP EXCESS POLICY



The Equations

When using a piecewise constant density for severity, where each layer has a constant density, the formulas needed for the results presented are given below. The set of three equations is for aggregate loss for all losses whose size is between the lower end point L_{i-1} and the upper end point, L_i of layer $_i$. The expected amount of aggregate loss, given the frequency F_i, in this layer is:

$$EL(L_{i-1}, L_i) = F_i \frac{L_{i-1}+L_i}{2}$$

In the special case when the layer has zero width, the expected loss is Fi x Li itself. The Variance in the layer, also based upon the rectangular severity is given by the next equation:

$$VAR(L_{i-1}, L_i) = F_i \frac{L_{i-1}^2 + L_{i-1} . L_i + L_i^2}{3}$$

When the layer endpoints are the same, the VAR is just

$$VAR(L_{i-1}, L_i) = F_i L_i^2$$

The RAC in the layer, a function of risk aversion level r, has the following formula:

$$RAC(L_{i-1}, L_i) = (\frac{F_i}{r}) . \left[\frac{\exp(r . L_i) - \exp(r . L_{i-1})}{r . (L_i - L_{i-1})} - 1\right]$$

The special case when the layer has zero width has the special formula as follows:

$$RAC(L_{i-1}, L_i) = (\frac{F_i}{r}) . [\exp(r . L_i) - 1]$$

The special cases of zero width usually occur when there is a policy limit. Then all the layers above are effectively collapsed into a degenerate layer at that limit and the frequency of the degenerate layer is the frequency above that layer. This is very conveniently organized into a spreadsheet format.

TRUE INHERENT HAZARDS AND THE FUTILITY THEREOF

John W. Carleton
(introduction by Robert A. Bailey)

June 22, 1992

Enclosed is a copy of an actuarial paper on the subject of Fair Discrimination in Insurance Rate Regulation which was written April 11, 1950 as a personal and confidential letter from John W. Carlton, then Actuary of the Liberty Mutual Insurance Company, to Arthur L. Bailey, then Actuary of the New York Insurance Department. It was part of the help my father received in preparing the paper he presented to the CAS on May 22, 1950 entitled, Credibility Procedures - "LaPlace's Generalization of Bayes' Rule and the Combination of Collateral Knowledge with Observed Data." It could be considered a review of that paper.

I have enjoyed reading this paper several times over the years. It remains as relevant now as it was when written. I believe enough time has passed to permit its release.

Robert A Bailey

April 11, 1950

STRICTLY PERSONAL

SUBJECT: TRUE INHERENT HAZARDS AND THE FUTILITY THEREOF

Dear Arthur:

This letter is prompted in part by various discussions we have had in the past regarding fundamental approaches to insurance ratemaking.

It is recognized that my contributions to these discussions occasionally may have seemed facetious to the point of irresponsibility. The observations which seem troublesome and the inferences which seem to flow from them require a nice balance between humor and serious consideration. Anyone who appears to believe that ignorance is an asset which the insurance industry should not dissipate thoughtlessly runs the risk of being thought of as either an irresponsible person or a futile humorist. Neither characterization is sought, but the latter is preferred to the former. Please give me the benefit of the doubt as you go along. Also, please keep this letter to yourself.

Nevertheless, if the fundamental approach to the pricing problem in insurance which you seem to accept is correctly understood by me, then it is of some importance that it be examined with care. It is stressed that concern is with the basic approach and not the improved techniques with which you from time to time suggest the industry implement that approach. Minor differences of opinion in the latter are separate issues.

The careful examination of this philosophy of pricing is of some importance for at least two cogent reasons. First, in the intensified operation of state rate regulation, the pursuit of this theory is bound to have some influence on required expense loadings, even if only to maintain the status quo. Anything which has a significant influence on the amount of money which the public pays the insurance industry to handle its loss dollars should not be taken for granted. Second, the pursuit of this theory may operate to make the product which the industry sells less and less what the customers want to buy. With regard to this reason it seems desirable to remember that the nature of the insurance business is such that the price structure is an integral part of the product that is sold to the public. Both of these reasons would seem especially cogent to those who want public support for the free enterprise system of insurance.

To give continuity to what follows, it may be well to provide a preliminary outline. First, I'd like to set up a concept of true inherent hazards. Second, I'd like to describe the operation of a ratemaking system which purports to provide as a pure premium for each risk (or maybe each class of risks) the best statistical estimate of the true inherent hazard. Next, effort will be made to tear down the true inherent hazard concept — and with it the rationale for a ratemaking system which sets up its measurement as a goal. Fourth, there will be reviewed the well-known circumstances which seem to make it necessary that some such ratemaking system be used if competitive carriers are to be expected to provide a market for substantially all comers — whether the system has a statistical rationale or not.

After four above, I am very much puzzled. It is hoped you are the same. In the rest of this letter, the puzzlement is used to justify a somewhat different standard of fair discrimination than is implicit in the pursuit of the inherent hazard approach.

You have from time to time expressed reluctance to provide a definition of the true inherent hazard on the grounds that as an unknowable it, according to furnished authority, does not lend itself to a certain kind of definition. Nevertheless, from the manner in which you use the expression I have acquired a concept of what I think you mean which, it is believed, can be conveyed in language even if not precisely defined.

Your good friend, Bertrand Russell, admits as valid for conveying ideas what he calls ostensive definitions. It is believed that by pointing at a static model, the idea which I have of your true inherent hazard can be conveyed without undue loss from one party to another.

If there is a dice box with ten dice in it, and if the person rolling the dice loses a dollar for each spot, then the numerical value of the inherent hazard for the roll is $35. The operations which comprise the Risk for the policy period is represented by the rolling of the dice. Seemingly, any risk can be represented this way, although, of course, small fire policies and the like would require polyhedral dice with blank facets predominating. Needless to say, in the insurance business only the total number of spots is known after each roll. The number of dice in the box cannot be directly counted or otherwise determined either before or after rolling.

You once commented on the small inherent hazard associated with large retrospectively-rated risks with high maximums. It is assumed that you had reference to the portion of the total inherent hazard assumed by the carrier. Since rating is concerned only with hazards assumed under specific contracts, it might be thought necessary to delimit the concept so that it will relate only to the hazard transferred contractually. However, it is thought that if this nicety were supplied, it would not interfere with or contribute to the ideas to be discussed. It is more convenient to think of the inherent hazard as an attribute of the insured, all or part of which may be transferred by the insurance contract.

It is, of course, possible to express this "expectation of spots" as a symbol with a mathematical definition sufficiently general to embrace expectation of loss. I don't want to do that for reasons which will become apparent later on. It seems better to start off by visualizing a dice box and abstracting from it the idea of a true inherent hazard. Such an idea involves

1. At any point of time the Risk has an exact quantitative inherent hazard, which quantity is absolutely independent of the method selected for approximating its measurement.

2. If the inherent hazard were known exactly, differences between actual losses and the inherent hazard would be a matter of chance — chance being defined ostensively by pointing at a dice box. More about chance later.

The absence of the time dimension from a roll of a dice box and the presence of the time element in the usual subject matter of insurance may seem troublesome, but the difference is not thought to have any bearing on the significant issues.

Now, rightly or wrongly, I think the basic approach to ratemaking which you accept is one which says in effect that the correct price for a risk is one which comprises the best estimate obtainable of the true inherent hazard and a suitable expense loading.

The best estimates referred to above are obtained by statistical inference from past experience. That is, dice boxes are grouped into classes and sub-classes according to size, shape, weight, color, or some other attribute which might lead to the surmise that they have similar spot potentials and the scores of past rolls are used to estimate quantitatively the current average spot potential. The heterogeneity of preliminary groupings may be tested by spot experience and re-groupings may be made. A pyramid of groupings may be used so that in effect the estimate for a small group uses its own experience, the experience of the next more general group, and so on, each with appropriate weights.

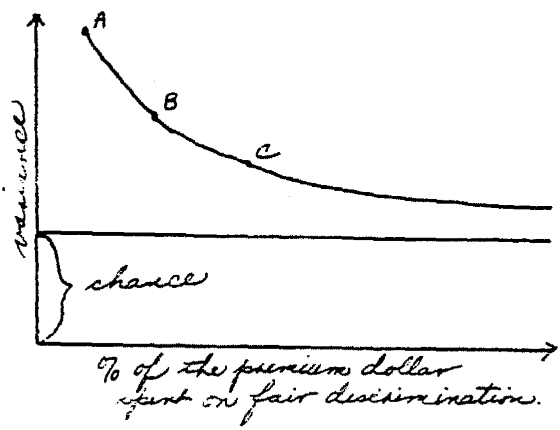
Fortuitous extremes may be identified by statistical techniques and discounted. The circumstance that the number of dice in a box does not remain constant over long periods may be recognized in the procedure — either quantitatively or arbitrarily. The spot experience of individual boxes may be compared with the average experience of their group and statistical inferences drawn as to the degree to which these individual boxes differ in spot potential from the average. And so on.

Workmen's Compensation prospective rating procedure looks as though it were such a statistical pursuit of inherent hazards, by state, by industry group, by class, and by individual risk. Although a comfortable majority of the people in the business do not have the expression "inherent hazard" in their active vocabularies, I think that those who do, if pressed, would say they thought the dice analogy applied to what was being done.

Moreover, I think that if a professional statistician were to examine the Compensation rating procedure and read the literature on the subject, he would be forced to the conclusion that there must be this concept of inherent hazard in the background and that the procedural steps must be someone's idea of how to use the statistics to approximate its measurement. This professional statistician might also conclude that the statistical techniques used are somewhat crude, that many relationships which should be tested and recognized are not being tested and recognized, that the detail in many of the rituals is not commensurate with the precision of the answers, that there are numerous inconsistencies, etc. If he were energetic, he might proceed to work on correcting these deficiencies.

This statistical pursuit of the inherent hazard is about ninety-nine and forty-four one hundredths per cent for the purpose of effecting fair discrimination among risks. With the concept of true inherent hazard in mind, the degree of success with which fair discrimination is effected can be revealed by the loss ratio variance. With this dice-box concept, the loss ratio variance will be the chance variance increased by the contribution to variance made by rating errors.

Moreover, refinement in the pursuit of the inherent hazard costs money, so, qualitatively at least, we could plot the percentage of the customer's premium dollar which is spent on effecting fair discrimination against an indication of the results achieved somewhat as follows:



To spend an absolute minimum on fair discrimination (Point A) a flat premium per policy would be used. Under this approach every New York Workmen's Compensation policyholder would pay a little over $350 and receive a card telling him he was insured. The total proceeds would be adequate to cover the benefits and the smaller expenses of handling the problem on this basis. The maximum percentage of the premium would be used to pay losses. This approach, however, would not even satisfy those socialists who advocate the tax approach to spreading losses, since it would burden the little fellow for the benefit of the corporate giants.

The next step (Point B) would involve a single payroll rate for all industries. Presumably, this refinement would materially reduce the loss ratio variance — at a price. I heard once that the Wyoming Monopolistic Fund operated on this basis but have been unable to confirm the rumor with information available in the office. This level meets the socialists' objections to Point A. Unfortunately, it cannot be used by competing private carriers unless they all have underwriters who are both ignorant and unprejudiced. It is unusual to find both of these attributes in the same underwriter.

The next step (Point C) would involve the establishment of a relatively few, say twenty, payroll rate classifications. Private insurance can operate at this level in the small risk field, particularly if it shys away from statisticians and actuaries. For the large risk field either more refinement or some other mechanism probably is necessary.

From Point C on there are introduced refined classification manuals, manuals of classification interpretations, fifty-page statistical plans, individual risk rating, individual risk rating exceptions, stamping bureaus and stamping bureau correspondence, payroll limitation rules, payroll auditors' manuals, special occupational disease procedures, a hundred odd endorsements to measure out a precise amount of coverage, etc. — all of which require the employment of more people by carriers and producers to handle a given amount of business.

The curve has been drawn as a continuous one, convex downward, approaching as an asymptote the ideal situation in which the rating measures the inherent hazard accurately and all residual loss ratio variance is due to chance. The main objective is to convey the idea of diminishing returns which is not always immediately obvious when individual refinements are being considered, but which is obvious, I believe, when the whole pattern is reviewed.

The level of the chance asymptote will depend upon whether it is assumed that the tail of the curve is a statistical pursuit of inherent hazards under a given degree of classification refinement or it is assumed that the tail involves both statistical refinements and classification refinements. In the latter instance, the asymptote would be the variance which you can determine quite accurately from the distribution of accidents by size of loss. In the former instance it would be considerably higher.

It is noteworthy that even if one accepts the premise that the goal of rating procedure is to pursue inherent hazards (as hereinbefore conceived) by using data, statistical or other, intelligently and scientifically, one still should stop the pursuit somewhere along the diminishing returns curve. I don't think it is sufficient that each suggested refinement be evaluated against its cost independently. Rather, I think some as yet unthought of mechanism for appraising the direction in which rating methods are moving should be injected — although I don't know what or how.

You have said that the mean rating error for New York Workmen's Compensation risks is about 40% (meaning from the lower asymptote, I assume). I don't know how much of our customer's money we are spending in effecting fair discrimination, but it is more than half of the expense loading. Nor is it known how the comparison of the 40% error with the amount expended should be made, but it does seem prudent to ask if we are moving in the right direction — even granting the inherent hazard concept.

Now it seems to me that the mathematics you are currently developing are essentially improved techniques of implementing the approach to insurance pricing which has been gingerly explored in what has been set down above. It is thought you could not explain fully your developments without at some time bringing in, explicitly or implicitly, the concept of chance — chance as used by the mathematicians who built up the theory of probabilities. To have an inherent hazard to pursue, it would seem that there must be a residue of causal determinants whose exact nature and interplay remain unknown but which will somehow produce results which can be expected to vary around a specific central value.

The concept causes no trouble in crap-shooting problems, but there is a tremendous difference between the behavior of the crap shooter and the behavior of the insurance business. The crap shooter goes to great lengths to keep the known causal determinants and the limited unknown residue separated. He puts a known number of balanced dice with known spot configurations in a box and then willfully operates so that the residual causal determinants will remain unknown to both himself and his opponent. If he is honest, he never moves a causal determinant from the unknown to the known.

The insurance business shows no such self-restraint. It is incessantly subtracting sources of variation from the residue and putting them in the rating manual. There are a number of practical reasons but no apparent theoretical reasons why this activity could not reduce chance to an insignificant consideration. Set forth below are a series of steps whereby one source of variation after another is subtracted from the residue and put in the manual.

1. The final premium for a Workmen's Compensation policy might be established at the time the policy is written. In this instance, the hazard would embrace the unknown volume of activity as an additional source of loss variation. I know of no theoretical reason why this augmented hazard would not be insurable.

2. The premium can be determined substantially as at present on the basis of actual payrolls. Compared with (1), the scope of insurance has been reduced by transferring the source of variation mentioned above from the hazard to the rating procedure.

3. The premium might be based on actual payrolls limited to the maximum compensable wage. Assume further that the ratemaking method somehow takes care of the current medical cost level. Then, the scope of insurance would be reduced by transferring from the hazard to the rating

procedure the contribution of inflationary and deflationary changes.

4. The premium might be based on man hours with appropriate changes in the ratemaking method. Another source of variation, the variability of exposed hours per dollar of limited payroll, would be transferred out of the hazard and into the rating procedure.

5. Man hours within a classification are not constant as respects hazard. Some people in the 8810 classification spend 10% or more of their time in transport planes. The man hour basis might be refined by subdividing classification rates according to what the employees are doing.

   Another source of variation, crude exposure measurements, would be partially transferred out of the residue.

6. The remaining two stages are essentially further efforts to get good relevant exposure measurements. The fractional man-hour basis in (5) suggests that real progress could be made in transferring sources of variation by using man minutes (or seconds) while engaged in activities which expose the hand to injury,

man minutes while engaged in activities for which the back is subject to strain, etc. — with appropriate rates for each and all.

7. Having gotten down to (6) it should be possible to eliminate the time element and use counts of situations. The manual would have to be by kind of injury and by situation. If a man leaves his hand in an unguarded metal cutter while the blade is falling, he is almost certain to have it cut off -- say 95% certain. If a travelling salesman is involved in a plane wreck he probably will be killed. A premium based on "audited" counts of such "exposures" should contain a loss element which would be within 10% or 15% of the actual losses even on very small risks. After having pursued fair discrimination this far, the insurance business will have rated itself out of the insurance business.

Mercifully, the procedural obstacles ceased being merely difficult and became insurmountable very early in the series of steps, so there is no real concern with the lower end of the ladder. The series of steps is set forth first to define a direction in which rating procedures may be moving and second, to raise a question with regard to your inherent hazard concept. To the second matter first.

I don't find any inherent hazards here which are exact "quantities absolutely independent of the method selected for approximating their measurement." It seems that the method of approximating their measurement can be made so absurdly precise as to eradicate chance entirely. With a large definite permanently segregated residue of unknown causal determinants such as there is in the dice-box analogy, I could rationalize the pursuit of the inherent hazard approach to ratemaking and understand the logical place your mathematical developments have in it, even though I probably would be unable to understand the mathematics themselves. However, with a collapsible residue, the use of the "true inherent hazard" as a criterion or standard with which to compare a pure premium to measure its correctness is very puzzling. Perhaps the answer is that the terms "true inherent hazard" and "precisely accurate rate" have not an absolute significance, but are limited by the unexpressed qualification "with respect to the level of rating refinement currently in vogue." When so qualified, the terms do not seem to have much significant meaning.

The more important aspect of this direction in which rating procedures might be made to move is that it may make what we have to offer less acceptable to insurance buyers. The insurance industry may be finding itself spending more and more of the customers' money in making the product less and less what the customers want to buy. If I were an insurance buyer I would look upon the insurance transaction as a device for replacing uncertain outgo with certain outgo (or outgo subject to certain upper limits). The transaction would be desired so that I could proceed to devote my undivided efforts to butchering, baking, or candlestick making with the happy awareness that my ignorance of future fires, third-party liabilities, defalcations, etc., was no bar to my turning in a satisfactory operating result. Hence, I would like this certain outgo to be in terms of something convenient for normal budgeting so that I could establish prices and run my fiscal affairs easily: per payroll, per gross sales, per store, per gross of candlesticks, etc. I don't think I would want my insurance carrier to spend a lot of money figuring out quite closely just about what my losses should have been and then billing me for this approximation to my actual losses plus the cost of servicing them, plus the cost of doing the figuring — particularly not if the carrier spent enough money to do such a good job that the whole idea of transferring uncertainty into certainty was impaired.

Needless to say, this discussion is confined pretty much to the question of rates for the policyholders who buy insurance in the popular sense of the word. Some policyholders buy the spreading of their losses in time, various services, etc. The pricing of packages which contain significant amounts of these ingredients involve a number of other considerations.

Of course, the possibility that rating methods will ever be developed to the point that the insurance element is perceptibly diminished is negligible, even though the practical limit on refinements seems to get moved back from one year to the next. The immediate difficulty with the direction of motion outlined above is that the complications annoy the customers and probably would annoy them more if they thought they were expensive.

Granting that it's impossible to move very far in the direction indicated, the first question which suggests itself is why willfully move in that direction at all. If there is an answer to this question — and there is — the second question is why move any further than necessary. Why in particular should supervisory officials push that way.

New information seems to be what used to bring into being rating refinements that limit the scope of insurance. As soon as a carrier finds out that it cannot underwrite freely the automobile business that emanates from a general agent in a town, it will endeavor to have that town set up as a separate rating territory. As soon as underwriters find out that young drivers produce poorer experience than others, a separate classification must be set up in order that a market can be found for that business. As soon as the right people find out that some excavating risks use dynamite and others do not, it will be necessary to subdivide the class in order that the dynamite users can find a market. Prior to the intensified interest in fair discrimination and other rating standards, the insurance industry hacked away at itself with rating complications only as fast as underwriting knowledge grew — nothing much to worry about.

It might seem that a dim view could be taken of rating law interpretations which accelerate this complication process.

Would it be out of order to consider fair discrimination not as an ultimate goal which must be actively pursued by statistical and other means until it is finally reached, but more realistically as a requisite of a good insurance market. As of any point of time there must be enough fair discrimination so that substantially all legitimate buyers can have a reasonable choice of carriers. Beyond that point (with incidental exceptions) it need not be pushed. Return the onus of increased complexity to the leisurely expansion of underwriting knowledge. Considering the actual dispersion of loss potentials within classifications, particularly in automobile rating territories, such an approach seems to be only realistic.

There are forces in the insurance market which, if left to themselves, tend to curb the drive toward expensive complexity. Agency-producing carriers have to compete for the good will of their agency plants. Direct-writing carriers cannot sharpshoot the market because of the necessity that they retain their business for long periods during which the specific attributes of their risks may change. Perhaps these and other similar factors would, if allowed to operate, keep the level of complexity balanced with the requirements of the market.

When middle pure premiums and arbitrary percentage change limitations have been discussed in the Compensation Board Actuarial Committee, concern has been expressed from some quarters that such devices interfere with the determination of correct rates. It is probably reasonable to assume that those concerned are either consciously or unconsciously subscribing to the pursuit of inherent hazards theory of ratemaking. You have said that the Department has not only condoned but has actually encouraged such technical inconsistencies because they enhance the acceptability of filed rates with the buying public. I have suggested that if such acceptability is a controlling consideration, then rate makers would do well to start with the marketing problem instead of a hypothetical statistical problem. In an unguarded moment you once suggested that such an approach be reduced to writing.

With fair discrimination being interpreted as a requirement of a satisfactory market rather than as the ultimate but unattainable goal of pursuing inherent hazards, devices which make rating procedures more acceptable to the buying public acquire a new legal stature. The complete development of such an approach would require the time and attention of a great many people. However, it is possible to start by making a few observations and, perhaps uncritically, drawing immediate inferences from them. Let's talk about New York Workmen's Compensation first.

1. From the success of the middle pure premium method, it might be inferred that a good system should endow a going rate with a certain validity and let it alone unless there is a good reason for a change.

2. From the success of arbitrary percentage change limitations, it might be inferred that a good system will not change any rate too much at any one time. It might be inferred further that a direct visible limitation is more convincing than an incomprehensible credibility formula.

3. From various experiences, although not generally in New York, it can be inferred that minor changes up and down are more annoying than satisfying.

4. From general considerations it might be inferred that the refinement of the system should not be incommensurate with the inherent limitations in providing for the unknown future. If the insurance industry goes around with a serious face endeavoring to measure with calipers a cloud in a high wind, it is only to be expected that rate controversies will be created by the pretty much irrelevant calipered measurements.

5. The justification for a rate change most satisfactory to the general public seems to be an understandable answer to the question: are you making money or are you losing money. The answer, to the extent possible, should be in regular accounting terms familiar to most business men.

If these were thought to be the more important considerations in setting up a system of manual ratemaking for Workmen's Compensation insurance, the procedure would probably be quite different from the one currently in effect.

Let us assume that a manual ratemaking procedure were devised in terms of these and similar considerations and that individual risk rating procedures were also retailored in terms of more easy buyer acceptance. It seems highly probable that such a price structure would result in both a better public acceptance of private insurance and a less accurate measurement of hazards. The paradox is very puzzling.

Believe it or not, this long inconclusive letter is not an effort to sell any particular bill of goods. I am honestly puzzled by the extent to which the set of premises which your mathematics requires actually corresponds with the rating problem. Examination of this question seems to be tied up with the issue of pricing objectives. It is felt that the latter issue from the long range viewpoint may be of more than academic interest.

Hence, this letter should be considered solely as a means of raising questions. Please don't ascribe any implied conclusions to me.

Also, please send me a copy of the paper you are preparing as soon as you have a satisfactory draft.

Best regards.

JC:lvw

John Carleton

OPERATION OF AN AUDITED-MILE/YEAR AUTO INSURANCE SYSTEM UNDER PENNSYLVANIA LAW

Patrick Butler

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Date: November 1992

To: Readers, The Forum, Casualty Actuarial Society

From: Patrick Butler, Ph.D.
Director, Insurance Project Patrick Butler

Re: Practicality of the Car-Mile Exposure Unit for Auto Insurance

The following 29-page review was prepared at the request of Pennsylvania legislators, who are considering rate regulatory bills that would mandate use of the car-mile exposure unit for driving coverages.

The focus is on individual transactions because the questions of convenience and control of odometer fraud are generally accepted as an impracticality barrier to a "pay-by-the-mile" method of earning premiums.

The theory behind the car-mile exposure unit is straightforward. Since every mile traveled by a car transfers risk to its insurer, the product of (a cents-per-mile class rate based on the class's per-mile cost experience) X (miles recorded on the car's odometer) appropriately earns prepaid premium while the car is driven.

Apparently there has been no other consideration of the impracticality issue since Paul Dorweiler's 1929 paper on exposure units stated that "[t]he devices and records necessary for the introduction of [the car mile] medium make it impractical under present conditions." 16 PCAS 319, 338; 58 PCAS 59, 78. For this reason, it is hoped that this review can serve as a framework for renewed, informed consideration of the practicality question.

OPERATION OF AN AUDITED-MILE/YEAR AUTO INSURANCE SYSTEM UNDER PENNSYLVANIA LAW

Prepared by
National Organization for Women
June 22, 1992

Executive Summary

This review examines the practical implications for insurance companies and Pennsylvania car owners of converting premium calculation for most coverages from dollars-per-year to cents-per-mile class rates. The purpose is to provide an operational model for evaluating proposed legislation mandating this conversion (SB 775 and HB 1881). Operation of a mile/year system is described through a sequence of transactions for a hypothetical car over four policy years.

Advance payment continues to be required for keeping insurance protection in force. Administrative expense and premium for nondriving coverages (theft, fire, hail) at year rates are paid at policy-year renewal time. Premium for driving coverages (liability, medical, collision) at mile rates is prepaid in mileage amounts and at intervals chosen by the car owner. The car's insurance ID card displays the odometer-mile and date limits to prepaid protection.

Policy renewal is conditional on taking the car to a garage designated by the company for the annual physical audit of its odometer. The odometer is calibrated and read, and tamper-evident seals are applied at the initial audit. Tampering with the odometer voids the insurance protection.

The possibility of stealing insurance protection under the mile/year system is explored. Control measures are described using two examples: a 10,000-mile roll back and stopping the odometer for 10,000 miles. (Driving with the cable unhooked, surprisingly, does not steal insurance protection, because it usually would be detected after an accident and tampering voids protection.)

The opposite possibility under the current year system is examined: policyholders having to pay premiums during nondriving periods when their cars are not consuming insurance protection and do not need it. Current "suspension of coverage" provisions for periods of non driving appear to be cumbersome, inadequate, and inconsistently applied. The present administrative handling of premium refunds for non-driving periods is compared to the mile/year system's automatic response to non-driving periods.

The review concludes by examining compulsory-insurance enforcement and compliance under the year and mile/year systems respectively. Attention is given to the negative effect that year-system enforcement has on ability to pay for insurance in comparison to the positive effect of the mile/year system on car owners' ability to comply with requirements.

OPERATION OF AN AUDITED-MILE/YEAR AUTO INSURANCE SYSTEM UNDER PENNSYLVANIA LAW

Prepared by
National Organization for Women
June 22, 1992

I. Introduction

This review examines the practical implications for insurance companies and Pennsylvania car owners of converting most automobile insurance coverages from year to mile class rates. The purpose is to provide a framework for evaluating legislation mandating this conversion from one-part to two-part pricing: from time rates only to a system using both distance rates and time rates. The legislation, which has been introduced in the Pennsylvania Senate and House and is under consideration in other states, would add one sentence to the state's Casualty and Surety Rate Regulatory Act: The exposure units for calculation of private passenger automobile insurance premiums at the appropriate classification rates shall be the mile by audited odometer readings for driving coverages and the year for nondriving coverages.[1]

The review assumes that this amendment is the only action by the Pennsylvania Legislature that would be needed to change prices for on-the-road coverages from *dollars per car year* to *cents per car mile*.[2] The methods of conversion and operation can be decided by the individual companies, constrained only by existing law on insurance and motor vehicles.[3] Self-interest and competition on service should

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1. Identical bills--Senate Bill 775 and House Bill 1881--were introduced in the 1991-92 Pennsylvania General Assembly and referred to the insurance committees.

Premiums for driving coverages charged at mile rates according to odometer readings is a method that works with any amount of coverage and all risk classifications. To calculate a premium: multiply the rate for the car's class (say 4 cents a mile) by the odometer miles of protection needed (say 10,000 miles) over a time period (say one year). The resulting premium: $400. For urban residents with the same coverage at a 9-cent rate, the premium for 10,000 miles protection would be $900.

2. Some regulatory changes would be necessary, however, because regulation of automobile insurance transactions is specific in some areas. Changes would be needed in current specifications for the insurance ID card contents, for example, and also regulatory review and approval would be needed for new policy language regarding odometer fraud.

3. For example, the mile rate for each classification and coverage would still be held to the Casualty and Surety Rate Regulatory Act standard that "[r]ates shall not be excessive, inadequate, or unfairly discriminatory." 40 P.S. Sec. 1183 (d).

NOW holds that, as an expression of public policy, this chief provision of rate regulation against assure development of company systems that are efficient, convenient and credible for consumers, and that effectively control premium fraud.

To test the operation of a mile/year system, it was judged preferable to study one method in detail rather than attempting to anticipate a range in methods that may be developed by individual companies. The test system is intended to be a fully functional prototype. System specifics, such as provisions in the insurance contract relating to odometers, are intended to help focus discussion.

As an introduction to its operation, the mile/year system selected is described in Section II (page 3) through a sequence of transactions for a hypothetical car over four policy years.

Section III (page 12) examines the methods of odometer auditing and the possibilities for fraud, in preparation for the next section on theft of insurance protection.

Section IV (page 14) explores the possibility under the mile/year system of theft of insurance protection by policyholders tampering with their odometers, and describes measures taken to prevent it.

Section V (page 20) examines the opposite possibility under the current system: policyholders having to pay premiums during nondriving periods when their cars are not consuming insurance protection and do not need it. The section describes how insurance companies now provide premium refunds for some kinds of nondriving periods, but not for others. The present administrative handling of premium refunds is compared to the mile/year system's automatic response to non-driving periods.

The final section (Section VI, page 26) reviews compulsory-insurance enforcement and compliance under the year and mile/year systems respectively. Attention is given to the negative effect that enforcement has on ability to pay for insurance under the year system in comparison to the positive effect of the mile/year system on car owners' ability to comply with requirements.

(continued)
cost-shifting among policyholders requires the use of distance rates rather than the current time rates for driving coverages in auto insurance pricing. The Insurance Commissioner, however, denied illegal cost-shifting in Pennsylvania NOW v. State Farm, and was upheld by the Commonwealth Court, 551 A.2d 1162 (1988). The evidence and NOW's response to the decisions are presented in three papers published by the Journal of Insurance Regulation: Butler, Butler, & Williams, *Sex Divided Mileage, Accident, And Insurance Cost Data Show That Auto Insurers Overcharge Most Women*, 6 J. INS. REG. 243, 373 (1988); Butler, Butler, & Williams, *Insurance Department 'Catch-22' Shields Auto Insurers From Consumer Challenges*, 7 J.INS. REG. 285 (1989); Butler & Butler, *Driver Record: A Political Red Herring That Reveals the Basic Flaw in Automobile Insurance Pricing*, 8 J.INS. REG. 200 (1989).

A subsequent paper will treat topics, such as ratemaking for conversion from year to mile units of exposure, that would be of direct interest to auto insurers but of less immediate concern to most legislators.[4] Work is also continuing on other related topics such as effect of the mile/year system on policy contract provisions that include accidents in a rented car under coverages for an owned car, and on arrangements for protection of lien holders' security interests.

II. How a mile/year system operates: an example

Automobile mechanical breakdown insurance ("service agreement" or "extended warranty") uses units of distance and time (miles and years) to measure and price insurance protection.[5] It thus provides a model for the mile/year auto insurance system. Contract language from a mechanical breakdown policy for used cars (**Exhibit A**) gives the necessary rules for measuring protection with an odometer:

> WHEN AND WHERE YOU ARE PROTECTED
> Protection included in the Plan YOU select is available as soon as YOU receive this Agreement.
> * * * *
> This Agreement expires 12 months after the Effective Date or, when YOUR CAR registers 12,000 miles more than the Odometer Reading at Inception, whichever comes first.
> * * * *
> WE will not pay benefits if the odometer of the covered vehicle has stopped or been changed.
> * * * *

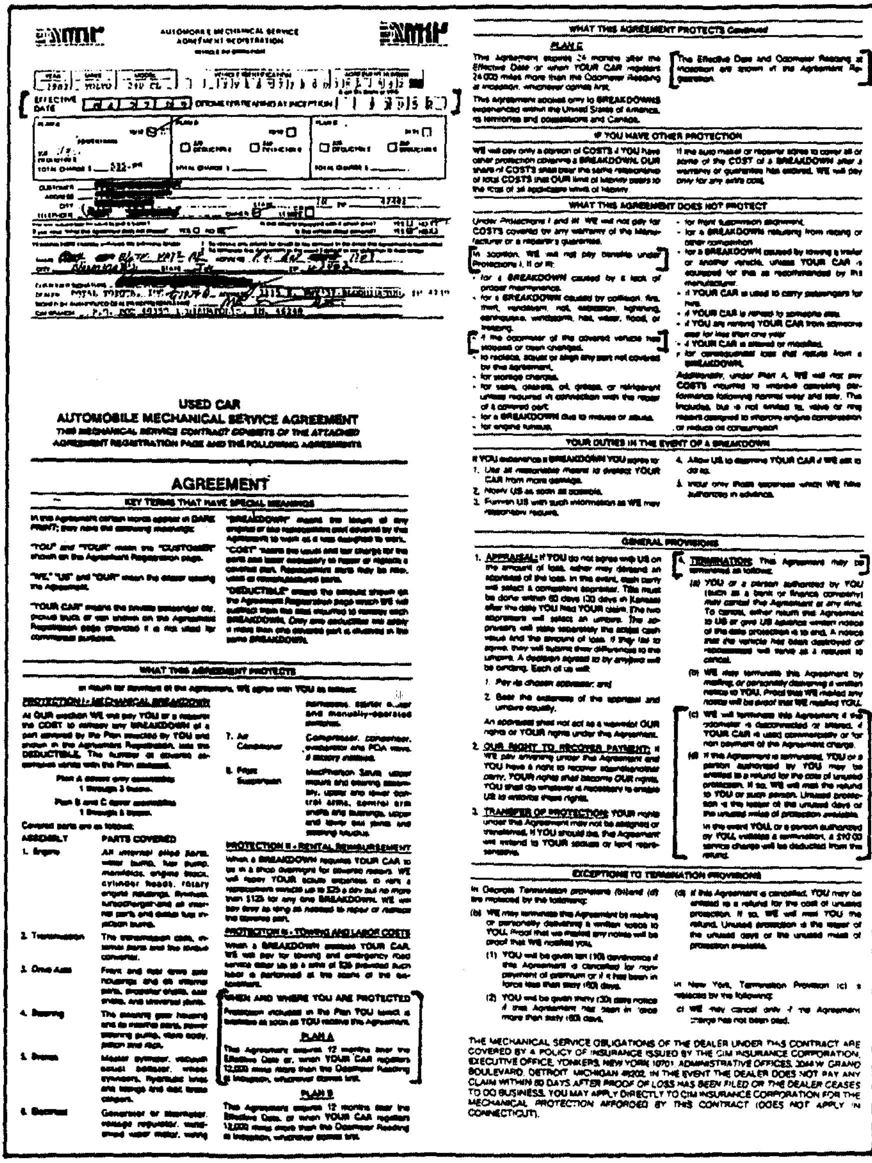
4. The paper *Making Mile Rates for Automobile Insurance* is in work. The proposal for doing the paper was accepted by the Casualty Actuarial Society in December 1991 as a candidate for the society's ratemaking seminar in March 1993.

The current method of determining the *cost per claim* does not need to be modified if appropriately applied. (Cost per claim = total cost of claims/total number of claims.) The mileage information needed to determine the *claims per mile* rate for each driving coverage is not collected at present but will be after the conversion. (Claims per mile = number of claims/number of miles driven.) The paper will examine ways in which the information can be determined in advance with sufficient accuracy for making the conversion. The *cost per claim* multiplied by number of *claims per mile* equals the per-mile cost of providing protection. For example, with an average cost of $2000 per claim and one claim per 100,000 miles, the mile cost for one coverage may be calculated: $2,000/claim x 1 claim/100,000 miles = $.02/mile.

5. The Pennsylvania insurance department regulates the rates and policy forms for mechanical breakdown insurance as for all other types of automobile insurance. Premiums for a policy on a used car can exceed $500 (4 cents per mile) for a 12,000-mile/1-year protection period.

EXHIBIT A

Mechanical breakdown insurance policy



USED CAR

AUTOMOBILE MECHANICAL SERVICE AGREEMENT

AGREEMENT

THE MECHANICAL SERVICE OBLIGATIONS OF THE DEALER UNDER THIS CONTRACT ARE COVERED BY A POLICY OF INSURANCE ISSUED BY THE CIM INSURANCE CORPORATION, EXECUTIVE OFFICE, YONKERS, NEW YORK 10701, ADMINISTRATIVE OFFICES, 3044 W GRAND BOULEVARD, DETROIT, MICHIGAN 48202. IN THE EVENT THE DEALER DOES NOT PAY ANY CLAIM WITHIN 60 DAYS AFTER PROOF OF LOSS HAS BEEN FILED OR THE DEALER CEASES TO DO BUSINESS, YOU MAY APPLY DIRECTLY TO CIM INSURANCE CORPORATION FOR THE MECHANICAL PROTECTION AFFORDED BY THIS CONTRACT (DOES NOT APPLY IN CONNECTICUT).

TERMINATIONS
This Agreement may be terminated as follows:
- WE will terminate this Agreement for non payment of the Agreement charge.
- WE will terminate this Agreement if the odometer is disconnected or altered.
- If this Agreement is terminated, YOU may be entitled to a refund for the cost of unused protection. Unused protection is the lesser of the unused days or the unused miles of protection available.
- In the event YOU initiate a termination, a $10 service charge will be deducted from the refund.

The same kind of policy conditions apply to coverages under the mile/year system: insurance protection is strictly prepaid (as it is now); consumption of driving protection is measured in distance units; consumption of nondriving protection is measured in time units; and odometer tampering voids the driving coverages.

Unlike the mechanical breakdown policy, however, the mile/year insurance system routinely renews mileage and time protection periods. Mileage renewals are in amounts and at intervals chosen by the policyholder, while the time period for renewal is the policy year. Policy year renewal is conditional on complying with company requirements (as it is now), such as providing rating information in the renewal application. An important renewal requirement in the mile/year system is taking the car for an annual physical audit of the odometer and its seals as directed by the company.

From the policyholder's perspective, the transactions that take place over a policy year are:

Before end of previous policy year, the policyholder

- Receives annual audit and renewal notice with premium bill
- Obtains physical audit of car's odometer
- Pays dollars-per-year premium for *non-driving* coverage and fixed expense; buys miles of *driving* coverage needed at current cents-per-mile rate
- Receives car's insurance ID card showing the odometer and date limits to prepaid protection

During policy year, the policyholder

- Buys additional miles needed at current cents-per-mile rate
- Receives car's insurance ID card showing the revised odometer limit to prepaid protection

To demonstrate operation of the mile/year system, the following hypothetical example (Exhibits B through E) tracks the insurance transactions for a single car over nearly four policy years.

Exhibit B. The sequence of transactions, which begins with 3,000 miles on the odometer when the car is acquired and ends with its sale at 37,000 miles, is shown in a graph of odometer readings vs. time.

The upper, stepped plot shows miles of insurance protection bought. Vertical segments of the "miles prepaid" line represent purchased miles of protection and are located at the dates on which the premium payments are credited. Each horizontal segment represents the odometer limit to prepaid protection until additional miles are bought.

The lower plot is a "miles driven" line connecting the odometer audit points. The line segments between audits represent average driving exposure, expressible in miles per day or miles per year. (A plot of the actual miles of exposure, by which the policyholder consumes prepaid protection and the company earns premium in providing it, would vary in slope between horizontal for periods of no driving to steeply positive--e.g. 500 miles per day--for long trips. A day-by-day plot of odometer reading, nonetheless, would also pass through the odometer audit points.)

Exhibit C. The insurance ID card, which the company is required by law to provide for each car it insures,[6] communicates the car's insurance status to the policyholder by prominently displaying both the mile total of prepaid protection (expressed as an odometer reading) and a policy year renewal month.

Exhibit D (& Exhibit B). A table of the transactions between policyholder and company for the example car lists the premium payments and audits over the four policy years examined.[7] (Transactions are keyed by number to the odometer vs. date graph, Exhibit B.)

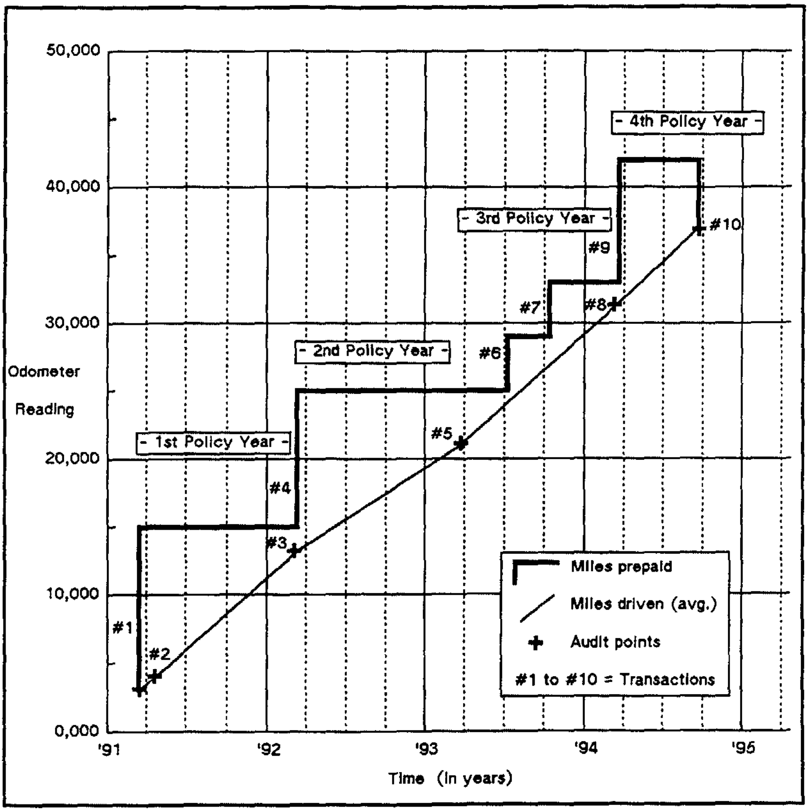
The first transaction takes place on March 15, 1991, when the new owner takes possession of the car. Its odometer reads 3,000 miles and the owner buys 12,000

6. 75 Pa.C.S. Sec. 1782 (d) and 31 Pa. Code Sec. 67.23 *et seq.*

7. The issue date of the ID Card is assumed to be 7 calendar days after the later of: 1) policyholder mailing of the renewal application with any premium paid; or 2) the odometer audit. (This time accounts for internal company processing, including transmittal of odometer audit information from vendors.) Receipt of the ID Card by the policyholder is taken as 4 days after the issue date.

EXHIBIT B

Transactions For Example Car



miles of insurance protection. The company provides a binder as proof of insurance pending issuance of an ID card, which is contingent on completion of the initial odometer audit and sealing within 30 days according to company rules.[8]

8. It is assumed that non-conformity to policy contract conditions would constitute valid cause for nonrenewal at the end of the policy year and the within-60-day cancellation period permitted for new policies. 40 P.S. Sections 1008.4 and 1008.6.

EXHIBIT C

Insurance ID Card For Example Car

Financial Responsibility Identification (ID) Card

Insurance Company Name   company number   Insurance policy #

Named insured   Address

Vehicle   Make Model   Vehicle Ident. Number (VIN)

ID Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
APR-20-91	15000 *	MAR 1992 *	3,700	APR-13-91

* *ID CARD IS NOT VALID AFTER MILE OR MONTH LIMITS SHOWN, OR IF ODOMETER STOPS.*

If a limit is reached, the car is NOT insured as required by Pennsylvania law. DO NOT DRIVE IT until more insurance is purchased. If the ODOMETER STOPS, telephone your insurance company for instructions before driving.

(back of card - required statements, 31 Pa.Code 67.24)

This card must be carried for production upon demand. It is suggested that you carry this card in the insured vehicle.

WARNING: Any owner or registrant of a motor vehicle who drives or permits a motor vehicle to be driven in this State without the required financial responsibility may have his registration suspended or revoked.

NOTE: THIS CARD IS REQUIRED WHEN:
(1) You are involved in an auto accident.
(2) You are convicted of a traffic offense other than a parking offense that requires a court appearance.
(3) You are stopped for violating any provision of 75 Pa.C.S. (relating to the Vehicle Code) and requested to produce it by a police officer.

You must provide a copy of this card to the Department of Transportation when you request restoration of your operating privilege and/or registration privilege which has been previously suspended or revoked.

After the first odometer audit on April 13, 1991, which shows that the car has been driven 700 miles since purchase, the company issues the ID card, Exhibit C. There are no further transactions until February 1992, near the end of the 1st policy year. Along with the renewal application form, the company communicates the 1992 mile rates and bills for any *year-rate* charges for the 2nd policy year. The policyholder, however, is responsible for buying sufficient miles of protection at *mile rates* for the anticipated use of the car.

EXHIBIT D

Transactions and ID Cards For Example Car

1ST POLICY YEAR 1991

	Mar-13	Fills application for insurance on car being purchased.
#1	Mar-15	Pays car-year charges plus 12,000 car miles of protection at 1991 rate, which added to the 3,000 on odometer (and recorded on title at transfer) puts a limit odometer reading of 15,000 miles. Gets binder as proof of insurance pending auditing and sealing the odometer and receipt of the Insurance ID Card.
#2	Apr-13	Takes car for odometer audit required by Company within one month of initiation of insurance on car. Odometer reads 3,700 miles
	Apr-24	Receives the Insurance ID Card, below, issued Apr-20 by Company

I.D. Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
APR-20-91	15000*	MAR 1992*	3,700	APR-13-91

2ND POLICY YEAR 1992

	Feb-28	Receives renewal application, bill with current car-mile and car-year rates, and notice that Company odometer audit is due in March.
#3	Mar-01	Takes car for odometer audit performed by Company-appointed, licensed, public garage. Odometer reads 13,000 miles, which garage reports to Company
	Mar-03	Sends Company premium for car-year charges plus 10,000 car miles of protection, which increases the mileage limit from 15,000 to 25,000, and completed renewal application
#4	Mar-14	Receives the Insurance ID Card, below, issued by Company Mar-10

I.D. Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
MAR-10-92	25000*	MAR 1993*	13,000	MAR-01-92

3RD POLICY YEAR 1993

	Mar-01	Receives renewal application, bill with current car-mile and car-year rates, and notice that Company odometer audit is due in March
	Mar-19	Sends Company premium for car-year charges and completed renewal application (pays for no additional mileage)
#5	Mar-23	Takes car for odometer check performed by Company-appointed, licensed, public garage. Odometer reads 21,000 miles
	Apr-03	Receives the Insurance ID Card, below, issued Mar-30

I.D. Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
MAR-30-93	25000*	MAR 1994*	21,000	MAR-23-93

	Jul-03	Sends payment for 4,000 additional car miles of protection at current 1993 car-mile rates, which increases the mileage limit from 25,000 to 29,000 miles
#6	Jul-12	Receives the Insurance ID Card, below, issued Jul-08

I.D. Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
JUL-08-93	29000*	MAR 1994*	21,000	MAR-23-93

	Oct-06	Sends payment for 4,000 additional car miles of protection at current 1993 car-mile rates, which increases the mileage limit from 29,000 to 33,000 miles
#7	Oct-17	Receives the Insurance ID Card, below, issued Oct-13

I.D. Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
OCT-13-93	33000*	MAR 1994*	21,000	MAR-23-93

4TH POLICY YEAR 1994

	Feb-27	Receives renewal application, bill with current car-mile and car-year rates, and notice that Company odometer audit is due in March
#8	Mar-05	Takes car for odometer check performed by Company-appointed, licensed, public garage. Odometer reads 31,000 miles
	Mar-13	Sends Company premium for car-year charges plus 9,000 car miles of protection, which increases the mileage limit from 33,000 to 42,000, and completed renewal application
#9	Mar-24	Receives the Insurance ID Card, below, issued Mar-20

I.D. Card Issue Date	Insurance protection ends on Odometer mile	Last day of	Last odometer audit done on Odometer mile	Date
MAR-20-94	42000*	MAR 1995*	31,000	MAR-05-94

#10	Sep-20	Car is sold. Company waives physical odometer audit for refund verification because sale is to a licensed dealer. Company accepts odometer reading of 37,000 recorded on Transfer title, which is filed with the state, to calculate return premium for unused miles of insurance.
	Oct-1	Receives refund for 5,000 miles (= 42,000 - 37,000) at 1994 rate paid Mar-13.

The policyholder buys more miles of protection at the beginning of the 2nd policy year, but does not buy any at the beginning of the 3rd policy year. Twice during the 3rd year, however, the policyholder buys more miles of protection at the 1993 mile rates in effect.

At the time of the 1994 renewal for the 4th policy year, the policyholder buys more miles of protection in expectation of continued higher car use. The car is sold in September, however, leaving the policyholder with a premium credit for the unused miles of protection. This credit can be applied to premium for another car on the policy, used to buy miles of protection for a replacement car (at a different mile rate if coverages change), or refunded to the policyholder.

The number of transactions, in general, differs between the mile/year system and the current year system. Although the physical audit required by the test system is a mandatory annual transaction, the number of payment transactions can be decreased or increased according to the circumstances of the policyholder. In **Exhibit E**, this difference is assessed by comparing transactions for the two systems in the 2nd and 3rd policy years for the example car. In the 2nd policy year payments are as large and infrequent as possible under both systems to minimize the number of transactions. During the 3rd policy year, however, smaller and more frequent mileage purchases are compared with a typical extended-payment plan for year-rate premiums.[9] Under the mile system the number and size of payments chosen by a policyholder are constrained only by company rules and charges, such as a one thousand mile minimum purchase and a $3 transaction fee.[10]

9. This paper uses the current State Farm system, defined in the company's 1992 Pennsylvania manual of rates and rules, as typical. The State Farm group is the largest in Pennsylvania with nearly 1.3 million vehicles insured in 1989 (20.2% of market). PENN. INS. DEP'T, *Private Passenger Motor Vehicle Single Carrier Study for [Philadelphia]*, (1991) Exhibit 3.

10. The question may arise as to the permissibility of hoarding a large amount of prepaid mileage in anticipation of a sharp rise in mile rates with inflation in medical and automobile repair costs. The company may put restrictions on the amount and may also choose to limit mileage purchase amounts during the time following filing of proposed new rates with the Insurance Commissioner--when increases become public--until the new rates take effect. The time between filing and implementation is generally at least 60 days, as set by the Motor Vehicle Insurance Rate Review Act, 75 Pa.C.S. Sec. 2003.

On the other hand, insurers may simply zero everything out at policy renewal time. That is, credit the insured for the dollar amount actually spent on miles not driven, then charge the rates in effect on the renewal date for the miles to be covered by the renewal policy.

Transaction fees charged for installment payments are currently $2 by State Farm and $3 by Geico.

EXHIBIT E

Mile/Year and Year Transactions Compared

MINIMUM ANNUAL TRANSACTIONS			
MILE/YEAR SYSTEM - 2nd Policy Year in Exhibit B		EQUIVALENT IN CURRENT YEAR SYSTEM	
MAR #3	Annual odometer audit (Mileage limit/policy year ID Card issued)		
MAR #4	Returns policy year reapplication with premium payment for any year charges plus premium for mileage needed at mile rates	MAR	Returns policy year reapplication and pays 1st semiannual premium (1/2 year ID Card issued)
		SEP	Pays 2nd semiannual premium (half-year ID Card issued)

EXTENDED PAYMENTS TRANSACTIONS*			
MILE/YEAR SYSTEM - 3rd Policy Year in Exhibit B		EQUIVALENT IN CURRENT YEAR SYSTEM*	
MAR #5	Annual odometer audit (ID card issued with odometer mile and month limits to protection)		
MAR	Returns policy year reapplication with any year charges (Pays no premium for car miles because sufficient unused mileage left from 2nd policy year)	MAR	Returns policy year reapplication and pays 50% of 1st semiannual premium (1/2 year ID Card issued)
JUL #6	Pays for additional miles (ID card issued with odometer mile and month limits to protection)	MAY	Pays balance of 1st semiann premium
OCT #7	Pays for additional miles (ID card issued with odometer mile and month limits to protection)	SEP	Pays 50% of 2nd semiann premium (1/2 year ID Card issued)
		NOV	Pays balance of 2nd semiann premium
		*	State Farm Manual Rule 104 on Renewal of Policy

III. Odometer auditing

Regular company audits are essential to the integrity of a mile-rate auto insurance system.[11] In parallel with the mechanical breakdown insurance provisions reproduced in Section II above, the test system's policy provisions on odometers are:

> The policyholder must submit each car covered by this policy for an odometer inspection and reading by the Company or its contractor when first insured by the Company, and thereafter annually prior to the end of each policy year. The Company may cancel or refuse to renew the policy if the odometer inspection requirements are not met.
> Driving coverages for any car under this policy are automatically void and afford no protection if the car's odometer:
> 1) Registers more miles than the limit paid
> 2) Has stopped and the Company has not been notified before further use
> 3) Has its Company seals broken or tampered with
> 4) Has been altered in any way that changes the calibrated operation.

Since the purpose of these provisions is to assure that the company receives advance payment for all of the on-road insurance protection it provides, monitoring compliance is the primary function of periodic odometer auditing.

An important secondary purpose of auditing is to provide accurate exposure data for ratemaking. Through overall and class-specific aggregations of actual, individual average[12] car mileages over given time periods (month and year), it is possible to relate miles of exposure to the claims aggregated in the same classes and during the same time periods. This would produce the necessary per-mile claim rates (claims per mile) for making cents-per-mile premium rates.[13]

Odometer audits are dated, independent (non-policyholder) odometer readings (the "audit points" of Exhibit B, *supra*, page 7). Two kinds of audits are used in the test system: physical and documentary.

A physical audit is performed on the car at the direction of the company by

11. "Audit: to examine with intent to verify." Webster's New Collegiate Dictionary (1980).

12. The audit lines connecting the audits for individual cars (Exhibit B) represent the average daily mileage of the car for the interval between audits.

13. It is worth noting that claims data on a per-mile basis would for the first time allow class and territory cost comparisons normalized to a common statistical basis that quantifies exposure.

employees or vendors, and includes inspection of seals, calibration, and reading.[14] Odometers are sealed for the detection of tampering and the initial audit includes application of tamper-evident seals. (Serialized one-way adhesive seals witness the integrity of cable connections and of the dashboard mounting of the meter itself.)[15]

Documentary audits are reviews of the odometer readings that are performed through transactions between policyholders and 3rd parties, e.g., the readings made at the transfer of ownership and attested to by both buyers and sellers on the title certificates.[16] There are a number of other transactions involving automobiles that provide information for auditing. For example, the Pennsylvania consumer code requires garages to record odometer readings on work orders when cars are accepted for repairs and again when they are returned to owners.[17]

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14. Inspection of cars applying for physical damage (Collision and Comprehensive) coverage is required by law in New York and California, and is under consideration in other states. In an opinion survey of car owners, 83% of respondents would be "very or somewhat willing" to take their cars to an insurer for inspecting and photographing when taking out a policy. INS. RESEARCH COUNCIL, *Public Attitude Monitor 1991*, page 12.

Technical columnist Armando Castellini, who is an insurance educator and New Jersey broker, noted that the inspection of cars by insurance companies ("underwriting report") is "something almost all companies have discontinued with the predictable results that (1) insureds lie about the use of their cars and who uses them, (2) producers lie about their clients to 'low-ball' premiums, and (3) the insurance companies overcharge the large majority of policyholders to make up for the sloppiness of the system." INS. ADVOCATE, May 4 1991.

In opposition to New Jersey legislation mandating company inspections of newly covered cars for physical damage coverage, Allstate Insurance estimated the cost at $13 per car. The maximum charge for an emissions inspection in Pennsylvania is $8. 75 Pa.C.S. Sec. 4706 (d).

15. Tamper-evident, serial-numbered company seals made of flexible film face stock are attached with strong adhesive to the ferrules and casing at either end of the odometer cable. Any attempt to turn a ferrule to detach the odometer cable visibly tears the face stock.

The cost of these seals in quantity would be 2 cents to 5 cents each, according to Valley Forge Tape and Label Co., Exton Pennsylvania, May 1992, for a total at of 15 cents per car at most for three seals.

16. Title certificate odometer readings gain further validity through state law for controlling odometer fraud in car sales:

> 75 Pa.C.S. Sec. 1105 (c) Title transfer odometer readings--The department shall compare the odometer reading of the vehicle each time a certificate of title is transferred and ascertain the reported mileage against the most recent previously reported mileage for the vehicle.

Such a review presumably would screen for a decrease, or an abnormally low increase, in the car's reported mileage from a previous transfer.

A PennDOT pamphlet *Odometer Roll Backs* distributed by the Office of Attorney General, Bureau of Consumer Protection gives instructions if a car buyer suspects fraud to write the Bureau of Motor Vehicle & Licensing Information Sales for "a photocopy listing previous title holders, their addresses, and in some cases, the car's mileage at the time of sale if PennDOT has such information available." Pub. 160 (2-85).

Dealers "shall retain for four years each odometer mileage statement which he receives. He shall also retain for four years a photostat, carbon or other facsimile copy of each odometer mileage statement which he issues." 75 Pa.C.S. Sec. 7133 (a).

17. 37 Pa.Code Sec. 301.5. The two readings control unauthorized use of the car while it is in

As a condition of annual policy renewal, the Company requires that a physical audit be done on each car it insures. The odometer readings and dates of these audits are included on the insurance ID cards, Exhibit C. Policyholder convenience is served by specifying renewal months rather than deadline dates.[18] Repair garages view the audits on behalf of insurance companies as a business opportunity.[19]

To secure insurance on cars just bought, a copy of the title certificate or mileage disclosure statement from the seller provides the initial odometer reading to the insurance company for binding coverage until the initial company physical audit is done, within 30 days.

IV. Stealing insurance protection

Stealing protection from auto insurance companies can be done in several ways under the mile/year system: biasing the drive train to make the odometer read low, resetting the odometer, and stopping the odometer. Federal and state laws against tampering with odometers penalize these prohibited activities with fines and jail.[20] This section describes procedures used in the mile/year test system to control theft of insurance.

(continued)
the custody of the garage.

18. With most or nearly all of premium charged at mile rates, there is relatively little per-year premium put at risk of non payment in the mile/year system through extending the effective due date from the anniversary within the month to the end of the month.

19. Sworn testimony by an owner of a garage licensed to do state inspections. The charge for odometer sealing, calibration, reading, and reporting to an insurance company was estimated at less than $10. Reproduced Record, Pennsylvania NOW v. Ins. Dept. of Pennsylvania, Commonwealth Court, (No. 1276 C.D. 1987 and No. 276 C.D. 1988) at 2441a.

20. Federal Odometer Act of 1972 (15 U.S.C. Sections 1901, 1981-1991); Pennsylvania Vehicle Code (75 Pa.C.S. Sections 7131-7139).

Section 7132 of the Pennsylvania vehicle code 75 Pa.C.S. states:

Prohibited activities relating to odometers.

(a) Devices causing improper odometer reading.--No person shall advertise for sale, sell, use or install, or cause to be installed, any device which causes an odometer to register any mileage other than the true mileage driven which is that mileage driven by the vehicle as registered by the odometer within the manufacturer's designed tolerance.

(b) Change of odometer reading.--No person shall disconnect, reset or alter, or cause to be disconnected, reset or altered, the odometer of any motor vehicle with intent to change the number of miles indicated on the odometer.

(c) Operation with disconnected or nonfunctional odometer.--No person shall, with intent to defraud, operate a motor vehicle on any street or highway knowing that the odometer of that vehicle is disconnected or non-functional.

Summaries of twenty years of odometer-fraud case law, as well as federal and state statutes and regulations, are contained in: NAT'L CONSUMER L. CENTER, *Odometer Law*, (1988) and *Odometer Law Cumulative Supplement* (1991).

Surprisingly, keeping the odometer cable unhooked for much of the time, and resealing it with a stolen or counterfeit seal before the next company audit is unlikely to result in significant theft of insurance protection. According to the policy provisions of the test system, a car operating with the odometer disconnected is simply being driven without insurance: no mile-rate premium is being earned and no protection is being provided.[21] Even if disconnecting and reconnecting of the odometer should go unnoticed, there is no theft of insurance protection. If the odometer is sealed and operating, premium is being paid for the protection provided.

Low-reading odometer. Odometers can be made to read less than the actual mileage driven without breaking any seals by increasing tire sizes or decreasing axle ratios. The premium savings, however, would appear to be small compared with the effort, the risk of severe federal and state penalties for odometer fraud, and the adverse effect on the car's operating characteristics.[22] The policyholder would have to switch from standard to larger wheels or a higher axle ratio after the annual audit and calibration, and reverse the change before the next annual audit. To cut the mileage readings about 10% from actual distance traveled would require a 2-inch increase in tire diameter. The car's insurer would be defrauded thereby of $100 for every $1,000 worth of protection provided. If the use of oversized tires to steal insurance protection should ever become a problem, however, it could be controlled by recording the tire size on the insurance ID card with the warning that use of a different tire size without a recalibration voids the on-the-road protection. Switching drive axle gear ratios before and after each annual audit would require even more effort than changing tire sizes, but can be controlled if necessary by application of a single seal to the axle housing.

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21. Protection would be received without premium payment only for accidents after which the policyholder was able to reconnect and seal the odometer without being observed.

Although using a car with the odometer cable unhooked is not stealing insurance protection because protection does not exist, use of a car in this condition violates the compulsory insurance law, which is the subject of section VI, *infra*.

22. The manufactured design optimizes handling performance with given tire sizes and axle ratios. A "slow" speedometer and low-reading odometer are inconveniences, at least whenever speed limits and map distances are of interest.

EXHIBIT F

Reset Odometer Example

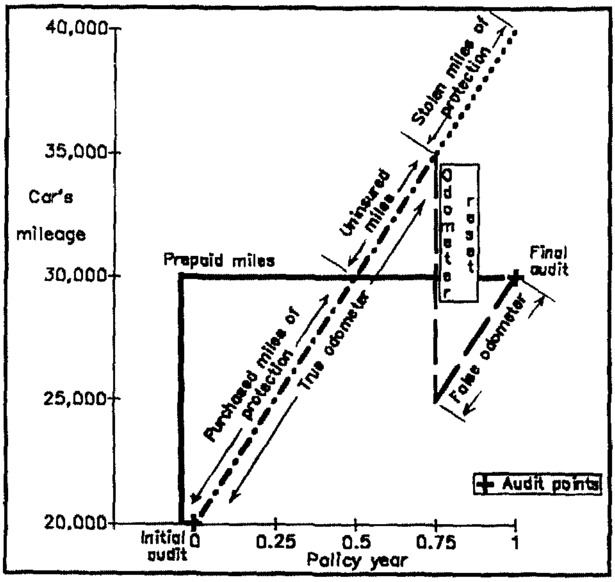
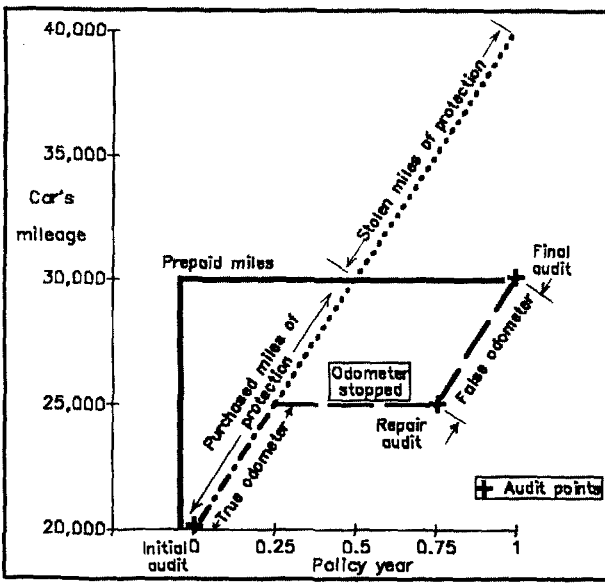


EXHIBIT G

Stopped Odometer Example



Some years ago, when odometers had metal gears that could stand high speeds, dishonest car dealers ran odometers rapidly in reverse by unhooking the cable and attaching a high-speed drill. For several decades, however, plastic gears have been standard in odometers. Such gears are durable in service because even the most rapidly revolving one-tenths digit turns very slowly--one rpm at sixty mph. These gears heat up and break, however, when attempts are made to back up the odometer rapidly with an electric drill.

Professional insurance theft by resetting the odometer. Criminal experts can turn back odometer tumblers with a thin pick. Charging $30 to $50 per two-minute job, the criminal can remove several tens of thousands of miles from the odometers of late model high mileage fleet or lease cars to increase resale value an average $1500.[23] Given the fact that insurance rates for full coverage of relatively expensive cars in high-rated territories can exceed $0.10 a mile, a policyholder could defraud the insurance company of $1000 in premium each year by paying $50 to have the ten thousands tumbler rotated back one digit.[24]

To counter such major odometer fraud in the mile/year system, odometer auditors and inspectors look for telltale signs of rollback tampering that can lead to convictions of the policyholders responsible. The following example shows how annual audits can control and constrain this kind of theft of insurance protection.

Exhibit F. In the initial audit, the odometer of a hypothetical insurance thief's car reads 20,000 miles. Although the car will be driven 20,000 miles during the coming year, the thief plans to have the odometer rolled back 10,000 miles and therefore only buys ten thousand miles of protection. To keep from producing an

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23. Connie McNamara, *Odometer cheats get a lot of mileage, officials say,* Harrisburg Sunday Patriot News, June 28, 1987.

24. Patrons of meter-tampering criminals take considerable risk. For example, when a New York lock picker who reduced gas and electric meter readings by half was caught, he cooperated with the prosecution of his clients--by wearing a hidden tape recorder while being paid--in exchange for reduced punishment. In addition to facing criminal prosecution, his customers are to pay restitution for tens of thousands of dollars of stolen gas and electricity. N.Y. Times Sep. 27, 1985, p.2 *45 L.I. Businesses Accused of Cheating Utility Meters.*

More recently in the Philadelphia region, criminal experts in altering electric meters to underrecord actual consumption up to 58% were involved in tampering with more than 50 meters for Bucks County homes and businesses. Phila. Inquirer, Jan 21, 1992, B2 *Third person faces charges in Bucks meter tamperings.*

On the other hand, meter-tampering criminals can be caught with the help of clients hoping to escape punishment. *56 had TV boxes rigged to cheat, police say,* Patriot-News (Harrisburg, Pa.) May 8, 1992. Facing $300 fines and 3 months in jail, customers who paid $35 to $100 to two criminal experts to alter pay-TV meters, are cooperating in their apprehension.

odometer reading that is less than the initial audit (20,000 miles) and thus voiding protection, however, resetting the ten-thousands digit has to be delayed until after 30,000 miles is passed at mid year. The rollback is done in the example at 9 months (0.75 year) to reduce the reading from 35,000 miles to 25,000 miles. Apparently unknown to the thief, however, there was no insurance protection for the last 5,000 miles before the rollback because these miles exceeded the 30,000 prepaid-miles limit. Therefore, the amount of protection actually stolen in the example is not 10,000 miles, but only 5,000 miles, Exhibit F.

A more sophisticated policyholder than the insurance thief described above could steal several thousand dollars of auto insurance protection annually on a fully covered expensive car in a relatively high-rated area.[25] It is significant that auto insurance companies and their honest policyholders are not the only victims of odometer rollbacks: providers of car warranties and mechanical breakdown insurance, and buyers of used cars are defrauded as well. Widespread public awareness of the seriousness of odometer tampering has developed from news reports on a decade of prosecution of strong federal and state odometer fraud statutes.[26]

Amateur insurance theft with a stopped odometer. Odometer failure, whether spontaneous or induced, presents an opportunity for theft of insurance protection.[27] According to policy language, insurance coverage is void while the odometer is stopped unless the company is notified. Nevertheless, to protect the validity of a claim, a policyholder can always assert that the odometer had failed just before the accident or was broken as a result of it. Test system procedures are designed to control such theft.

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25. Apparently some sophisticated car owners violate mandatory insurance requirements. State police testimony pointed out that "It is just as probable to find a counterfeit inspection sticker or false insurance identification card associated with a Mercedes Benz as a Chevrolet. The motivation to avoid the law is economic, whether the owner or lessor can afford the insurance or not." House Insurance Committee hearing April 25, 1991, Tr. 117. Under the mile/year system, federal and state odometer anti-tampering law provide additional strong sanctions against cheating.

26. Although the focus has been on professional thieves who tamper with tens to hundreds of odometers, some individuals are being punished. *E.g.*, a Baltimore police lieutenant recently was indicted for theft for having his own odometer rolled back to increase the car's resale value. Baltimore Sun, *Brief*, April 22, 1992.

27. An odometer cable can be caused to wear rapidly and break by pulling its casing into an overly tight curve. Society of Automotive Engineers specifications put the minimum radius of curvature at six inches. SAE J678 Dec 88.

In addition to the inconveniences of not having a speedometer and odometer (note 22, *supra*), cars built after 1980 will not run efficiently with the odometer cable broken because it provides a signal to the ignition/fuel-injection computer. R. Morse, Chief of Odometer Fraud Staff, USDOT, at the

Should an odometer stop, policyholders are instructed on the ID card to stop driving and to telephone the Company in order to maintain coverage, Exhibit C (*supra*, page 8). The company responds with a confirmation code, a time limit for repair, and any other instructions or limitations appropriate for the situation.[28] Before any seal is broken to replace the odometer or its cable, a mandatory first step is to have a physical audit to get the reading and inspect the seals. This audit comes between annual audits and shows the average driving before and after the odometer failure. An unexplained and marked difference in the averages indicates possible premium fraud, which can be further investigated. A hypothetical example of protection theft shows how the audits are used.

Exhibit G. Actual use of a hypothetical car is 20,000 miles during a policy year. At the beginning of the year the odometer reads 20,000 miles and 10,000 miles of insurance protection is bought for the coming year. The odometer cable breaks (or is broken) at 0.25 year with a reading of 25,000 miles, but is not reported to the Company until 10,000 miles more have been driven in the next half year. If an accident happens during this 10,000 mile period, the policyholder can claim coverage with the excuse that the odometer "just broke." With the excuse sustained, the Company has provided coverage without collecting premium for 10,000 miles. The excuse can be challenged, however, after the end of the policy year with audit information.

At the repair audit the odometer shows the same 25,000 mile reading it did six months earlier when it stopped. A "miles-driven" line joining the initial and repair audits would show 5,000 miles in 9 months, which is a rate of 6,670 miles per year, Exhibit G. An increase of 5,000 miles on the odometer in the next three months between the repair audit and next annual audit, however, indicates the true driving rate is 20,000 miles per year. Even though such an apparent strong change in car use might be insufficient to prove theft of insurance protection, it nonetheless alerts the test system to get more evidence on the actual amount of driving done. Another odometer failure in a following year would be even more suspicious. Stealing insurance protection through odometer tampering is a risky way for policyholders to try to save money.[29]

(continued)
11th Ann. Conf., National Odometer Enforcement Association, August 12, 1991.

28. If the failure happens on a trip, the insurance company specifies that coverage stays in effect over the route for completion of the trip. A value for the unrecorded miles of exposure is derived from the route distance.

29. This kind of amateur theft is akin to that in which householders steal gas by running a bicycle inner tube around the meter or steal electricity by removing the meter and inserting spoons or forks

V. Premium charges for nondriving periods

If the possibility that policyholders may be able to steal insurance protection is cause for concern, then the possibility that companies may be able to charge premium for driving coverages during nondriving periods must be an equally serious concern. This section examines various administrative provisions made for periods of nondriving and the effects they have on premiums. In the current year system, rate manual rules allow interruptions of insurance protection and premium charges during nondriving periods, such as:

> SUSPENSION OF COVERAGE, SEASONAL USE, WITHDRAWAL FROM USE
> A. Suspension of Coverage
> Coverage afforded under a policy insuring a motor vehicle may be suspended during the time the vehicle is withdrawn from service. The coverages suspended *afford no protection* under the policy during the period of suspension.
> * * * *
> The continuation of certain coverages during the period of suspension may be desirable; e.g. comprehensive [coverage for nondriving losses].
> * * * *
> Premium credits on suspended coverages will be computed pro rata for the period of suspension.

General Rule 106 A, State Farm Mutual Auto. Ins. Co. (emphasis added)

The administrative problems of this and several other ways that the year system currently handles nondriving periods can be compared to the automatic response of the mile/year system to nondriving periods:

Year system

- When there is a period of "withdrawal from use" accompanied by "suspension of coverage," as the above manual rule provides, prepaid premium for the non-covered period is refunded to the individual policyholder.

  Example: Hypothetical car considered below in 2nd policy year.

- When many policyholders in an identifiable group are not driving, a portion of prepaid premium is refunded uniformly to all policyholders in the group.

  Example: Policyholders who served in the Middle East armed forces in 1990 and 1991, were refunded prepaid premium for a fraction of the time they were

(continued)
across the connections. Control on such theft includes monitoring consumption for anomalous patterns and abrupt changes. P. VALENTINE, *On the Trail of Power-Hungry Thieves*, Wash. Post, April 6, 1991 at B1.

overseas, despite the fact that companies had no way of knowing whether the cars actually were withdrawn from use or even driven less in the owner's absence.[30]

- When economic recession triggers a reduction in claims because many policyholders drive less, insurance companies provide uniform refunds ("dividends") to all policyholders without distinguishing whose cars actually were driven less.[31]

  Example: Owing to a decrease in accident claims since the current recession started in mid-1990, State Farm made statewide refunds in 12 states reaching 20 percent of semiannual premium.[32]

- When individuals interrupt driving for periods of time, in most cases no refund of prepaid premium occurs at all.

  Example: Hypothetical car considered below in 3rd and 4th policy years.

<u>Mile/year system</u>

- Only the miles driven by each car, as recorded on its odometer, determines individual premium consumption and obviates the need for group refunds. With miles prepaid, the car is fully insured whenever driving is resumed after a nondriving period. Therefore, no administrative costs are incurred for suspending and reinstating insurance.

  Example: Hypothetical car considered below over four policy years.

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30. Geico Insurance Company's "Desert Shield dividend" consisted of a 25% premium credit for the period on active duty in the Middle East in 1990 as certified by a superior officer. Source: Geico forms (P-294a & P-295) sent to policyholders on request.

This refund appears to assume that the estimated 16,000 Geico-insured cars eligible were on average driven 75 percent as much as usual while their owners were overseas. (*I.e.*, for every four months that the policyholder was overseas, one month's prepaid premium was refunded.) A Geico official's reply to a reporter's question about an equivalent "Desert Storm" dividend for 1991, however, suggests that the refunds were not based on a cost-savings estimate, but instead on the budget for public relations: "For this year, we don't have an idea as to whether the company is making a profit or not, so we can't make a decision yet." NAT'L UNDERWRITER, *Geico To Pay Desert Shield Auto Dividend*, Feb. 4, 1991.

31. Speculation that "a lot of cars are up on blocks" by the State Farm vice president for Pennsylvania was cited by the president of the Insurance Federation of Pennsylvania to dramatize the marked drop in claims following the July 1990 onset of the current recession. Transcript of testimony before the House Insurance Committee November 14, 1991, page 112.

32. J. Commerce, *State Farm to Refund Millions in Car Premiums*, Dec. 18, 1991, at 9A. State Farm's reported explanation was that "claim costs were less than anticipated." At rate hearings and in other forums, however, officials of State Farm and other auto insurance companies directly attributed a drop in claims to a recession-related decrease in driving and a rise in gasoline prices. In Pennsylvania where State Farm had litigated strongly against premium reductions mandated by Act 6 of 1990, it seems clear that the company did not take the nearly 6 percent increase in July 1991 authorized by the law because of the drop in claims caused by the recession and gasoline price rise. The effect of the recession on claims is evidently continuing because the State Farm Pennsylvania rate manual pages effective May 15, 1992 show only moderate changes (about -6% to +7% depending on coverage and territory).

EXHIBIT H

Example: Effects of NonDriving Periods on Premiums

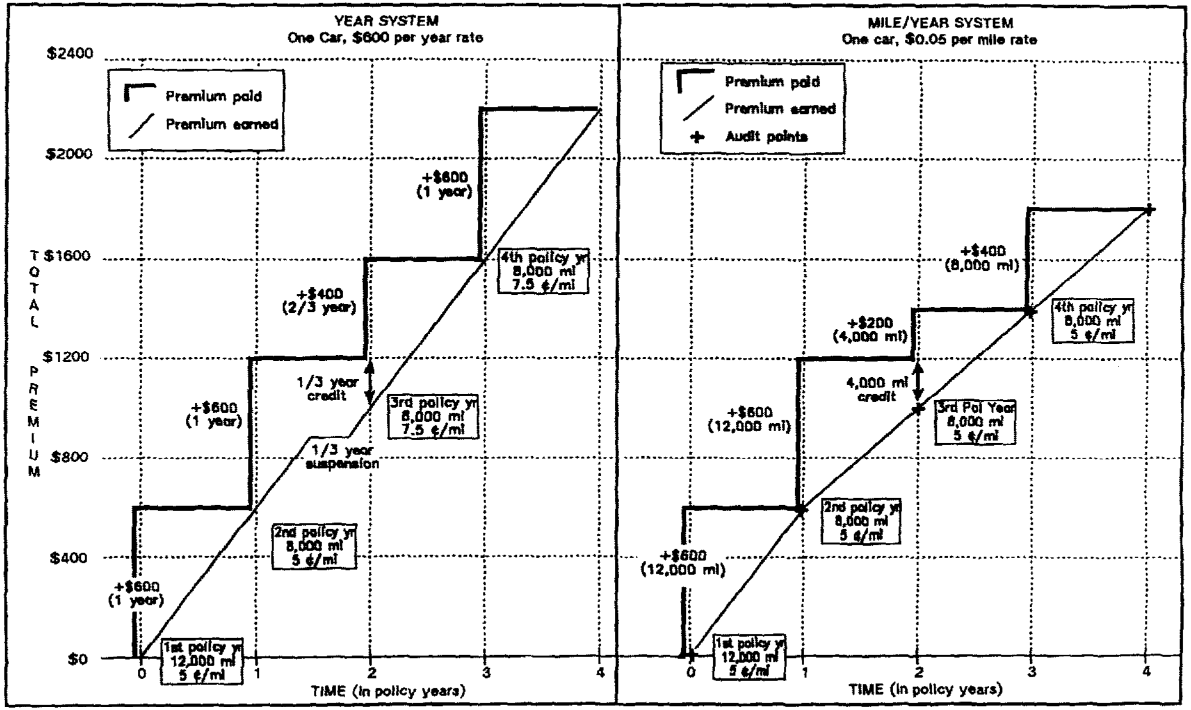

Exhibit H. A hypothetical example involving one car compares the response of each system to a decrease in driving from 12,000 miles during the first policy year to 8,000 miles a year for the next three years. Graphs of premium vs. time (in policy years) for each system show the relationship between premium prepaid and premium consumed throughout the year.

Prepaid premium is represented by a stepped plot in the graph for each system. (Compare with the graph of odometer readings vs. time for the mile/year system in Exhibit B, *supra*, page 7). The vertical segments are payments made shortly before the start of each policy year.[33] The horizontal segments represent the passage of time between additional premium payments.

Year system. Premium for all coverages is earned proportionally with time, as shown by the inclined, lower line. By the end of the first policy year, all of the $600 has been earned. At the beginning of the second policy year, $600 is again paid in advance. During this year, however, the car is not driven for four months (1/3rd year) and insurance coverage is suspended for this period.

The earned-premium plot is flat with time during the 1/3rd year period of suspension because no insurance is in force. When coverage is reinstated at the end of the period, the earned-premium plot resumes proportionality with time. Because of the suspension of insurance, however, 1/3rd ($200) of the prepaid premium remains unearned at the end of the 2nd policy year. This amount is credited against the $600 premium due for the 3rd policy year so that only $400 is paid.

In the third and fourth policy years, driving remains at 8,000 miles annually, but the periods of non driving are spread throughout the year. The periods are either shorter than the Company allows for suspending coverage, or the car may be needed occasionally during the longer periods and there would not be time to reinstate insurance and get the license plate back from PennDOT.[34] Therefore, even though mileage has not increased from the second policy year when $400 was paid for insurance, the policyholder pays $600 per year because coverage cannot be

33. Payment is shown 20 days before the beginning of the policy year.

34. Given the fact that suspension of insurance benefits only the policyholder while reducing both premium income and commissions for the company and agent with no offsetting transaction charges, it is not surprising that few policyholders know that coverage can be suspended during periods of nondriving. Sworn testimony by actuaries in Pennsylvania NOW v. State Farm indicates reluctance of companies to suspend coverage, because "someone has to make a notation on the policy and recalculate the premium." 6 J. INS. REG. 243, 282 (1988).

suspended. The policyholder's cost per mile of protection increases by 50 percent from 5 cents to 7.5 cents for the final two years solely because the year system makes it no longer practical or even possible to suspend coverage during non-driving periods, as it was in the 2nd policy year.[35]

Mile/year system. At an assumed rate of 5 cents a mile for coverage of the hypothetical car, the test system produces a $600 premium for 12,000 miles in the 1st policy year and a $400 premium for 8,000 miles in the 2nd policy year, as did the current year system. The annual odometer audits, connected by lines, show the increases in miles recorded by the car's odometer as the miles of premium earned.

In the 3rd and 4th policy years, however, when driving continues at 8,000 miles a year, the mile/year system premiums continue to be $400 at mile rates, equal to the $400 premium at the $600 per year rate when coverage was suspended for 1/3 year. Mile-rate premiums are $200 less than the year-rate premiums in the final 2 policy years simply because, as noted above, the year-rate coverage could not be suspended for part of the year as it was in the 2nd policy year.

Quasi-suspension of coverage produced by the year system. Insurance enforcement apparently makes suspension of coverage both difficult for companies to administer and costly for policyholders to use, judging from the special provisions companies make for suspending required coverages. For example, State Farm has added a Pennsylvania section 106 C to its rule 106 A (quoted above), resulting in what appears to be a quasi-suspension of coverage.

> SUSPENSION OF COVERAGE, SEASONAL USE, WITHDRAWAL FROM USE
> A. Suspension of Coverage
> * * * *
>
> Any coverage may be suspended unless it is *required by statute* to remain in force. (See Section C for statutory coverages.)[36]
>
> * * * *

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35. Lienholders also provide an impediment to suspension of coverage, to judge from the intervention that Geico provided for Desert Shield policyholders who stored their cars while overseas. The Geico letter to the service person accompanying the dividend certificate states: "If your car is in storage but you've been told by a lien holder that full coverage must stay in effect, let us know. We've intervened successfully in getting some lien holders to waive this requirement for our insureds."

36. Despite Rule 106's implication here that "statutory coverages" means insurance that car owners must buy, the coverages listed in Rule 106 C include non required Combined Benefits, Uninsured Motor Vehicle, and Underinsured Motor Vehicle in addition to the Bodily Injury Liability, Property Damage Liability, and Medical Payments coverages that are required by Pennsylvania law. The law requires companies to make these additional coverages available, but does not require their purchase. 75 Pa.C.S. Sec. 1791-1792.

> C. Premium Credit on Statutory Coverages for Vehicles Withdrawn from Use
> During the period when a motor vehicle is withdrawn from service, the coverages indicated below may, at the option of the insured, remain in force at 40% of the otherwise applicable premium.[37] The period of withdrawal must be for at least 30 days, and the insured must complete a *certificate of withdrawal.*

General Rule 106 A & C, State Farm Mutual Auto. Ins. Co. (emphasis added)

This option of keeping statutory coverages in force on a car while it is not being driven seems to be a response to the Pennsylvania requirement that the car's registration card and plate must be returned to PennDOT while insurance is not in force.[38] The "certificate of withdrawal" specified above is a company form to be signed by the policyholder which states: "I hereby certify that the motor vehicle described below will be withdrawn from use for a period of not less than 30 days from the date indicated." The policyholder further agrees on the form that "In recognition of the fact that my motor vehicle will not be used, the premium for the coverages required by law will be reduced."[39] The question is: why is the premium not reduced to nothing if it is believed that the car will not be used? Why is it worth 40 percent of the premium to the owner to keep the license plate? Why does the company need to get 40 percent of premium to keep driving coverage on a nondriven car?[40] Such an arrangement argues that the company expects the car to be driven despite its nominal "withdrawal from service."[41]

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37. Apparently the basis to which the 40% of full rate applies is not just the rate for the required minimum amounts of protection, but for any increased protection amounts--"limits"--of each coverage chosen as well.

38. Although California also requires all cars to be insured, Rule 106 in the State Farm manual on file at the California insurance department (Oct. 9, 1991) does not have a section "C" with its special provisions for required or statutory coverages. The difference may be that some enforcement provisions, including criminal penalties and proof of insurance as a registration requirement, were allowed to sunset in California in 1990. NAT'L UNDERWRITER, *Change In Regulators Worries Calif.*, Jan. 7, 1991, at 4. (Rule 106 "B" provides for "Seasonally Used Farm Trucks," and is nearly identical for both states.)

39. State Farm Insurance Companies form G-4658_7 Rev. 07-91 "Notification that Motor Vehicle is Withdrawn From Use."

40. What this provision means in terms of premium cost to policyholders may be assessed from the example of Exhibit H, above. During the 2nd policy year the car was not driven for four months, and the "suspension of coverage" rule was used to get a refund of $200 on a $600 prepaid premium. Assuming that the $600 premium was only for State Farm's "statutory" coverages, State Farm would have retained 40%, or $80, of the refund to keep enough coverage so that the policyholder presumably could keep the car registered and not have to return the license plate and registration card to PennDOT.

VI. Insurance enforcement and compliance

This section examines enforcement provisions of mandatory insurance under the current *year* system and under the *mile/year* test system.[42] In each case, the analysis assesses the effect of these provisions on both enforcement efficiency and the ability of the car owner to achieve compliance.

With respect to the intent of the law that all cars have minimum insurance while they are *being driven*, two kinds of enforcement are involved: at-car verification of insurance when it is certain that the car is being driven; and indirect enforcement through the registration-license plate process when the car may or may not be being driven.

Direct at-car enforcement. A random sample of cars being driven receive at-car insurance verification by police and state officials through the happenstance of accident investigation and citations for moving violations where verification is generally required, and in the course of roadside checks for various reasons where insurance verification may be included.[43] Under both systems, the at-car verification is determined by the policy expiration date on the car's insurance ID card. Under the *mile/year* system, full verification also requires that the odometer reads less than the ID card's prepaid miles limit, is operating, and shows no signs of tampering.[44]

Although at-car proof of insurance is required by annual safety inspections and provides a strong incentive to get insurance, few uninsured cars are likely to be

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41. Since the 40% charge is applied to premiums rated by territory and other class categories, it is not just an administrative fee, but varies presumably to reflect different driving conditions. Under rate regulation law, State Farm is supposed to have claim-cost statistics to justify the charges. 40 P.S. Sec. 1183(c).

42. Minimum coverage required is $15,000/$30,000 bodily injury liability, $5,000 property damage liability, and $5,000 medical payments. 75 Pa.C.S. Sections 1702 and 1711.

43. Accidents, and to a large extent law enforcement stops, are inherently processes of random sampling of the cars being driven at the time. INS. INDUSTRY COMMITTEE ON MOTOR VEHICLE ADMIN., *Guidelines for Compulsory Liability Insurance Enforcement*, July 1992.

The sample size for checking insurance compliance via accidents may be approximated from the 1990 PennDOT report: 234,814 reported driver involvments gives the number of vehicles sampled, which is about 3% of the 8.7 million registered vehicles which were checked for insurance in this way. If traffic violation checks were verified on approximately the same number of cars, then the proportion of cars randomly checked for insurance this way would be less than 10% annually.

In vehicle law enforcement checks, police officers radio in driver's and registration information to PennDOT computers for verification. Insurance information, although entered into the PennDOT system, could not be checked the same way in 1991. State Police testimony before the House Insurance Committee, April 25, 1991, Tr. 133.

identified this way. Owners of uninsured cars are able to bypass this requirement illegally, as described by the state police.[45]

Under the *mile/year* system, the company odometer audits enhance enforcement of insurance because direct company involvement and self-interest in verification improves control on illicit ID cards beyond what police officials and inspection stations can do.[46] Furthermore, policyholder no-shows for renewal or final audits (dropouts) indicate that the cars have been driven uninsured without prepaid miles of protection. A gap in protected miles would be evidenced by odometer readings or signs of tampering even if insurance is re-initiated with another company. Enforcement sanctions could be invoked for owning a car driven without insurance, or for odometer tampering.

Indirect enforcement. The logic behind indirect enforcement through the license plate issue and revocation process is that requiring insurance on a licensed car to be kept continuously in force assures that insurance will be in force on the car whenever it is *being driven*. Specifically, the law requires that a license plate may be retained only while insurance is in force.[47] When insurance coverage terminates, sanctions can be avoided by not driving the car and by returning the license plate to PennDOT within 21 days if insurance has not been reinstated or replaced.[48]

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44. Owning a car that is *being driven* with no insurance in force is a direct violation of the law's intent. It is fully sanctioned by a $300 fine and three-month revocations of the license plate and the owner's driving license. The restoration fee at the end of the suspension periods is $50 for each license. 75 Pa.C.S. Sections 1786 (d), 1786 (f), & 1960.

45. Illicit inspection stickers are used to avoid the inspection altogether, or illicit insurance ID cards or other insurance documents are used to defeat the verification process at the inspection station. Testimony to the House Insurance Committee, April 25, 1991, by Lt. Colonel Robert Hicks, Tr. 102-134.

Although the law requires inspection stations to report any uninsured cars seeking inspections, it seems that stations have little to gain by reporting the few customers unaware of the insurance requirement for inspection. 75 Pa.C.S. Sec. 4727 (d)(2).

On the other hand, at-car information for the *mile/year* system is collected as part of the inspection process because mileage readings for verified-working odometers are reported to PennDOT and help build an audit trail for each car. (Two odometer readings are reported: "present odometer reading" and "odometer reading on old inspection sticker." PennDOT *Inspection Record*, form TS 431 (11/81)).

46. The company audits may or may not be done in conjunction with the state safety inspections according to individual arrangements between auto insurance companies and private inspection stations.

47. The partial sanctions applied for violation are the three-month revocation of the license plate followed by a $50 reissuing fee. 75 Pa.C.S. Sec. 1786 (d); Sec. 1960.

The law appears to specify the 3-months suspension of registration penalty only for cars being driven without insurance, and not just for keeping an uninsured car's license plate. (75 Pa.C.S. 1786 (d).) According to testimony by PennDOT, however, the 3-month registration suspension periods are being applied to cases where the license plate has been kept for an uninsured car, without establishing

Whenever insurance for a car is terminated and driving coverage is not in force, the insurance company is required by law to notify PennDOT.[49] When suspended insurance is reinstated however, it is the policyholder who must provide the insurance information to PennDOT. PennDOT in turn sends a sampling of such reports to the Company for verification.[50] The Company may also notify lienholders when the car securing the loan has no collision insurance, and also when the coverage is restored.

Under the current *year* system there is no reliable way to establish whether or not a car is actually being, or has been, driven without insurance beyond scattered information that is produced by the random sampling process during at-car enforcement, as described above. Under the *mile/year* system, however, the odometer serves as a witness to prove nondriving for the policyholder, or to prove uninsured driving for enforcement purposes.

Compliance. Under the current *year* system, premium payments are fixed costs of car ownership with inevitable due dates. A policyholder in straitened circumstances has no legal option but to lapse insurance, surrender the license plate, and do without the car. If a policyholder cannot meet a deadline for a premium payment, and cannot suspend coverage to stop or lower premiums owed, it is not surprising that there may be little real choice but to drive illegally without insurance.[51]

(continued)
that the car was actually being driven uninsured. (Douglas Tobin, House Insurance Committee hearing transcript Oct. 30, 1991, page 168.)

48. 75 Pa.C.S. Sec. 1786 (d)(1) & (g)(2). The instruction given by PennDOT's public information telephone (March 1992) for interrupting insurance while the car is not being driven is to send in the license plate (not the registration card) to PennDOT with a letter of explanation. According to PennDOT testimony before the House Insurance Committee, returned plates are destroyed and new plates issued with no charge when insurance is again in-force. Douglas Tobin, Oct. 30, 1991, Tr. 169.

49. 75 Pa.C.S. Sec. 1786 (e)(2): "Obligations upon termination of financial responsibility--An insurer who has issued a contract of motor vehicle liability insurance . . . shall notify the department in a timely manner."

Companies provide notices of cancellation of insurance to PennDOT on computer tape in batches covering a week or two of activity. NOW telephone information from Chairman's office, Erie Insurance Group, Feb. 1, 1991.

50. PennDOT's goal is to have companies verify the insurance information provided on registration forms of 50 percent of Philadelphia registrants and 25 percent of registrants elsewhere. Joint State Government Commission, "Insure-the-Driver Program" study pursuant to Act 6 of 1990, Section 29 (1991), page 16. (These goals would require about 2 million company verifications annually.)

51. Under the current year system, considerable administrative effort is expended in sending billing and nonpayment-cancellation notices to installment payers who are on very tight budgets. This is especially true for assigned-risk plans in high-rated territories. An active and ongoing discussion

Under the *mile/year* system, in constrast, the only fixed costs for keeping mandated insurance in force are the cost of the annual odometer audit plus any administrative charges (about $20 total per year). Premium for driving coverages is earned by the company only while the car is being driven. To the extent that the *mile/year* system reduces mid-term lapses and eliminates suspension of coverage transactions, there is a comparable reduction of state and company administrative expense for recalling and reissuing license plates, with attendant insurance verifications. The *mile/year* system makes required insurance an operating cost and promotes compliance by providing the public with a means of direct individual control over the amount and timing of premium payments.

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(continued)
continues in the weekly INS. ADVOCATE column *Views of a Storefront Broker* by Michael Carbajal in New York City. April 18, 1992, for example, on the size of the premium deposit needed and the administrative expense to companies and agents. In Philadelphia the minimum cost assigned risk plan premium is $696 annually, paid $211 down (30%) and $98 per month for five months, as advertised for months in The Review (Chronicle, S. Phila.), *e.g.*, April 16, 1992, at C14. In the past, eighty percent of assigned risk car owners did not pay all of the installments, which are billed, and were canceled in their first year. JOINT STATE GOV'T COMM. staff analysis, *Insure-the-Driver Program for Philadelphia* (1991) at 15.

HOMEOWNERS EXCESS WIND LOADS: AUGMENTING THE ISO WIND PROCEDURE

John Bradshaw
Mark Homan

Editor's Note: This article was originally published in the Spring 1992 edition of the *Casualty Actuarial Society Forum*. Two exhibits were unintentionally excluded, and we are reprinting the article in its entirety.

Homeowners Excess Wind Loads:

Augmenting the ISO Wind Procedure

BY JOHN BRADSHAW & MARK J. HOMAN

The ISO excess wind procedure is widely used by many companies. However, it has one major flaw. It depends on the loss history in the state to provide a true representation of the future expected wind experience. The procedure presented here removes this flaw. Modeling is used to augment history to yield more accurate wind expectations. The procedure has the added side benefit of providing a means to reflect different wind loadings by territory.

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Overview

The ISO Excess Wind Procedure is a popular procedure that is in use by many companies. The procedure relies on the past history, currently about thirty years, to be a representative sample of true long term wind experience. This assumption is not valid in many cases. Most experts have stated that the past thirty years of experience in Florida have had much less hurricane activity than any other thirty year period. South Carolina's experience now includes Hurricane Hugo. Hugo is treated as if it will recur once every thirty years by the ISO procedure. However, experts feel that Hugo is more likely a one in one hundred year event, if not less frequent.

The procedure outlined in this paper uses modeling to determine the expected wind experience over a longer period of time. In this case, it is a 50 year time period. The procedure augments the scant history in a state like Florida and makes adjustments to allow removal of events like Hurricane Hugo in South Carolina. It still rests primarily on the ISO procedure.

It should be noted that the ISO procedure has been criticized in other ways and other procedures have been developed. [1] However, most companies lack sufficient data to use these other procedures. We are looking for ways to improve the ISO procedure without requiring historical data which may be unobtainable.

ISO Excess Wind Procedure

We will start by explaining the ISO excess wind procedure briefly. As the name implies, the procedure only makes adjustments for excess wind losses. It makes no adjustment for non-wind catastrophes that occur, such as freezing in the South. The procedure determines which losses should be considered excess and removed from an experience period and calculates a long-term load to replace the excluded losses by spreading them over a longer time period.

Currently, the history period used in the ISO procedure in most states is about 30 years. This corresponds to the introduction of the Homeowners policy. History before that period is difficult to use since the coverages were not the same.

Exhibit I shows the calculation of the excess wind threshold and the long term load for a sample state. The procedure starts by breaking down the losses into wind and non-wind categories. The ratio of wind to non-wind is then calculated. The median wind/non-wind ratio is calculated to determine the excess wind threshold.

The excess wind threshold is the greater of 1.5 times the median or 0.25. By using a threshold that is greater than the median, adjustments are only made for the truly unusual wind years rather than for some fairly common events. The use of 0.25 as a minimum threshold eliminates the need to make adjustments in states where the wind experience is relatively light.

Each wind/non-wind ratio is tested against the threshold to determine whether it is an excess year. If the ratio is greater than the threshold, it is an excess year and the excess portion is calculated. The excess ratio is the portion of the wind/non-wind ratio greater than the median. The excess losses are then calculated by taking the excess ratio multiplied by the non-wind losses. The non-excess losses are then calculated by subtracting the excess losses from the total losses.

The excess wind load is calculated by taking the average excess ratio multiplied by the average non-excess ratio.

Modeling

Modeling is used to project expected losses from a fifty year event. A fifty year event is a storm that is expected to occur once every fifty years. A storm of fifty year intensity is determined by the expected wind speeds. The fifty year event differs from area to area due to storm expectations in the area.

The model used to develop this paper is one that was developed at the Hartford Re Management Company. Other reinsurers and reinsurance brokers have developed similar models. The model will not be discussed in detail but a brief outline is needed.

The model uses projected storm tracks through a state or group of states. The storm track includes average wind speeds as the storm moves along the track and a damage matrix based on these wind speeds and the distance from the track. The model applies this information against the distribution of business in a company's book to determine expected losses from the storm.

The expected losses are output by area and in total. We take several possible storm tracks through a state and then average them. Exhibits II and III are the output from the model for the projected storm tracks through New York and Connecticut.

Adding "History"

The average projected losses that we get from the model represent the losses expected from a storm of fifty year severity. In order to include this as "history" in the ISO procedure, we must act as if we have 50 years of data.

Exhibit IV shows how we make this adjustment. We start with the 29 years of data that we already have. Since none of the events in the 29 year period are more severe than the 50 year projection, we do not eliminate any years. We then insert a year to represent the 50 year event.

The non-wind losses used are a projection from the level of losses in the most recent years of data. The company losses should be used for this projection to match the modelled wind losses even though ISO data may be used for the history. The excess calculation continues as before. However, the averages are now weighted averages using the 29 years of history to represent 49 years and the projection from the model to represent the fiftieth year. The median wind/non-wind ratio is not adjusted since it is assumed that one extreme year should have no impact on the median.

The final wind load is used in the same way as the typical ISO wind load. No further adjustments are necessary.

In a case like South Carolina, one additional step would be needed in the above process. A year that was more severe than the 50 year event should be eliminated. In South Carolina, for example, the year of Hurricane Hugo (1989) would be dropped from the 29 year history. We recommend totally eliminating it and using only the remaining years of history, with the addition of the 50 year event from the model. One could also consider replacing 1989 with a "typical" year. Given the difficulty in determining a typical year, we do not recommend this alternative.

Territorial Loadings

An additional benefit of this modeling is that you get information on the distribution of the storm losses by area within the state. This data can be used to develop territorial wind loadings to be used in ratemaking rather than merely using statewide loadings.

To use the model output, you start by taking averages of the losses by area across the various storm tracks modeled as shown in Exhibit III. The expected wind losses by area from the model are then divided by the non-excess losses in the area. This gives a wind to non-excess ratio for each area. The territorial ratio is divided by the statewide ratio to determine a relativity for each area. These indices by area are multiplied by the statewide wind load to determine a wind load for each area. These adjusted wind loads are then applied to the territories that comprise the area when calculating new territorial relativities for ratemaking.

Exhibit V shows this calculation using 5 year incurred losses and 5 year earned premiums at current rates. The loss ratio relativities before the loading show the results that would occur using a typical statewide loading. The relativities after the loading show the more accurate results.

One variation on this procedure that we recommend is using the current in-force amount of insurance by territory instead of non-wind losses. By dividing the wind losses from the model by the exposures, one obtains a damage potential for each territory. Since the exposures form the base for the model, using exposures will be slightly more accurate. The additional accuracy results from removing the variation due to changes in distribution and the random variation in the actual losses.

Conclusion

The ISO procedure has its flaws. However, due to the difficulty in obtaining a sufficient volume of credible data for any other method, it remains the most widely used method. The adjustment outlined in this paper allows for the elimination of one of the major flaws in the ISO procedure, namely its reliance on past history as a representative sample of possible losses. We recognize that not every company has a wind loss model in their company. However, several reinsurance companies and brokers do have these models and contract for their use.

An additional shortcoming of the ISO procedure is that it fails to adjust for demographic shifts. In particular it does not consider the increase in coastal exposures. The adjustment of the model reflects the current distribution of a company's book and can be updated periodically to reflect any shifts. This does not eliminate the ISO shortfalls since many of the years are still based purely on history. However, the additional year from the model will dampen this problem with the ISO procedure.

Finally, the more accurate territorial indications that result allow a company to more accurately charge for the additional exposure in the wind territories.

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[1] See the 1990 Pricing Discussion Paper titled "Pricing the Catastrophe Exposure" by David H. Hays and W. Scott Farris, Vol. II pp. 559-603.

Exhibit I

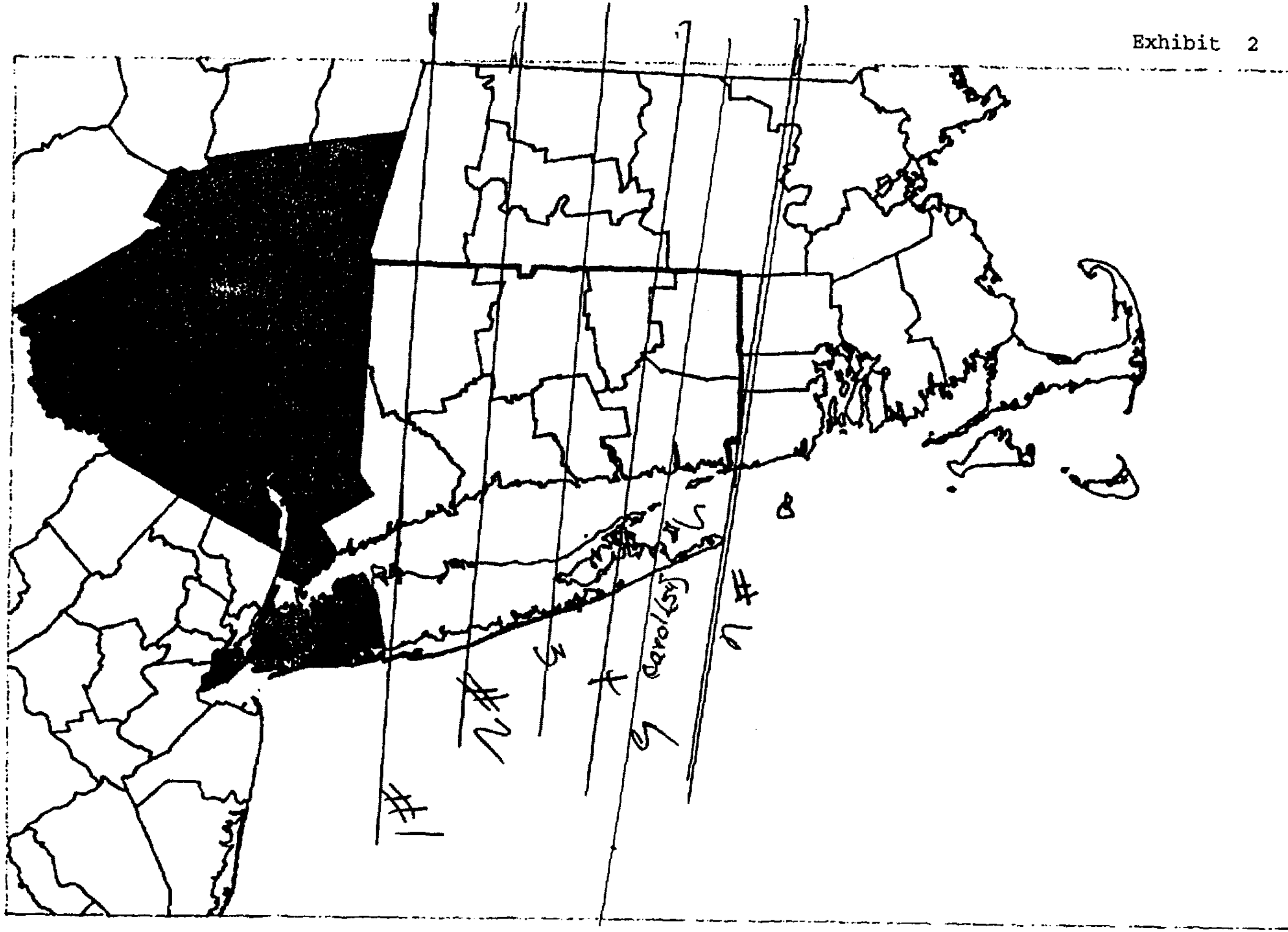
CONNECTICUT

HOMEOWNERS INSURANCE - FORMS 1,2,3&5
DERIVATION OF EXCESS WIND FACTOR

Year	HO Wind Losses	HO Total Losses	Non-Wind Losses	Wind-to-Non-Wind	Excess Years*	Excess Ratio	Excess Losses	Non-Excess Losses	Non-Wind/ Non-Excess
1961	39180	421841	382661	0.102	0.000	0.000	0	421841	0.907
1962	57857	525788	467931	0.124	0.000	0.000	0	525788	0.890
1963	38690	579712	541022	0.072	0.000	0.000	0	579712	0.933
1964	24077	483403	459326	0.052	0.000	0.000	0	483403	0.950
1965	22309	721579	699270	0.032	0.000	0.000	0	721579	0.969
1966	22428	750139	727711	0.031	0.000	0.000	0	750139	0.970
1967	44329	922439	878110	0.050	0.000	0.000	0	922439	0.952
1968	52551	1064312	1011761	0.052	0.000	0.000	0	1064312	0.951
1969	54499	1276897	1222398	0.045	0.000	0.000	0	1276897	0.957
1970	49047	1493849	1444802	0.034	0.000	0.000	0	1493849	0.967
1971	128182	1639387	1511205	0.085	0.000	0.000	0	1639387	0.922
1972	120507	1871461	1750954	0.069	0.000	0.000	0	1871461	0.936
1973	103326	2653614	2550288	0.041	0.000	0.000	0	2653614	0.961
1974	222439	2854392	2631953	0.085	0.000	0.000	0	2854392	0.922
1975	91049	2679652	2588603	0.035	0.000	0.000	0	2679652	0.966
1976	112610	2618827	2506217	0.045	0.000	0.000	0	2618827	0.957
1977	43872	2309037	2265165	0.019	0.000	0.000	0	2309037	0.981
1978	198862	2160841	1961979	0.101	0.000	0.000	0	2160841	0.908
1979	523824	2899303	2375479	0.221	0.000	0.000	0	2899303	0.819
1980	152170	3088639	2936469	0.052	0.000	0.000	0	3088639	0.951
1981	125697	4422524	4296827	0.029	0.000	0.000	0	4422524	0.972
1982	143262	4229727	4086465	0.035	0.000	0.000	0	4229727	0.966
1983	206742	4414828	4208086	0.049	0.000	0.000	0	4414828	0.953
1984	367046	5290981	4923935	0.075	0.000	0.000	0	5290981	0.931
1985	2772884	8654450	5881566	0.471	0.471	0.420	2468097	6186353	0.951
1986	412685	5954039	5541354	0.074	0.000	0.000	0	5954039	0.931
1987	415849	9040467	8624618	0.048	0.000	0.000	0	9040467	0.954
1988	161040	9480386	9319346	0.017	0.000	0.000	0	9480386	0.983
1989	2310963	12857786	10546823	0.219	0.000	0.000	0	12857786	0.820
Total	9017976	97360300	88342324	2.364		0.420	2468097	94892203	27.230
Average						0.014			0.939
			Median	0.052					
		Excess Wind	Factor	1.014		[1 + (0.014 * 0.939)]			

*The ratio for a year must be > 1.5M and at least .250 for that year to qualify as an excess year.

Exhibit 2



81 mile(s)

THE HARTFORD INSURANCE GROUP

HOMEOWNERS LOSSES FROM 50 YEAR EVENTS
NEW YORK AND CONNECTICUT

	Track #1	Track #2	Track #3	Track #4	Track #5	Track #6	6 Track Average
Connecticut							
Fairfield	30,356	6,071	1,308	336	168	0	6,373
Hartford	689	3,447	2,757	689	1,103	1	1,448
Litchfield	538	269	81	1	1	0	148
Middlesex	274	727	2,341	2,018	1,292	210	1,144
New Haven	3,141	6,853	13,421	1,028	628	114	4,198
New London	73	379	1,895	2,239	2,368	2,497	1,575
Tolland	41	81	326	326	163	163	183
Windham	0	10	10	101	101	81	51
Total	35,112	17,837	22,139	6,738	5,824	3,066	15,119
New York							
Bronx	103	1	0	0	0	0	17
Kings	443	89	0	0	0	0	89
Nassau	35,341	1,767	177	0	353	0	6,273
New York	35	9	0	0	0	0	7
Queens	677	135	0	0	0	0	135
Richmond	125	42	0	0	0	0	28
Suffolk	53,326	59,600	14,429	10,259	6,399	0	24,002
Westchester	1,562	234	0	0	0	0	299
Total	91,612	61,877	14,606	10,259	6,752	0	30,851

* - Tracks are 20 miles apart.

Exhibit IV

CONNECTICUT

HOMEOWNERS INSURANCE - FORMS 1, 2, 3 & 5
DERIVATION OF EXCESS WIND FACTOR

Year	HO Wind Losses	HO Total Losses	Non-Wind Losses	Wind-to-Non-Wind	Excess Years*	Excess Ratio	Excess Losses	Non-Excess Losses	Non-Wind/ Non-Excess
1961	39,180	421,841	382,661	0.102	0.000	0.000	0	421841	0.907
1962	57,857	525,788	467,931	0.124	0.000	0.000	0	525788	0.890
1963	38,690	579,712	541,022	0.072	0.000	0.000	0	579712	0.933
1964	24,077	483,403	459,326	0.052	0.000	0.000	0	483403	0.950
1965	22,309	721,579	699,270	0.032	0.000	0.000	0	721579	0.969
1966	22,428	750,139	727,711	0.031	0.000	0.000	0	750139	0.970
1967	44,329	922,439	878,110	0.050	0.000	0.000	0	922439	0.952
1968	52,551	1,064,312	1,011,761	0.052	0.000	0.000	0	1064312	0.951
1969	54,499	1,276,897	1,222,398	0.045	0.000	0.000	0	1276897	0.957
1970	49,047	1,493,849	1,444,802	0.034	0.000	0.000	0	1493849	0.967
1971	128,182	1,639,387	1,511,205	0.085	0.000	0.000	0	1639387	0.922
1972	120,507	1,871,461	1,750,954	0.069	0.000	0.000	0	1871461	0.936
1973	103,326	2,653,614	2,550,288	0.041	0.000	0.000	0	2653614	0.961
1974	222,439	2,854,392	2,631,953	0.085	0.000	0.000	0	2854392	0.922
1975	91,049	2,679,652	2,588,603	0.035	0.000	0.000	0	2679652	0.966
1976	112,610	2,618,827	2,506,217	0.045	0.000	0.000	0	2618827	0.957
1977	43,872	2,309,037	2,265,165	0.019	0.000	0.000	0	2309037	0.981
1978	198,862	2,160,841	1,961,979	0.101	0.000	0.000	0	2160841	0.908
1979	523,824	2,899,303	2,375,479	0.221	0.000	0.000	0	2899303	0.819
1980	152,170	3,088,639	2,936,469	0.052	0.000	0.000	0	3088639	0.951
1981	125,697	4,422,524	4,296,827	0.029	0.000	0.000	0	4422524	0.972
1982	143,262	4,229,727	4,086,465	0.035	0.000	0.000	0	4229727	0.966
1983	206,742	4,414,828	4,208,086	0.049	0.000	0.000	0	4414828	0.953
1984	367,046	5,290,981	4,923,935	0.075	0.000	0.000	0	5290981	0.931
1985	2,772,884	8,654,450	5,881,566	0.471	0.471	0.420	2468097	6186353	0.951
1986	412,685	5,954,039	5,541,354	0.074	0.000	0.000	0	5954039	0.931
1987	415,849	9,040,467	8,624,618	0.048	0.000	0.000	0	9040467	0.954
1988	161,040	9,480,386	9,319,346	0.017	0.000	0.000	0	9480386	0.983
1989	2,310,963	12,857,786	10,546,823	0.219	0.000	0.000	0	12857786	0.820
Total	9,017,976	97,360,300	88,342,324	2.364		0.420	2468097	94892203	27.230
Average						0.014			0.939
50 Year	15,119,000	26,119,000	11,000,000	1.374	1.374	1.323	14548972	11570028	0.951
Average						0.041			0.939
			Median	0.052					
			Excess Wind Factor	1.038		[1 + (0.041 * 0.939)]			

*The ratio for a year must be > 1.5M and at least .250 for that year to qualify as an excess year.

Exhibit V

HOMEOWNERS TERRITOTIAL EXPERIENCE

CONNECTICUT TERRITORIAL EXCESS WIND FACTORS

Zone	Earned Premium	Ex-Wind Incurred Losses	Loss Ratio	Loss Ratio Relativity	Territotial Excess Wind Factor	Adjusted Incurred Losses	Loss Ratio	Loss Ratio Relativity
28	1,368,915	672,307	49.1%	1.047	1.059	711,743	52.0%	1.068
29	2,231,951	1,410,928	63.2%	1.348	1.059	1,493,688	66.9%	1.375
31	17,377,565	7,866,176	45.3%	0.965	1.059	8,327,578	47.9%	0.985
32	1,544,439	682,356	44.2%	0.942	1.073	732,222	47.4%	0.974
33	478,717	381,935	79.8%	1.702	1.073	409,847	85.6%	1.759
34	7,623,692	4,195,286	55.0%	1.174	1.073	4,501,877	59.1%	1.213
35	1,587,717	718,700	45.3%	0.965	1.010	725,980	45.7%	0.939
36	3,514,166	1,316,946	37.5%	0.799	1.010	1,330,284	37.9%	0.778
37	991,207	404,694	40.8%	0.871	1.010	408,793	41.2%	0.847
38	22,875,106	10,647,978	46.5%	0.993	1.010	10,755,826	47.0%	0.966
39	3,793,237	1,818,060	47.9%	1.022	1.079	1,962,300	51.7%	1.063
40	3,399,010	1,478,268	43.5%	0.928	1.071	1,582,994	46.6%	0.957
41	6,164,932	2,632,560	42.7%	0.911	1.005	2,646,143	42.9%	0.882
42	4,753,070	2,207,787	46.4%	0.991	1.010	2,229,199	46.9%	0.964
Total	77,703,724	36,433,981	46.9%	1.000	1.038	37,818,472	48.7%	1.000

Zones	County	Ex-Wind Incurred Losses	50 Year Model Wind Losses	Wind/ Non-Wind Ratio	Wind/ Non-Wind Relativity	Excess Wind Factor
28,29,31	Fairfield	9,949,411	6,373,167	0.641	1.544	1.059
35-38	Hartford	13,088,318	1,447,667	0.111	0.267	1.010
41	Litchfield	2,632,560	148,333	0.056	0.136	1.005
40	Middlesex	1,478,268	1,143,667	0.774	1.864	1.071
32-34	New Haven	5,259,577	4,197,500	0.798	1.923	1.073
39	New London	1,818,060	1,575,167	0.866	2.088	1.079
42	Tolland & Windham	2,207,787	233,833	0.106	0.255	1.010
	Total	36,433,981	15,119,333	0.415	1.000	1.038

CASUALTY RATE PREDICTION FOR OIL TANKERS

Douglas McKenzie

Casualty Rate Prediction for Oil Tankers

Douglas McKenzie

A model of oil tanker casualties is presented which permits an expected casualty rate for each tanker to be calculated based on its age and casualty history. These expected rates are shown to be good predictors of both the actual casualty experience and the probability of total loss. The model is based on the findings that 1) the casualty behavior of an individual tanker follows a Poisson distribution and 2) the Poisson parameters for all tankers of a specific age follow an exponential distribution. As a result, Bayes' theorem can be used to calculate each tanker's expected casualty rate given its age and casualty history.

Ocean Marine Insurance

A brief summary of ocean marine premium-setting practices is given to provide context for the risk model presented.[1]

A five-year average of claims is used as an estimate of the financial risk associated with *small partial losses* (eg. less than $100,000) of a particular owner's fleet of ships. A fleet of five ships with five years of claims history is often considered to be self-rating for this component of the ***hull & machinery insurance***.

Premiums also have to be established for *large partial losses* and *total losses*. These events are much less frequent, so, for most owners, having just a few ships, the rates are established using industry-wide statistics. These general rates are then multiplied by factors which reflect higher or lower relative risk of a particular fleet as compared to the larger fleet from which the statistics were taken. These factors, called 'relativities', are developed for age, size, trade (ie. routes traveled), flag (ie. nationality of registered owner) and anything else that the underwriter believes might affect the risk of loss.

Hull & machinery insurance is generally carried by commercial insurers so the attempt to define a specific fleet's (ie. owner's) level of risk is expected . The underwriting cycles in ocean marine insurance, however, are pronounced hence the actual premiums that are charged may not always directly reflect that risk.[2] After several years of disappointing underwriting results, though, the early '90s have seen rates, deductibles and exclusions all increase dramatically. In addition to the overall rise in premiums, underwriters are making unprecedented efforts to identify 'substandard' vessels that require special attention even to the point of contracting ship inspections.

The liability side of ocean marine insurance, called ***P&I insurance*** for protection and indemnity, is largely handled by mutualized shipowner groups known as the 'P&I clubs'. 'Advance calls' are prepaid by the shipowners early in the year and 'supplementary calls' are made if the aggregate of advance calls do not cover all the claims that year. Unlimited coverage is provided except for oil pollution with a $500 million limit with another layer of $200 million of protection available commercially.

It is, perhaps, somewhat less clear than with hull insurers how the P&I clubs allocate the total calls required to the specific fleets at risk since the statistics available are even more limited. Access to supplementary calls may make the question less compelling than with hull insurance in the commercial arena. Underwriters for the commercial layer of oil pollution coverage, though, *are* trying to improve selectivity. Just this year, for example, London underwriters agreed on a schedule of rates depending on age and hull design features as indicators of risk.

It is also pertinent to note that at this time, and for the foreseeable future, freight rates are generally depressed and cannot support the aging fleet's replacement needs. Many in the industry feel that insurers could help this situation by pricing insurance for the substandard ships high enough to drive them into the scrap yards.

It appears, from the description above, that improved estimates of risk could be of use to the industry at this time. This paper presents a new model of tanker risk which combines the two types of risk estimates currently being used into a single, consistent framework based on 'reported casualties'. The two types of estimates that are combined are:

Five-year averaging of claims within a fleet for the more frequent, small losses and

Statistically derived rates for the rare, large losses calculated by looking across all the fleets.

The model presented represents a first attempt at this consolidation and much work remains to be done.

Contents of the Paper

- 'Reported casualties' are introduced as a surrogate for actual claims.
- The statistics of these reported casualties are then described.
- The method used to calculate an expected casualty rate for each ship, using the statistics, is described.
- Modifications to the basic model are briefly discussed.
- Comparison of the calculated casualty rates with actual casualty experience is made for 1991 and 1992.
- The expected casualty rates are used to predict the probability of total loss.
- Areas in which further research is needed are discussed.

Reported Casualties

Combining the two types of risk estimates requires a new variable to overcome the general unavailability of claims information. Even marine underwriters may not have reliable five-year claims information if the fleet being considered is new to them.

Lloyd's List, a daily newspaper published by Lloyd's of London Press, provides a suitable variable. The List reports casualties incurred by all types of ships all around the world. These casualties, reported by the network of Lloyd's agents following ship activities all around the world, are used as a surrogate for claims.

The New York-based Tanker Advisory Center has compiled a unique database which includes every oil tanker casualty reported in Lloyd's List since 1964. The Center has kindly made this database available to Pyramid Systems to make the analysis reported here possible.

This analysis focuses on 2,500 privately-owned oil tankers which incur between 350 and 450 casualties each year that are reported in the List. These casualties range in severity from plugged fuel lines to total loss. They do not usually have financial impact associated with them. The overall frequency of these casualties (1 per ship every 5-7 years) is seen to lie between the more frequent small insurance claims and the less frequent large claims.

There are a few points to make about these casualties before describing their statistical behavior:

- Virtually all 'serious' incidents undoubtedly appear as reported casualties. This common sense expectation is supported by the experience of government-owned vessels. These ships have substantially fewer reported casualties than privately-owned vessels, however, they have essentially the same number of serious casualties. This is probably due to mechanisms which can render the small casualties incurred by government ships invisible to the Lloyd's network but not the serious ones.

- The Lloyd's reporting network provides a reasonably uniform mechanism that does not introduce any *obvious* biases. There are certainly other networks that are more comprehensive in specific areas but they would introduce considerable bias because of uneven interest in some ships over others - eg. ships that visit American ports or ships insured by Lloyd's or ships of a certain flag etc.

- There is a wide variety of types and severities of incidents reported by Lloyd's. This analysis only considers the fact of the incident, not the type or severity.

The Statistics of Reported Casualties

The purpose of the model is to *quantify the propensity to have casualties* for each of the 2,500 tankers of interest. This can then be used to estimate other things as well, for example, the probability that the ship will become a total loss during the following 12 months.

The method presented is based on the fact that the occurrences of casualties are described very well by conventional probability distributions. The discussion of these distributions is broken up into two parts: First, the number of casualties that occur during any one calender year and second, the number of casualties that have occurred since a tanker first enters service.

Annual Casualty Experience

The first component of the basic model is the use of *the Poisson distribution to describe the number of casualties that a tanker has in one year.* The single parameter of the distribution, λ, is the average number of casualties in a year. This parameter provides the quantification of the propensity to have casualties that we are trying to establish for each tanker. The fleet average is about 0.17 casualties per tanker per year.

An estimate of λ could be made from the tanker's own average annual rate over, for example, the last five years or even over its entire lifetime. This paper describes a different method for estimating λ which takes into account the statistical behavior of the entire fleet.

The second component of the basic model is the use of *the exponential distribution to characterize the variation of the λ's for tankers of a particular age.* That is,

$$\mathrm{pdf}(\lambda \mid \mathrm{age=a}) = e^{-\lambda/\lambda_a}/\lambda_a$$

where λ_a is the average number of casualties for all ships of age 'a'.

The expected value for the probability of 'n' casualties occurring for all of these vessels (as opposed to just one specific vessel) is calculated from:

$$\begin{aligned} E[\ \mathrm{pr}(n \mid \mathrm{age=a})\ ] &= \int_{0\to\infty} \mathrm{pr}(n \mid \lambda) * \mathrm{pdf}(\lambda \mid \mathrm{age=a})\, d\lambda \\ &= \int_{0\to\infty} e^{-\lambda}\, \lambda^n/n! * e^{-\lambda/\lambda_a}/\lambda_a\, d\lambda \\ &= (\lambda_a)^n \ /\ (1+\lambda_a)^{(n+1)} \end{aligned}$$

showing that the frequency of casualties for ships of the same age are expected to follow a geometric distribution. This formulation can be described as a Bayesian model with a Poisson process, a prior distribution of a degenerate Gamma function (ie. exponential) and a posterior distribution of a degenerate negative binomial (ie. geometric). General derivations are presented by Dropkin.[3]

[This space keeps Figure 1 & its text together on the next page]

Figure 1 shows the actual frequencies of casualties for three different ages. The theoretical results are shown for both the geometric and Poisson distributions with the same λ. The geometric distribution is superior to the Poisson at all three ages. In fact, the geometric distribution matches the actual data well at all ages considered, ie. from 0 to 34.

Figure 1 - *Annual* Casualty Frequencies - Actual Compared to Theory

Table entries are the number of ships that incurred the # of casualties shown in the left hand column. For each age the actual # of ships is shown (Act.), the # predicted by the geometric distribution (Geo.) and the # that would have been predicted had we used the Poisson distribution (Poi.).

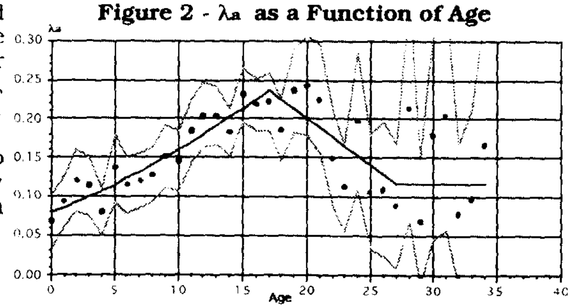
# of	1 Year Old Ships			10 Year Old Ships			15 Year Old Ships		
Casualties	Act.	Geo.	Poi.	Act.	Geo.	Poi.	Act.	Geo.	Poi.
0	353	350.1	348.7	415	412.7	408.7	748	744.8	727.9
1	25	30.1	32.8	48	52.6	59.7	133	139.9	168.1
2	4	2.6	1.5	9	6.7	4.4	31	26.3	19.4
3	1	0.2		1	0.9	0.2	4	4.9	1.5
4					0.1		0	0.9	0.1
5							1	0.2	
Total Ships	383			473			917		
	$\lambda_1 = 0.094$			$\lambda_{10} = 0.146$			$\lambda_{15} = 0.227$		

The ships used at each age to calculate the λ_a's were drawn from all relevant ships at risk over the most recent 5 years. For example, consider the 383 ships that are used to establish $\lambda_1 = 0.094$. 89 of these ships were 1 year old (ie. 1 year old at their last 'birthday') on 1/1/92 and they incurred 8 casualties during 1992. Similarly, 77 of the ships were 1 on 1/1/91 and incurred 8 casualties during 1991. 76 ships were at risk during 1990 and had 3 casualties while 74 ships, during 1989, had 6. The oldest group of ships used were 67 vessels that were 1 on 1/1/88 and incurred 11 casualties during 1988.

When all 35 ages (0 to 34) are considered the λ_a's are seen to follow a reasonably smooth progression shown in **Figure 2**. The solid dots are the actual λ_a's calculated from the raw data. The light lines are the limits of the 95% confidence intervals around the actual λ_a's, ie. we are 95% confident that the 'real' λ_a's lie within the band of the light lines. The solid line is just a fitted curve with which age-specfic casualty rates can be conveniently calculated. The confidence intervals are determined from the variance of the casualty ratio which, for the geometric distribution, is given by $\lambda_a*(1+\lambda_a)/\#$ ships.

At this time, there is no completely satisfactory explanation for the drop in casualty rate after 17 years.

Figure 2 - λ_a as a Function of Age



Lifetime Casualty Experience

Since the annual number of casualties, n_{ta}, of tanker 't' at age 'a', follows a Poisson distribution, with parameter λ_{ta}, then the number of casualties accumulated by a single tanker after 'a' years, N_{ta}, must also follow a Poisson distribution, with parameter Λ_{ta} given by:

$$\Lambda_{ta} = \Sigma_k \lambda_{tk}, \qquad k = 0 \text{ to } a-1$$

Capitals indicate *lifetime*, or cumulative, (as opposed to *annual*) variables or parameters.

That the lifetime experience follows a Poisson distribution is demonstrated through iterative convolutions of the annual experience. In general,

$$PR(N|yrs{=}a) = \sum_n PR(N-n|yrs{=}a-1) * pr(n|age{=}a-1), \qquad n = 0 \text{ to } N$$

where 'PR' indicates the probability for the lifetime number of casualties and 'pr', the probability for the annual number.[4] At the end of the second year, for example, this becomes

$$\begin{aligned} PR(N|yrs{=}2) &= \sum_n PR(N-n|yrs{=}1) * pr(n|age{=}1), && n = 0 \text{ to } N \\ &= \sum_n pr(N-n|age{=}0) * pr(n|age{=}1), && n = 0 \text{ to } N \\ &= \sum_n e^{-\lambda t0} \lambda_{t0}^{(N-n)}/(N-n)! * e^{-\lambda t1} \lambda_{t1}^{n}/n!, && n = 0 \text{ to } N \\ &= e^{-(\lambda t0+\lambda t1)} (\lambda_{t0}+\lambda_{t1})^N/N! \end{aligned}$$

ie, a Poisson distribution with parameter $\Lambda_{t2} = \lambda_{t0} + \lambda_{t1}$. Repeated convolutions yield Poisson parameters, Λ_{ta}, given by:

$$\begin{aligned} \Lambda_{ta} &= \Lambda_{t(a-1)} + \lambda_{t(a-1)}, && \text{where } \Lambda_0 = 0 \\ &= \Sigma_k \lambda_{tk}, && k = 0 \text{ to } a-1 \end{aligned}$$

Because the λ_{ta}'s vary with age it is not clear how the Λ_{ta}'s ought to vary across the fleet for any given age. This is because the distribution of the sum of independent variables, such as the λ_{ta}'s, even with simple distributions, like the exponential, are usually difficult. It turns out, in this case though, that the Λ_{ta}'s, like the λ_{ta}'s, are also distributed exponentially. This is implied from the fact that the frequency of *lifetime* casualties, like the frequency of *annual* casualties, nearly follows a geometric distribution. That the Λ_{ta}'s are distributed exponentially is crucial to the basic model and discussed further in the section "Calculating the Expected Casualty Rate".

Figure 3 shows the actual lifetime frequencies of casualties for three different ages. The theoretical results are shown for both the geometric and Poisson distributions with the same Λ. The geometric distribution matches the actual data reasonably well at all three ages, while the Poisson grossly deviates at the larger values of Λ for 10 and 15 year old tankers. The geometric distribution matches the actual data reasonably well at all ages considered, ie. from 0 to 34.

Figure 3 - ***Lifetime* Casualty Frequencies - Actual Compared to Theory**

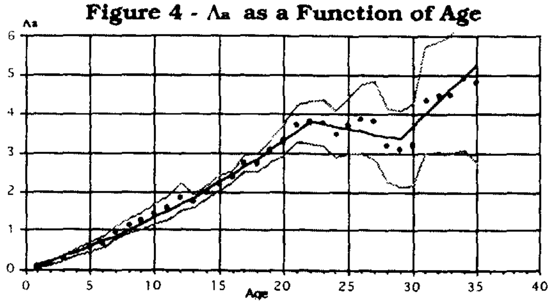
Table entries are the number of ships that incurred the # of casualties shown in the left hand column. For each age the actual # of ships is shown (Act.), the # predicted by the geometric distribution (Geo.) and the # that would have been predicted had we used the Poisson distribution (Poi.).

# of Casualties	1 Year Old Ships			10 Year Old Ships			15 Year Old Ships		
	Act.	Geo.	Poi.	Act.	Geo.	Poi.	Act.	Geo.	Poi.
0	335	331.1	326.4	184	182.9	96.5	238	268.7	82.4
1	39	44.8	52.2	114	112.2	153.3	238	189.9	198.5
2	7	6.1	4.2	63	68.8	121.9	137	134.3	239.2
3	1	0.8	0.2	48	42.2	64.6	104	95.0	192.1
4	1	0.1		24	25.9	25.7	67	67.1	115.8
5				12	15.9	8.2	35	47.5	55.8
6				8	9.7	2.2	17	33.6	22.4
7				10	6.0	0.5	15	23.7	7.7
8				4	3.7	0.1	15	16.8	2.3
≥9				6	5.7		51	40.4	0.8
Total Ships	383			473			917		
	$\Lambda_1 = 0.16$			$\Lambda_{10} = 1.59$			$\Lambda_{15} = 2.41$		

There is a slight systematic difference between the actual frequencies and those given by the geometric distribution for tankers that have been in service longer than 10 years. The number of ships with no casualties is overstated while the number of ships with one casualty is understated. This effect, seen in **Figure 3** for the 15 year old ships, is discussed later in the section "Modifications to the Basic Model".

When all 35 ages (0 to 34) are considered the Λ_a's are seen to follow a reasonably smooth progression shown in **Figure 4**. The solid dots are the actual Λ_a's calculated from the raw data. The light lines are the limits of the 95% confidence intervals around the actual Λ_a's, ie. we are 95% confident that the 'real' Λ_a's lie within the band of the light lines. The solid line is just a fitted curve with which age-specfic lifetime casualty rates can be conveniently calculated. The confidence intervals are determined from the variance of the lifetime casualty ratio given

Figure 4 - Λ_a as a Function of Age



by $\Lambda_a*(1+\Lambda_a)/\#$ ships. The drop in casualty rate between 22 and 29 years is not satisfactorily explained at this time.

Calculating the Expected Casualty Rate

The calculation of λ_{ta}, the casualty rate for tanker 't' at age 'a', is based on the assumption that $\lambda_{ta}/\lambda_a = \Lambda_{ta}/\Lambda_a$.

This assumption follows from an effort to understand why the Λ_{ta}'s are exponential. An explanation could be that the λ_{ta}'s are not really independent at all because λ_{ta}/λ_a remains more or less constant over a tanker's lifetime. This condition eliminates the complexities of convolutions and assures that the lifetime casualty rates will be exponential. It also implies that Λ_{ta}/Λ_a will be constant and have the same value, hence $\lambda_{ta}/\lambda_a = \Lambda_{ta}/\Lambda_a$ as specified.

Special importance is assigned to this ratio because of its persistence. It will be referred to as the 'casualty relativity', 'R_t', of the ship because it specifies an individual ship's risk relative to the rest of the fleet.

The calculations proceed in three steps: Bayes' theorem is first used to calculate an expected value for Λ_{ta} given N_{ta} as described below. Then, R_t is calculated from $R_t = \Lambda_{ta}/\Lambda_a$. Finally, the expected value of λ_{ta} is calculated from $\lambda_{ta} = R_t * \lambda_a$.

The development of $E[\Lambda_{ta}]$ begins with

$$E[\Lambda_{ta} \mid N_{ta}] = \int_{0\to\infty} \Lambda * \mathrm{pdf}(\Lambda \mid \mathrm{age}=a, N_{ta})\, d\Lambda,$$

where $\mathrm{pdf}(\Lambda \mid \mathrm{age}=a, N_{ta})$ is obtained from Bayes' theorem as follows

$$\mathrm{pdf}(\Lambda \mid \mathrm{age}=a, N_{ta}) = \frac{\mathrm{pf}(N_{ta} \mid \Lambda) * \mathrm{pdf}(\Lambda \mid \mathrm{age}=a)}{\mathrm{pf}(N_{ta})}$$

$$= \frac{e^{-\Lambda}\, \Lambda^{N_{ta}}/N_{ta}! * e^{-\Lambda/\Lambda_a}/\Lambda_a}{(\Lambda_a)^{N_{ta}} / (1+\Lambda_a)^{(N_{ta}+1)}}$$

Hence,

$$E[\Lambda_{ta} \mid N_{ta}] = \frac{(1+N_{ta}) * (\Lambda_a)^{(N_{ta}+1)} / (1+\Lambda_a)^{(N_{ta}+2)}}{(\Lambda_a)^{N_{ta}} / (1+\Lambda_a)^{(N_{ta}+1)}}$$

$$= \frac{(1+N_{ta})}{(1+\Lambda_a)} * \Lambda_a,$$

which yields $R_t = (1+N_{ta}) / (1+\Lambda_a)$. λ_{ta} is then calculated as $R_t * \lambda_a$.

Modifications to the Basic Model

There are two modifications that are made to the basic model as described above.

The first relates to the *systematic error in lifetime casualties for ships that have been in service more than 10 years*. The basic model overstates the number of these ships which have not incurred any casualties and correspondingly understates the number that have incurred only one. Other frequencies are predicted accurately.

A change in the assumed distribution of Λ's from the exponential to the more general translated Gamma function eliminates this systematic error. The effect of this change on the calculation of R was studied for all ages between 9 and 23 for $N = 0,1,2$ and 3. It was found that for $N = 0$ the basic model predicted a smooth drop in R from 0.42 at 9 years old down to 0.22 at 23 years whereas the more accurate model yielded a constant R of 0.42 between 9 and 23 years of service. Similarly for $N = 1$ the more accurate model predicts a more or less constant R of 0.50 for ships older than 13 years. For $N = 2$ and 3 there was no significant difference between the basic model and the more accurate model.

The basic model has been modified by replacing the R value calculated by the exponential model by the constant value found above. This method of making the modification was chosen for two reason: First, the calculations with the translated Gamma function are much more complex and time consuming than those with the exponential hence avoiding them with no loss in accuracy is convenient. Second, the roughly 800 ships that are affected by this are at *below*-average risk whereas the value of the model is in its ability to accurately quantify the risk of those ships that are at *above*-average risk.

The second modification results from *the basic model's tendency to exaggerate the deviation of a tanker's casualty rate from the average rate*. For example, tankers that the model identifies as being at high risk, do have many casualties, but not quite as many as predicted. Similarly, tankers identified as being at low risk, do have very few casualties, but slightly more than predicted.

At this time there is no satisfactory explanation for this 'regression towards the average' but, nonetheless, a satisfactory, heuristic correction is made with:

$$R_{corrected} = R^{0.74}$$

For all practical purposes the range of corrected R-values is 1/2 to 3.

Comparison of Expected Casualty Rates with Actual Rates

Casualties in 1991

On 1/1/91 there were 2,420 privately-owned tankers. The basic model was applied using the same kind of casualty information presented earlier but only using data before 12/31/90. Values for λ were calculated for all of the ships. Adding up all the λ's yielded a total prediction of 436.6 casualties for an average rate of 0.180 (436.6/2420). The fleet was then broken up into the 6 risk groups shown in **Figure 5**.

Figure 5 - 1991 Casualties, Pred. & Act.

Risk Group	Casualty Rate Range	#Ships	# of Casualties — Predicted	Actual	z
0.5	-0.135	1043	105.0 ±10.7	101	-0.37
1.0	0.135-0.225	820	139.4 ±12.8	124	-1.20
1.5	0.225-0.315	299	79.9 ±10.1	94	+1.40
2.0	0.315-0.405	128	45.1 ± 7.8	39	-0.78
2.5	0.405-0.495	72	32.0 ± 6.8	40	+1.18
3.0	0.495-	58	35.2 ± 7.5	27	-1.09
		2420	436.6 ±22.7	425	

The lowest risk group includes ships with λ's less than 75% of the average rate. These 1043 ships (43%) collectively had an actual casualty rate of 0.097 (101/1043) while the predicted rate was 0.101 (105.0/1043). Since this rate is about half the fleet average of 0.180, the group is labeled '0.5'.

The average risk group, labeled '1.0', consists of all ships with λ between 75% and 125% of the average rate. With 820 ships, this group is 34% of the fleet. Collectively they experienced a casualty rate of 0.151 (124/820) while the predicted rate was 0.170 (139.4/820).

The remaining 557 (23%) of the ships are spread between the four high risk groups which run from 1.5 up to 3 times the average rate. These ships, all taken together, had a casualty rate of 0.359 (94+39+40+27/557), twice the average rate, while the predicted rate was 0.345 (79.9+45.1+32.0+35.2/557).

The predictions seem to match the actual results well but verifying this requires that the difference between the actual and predicted number of casualties be looked at carefully. These differences are expected to be the result of the Poisson processes themselves and not 'error'. In this sense, these differences are part of the prediction - they *must* occur, otherwise the model cannot be correct. The issue, then, is determining whether the actual differences are consistent with the statistics of the model. To do this, the z-values given by $z = (A-P)/\sigma$ are considered - 'A' and 'P' are the predicted and actual number of casualties and σ is the expected standard deviation. Taken all together, the z-values should behave like a random sample from the unit normal distribution, N(0,1).

The mean of the z's is 0.14 ($p>.8$) with $\sigma = 1.15$ ($p>.3$). These values are comfortably consistent with N(0,1). Further, there is no evidence of skewness (coef. of skew= -0.52) and only slight evidence of negative kurtosis (coef. of kur= -1.50). There were no tables available to calculate p values for skew and kurtosis since n = 6 is so small. An alternate measure, a 3 df Chi2 test constructed to maximize the effect of any kurtosis, yielded p=0.29.

Casualties in 1992

On 1/1/92 there were 2,507 privately-owned tankers. The basic model was again applied using, in addition, the casualties incurred during 1991. New values for λ were calculated for all of the ships. Adding up all the λ's yielded a total prediction of 448.8 casualties for an average rate of 0.179 (448.8/2507). **Figure 6** shows the fleet broken up into the same 6 *relative* risk groups.

The first thing to note for 1992 is that the actual number of reported casualties, 341, is only 76% of the total predicted. This is 4.7 σ's below the prediction ($p<0.0002\%$). This large difference is unlikely to be part of normal variation. Possibly this reduction is due to the increased deductibles and exclusions mentioned in the introduction, resulting in more casualties going unreported.

Figure 6 - 1992 Casualties, Pred. & Act.

Risk Group	Casualty Rate Range	#Ships	# of Casualties Predicted	# of Casualties Actual
0.5	-0.134	1115	111.9 ±11.1	95
1.0	0.134-0.224	812	135.8 ±12.6	98
1.5	0.224-0.313	313	83.1 ±10.2	67
2.0	0.313-0.403	137	48.4 ± 8.1	32
2.5	0.403-0.492	59	25.8 ± 6.1	21
3.0	0.492-	71	43.8 ± 8.4	28
		2507	448.8 ±23.0	341

If all of the λ's are scaled down to 76% of their calculated value we will still be able to assess the model's ability to quantitatively discriminate between the different risk levels. **Figure 7** shows that the scaled-down predictions agree well with the actuals.

Figure 7 - 1992 Casualties, Pred. & Act.
Revised Predictions

Risk Group	Casualty Rate Range	#Ships	# of Casualties Revised Pred.	# of Casualties Actual	z
0.5	-0.102	1115	85.0 ± 9.6	95	+1.04
1.0	0.102-0.170	812	103.2 ±10.8	98	-0.48
1.5	0.170-0.238	313	63.1 ± 8.7	67	+0.45
2.0	0.238-0.306	137	36.8 ± 6.8	32	-0.71
2.5	0.306-0.374	59	19.6 ± 5.1	21	+0.27
3.0	0.374-	71	33.3 ± 7.0	28	-0.76
		2507	341.0	341	

The z-values have a mean of -0.03 and σ = 0.73, again, comfortably consistent with the expected N(0,1). The skewness of 0.33 continues to be insignificant and the kurtosis is -1.26. The two year persistence of negative kurtosis is noted with no explanation.

Predicting the Risk of Total Loss

There is a direct relation between the probability of a ship becoming a total loss and its predicted casualty rate. This is established by analyzing all 202 total losses, both actual and constructive, that have occurred to privately-owned tankers since 1976. The basic model was applied to each of these ships based on their age and casualty record on 1/1 of the year they were lost. Account was made, in these calculations, for the fact that more casualties were reported in the '60s and early '70s than are reported now.

The TLs were then grouped into the same 6 risk groups used before. **Figure 8** shows an estimate of how many ship-years at risk there have been, in each risk group, during the 17 years since 1976. These estimates were made by: First, assuming 2,500 ships were at risk each year. Second, assuming the percentage of ships in each risk group has been relatively constant and can be estimated by averaging the percentages in the '91, '92 and '93 fleets. The ratio of TLs to number of ships at risk is then given along with its σ. The σ shown reflects no model error, only variation implied by the statistics of the Poisson distribution.

The three high risk groups are pooled in the last line of **Figure 8**. The ships in this pool, with risk = 2.4 (ie. casualty rate is 2.4 times the average), *are 3x more likely to be reported as total losses than average and 10x more likely to be reported as total losses than the low risk ships.*

There is no formal prediction of total loss rates to compare with the actual values, however, it is seen that, generally, as the risk goes up, the rate of TLs goes up. A straight line of total loss rate vs risk fits well to the three lowest risk groups and the pooled high risk group. The line is given by 0.69*(risk-0.31) and can be used as a 'predictor' for the total loss probability of a ship where risk = $\lambda_t/\lambda_{average}$.

Figure 8 - 202 TLs from '76 to '92
Actual and Fitted

Risk Group	#Ships	#TLs	TL rate	Fit
0.5	18,600	24	0.13% ±0.03	0.13%
1.0	14,100	74	0.52% ±0.06	0.48%
1.5	5,300	37	0.70% ±0.11	0.82%
2.0	2,300	40	1.74% ±0.27	1.17%
2.5	1,100	18	1.64% ±0.39	1.51%
3.0	1,100	9	0.82% ±0.27	1.86%
	42,500	202	0.48% ±0.03	0.48%
Pool of 3 High Risk Groups				
2.4	4,500	67	1.49% ±0.18	1.44%

In actual practice, the total loss probabilities for all ships are scaled, after being calculated, so that 7 total losses are predicted for the coming year since this has been the consistent fleet experience since 1985.

Summary and Areas of Further Research

The statistics of oil tanker casualties reported in Lloyd's List are found to follow Poisson's distribution for individual tankers while the Poisson parameters for all tankers of the same age are found to follow exponential distributions. Bayes' theorem permits the calculation of the casualty relativity, R, for each ship given its age and lifetime number of casualties. An estimate of a ship's casualty rate is made by multiplying the average casualty rate for tankers of the same age by R.

The predicted casualty rates permit the tankers to be separated into six risk groups in order to check their accuracy. The predicted number of casualties for each group was found to be consistent with the number actually incurred

The usefulness of the predicted casualty rate was demonstrated by showing that the probability of total loss correlates with the predicted rate.

Oil spills and other serious casualties are currently being examined as their frequency varies with λ and also with age and R separately.

There are three other areas which need additional attention:

The uncertainty in λ
Experience-based ratings can suffer from the infrequency of the events. The principal effect that this has on the λ's is a relatively large variation for a given N. [σ for λ is $(1+N)^{1/2}/(1+\Lambda)$ as compared to the expected value of $(1+N)/(1+\Lambda)$.] One purpose of Dropkin's paper, in fact, was to point out this problem in the arena of auto insurance for individuals. For oil tanker casualties, it could be useful to address this problem by using additional information to select a value for λ slightly different from its expected value. For example, a tanker with an owner who has few casualties, could be assigned a λ somewhat less than the expected value, while a tanker with an owner who has many casualties could be assigned a λ somewhat greater than the expected value.

R may change with time
The basic model assumes that the casualty relativity, R, is constant throughout a tanker's lifetime. There are some circumstances, though, where this may not be reasonable, for example, after a tanker is sold to a new owner. It would be desirable to identify, as quickly as possible, when recent casualty experience may indicate a change from the historical experience.

Utilizing claims information
Establishing a relationship between actual claims and λ could increase the utility of the model.

Notes and References

1 Flitner and Brunck, *Ocean Marine Insurance*, Insurance Institute of America discusses all aspects of marine insurance in detail.

2 Borch, Karl, "Mathematical Models for Marine Insurance," *Scandinavian Actuarial Journal*, 1979, pp 25-36 discusses factors other than risk that enter into marine insurance.

3 Dropkin, Lester, "Some Considerations on Automobile Rating Systems Utilizing Individual Driving Records", *Proceedings of the Casualty Actuarial Society* XLVI, 1959, pp 165-176.

4 Strictly speaking 'n' in these equations is 'n_{ta}' and 'N' is '$N_{t(a-1)}$'. The 't' and age designating subscripts are dropped to improve readability.

A NOTE ON USING INFLATION-TRUNCATED DATA

Rodney Kreps

A NOTE ON USING INFLATION-TRUNCATED DATA

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Abstract:

When losses are reported excess of a fixed amount, the effect of inflation on the trended values is to eliminate information from the lower end of the data for the older years. Consequently, the corresponding low end of the recent years is not used in analyses. A simple maximum likelihood solution is proposed which uses all the data. The price paid is that the frequency and severity distribution analyses are then intertwined.

Introduction:

In pricing any insurance or reinsurance contract, it is always necessary to restate past loss data to current or future conditions. In doing this, the four elements are changes in exposure, development on known claims, IBNR claims, and trending for inflation. This note considers only the latter. When all claims are known from ground up, inflation is frequently represented by applying a common index to all claims from a given accident year; or, rarely, by different indices for different sizes of loss.

For certain contracts there is another complication induced by inflation. Loss data in reinsurance and excess pricing is frequently only reported when the loss amount is excess of some value, for example half of the attachment point. Inflation makes losses in the older years economically equivalent to larger losses in the more recent years. For example, with a reporting level of $50,000, a $40,000 1985 loss will not be reported, whereas the same physical loss in 1990 may cost $60,000 and will be reported. With a constant reporting value, the net effect is that the on-level data is truncated from below by an increasing amount as one goes backward from the most recent year. In order to regard each year's data as a sample from the same population for statistical purposes, one must use economically equivalent data across the years. This implies that the lower values of more recent data are not used, thus losing information.

The solution using all data is approached starting from the most intuitive case of Poisson frequency and multinomial severity. There, the explicit maximum likelihood equations are given and solved. Next, the negative binomial is considered. Although its maximum likelihood equations can be written down, numerical solution of the minimization of the negative log-likelihood seems the way to go. From there, a heuristic argument leads to the form of the negative log-likelihood for a continuous severity distribution and either frequency distribution. A consequence of the form is that frequency and severity cannot be determined independently.

The simplest version: Poisson-multinomial

The typical problem is to estimate for a prospective year the frequency λ of events and the severity distribution, having exposure information and past losses reported excess of a fixed amount. The losses are brought to ultimate, including IBNR losses, and indexed to the year of interest. This is, or course, the actuarially problematical part.

For simplicity's sake, it is first assumed that a number of loss ranges ("bins") are defined, e.g. $1001 to $2000, $2001 to $5000, etc. The data is the number of events in each bin, by year. The information desired is the overall frequency of loss and the probability of a loss falling into each bin. This brings up a situation such as is pictured below:

probabilities	dollar bins	COUNTS			
p_5	5	n_{51}	n_{52}	n_{53}	N_5
p_4	4	n_{41}	n_{42}	n_{43}	N_4
p_3	3	n_{31}	n_{32}	n_{33}	N_3
p_2	2	**X**	n_{22}	n_{23}	N_2
p_1	1	**X**	**X**	n_{13}	N_1
	year:	1	2	3	
	exposure:	ε_1	ε_2	ε_3	
	Poisson parameter:	$\lambda\varepsilon_1$	$\lambda\varepsilon_2$	$\lambda\varepsilon_3$	

The dollar bins run vertically upward and the years run horizontally to the right. The n_{ik} are the number of event counts in each bin, by year. The underlying probability for an event to be in bin "i" is p_i and the total number of seen events in bin "i" is N_i. The exposure index relative to the year of interest for year "k" is ε_k. The process is taken to be Poisson, with parameters given by the product of the exposure index and the Poisson parameter of the year of interest. The problem is to estimate both lambda and the probabilities for each bin.

The complicating feature is the missing data (indicated by **X**) in bins 1 and 2 for year 1, and in bin 1 for year 2. Usually, in order to compare economically equivalent data it is necessary to disregard the lower two bins for all years. This has two unfortunate consequences: First, the lower end of the available data may be higher than we require for the problem at hand. Alternatively, in order to get data low enough, we may be limited in the number of past years that we could otherwise use. Second, we ignore perfectly good data (as much as any reinsurance data is perfectly good) which could add information. A *caveat* is appropriate here - the IBNR and development is more uncertain in the recent years, and this may temper one's desire to use the data. The other side of the coin is that the older years' data may also be suspect because of changes in the business mix and possible inappropriateness of the inflation indices.

Happily, there is a maximum likelihood solution to the problem of using all the data. In order to provide it, begin by considering only year 2 (and drop the corresponding subscript to save typography). Given p_1 to p_5, the probability of observing n_1 to n_5 is the multinomial formula

$$M(n_1,..,n_5) = \Gamma(N+1)\prod_{i=1}^{5}\frac{(p_i)^{n_i}}{\Gamma(n_i+1)}, \quad N = \sum_{i=1}^{5} n_i \text{ and } \sum_{i=1}^{5} p_i = 1$$

The Poisson probability with parameter λ of observing N events is

$$P(N,\lambda) = \frac{\lambda^N e^{-\lambda}}{\Gamma(N+1)}$$

The key remark is that if the total is Poisson distributed with parameter λ, the probability of observing $n_2,..,n_5$ with no information on n_1 is the sum over the probabilities of observing no events in bin 1, one event, two events, etc.:

$$\begin{aligned}\text{prob} &= \sum_{v=0}^{\infty} M(v,n_2,..,n_5)P(v+n_2+..+n_5,\lambda)\\ &= \prod_{i=2}^{5}\frac{(p_i)^{n_i}}{\Gamma(n_i+1)}\sum_{v=0}^{\infty}\frac{(p_1)^v\lambda^{(v+n_2+..+n_5)}e^{-\lambda}}{\Gamma(v+1)}\\ &= e^{-\lambda(1-p_1)}\prod_{i=2}^{5}\frac{(\lambda p_i)^{n_i}}{\Gamma(n_i+1)}\end{aligned}$$

The effect is that of a multinomial in the observed counts times a factor which accounts for the reduced probability available to them.

For any year, a similar formula holds, which can be obtained by thinking of merging all the empty bins and using the preceding derivation. The probabilities have individual Poisson parameters $\varepsilon_k\lambda$, and the product of the probabilities is the overall likelihood. Ignoring terms which do not depend upon λ or p_i, the negative logarithm of the likelihood (NLL) is the sum of the NLLs for each year:

$$\text{NLL} = \varepsilon_1\lambda(1-p_1-p_2) - \sum_{i=3}^{5} n_{i1}\ \{\ \ln[p_i]+\ln[\lambda]\ \}$$

$$+\varepsilon_2\lambda(1-p_1) - \sum_{i=2}^{5} n_{i2}\{\ln[p_i]+\ln[\lambda]\}$$

$$+\varepsilon_3\lambda - \sum_{i=1}^{5} n_{i3}\{\ln[p_i]+\ln[\lambda]\} + \gamma\left(\sum_{i=1}^{5} p_i - 1\right)$$

A Lagrange multiplier term γ has been added, to facilitate solution. To find the maximum likelihood, we set equal to zero the partial derivatives with respect to γ, λ, and all the p_i :

$$\frac{\partial(NLL)}{\partial\gamma} = 0 \Rightarrow \quad \sum_{i=1}^{5} p_i = 1$$

$$\frac{\partial(NLL)}{\partial p_1} = 0 \Rightarrow \quad \frac{n_{13}}{p_1} = \gamma - (\varepsilon_1+\varepsilon_2)\lambda$$

$$\frac{\partial(NLL)}{\partial p_2} = 0 \Rightarrow \quad \frac{n_{22} + n_{23}}{p_2} = \gamma - \varepsilon_1\lambda$$

$$\frac{\partial(NLL)}{\partial p_3} = 0 \Rightarrow \quad \frac{n_{31} + n_{32} + n_{33}}{p_3} = \gamma$$

$$\frac{\partial(NLL)}{\partial p_4} = 0 \Rightarrow \quad \frac{n_{41} + n_{42} + n_{43}}{p_4} = \gamma$$

$$\frac{\partial(NLL)}{\partial p_5} = 0 \Rightarrow \quad \frac{n_{51} + n_{52} + n_{53}}{p_5} = \gamma$$

$$\frac{\partial(NLL)}{\partial\lambda} = 0 \Rightarrow \quad \lambda = \frac{\sum_{i=1}^{5} N_i}{\varepsilon_1(1-p_1-p_2)+\varepsilon_2(1-p_1)+\varepsilon_3}$$

Thus, we end up with a nonlinear system of seven equations in seven unknowns.

Fortunately, the solution is both intuitive and easily generalized. The values $\varepsilon_k\lambda$ are the mean total number of events, <u>including</u> the unseen events, in year "k". Remembering that N_i is the total seen events in bin "i", the solution can be expressed as

$$p_1 = \frac{N_1}{\varepsilon_3\lambda}$$

$$p_2 = \frac{N_2}{(\varepsilon_2+\varepsilon_3)\lambda}$$

$$p_3 = \frac{N_3}{(\varepsilon_1+\varepsilon_2+\varepsilon_3)\lambda}$$

$$p_4 = \frac{N_4}{(\varepsilon_1+\varepsilon_2+\varepsilon_3)\lambda}$$

$$p_5 = \frac{N_5}{(\varepsilon_1+\varepsilon_2+\varepsilon_3)\lambda}$$

That is, the probability for each bin is the total number of events seen in it divided by the expected total number of events that could have contributed.

The quantity γ is the mean total number of events

$$\gamma = (\varepsilon_1+\varepsilon_2+\varepsilon_3)\lambda$$

and finally, the frequency parameter λ is

$$\lambda = \frac{N_1}{\varepsilon_3} + \frac{N_2}{(\varepsilon_2+\varepsilon_3)} + \frac{N_3+N_4+N_5}{(\varepsilon_1+\varepsilon_2+\varepsilon_3)}$$

The expected frequency is a sum over bins of the exposure-leveled number of seen events.

These rules seem quite intuitive. The generalizations to more complicated bin and/or date structures are fairly self-evident, as the same rules will still hold. Variable reporting levels by year would be one way the structure could be more complex.

Negative Binomial:

If the distribution is taken to be negative binomial instead of Poisson, when we go back to the discussion of year "2" the lemma is still straight-forward. The negative binomial probability with parameters (α,p) of observing N events is

$$NB(N,\alpha,p) = \frac{p^N\Gamma(N+\alpha)(1-p)^\alpha}{\Gamma(N+1)\Gamma(\alpha)}$$

$$\text{with} \quad \lambda \equiv \text{mean} = \frac{\alpha p}{1-p} \quad \text{and} \quad \frac{\text{variance}}{\text{mean}} = \frac{1}{1-p}$$

The probability of observing $n_2,..,n_5$ with no information on n_1 becomes

$$\text{prob} = \frac{(1-p)^\alpha\Gamma(n_2+..+n_5+\alpha)}{(1-pp_1)^{n_2+..+n_5+\alpha}\Gamma(\alpha)}\prod_{i=2}^{5}\frac{(pp_i)^{n_i}}{\Gamma(n_i+1)}$$

This has a similar form to the Poisson case, but with a different modifying function. The Poisson form is recovered in the limit p -> 0 with λ held constant.

The NLL for the three years has the corresponding changes. It is assumed that p, which governs the ratio of variance to mean, is held fixed, so that the exposure changes manifest (proportional to the mean values) through the $\alpha_k = \varepsilon_k \alpha$.

Apart from irrelevant quantities, the NLL is

$$
\begin{aligned}
NLL = {} & \varepsilon_1 \alpha \ln\left[\frac{1 - p(p_1+p_2)}{1 - p}\right] + (n_{31}+..+n_{51})\ln[1 - p(p_1+p_2)] \\
& - \sum_{v=0}^{(n_{31}+..+n_{51}-1)} \ln[\varepsilon_1 \alpha + v] - \sum_{i=3}^{5} n_{i1} \{ \ln[p_i] + \ln[p] \} \\
& + \varepsilon_2 \alpha \ln\left[\frac{1 - pp_1}{1 - p}\right] + (n_{22}+..+n_{52})\ln[1 - pp_1] \\
& - \sum_{v=0}^{(n_{22}+..+n_{52}-1)} \ln[\varepsilon_2 \alpha + v] - \sum_{i=2}^{5} n_{i2} \{ \ln[p_i] + \ln[p] \} \\
& - \sum_{v=0}^{(n_{13}+..+n_{53}-1)} \ln[\varepsilon_3 \alpha + v] - \sum_{i=1}^{5} n_{i3} \{ \ln[p_i] + \ln[p] \}
\end{aligned}
$$

Again, the extensions to more complicated date or bin structures follow the same form. The partial derivative equations here are far more complex than in the Poisson case. At this point it is easier just to work directly with the NLL and do the minimization numerically, rather than trying for analytic solutions (this is why the Lagrange term has been omitted).

Continuous distributions:

Often parameterization of the loss distribution - for example by a Pareto family - is of interest. Heuristically, this may be thought of as the limit where the bins become very small. All the n_i are zero or one (except for the case of identical losses), and the probabilities p_i are not independent, but given by the underlying distribution. Let us denote the lowest observable loss value for the year "k" by L_k; the underlying cumulative distribution function by F(x); and the corresponding probability density function by f(x), where we have suppressed the explicit parameter dependence in the severity distribution.

The parallel to the discussion of year "2" is that there are n events $x_1,..,x_n$ observed above the value L and the overall frequency is Poisson distributed with parameter λ. By a similar development to the earlier discussion, the probability of seeing these n events with no information below L is essentially

$$
prob = e^{-\lambda(1-F(L))} \lambda^n \prod_{i=1}^{n} f(x_i)
$$

The overall likelihood is the product of these for each year, as before:

$$\text{likelihood} = \prod_{k=1}^{3} e^{-\varepsilon_k\lambda[1-F(L_k)]}(\varepsilon_k\lambda)^{n_k}\prod_{i=1}^{n_k} f(x_{ik})$$

The corresponding NLL is, ignoring irrelevant terms,

$$NLL = \sum_{k=1}^{3}\left\{ \varepsilon_k\lambda[1-F(L_k)] - n_k\ln(\lambda) - \sum_{i=1}^{n_k} \ln[f(x_{ik})] \right\}$$

Letting N be the total number of seen events, this achieves the conceptually simpler and perhaps more familiar form

$$NLL = \sum_{k=1}^{3} \varepsilon_k\lambda[1-F(L_k)] - N\ln(\lambda) - \sum_{i=1}^{N} \ln[f(x_i)]$$

Equating to zero the partial derivative with respect to λ gives

$$\lambda = \frac{N}{\sum_{k=1}^{3} \varepsilon_k[1-F(L_k)]}$$

This equation is completely parallel to that of the last partial derivative in the multinomial case. It gives λ as a function of the data and the parameters of the distribution. The parallel solution for λ would be

$$\lambda = \frac{M_1}{(\varepsilon_1+\varepsilon_2+\varepsilon_3)} + \frac{M_2}{(\varepsilon_2+\varepsilon_3)} + \frac{M_3}{\varepsilon_3}$$

where M_1 is the total number of events greater than L_1, M_2 is the total number of events greater than L_2 and less than L_1, and M_3 is the total number of events greater than L_3 and less than L_2. Since there are many fewer degrees of freedom in this case than in the multinomial, this value of λ is unlikely to be the actual solution. However, it should provide a good starting point for the minimization of the NLL.

If we denote the parameters in the severity function collectively by the vector β, the partial derivative equations have the form

$$0 = \sum_{k=1}^{3}\left\{ -\varepsilon_k\lambda\frac{\partial F}{\partial\beta}(L_k,\beta) + \sum_{i=1}^{n_k} \frac{1}{f(x_{ik})}\frac{\partial f}{\partial\beta}(x_{ik},\beta)\right\}$$

Once more, numerical minimization is probably easier than trying to solve these equations.

The negative binomial case has a completely parallel development, with the probability of observing n events with no information below L being

$$\text{prob} = \frac{(1-p)^{\alpha}\Gamma(n+\alpha)}{\{1-p[1-F(L)]\}^{n+\alpha}\Gamma(\alpha)} p^n \prod_{i=1}^{n} f(x_i)$$

The likelihood and NLL for the three years have the corresponding changes. Again letting N be the total number of seen values,

$$\begin{aligned} NLL = & -\alpha \ln[1-p] \sum_{k=1}^{3} \varepsilon_k - N\ln(p) - \sum_{i=1}^{N} \ln[f(x_i)] \\ & + \sum_{k=1}^{3} \left\{ (n_k+\varepsilon_k\alpha)\ln[1-p(1-F(L_k))] - \sum_{v=0}^{(n_k-1)} \ln[\varepsilon_k\alpha+v] \right\} \end{aligned}$$

Conclusion:

The price we pay for being able to use more data is that the frequency and severity maximum likelihood calculations are now interdependent. This will induce correlations between the frequency and severity parameters, which will manifest in the variance-covariance matrix[1] resulting from the numerical minimization. In doing any model which allows for the uncertainty of the parameters, these correlations must be taken into account aw well as the parameter variance.

We lose, except in the simplest case, the possibility of finding analytic solutions. Fortunately, we usually want numbers anyway, and the explicit construction for the NLL allows (relatively) straightforward computation.

Addendum:

Since we have the NLL, we can also put in the possibility of trend by making λ or α an explicit function of time, in an obvious extension. Then for a given severity distribution family, there will be at least four possible frequency distributions: trended and untrended Poisson and negative binomial. The decision between them can be made on the basis of the smallest NLL, with appropriate allowance for the different numbers of parameters. One way of doing this is to use the Akaike[2] criterion: add to the minimized NLLs the number of parameters in the fit, and choose the lowest value.

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[1]The derivation of the variance-covariance matrix from the mixed partial derivatives of the NLL is given in, for example, *Loss Distributions* by Hogg and Klugman, John Wiley and Sons (1984) page 81 and following.

[2]See the discussion in any good econometrics book, or go to Akaike, H. (1973), "Information Theory and the Extension of the Maximum Likelihood Principle," in B.N. Petrov and F. Csaki, eds., *2nd International "Symposium on Information Theory*, Akailseoniai-Kuido, Budapest, pp. 267-281 and the subsequent work, especially Akaike, H (1978), "On the Likelihood of a Time Series Model," Paper

Appendix - a formal derivation

Although a heuristic derivation of the continuous case was given earlier, the following is a formal derivation due to Ed Weissner which holds for either case.

Let A = a random sample was observed
B = of size N
C = with precisely M observations $\geq L$
D = and the observations (no particular order) are $x_1, \ldots, x_M$

The likelihood function is given by

$$L(\lambda) = P[ACD] = \sum_{N=M}^{\infty} P[ABCD] \qquad \text{(law of total probabilities)}$$

$$= \sum_{N=M}^{\infty} P[AB]\ P[C|AB]\ P[D|ABC]$$

Now, AB obeys a Poisson law

C|AB obeys a Binomial Law with n = N, # of successes = M, and probability of success p defined by

$$p = 1 - F(L) \qquad \text{for continuous}$$

$$= \sum_{i \geq i(L)}^{\infty} p_i \qquad \text{for discrete}$$

D|CAB obeys a likelihood function that accounts for "no particular order" and draws each observation from the truncated distribution

$$\frac{f(x)}{1-F(L)} \qquad \text{for continuous}$$

$$\frac{p_i}{\sum_{i \geq i(L)}^{\infty} p_i} \qquad \text{for discrete}$$

Applying these to the likelihood above, it follows that for the continuous case

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presented at the Institute of Statisticians 1978 Conference on Time Series Analysis, Cambridge University, Cambridge, England, July 1978.

$$L(\lambda) = \sum_{N=M}^{\infty} \left[\frac{e^{-\lambda}\lambda^N}{N!}\right] \left[\frac{N!}{M!(N-M)!} [1-F(L)]^M [F(L)]^{N-M}\right] \left[M! \frac{\prod f(x_i)}{[1-F(L)]^M}\right]$$

and in the discrete case

$$L(\lambda) = \sum_{N=M}^{\infty} [.....] [....] \left[\frac{M!}{\prod n_i!} \frac{\prod p_i^{n_i}}{[1-F(L)]^M}\right]$$

where the products $\prod_{i \geq i(L)}$ are i ≥ 2 for bin 1 missing, etc. Note that the combination of the binomial and "truncated multinomial" give the multinomial used in the text.

THE UNDERWRITING CYCLE

David Skurnick

THE UNDERWRITING CYCLE

BY DAVID SKURNICK

CAS UNDERWRITING CYCLE SEMINAR
APRIL 19, 1993

IN 1985, PAUL INGREY, PRESIDENT OF F&G RE DESIGNED AN INSURANCE CLOCK, TO MEASURE THE UNDERWRITING CYCLE. IT DESCRIBES THE CYCLE IN TERMS OF PRICING, PROFITS, REINSURANCE, MGA'S, CASH FLOW, ETC. THE TONE IS LIGHT, BUT IT IS A SERIOUS AND USEFUL DESCRIPTION OF A TYPICAL CYCLE. YOU CAN READ THE CHART AT YOUR LEISURE. IN SUMMARY,

1:00 - PRICING STARTS TO DROP
2:00 - COMPANIES COMPETE TO INCREASE MARKET SHARE
3:00 - PRICES FALL DRAMATICALLY
4:00 - PROFITS SLIDE
5:00 - RESULTS HORRIBLE
6:00 - PRICING CANNOT GO LOWER
7:00 - A. M. BEST WRITES THIS DECADE'S "LETTER OF CONCERN"
8:00 - CRUNCH
9:00 - PRICES UP SHARPLY
10:00 - CAPACITY BECOMES EXPENSIVE
11:00 - ALL COMPANIES FLOURISH
12:00 - EUPHORIA!
1:00 - PRICING STARTS TO DROP
ETC.

HOW DOES THIS CHART FIT THE LAST 8 YEARS? I'D SAY, "VERY WELL."

IN THE NEXT FEW MINUTES I WILL DISCUSS THE FOLLOWING QUESTIONS:

1. WHAT FACTORS CREATE UNDERWRITING CYCLES?

2. WHAT DO THESE FACTORS TELL US ABOUT THE TURN IN THE CYCLE?

3. WHAT DOES THE INSURANCE CLOCK SAY ABOUT A TURN IN THE CYCLE?

4. WHEN WILL THE CYCLE TURN?

WHAT FACTORS CREATE UNDERWRITING CYCLES?

1. DIFFICULTY OF BUILDING A BOOK OF BUSINESS - DISCOURAGES PROMPT ACTION, WHEN RATES GO DOWN. A COMPANY WANTS TO KEEP ITS STAFF, ITS PRODUCTS, ITS MARKETS, AND ITS AGENCY PLANT.

2. RISE AND FALL OF SUPPLY AND DEMAND - SUPPLY IS MEASURED BY INDUSTRY SURPLUS AND DEMAND BY PREMIUM. PERSONAL LINES DEMAND IS EXTREMELY STABLE. COMMERCIAL LINES DEMAND IS MORE STABLE THAN IN MANY OTHERS INDUSTRIES, BUT IT IS AFFECTED BY THE OVERALL ECONOMY AND BY THE USE OF ALTERNATIVE MARKETS. IT IS INTERESTING THAT AT THE POINT IN THE CYCLE WHEN PRICES START TO RISE, THE DEMAND (AS MEASURED BY THE PREMIUM TO SURPLUS RATIO) APPARENTLY INCREASES, WHICH TENDS TO PROVOKE MORE INCREASES.

3. PROFIT AND LOSS - CORPORATIONS ARE DRIVEN BY REPORTED OPERATING PROFIT AND RETURN ON EQUITY. BOTH MUTUALS AND STOCK INSURANCE COMPANIES MUST BE CONCERNED WITH SURPLUS. PROFIT DIRECTLY ADDS TO SURPLUS. ALSO, A PROFITABLE COMPANY WILL HAVE ACCESS TO THE CAPITAL MARKETS. PROFIT ALSO INFLUENCES MANAGEMENT PSYCHOLOGY.

4. CASH FLOW - ULTIMATELY, IF NOTHING ELSE TURNS THE CYCLE, CASH FLOW WILL. IF COMPANIES RUN OUT OF MONEY, THEY MUST RAISE PRICES.

5. RESERVE ADJUSTMENTS - IN THE LAST CYCLE, MANY COMPANIES STARTED USING "EARNED BUT UNBILLED PREMIUM" TO INCREASE EARNED PREMIUM. LOSS RESERVES CAN BE ADJUSTED BY MEANS OF FINANCIAL REINSURANCE CONTRACTS OR BY MORE OPTIMISTIC CLAIMS RESERVING AND IBNR RESERVING.

MANY BUSINESSES SWITCH TO MORE FAVORABLE ACCOUNTING TREATMENTS DURING A DOWNTURN, BUT INSURANCE HAS GREATER SCOPE FOR CONTROLLING RESULTS, DUE TO THE RESERVES. THE PRACTICE OF UNDER-RESERVING DURING BAD YEARS AND STRENGTHENING RESERVES DURING GOOD YEARS SERVES TO MODERATE THE CYCLES AND THEREFORE TO EXTEND THEM.

6. REINSURANCE AVAILABILITY AND COST - PRICES AND TERMS SWING MORE FOR REINSURANCE COMPANIES THAN FOR PRIMARY COMPANIES. IT IS BELIEVED THAT THE REINSURANCE CYCLE CAN DRIVE THE PRIMARY CYCLE.

7. FINANCIAL REINSURANCE FOR CATASTROPHES - SERVES TO EXPAND CAPACITY. HOWEVER, THE FINANCIAL ACCOUNTING STANDARD BOARD HAS PROPOSED FAS 113, WHICH COULD CHANGE THE RULES ON THIS PRODUCT, THEREBY REDUCING CAPACITY.

8. INTEREST RATE CHANGES - HIGH INTEREST RATES ENCOURAGE PRICE CUTTING, BECAUSE INVESTMENT INCOME IS HIGHER.

9. UNRECOGNIZED GAIN OR LOSS IN THE BOND PORTFOLIO - IN 1917, THE NAIC DECLARED THAT BONDS SHOULD BE VALUED AT

AMORTIZED OR BOOK VALUE, RATHER THAN MARKET. AS A RESULT, WHEN INTEREST RATES DROP THERE IS AN UNRECOGNIZED GAIN IN THE BOND PORTFOLIO. SIMILARLY, THERE IS AN RECOGNIZED LOSS WHEN INTEREST RATES RISE. (HOWEVER, FASB JUST ANNOUNCED A REVISION IN THIS PROCEDURE. CERTAIN BONDS WILL BE HELD AT MARKET.)

IN THE EARLY 80'S INTEREST RATES BECAME HIGH AND BONDS WERE UNDER WATER. INSURANCE COMPANIES COMPETED WILDLY FOR CASH FLOW, NOT ONLY FOR THE HIGH YIELDS, BUT ALSO TO AVOID HAVING TO SELL THE BONDS AND REALIZE A LOSS OF SURPLUS AND A DROP IN EARNINGS.

10. NAIVE CAPITAL - DEFINED, AFTER THE FACT, AS ANYONE WHO INVESTED DURING THE DOWN CYCLE, LOST MONEY THEN WITHDREW WHEN PRICES WENT UP. THESE COMPANIES INCREASE SUPPLY, PROLONGING THE DOWN CYCLE.

11. MANAGEMENT BY HIRED HANDS, NOT OWNERS - A COMPANY PRESIDENT WHO DOESN'T OWN MUCH STOCK MAY HAVE LESS LOYALTY TO THE BOTTOM LINE THAN TO THE CONTINUED EMPLOYMENT OF HIS FELLOW EMPLOYEES AND HIMSELF.

12. CALENDAR YEAR RESULTS VS POLICY YEAR ACTIONS - ALTHOUGH MANY ORDINARY DECISIONS MAY BE BASED ON ACCIDENT YEAR OR POLICY YEAR PROJECTIONS, THE REALLY BIG DECISIONS, THE ONES MADE AT THE HIGHEST LEVEL, ARE MORE LIKELY TO BE BASED ON CALENDAR YEAR RESULTS, RESULTING IN A DELAYED RESPONSE. THIS DELAY PLUS THE OTHER DELAYS MENTIONED EARLIER HELP CREATE THE CYCLE. FOR EXAMPLE, HERE'S HOW A HYPOTHETICAL 11 YEAR CYCLE COULD OCCUR.

ASSUME THAT PREMIUM RATES BECOME TOO LOW IN YEAR 1. THEN, BAD LOSS RATIOS <u>SHOULD</u> BE REPORTED IN CALENDAR YEAR 2. WITH OPTIMISTIC RESERVING, ACCOUNTING CHANGES, FINANCIAL REINSURANCE, AND BY SWAPPING BONDS, THE REPORTED BAD RESULTS MIGHT BE POSTPONED UNTIL YEAR 5. DURING YEARS 2 THROUGH 5, RATE ADEQUACY CONTINUES TO FALL. IN YEARS 5, 6 AND 7 MANAGEMENT TAKES MODERATE REMEDIAL STEPS, WHICH DON'T WORK. FINALLY, IN YEAR 8, THE <u>TOP</u> MANAGEMENT ORDERS DRAMATIC RATE INCREASES, <u>NO MATTER WHAT THE EFFECT ON VOLUME</u>. RATES BEGIN TO IMPROVE DURING YEAR 8 AND BECOME REDUNDANT BY YEAR 9. RESERVE STRENGTHENING KEEPS CALENDAR YEAR RESULTS BAD UNTIL YEAR 9 OR 10.

MEANWHILE, <u>OPERATING</u> MANAGEMENT UNDERSTANDS POLICY YEAR RATE ADEQUACY, SO THEY BEGIN REDUCING RATES SOME TIME IN YEAR 9. AS REPORTED RESULTS IMPROVE, RATES CONTINUE TO FALL. BY YEAR 12, THE RATES HAVE REACHED A LEVEL OF INADEQUACY COMPARABLE TO YEAR 1.

13. RATE REGULATION - CAN REGULATORS HELP TO SMOOTH THE CYCLE? MAYBE. EVEN WHEN REGULATION IS POLITICALLY

MOTIVATED, IT ADDS INERTIA. PERSONAL LINES REGULATION IS BURDENSOME ENOUGH TO ADD INERTIA. AN INSURANCE COMPANY WOULD BE FOOLISH TO CUT PERSONAL LINES PRICES, BECAUSE THE REGULATORS MIGHT NOT LET THEM RAISE THE PRICES. DURING THE LAST TEN YEARS, PERSONAL LINES PRICES HAVE BEEN FAR MORE STABLE THAN COMMERCIAL LINES PRICES.

14. CATASTROPHES - HURRICANE BETSY TURNED THE UNDERWRITING CYCLE IN THE MID-60'S. SOME OBSERVERS BELIEVE THAT ANDREW WILL DO THE SAME TODAY.

15. CHANGES IN LOSS TRENDS AND LOSS DEVELOPMENT – SOMETIMES LOSS PATTERNS REALLY DO CHANGE. WE SAW MEDICAL MALPRACTICE WITH EXTREME TRENDS FROM PERHAPS 1965 TO 1985. SINCE THEN, TRENDS HAVE MODERATED. TODAY, GL SEEMS TO HAVE MODERATED AND WC IS A BEAR.

16. PSYCHOLOGY - THERE IS A WONDERFUL OLD BOOK, WRITTEN IN 1841, CALLED EXTRAORDINARY POPULAR DELUSIONS AND THE MADNESS OF CROWDS. THIS BOOK VIVIDLY DESCRIBES VARIOUS PERIODS OF ECONOMIC "MADNESS", SUCH AS THE TULIPOMANIA IN HOLLAND IN 1636, WHEN A SINGLE TULIP BULB COULD BE BOUGHT OR SOLD FOR A LIFETIME'S EARNINGS.

INSURANCE MANAGEMENTS ARE HUMAN BEINGS. WE DON'T ALWAYS MAKE RATIONAL DECISIONS. WE'RE UNDULY INFLUENCED BY RECENT EVENTS, EVEN WHEN WE'RE MAKING PLANS BASED ON THE LONG-TERM ODDS.

I WENT THROUGH A DOWN CYCLE AS HEAD OF UNDERWRITING AT ARGONAUT INSURANCE COMPANY DURING THE EARLY 80'S. WHEN THE COMPETITORS CUT THEIR LIABILITY AND COMMERCIAL PACKAGE PRICES PRICES 25%, WE DID THE SAME. WE THOUGHT WE HAD GOOD REASONS, BASED ON THE STRONG INVESTMENT INCOME AND STRONG SURPLUS OF THE COMPANY AND THE DESIRE TO MAINTAIN MARKET SHARE.

OF COURSE, OUR THINKING WAS INCOMPLETE. OUR BIGGEST MISTAKE MAY HAVE BEEN FAILING TO REALIZE THAT THE HOLDING COMPANY WOULD DEMAND DRAMATIC ACTION.

SOME COMPANIES DIDN'T MONITOR RATES AND USE ACTUARIAL INPUT. WHAT'S SIGNIFICANT IS THAT WE PERSISTED IN SELLING EVEN THOUGH WE MONITORED RATES AND PRICES AND WE KNEW WE'D LOSE MONEY.

ANOTHER HUMAN TRAIT IS A TENDENCY TO FOLLOW THE CROWD. I'LL NEVER FORGET IN 1971 REPORTING TO THE PRESIDENT OF INA THAT IBNR WAS DEFICIENT BY $140 MILLION. HE PAID CAREFUL ATTENTION TO MY PRESENTATION, WITH ITS MANY WORKSHEETS, EXHIBITS AND CHARTS. FINALLY, HE SAID TO ME, "WHAT'S TRAVELERS DOING?"

MOST OF YOU ARE OLD ENOUGH TO HAVE GONE THROUGH THE LAST 10 YEARS. REMEMBER THE PAIN OF THE EARLY 80'S? THEN WE HAD THE CRUNCH IN 1984, THE RATE INCREASES IN 1985 AND '86 AND GREAT RESULTS STARTING IN 1986. IT RAINED MONEY. THE QUESTION ON EVERYONE'S LIPS IS, "HOW LONG DO WE HAVE TO WAIT FOR THE NEXT DRAMATIC CYCLE TURN? HERE ARE SOME FACTORS THAT POINT TO A TURN IN THE CYCLE:

1. ACCORDING TO MANY OBSERVERS, HURRICANE ANDREW WILL TURN THE CYCLE. AS A RESULT OF THIS STORM, PROPERTY CATASTROPHE REINSURANCE IS SCARCE AND EXPENSIVE. PRIMARY CAPACITY IS SHARPLY REDUCED IN COASTAL AREAS.

2. COMPANIES' BOND PORTFOLIOS HAD SHARP GAINS DUE TO INTEREST RATE DROPS OVER THE PAST TWO YEARS, BUT MUCH OF THIS GAIN IS GONE. MANY COMPANIES REALIZED THE GAIN IN ORDER TO OFFSET LOSSES FROM HURRICANE ANDREW. INCIDENTALLY, IF INTEREST RATES WERE TO RISE, OUR BONDS WOULD BE UNDER WATER, AND WE MIGHT SEE THE KIND OF PANICKED COMPETITION THAT TYPIFIED 1982-84.

3. THE INDUSTRY IS UNDER-RESERVED. ACCORDING TO ISO, AT YEAR END 1991, THE UNDISCOUNTED LOSS RESERVE WAS UNDERSTATED BY $38 TO $50 BILLION.

4. THE INTRODUCTION OF RISK BASED CAPITAL, PERHAPS AS OF YEAR-END 1994, IS INTENDED TO BE A MORE ACCURATE MEASUREMENT OF CAPACITY AND ALSO MORE CONSERVATIVE. EVEN THE EXPECTATION OF RISK BASED CAPITAL MAY BE MODERATING GROWTH PLANS RIGHT NOW.

5. ASBESTOS AND POLLUTION ARE MAJOR WORRIES. ACCORDING TO A STUDY BY TILLINGHAST, GIVEN THE CURRENT SUPER-FUND LAW, THE COST TO INSURANCE COMPANIES COULD EVENTUALLY AMOUNT TO HUNDREDS OF BILLIONS OF DOLLARS.

6. FASB 113 WILL REDUCE THE ABILITY TO USE FINANCIAL REINSURANCE TO CREATE SURPLUS AND TO PROVIDE CAT REINSURANCE.

ON THE OTHER HAND, HERE IS A LIST OF FACTORS OPPOSING A TURN IN THE CYCLE:

1. THE INDUSTRY SURPLUS IS AT A RECORD HIGH OF $164 BILLION. WITH PREMIUM VOLUME AT $230 BILLION, THE PREMIUM TO SURPLUS RATIO IS AT A ROCK SOLID 1.4 TO 1.

2. ALTERNATIVE MARKETS ARE GROWING BY LEAPS AND BOUNDS. IN WORKERS COMP, PERHAPS 1/3 OF THE BUSINESS IS NOT IN THE INSURANCE MARKET. THE HUGE ASSIGNED RISK CHARGES ARE PUSHING CUSTOMERS INTO USING DEDUCTIBLES, CAPTIVES, AND SELF-INSURANCE. TO SOME EXTENT, OTHER COMMERCIAL COVERAGES MOVE WITH THE COMP. THIS IS A

REDUCTION IN DEMAND, OR, LOOKED AT ANOTHER WAY, AN INCREASE IN SUPPLY, AS THE CUSTOMERS BECOME INSURERS.

3. FINANCIAL REINSURANCE SERVES TO INCREASE CAPITAL AND PROVIDE CAT REINSURANCE. IT IS NOT CLEAR WHAT CAN BE DONE AFTER FASB 113 IN IN EFFECT.

4. TODAY RESERVES ARE A HIGHER PER CENT OF PREMIUM THAN ANY PAST CYCLE; THERE IS PLENTY OF ROOM FOR MORE UNDER-RESERVING.

5. LIABILITY LOSSES ARE DEVELOPING FAVORABLY, ON BOTH AN INCURRED AND A PAID BASIS. THIS HAS PRODUCED GOOD CALENDAR YEAR RESULTS AND IMPROVED OPTIMISM.

6. CAPITAL IS COMING IN TO THE INDUSTRY. SEVERAL COMPANIES ARE BEING ESTABLISHED TO DO PROPERTY CAT, WITH CAPITAL IN THE HUNDREDS OF MILLIONS. IT'S AMAZING HOW MUCH CAPITAL IS AVAILABLE. INSURANCE STOCK PRICES ARE HIGH, FACILITATING SALES OF EQUITY. A NUMBER OF NEW COMPANIES HAVE BEEN GROWING VERY RAPIDLY IN CASUALTY BUSINESS. TIME WILL TELL IF THEY WERE WISE OR NAIVE. IN ANY EVENT, THE EFFECT IS THAT COMPETITION HAS INCREASED AND RATES HAVE BEEN HELD DOWN.

7. FINALLY, MOST IMPORTANT, <u>PSYCHOLOGY</u> - <u>I JUST DON'T SEE PANIC OR DESPAIR</u>. THE INDUSTRY SEEMS TO HAVE ABSORBED ANDREW. EXECUTIVES SAY, "I KNOW THINGS ARE TOUGH, BUT <u>WE</u> HAVE AN APPROACH THAT'S WORKING." ONE EXECUTIVE TOLD ME THAT PRICING ISN'T WHAT IT SHOULD BE, BUT HIS COMPANY INTENDS TO GROW THIS YEAR TO IMPRESS THE SECURITIES ANALYSTS." IN THE LAST CYCLE, THE INDUSTRY WAS ALREADY PANICKED IN 1982, BUT PRICES DIDN'T GO UP UNTIL 1985. THIS IS BAD NEWS, AS IT SUGGESTS THAT THE TURN COULD BE YEARS AWAY.

NOW LET'S SEE WHAT PAUL INGREY'S INSURANCE CLOCK TELLS US. <u>WHAT TIME IS IT RIGHT NOW?</u>

IT SEEMS TO BE SOMEWHERE BETWEEN 1:00 AND 7:00.

TODAY, UNDERWRITING "PENS" AND MGA'S ARE THRIVING, LIKE 1:00.

PROFITS HAVE LEVELED OFF, AND MOST COME FROM INVESTMENTS AND INVESTMENT INCOME. LIKE 3:00.

REDUCTIONS IN FORCE ARE OCCURRING, LIKE 4:00. (AT USF&G THE STAFF CUT IN THE LAST TWO YEARS WAS OVER 25%.)

COMPANIES ARE SELLING ADDITIONAL SHARES IN THE EQUITY MARKET, LIKE 7:00. (E.G. USF&G RAISED $300 MILLION THROUGH A PREFERRED STOCK OFFERING A YEAR AGO. SEARS JUST

ANNOUNCED AN EFFORT TO RAISE OVER $2 BILLION BY SELLING UP TO 20% OF ALLSTATE STOCK IN AN INITIAL PUBLIC OFFERING.)

IF EACH "HOUR" REPRESENTS 6 MONTHS TO A YEAR, THEN THE INSURANCE CLOCK WOULD PREDICT A SHARP PRICE INCREASE POSSIBLY AS EARLY AS 1994, OR AS LATE AS SEVERAL YEARS AWAY. ON AVERAGE, THE TURN DOES NOT APPEAR CLOSE.

MANY OBSERVERS PREDICT A MAJOR RISE IN PRICES BEGINNING IN LATE THIS YEAR. I WISH I COULD AGREE. HOWEVER, MOST OF THE FACTORS DISCUSSED EARLIER AND THE INSURANCE CLOCK ARE NOT ENCOURAGING. I PREDICT THAT THE CYCLE TURN IS 2 YEARS AWAY.

(OF COURSE, THIS PREDICTION MAY BE ONLY WORTH WHAT THE CAS PAID ME FOR PRESENTING IT.)

THANK YOU FOR YOUR ATTENTION.

AN EXAMPLE OF PROVIDING INFORMATION ON THE RESIDUAL MARKET BURDEN

Howard Mahler
Ling Ling Liu

An Example of Providing Information on the Residual Market Burden

In 1991, the most recent year for which we have data, the residual market accounted for a quarter of total premium, and the burden of supporting it was 18 cents on every premium dollar. In other words, in a typical state, insurers were assessed 18 cents for every dollar of premium they received from the voluntary market in that state.

Obviously, there is an increased need for an insurer to monitor the foreseeable financial burden of Residual Market Assessments.

Two objectives are to be accomplished in our illustration:

1. Develop formulas to estimate residual market burdens, including all the variables related to the Residual Market's financial results. The basic variables include expense components in writing an assigned risk policy, losses, and assessable premiums.

2. Provide a flexible and sensible burden analysis in a timely manner to member insurers.

The Workers' Compensation Rating and Inspection Bureau of Massachusetts has distributed the residual market burden estimates to our member insurers since mid-1990. We believe that this general format might be of interest to a wider audience.

The general methodology for calculating the residual market overburden follows the methodology in "Workers' Compensation Involuntary Markets - A Company Perspective," by William J. Miller.[1]

Assigned Risk Overburden

$$= \frac{\text{Pool Operating Losses}}{\text{Voluntary Assessable Premiums}}$$

$$= \frac{\text{Pool Net Operating Loss}}{\text{Pool Premium}} \times \frac{\text{Residual Market Share}}{1 - \text{Residual Market Share} - \text{Takeout Credit Share}}$$

[1]CAS Ratemaking Seminar - 1990

Attached are two charts which demonstrate the burden for the residual market an insurer would incur for writing voluntary Workers' Compensation premium in Massachusetts.

The first chart, Exhibit 1a, deals with nominal losses; i.e., it ignores the time value of money. For example, the 20.2% burden shown in Exhibit 1a (Column 4, Row 4) represents 20.2 cents of residual market assessment for every dollar of premium written in the voluntary market (adjusted for take-out credits). A Company's total assessment equals 20.2% multiplied by its voluntary written premium subsequent to adjustment for take-out credits.

The second chart, Exhibit 1b, takes into account the time value of money. The results displayed in the two charts are substantially different. The second chart better reflects both economic reality and the way Workers' Compensation is priced. A negative profit loading in Massachusetts Workers' Compensation rates reflects the investment income on cashflows.

The analysis uses several inputs. Each chart is also based on the overall rate level inadequacy on the vertical axis and the residual market share located on the horizontal axis. When this chart is sent to insurers, the Bureau includes its current estimate of the residual market share.

The inputs in Exhibit 2 are usually stable from year to year, but the market share and rate level inadequacy will depend on the workers' compensation market conditions and underwriting cycle. By putting these two factors on the X and Y axes with a range of inputs, it will allow us to show the impact on burden of these two factors. By supplying the information in the form of a chart, individuals can easily incorporate their own estimates of these two key inputs.

We have only illustrated an example applicable to the Massachusetts Workers' Compensation market. One should carefully study the inputs in the burden formula to tailor them to the particular application. For example, in a state with competitive rating, a different method would have to be devised to estimate the residual market loss ratio than is used here.

A key element in the burden is the Residual Market Loss Ratio. One of the inputs in estimating the residual market loss ratio is the loss ratio differential. An undeveloped two-year average differential in loss ratio is the basis of our estimate,[2] which assumes a similar reporting and development pattern in both markets. This is definitely not a sophisticated method, but it provides a simple reasonable estimate for this calculation.[3]

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[2]Adjusted for changes in the Pool, e.g., removal of premium discounts and introduction of the All Risk Adjustment Program.

[3]A more detailed study in this area might adjust for shifts in market share, differing development patterns, etc.

As with any actuarial analysis, all inputs to the calculation should be carefully reviewed on a regular basis. Continuous adjustments and changes may be required because of the introduction of new programs and changes in circumstances in the assigned risk market. This example was meant to illustrate the type of calculation that might be appropriate. For use in a particular place and time, modifications will have to be made.

LL/pw/3384
Enclosure

F O R M U L A

Assigned Risk Overburden

$$= \frac{\text{Pool Net Operating Loss}}{\text{Pool Premium}} \times \frac{\text{Residual Market Share}}{\text{(1-Residual Market Share-Take Out Credit Share)}}$$

$$= [1 - \text{Pool Loss Ratio} - \text{Pool Expense Ratio}] \times \frac{\text{Residual Market Share}}{1 - \text{Residual Market Share} - \text{Take Out Credit Share}}$$

$$\text{ARO} = [(1\text{-L} \times \text{D-E}) \times \frac{\text{M}}{[(1\text{-M})\text{-T}]\ \text{A}} \times \text{F}]$$

$$\text{L} = \frac{(1+\text{I}) \times \text{DR}}{\text{M} \times \text{DR} + (1\text{-M})}$$

ARO	=	The Assigned Risk Overburden
I	=	The Rate Level Inadequacy (Total Market)
M	=	The Residual Market Share (as a portion of Total Market Premiums)
D	=	The Loss Discounting Factor which reflects the timing of the cash flow
ELR	=	The Expected Loss Ratio (Total Market)
E	=	The Pool Expense Ratio; servicing carrier allowances plus producers' fee plus administrative expense
L	=	Projected Involuntary Market Loss Ratio
DR	=	Differential between the Involuntary Loss Ratio and the Voluntary Loss Ratio
F	=	Factor to adjust Calendar Year written premium to Policy year premium
T	=	Eligible Take-Out credits as a percentage of Total Market Premium
A	=	Factor to anticipate the effect of insolvencies of Pool members

Exhibit-1a

Massachusetts Workers' Compensation
1993 Projected Residual Market Burden
Nominal Losses

Inadequacy of Loss Provision in the Total Market Rate *	Residual Market Share (as a percentage of Standard Premium)						
	10%	20%	30%	40%	50%	60%	70%
-10%	2.3%	4.5%	6.8%	9.2%	11.9%	15.2%	20.2%
-5%	2.9%	5.9%	9.2%	12.9%	17.5%	23.8%	34.3%
0%	3.5%	7.3%	11.5%	16.5%	23.0%	32.3%	48.4%
5%	4.1%	8.7%	13.9%	20.2%	28.5%	40.8%	62.6%
10%	4.8%	10.1%	16.2%	23.9%	34.1%	49.3%	76.7%
15%	5.4%	11.4%	18.6%	27.5%	39.6%	57.9%	90.9%
20%	6.0%	12.8%	21.0%	31.2%	45.1%	66.4%	105.0%
25%	6.6%	14.2%	23.3%	34.9%	50.7%	74.9%	119.2%
30%	7.3%	15.6%	25.7%	38.5%	56.2%	83.4%	133.3%
35%	7.9%	17.0%	28.0%	42.2%	61.7%	92.0%	147.5%
40%	8.5%	18.4%	30.4%	45.8%	67.3%	100.5%	161.6%

* A negative "inadequate loss provision" implies an excessive loss provision.

Exhibit-1b

Massachusetts Workers' Compensation
1993 Projected Residual Market Burden
With Loss Discount

Inadequacy of Loss Provision in the Total Market Rate *	Residual Market Share (as a percentage of Standard Premium)						
	10%	20%	30%	40%	50%	60%	70%
-10%	0.8%	1.3%	1.4%	0.8%	-0.8%	-4.4%	-12.4%
-5%	1.4%	2.5%	3.4%	4.0%	4.0%	3.0%	-0.1%
0%	1.9%	3.7%	5.5%	7.2%	8.8%	10.5%	12.2%
5%	2.5%	4.9%	7.5%	10.4%	13.7%	17.9%	24.6%
10%	3.0%	6.1%	9.6%	13.6%	18.5%	25.3%	36.9%
15%	3.5%	7.4%	11.6%	16.7%	23.3%	32.8%	49.2%
20%	4.1%	8.6%	13.7%	19.9%	28.1%	40.2%	61.6%
25%	4.6%	9.8%	15.8%	23.1%	33.0%	47.6%	73.9%
30%	5.2%	11.0%	17.8%	26.3%	37.8%	55.1%	86.2%
35%	5.7%	12.2%	19.9%	29.5%	42.6%	62.5%	98.6%
40%	6.3%	13.4%	21.9%	32.7%	47.4%	69.9%	110.9%

Note: Losses were discounted at 3.29% after-tax risk adjusted rate of return.

* A negative "inadequate loss provision" implies an excessive loss provision.

Massachusetts Workers' Compensation

Exhibit 2

Inputs for the Burden Calculation

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Expected Total Market Loss Ratio	Involuntary and Voluntary Market Loss Ratio Differential	Discount Factor for the Loss Ratio	Residual Market Expense Ratio	Assessment Base	CY to PY Adjustment Factor	Take-Out Credit
0.798	1.260	0.872	0.295	0.995	1.04	0.08

(1) Underlying the rate filing for 7/1/92. (Total Market Loss and Loss Adjustment Expense Ratio of 87.8%, based on an underwriting profit provision of -5.2%, an LAE provision of 10.0%, and other provisions from the 7/1/92 rate filing.) The loss ratio excluding loss adjustment expense (LAE) is used because LAE is included in the servicing carrier allowance.

(2) Adjusts for the impact of ARAP and the elimination of premium discounts in the pool. See Exhibit 6.

(3) Discount factor for the loss flow 0.8538 divided by the discount factor for the premium flow 0.9793 This is based on a risk-adjusted after-tax rate of return of 3.29% to the premium and the loss flow from the 7/1/92 filing. Note that 3.29% = 5.00% x (1 - 34.3%), where 5.00% is the pre-tax risk adjusted rate of return and 34.3% is the tax rate on investment income.

(4) The expense ratio including the current Pool payment of 25% of net written premium to servicing carriers (since there are no retrospective plans or premium discounts in the Massachusetts Assigned Risk Pool, this is also 25% of standard premiums), the 3.9% average commission to agents, and 0.6% for the Pool's administration expense. See Exhibits 3 & 4.

(5) The assessment base is the percentage of premium written by the Pool members. The Mass. Assigned Risk Pool assessments apply to all (solvent) carriers. This factor is less than unity in order to anticipate the effect of insolvencies.

(6) Adjusts the assigned risk direct written premium from calendar year to policy year. See Exhibit 5.

(7) Estimated total credit for Calendar Year 1993, assuming credits of 3.4% of total premium (as in 1991) and retentions of 60% and 70% of credits from 1991 and 1992, respectively; see Exhibit 7. The Calendar Year voluntary assessable premium is the voluntary premium reduced by the amount of eligible credits in the Take-Out program.

Exhibit 3

Massachusetts Workers' Compensation

Calculation of Average Commission

Assigned Risks

Premium by Layer	Standard Premium*	Distribution	Commission (%)
First $ 1,000	60,020,575	4.63%	9%
Next $ 4,000	142,717,556	11.00%	5%
Next $ 95,000	569,197,398	43.89%	4%
Over $100,000	525,083,328	40.48%	3%
TOTALS	1,297,018,857	100.00%	3.9%

* Obtained by trending 89/90 composite policy year Schedule Z first report data for the Residual Market to the policy effective period.

Massachusetts Workers' Compensation

Exhibit 4

Administration Expense for the Pool

Policy Year	(1) Administration & Other Expenses	(2) Assigned Risk Written Premium*	(1)/(2) Administration & Other Expense Ratio
86	949,304	194,820,996	0.49%
87	1,472,482	248,620,039	0.59%
88	2,143,472	362,190,846	0.59%
89	3,320,457	505,771,245	0.66%
90	3,585,110	619,504,775	0.58%
Average of 86 - 90			0.58%
Selected			0.6%

* Net of uncollectible.

Source: NCCI, as of 12/31/91.

Massachusetts Workers' Compensation

Exhibit 5

Assigned Risk Written Premium (in Millions)

Policy Year	(1) Policy Year Earned Premium*	(2) Calendar Year Written Premium	(1)/(2) Adjustment Factor
86	195	176	1.108
87	249	231	1.078
88	362	349	1.037
89	506	513	0.986
90	620	615	1.008
Average of 86-90			1.043
Selected			1.04

* Includes EBNR (Earned But Not Reported).

Note: This adjustment factor takes into account that Policy Year results for the Pool are assessed to member companies based on the generally smaller Calendar Year premiums.

Massachusetts Workers' Compensation
Exhibit 6
Page 1

Differential Analysis

Adjusted for ARAP and the Removal of Premium Discount in the Pool

		PY 1989	PY 1990
(1)	Assigned Risk Loss Ratio [1]	110.5%	74.9%
(2)	Voluntary Market Loss Ratio [1]	78.7%	55.7%
(3)	Effect of ARAP in Voluntary Risk [2]	0.978	1.000
(4)	Effect of ARAP in Assigned Risk [2]	0.939	1.000
(5)	Removal of Premium Discount from Assigned Risk [3]	0.936	0.936
(6)	Assigned Risk Loss Ratio Adjusted for ARAP and Premium Discount = (1)x(4)x(5)	97.1%	70.1%
(7)	Voluntary Risk Loss Ratio Adjusted for ARAP and Premium Discount = (2)x(3)	77.0%	55.7%
(8)	Differential in Loss Ratio between Assigned Risk and Voluntary Risk = [(6)/(7)]	1.261	1.259
(9)	Two-year average in differential	1.260	

1 From page 2.
2 A 2.4% increase in 93.6% of the Voluntary Market premiums from ARAP.
A 7.4% increase in 87.5% of the Residual Market premiums from ARAP.
As of 1/1/90, ARAP is included in reported Earned Premium.
3 Based on trended first report data (composite policy year 89/90) from Schedule Z, average premium discount in the Pool would be 6.4%.

Note: In Massachusetts, ARAP was introduced 1/1/90 and premium discounts were eliminated in the Pool 1/1/91.

Exhibit 6
Page 2

Massachusetts Workers' Compensation
Differential Analysis
Premiums and Losses as of 12/31/91 (in $ Millions)

POLICY YEAR 1989

	(1) Total Market*	(2) Assigned Risks**	(3) = (1) - (2) Voluntary Market	(4) = (2) / (3) Differential
(1) Net Earned Premium	1229.2	505.8	723.4	
(2) Reported Losses = Paid + Case Reserves	1128.1	558.7	569.4	
(3) Loss Ratio	91.8%	110.5%	78.7%	140.4%

POLICY YEAR 1990

	(1) Total Market*	(2) Assigned Risks**	(3) = (1) - (2) Voluntary Market	(4) = (2) / (3) Differential
(1) Net Earned Premium (including ARAP)	1355.6	619.5	736.1	
(2) Reported Losses = Paid + Case Reserves	874.3	464.0	410.3	
(3) Loss Ratio	64.5%	74.9%	55.7%	134.5%

Average in differential for PY 89-90 prior to the adjustment for ARAP and the removal of premium discount in the Pool — 1.375

* From Financial Aggregate Data (Total Market).
** From NCCI, Massachusetts Combined Data in National Pool.

Massachusetts Workers' Compensation

Exhibit 7

Adjustment for Take-Out Credit Program

Data for Calendar Year 1991

(1) Take-Out Credits ($ million)	(2) Direct Written Premium ($ million)	(1)/(2) Take-Out Percentage
49.2	1,431.0	3.4%

Source: NCCI Massachusetts Premium Analysis

Data for First 8 Months

Year	New Take-Out Credits ($ million)	Average Premium Size ($ thousand)
1991	38.3	42.7
1992	32.6	69.4

Source: WCRB approximate data (to be used only for purposes of this comparison).

Estimated Impact of Take-Out Credit Program

Year	(1) New Take-Out Credits*		(2) Rate of Retention to 1993 **	(1)x(2) Credit in 1993
1991	3.4%		60%	2.0%
1992	3.4%	**	70%	2.4%
1993	3.4%	**		3.4%
Total Credits in 1993, as percentage of Total Market Premium				7.8%
Selected Value				8%

* As percentage of total premium.

** WCRB estimates.

Note: Take-Out Credits are available for up to three years. The Massachusetts Take-Out program became effective in 1991.

1993 Residual Market Overburden Sample Calculation

With Loss Discount

A. Residual Market Loss Ratio:

(1)	Expected Total Market Loss Ratio including LAE	0.878
(2)	Loss Adjustment Expense Ratio (as a percentage of losses)	10.0%
(3) = (1)/[1 + (2)]	Expected Total Market Loss Ratio excluding LAE	0.798
(4)	Inadequacy of Loss provision in the Total Market Rate (Chosen for Example)	30%
(5) = [(3) X (1 + (4)]	Expected Total Market Loss Ratio excluding LAE (loaded in inadequacy of loss provision in the Total Market Rate)	1.037
(6)	Differential in Loss Ratio between Voluntary and Involuntary Market	126.0%
(7)	Residual Market Share (Chosen for Example)	60%
(8) = (5)/{[(1-(7))/(6)] + (7)}	Residual Market Loss Ratio	1.130
(9)	Loss Ratio Discount Factor	0.872
(10) = (8) X (9)	Residual Market Loss Ratio with Loss Discount	0.985

B. Pool Net Operating Losses:

(11)	Servicing Carrier Allowance	25%
(12)	Selected Producers' Fee	3.9%
(13)	Administration & Other Expense Ratio	0.6%
(14) = (11) + (12) + (13)	Pool's Expense Ratio	29.5%
(15) = [(10) + (14)-1]	Pool Net Operating Losses	28.0%

Sample Calculation, Page 2

C. Residual Market Burden:

(16)	Pool Assessment Base	0.995
(17)	Adjustment Factor, Calendar Year vs. Policy Year	1.04
(18)	Adjustment for Take-Out Credit	8%
(19) = (15) X (17)/(16) X (7)/[1 - (7) - (18)]	Residual Market Overburden	54.9%

Note: The burden calculated in this example differs slightly from that shown in Chart 1b due to rounding.

STATEMENT OF ACTUARIAL OPINION— ANNUAL STATEMENT INSTRUCTIONS (INCLUDING A LETTER BY R. MICHAEL LAMB, AND SUGGESTED REVISIONS BY THE NAIC CASUALTY ACTUARIAL TASK FORCE)

National Association of Insurance Commissioners

Statement of Actuarial Opinion

Annual Statement Instructions

The National Association of Insurance Commissioners (NAIC) adopted a revision to the instructions for the 1992 annual statement Blank due March 1, 1993 regarding the scope and content of the statement of actuarial opinion on casualty loss reserves. A final copy of those 1992 instructions follow. The changes from the 1991 instructions are noted with sidebars. Some of those changes were adopted in June 1992.

In addition, please find a letter and attachment from R. Michael Lamb, Chairman of the NAIC Casualty Actuarial (Technical) Task Force to the Chairman of the NAIC Blanks Task Force dated June 17, 1992. That material contains suggested additional revisions for the 1993 instructions (the opinion due March 1, 1994).

Due to the significance and the scope of these changes, we thought this material would be useful to you.

ACTUARIAL OPINION

1. There is to be included or attached to Page 1 of the Annual Statement, the statement of a qualified actuary, entitled "Statement of Actuarial Opinion," setting forth his or her opinion relating to loss and loss adjustment expense reserves. The qualified actuary must be appointed by the Board of Directors, or its equivalent, or by a committee of the Board, by December 31 of the calendar year for which the opinion is rendered. Whenever the appointed actuary is replaced by the Board of Directors, the company must notify the domiciliary commissioner within 30 days of the date of the Board action and give the reasons for the replacement. The appointed actuary must present a report to the Board of Directors each year on the items within the scope of the opinion.

2. Definitions

"Qualified actuary" is a person who is either:

A. A member in good standing of the Casualty Actuarial Society, or

B. A member in good standing of the American Academy of Actuaries who has been approved as qualified for signing casualty loss reserve opinions by the Casualty Practice Council of the American Academy of Actuaries, or

C. A person who otherwise has competency in loss reserve evaluation as demonstrated to the satisfaction of the insurance regulatory official of the domiciliary state. In such case, at least 90 days prior to the filing of its annual statement, the insurer must request approval that the person be deemed qualified and that request must be approved or denied. The request must include the NAIC Biographical form and a list of all loss reserve opinions issued in the last 3 years by this person.

Notwithstanding the above, a domiciliary commissioner may, by bulletin or regulation, specify who may sign an opinion. Also, a domiciliary commissioner may require particular qualifications, including independence, for specific insurers.

"Insurer" means an insurer authorized to write property and/or casualty insurance under the laws of any state and includes but is not limited to fire and marine companies, general casualty companies, local mutual aid societies, statewide mutual assessment companies, mutual insurance companies other than farm mutual insurance companies and county mutual insurance companies, Lloyd's plans, reciprocal and interinsurance exchanges, captive insurance companies, risk retention groups, stipulated premium insurance companies, and non-profit legal services corporations.

"Actuarial report" means 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 insuring that the parties addressed are aware of the significance of the actuary's opinion or findings and which documents the analysis underlying the opinion.

"Annual Statement" means the annual financial statement required to be filed by insurers with the commissioner.

Revised

3. Content

The opinion shall be in the format of and contain the information required by this Section 13 of the Annual Statement Instructions: Property and Casualty.

4. Exemptions

An insurer who intends to file for one of the exemptions under this section must submit a letter of intent to its domiciliary commissioner no later than December 1 of the calendar year for which the exemption is to be claimed. The commissioner may deny the exemption prior to December 31 of the same year if he deems the exemption inappropriate.

A certified copy of the approved exemption must be filed with the annual statement in all jurisdictions in which the company is authorized.

Exemption For Small Companies

An insurer otherwise subject to the requirement that has less than $1,000,000 total direct plus assumed written premiums during a calendar year in lieu of the opinion required for the calendar year, may submit an affidavit under oath of an officer of the insurer that specifies that amount of direct plus assumed premiums written.

Exemption for Insurers under Supervision or Conservatorship

Unless ordered by the domiciliary commissioner, an insurer that is under supervision or conservatorship pursuant to statutory provision is exempt from the filing requirements contained herein.

Exemption for Nature of Business

An insurer otherwise subject to the requirement and not eligible for an exemption as enumerated above may apply to its domiciliary commissioner for an exemption based on the nature of business written. This exemption is available to those companies writing property lines only.

Financial Hardship Exemption

A. An insurer otherwise subject to this requirement and not eligible for an exemption as enumerated above may apply to the commissioner for a financial hardship exemption.

B. Financial hardship is presumed to exist if the projected reasonable cost of the opinion would exceed the lesser of:

   (i) One percent of the insurer's capital and surplus reflected in the insurer's latest quarterly statement for the calendar year for which the exemption is sought; or

   (ii) Three percent of the insurer's projected net direct plus assumed premiums written during the calendar year for which the exemption is sought as reflected in the insurer's latest quarterly statement filed with its domiciliary commissioner.

5. Such a statement of opinion must consist of a paragraph identifying the actuary; a scope paragraph identifying the subjects on which an opinion is to be expressed and describing the scope of the actuary's work (see sections 8-10 below); and an opinion paragraph expressing his or her opinion with respect to such subjects (see sections 11-13 below). One or more additional paragraphs may be needed in individual cases if the actuary considers it necessary to state a qualification of his or her opinion or to explain some aspect of the annual statement which is not already sufficiently explained in the annual statement.

6. The opening paragraph should generally indicate the actuary's relationship to the company. For a company actuary the opening paragraph of the actuarial opinion should contain the sentence:

   "I, (name and title of actuary), am an officer (employee) of (named insurer) and a member of the American Academy of Actuaries and meet its qualification standards. (and/or) I am a Fellow/Associate of the Casualty Actuarial Society. I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

   For a consulting actuary, the opening paragraph of the actuarial opinion should contain the sentence:

   "I, (name and title of actuary), am associated with the firm of (name of firm). I am a member of the American Academy of Actuaries and meet its qualification standards. (and/or) I am a Fellow/Associate of the Casualty Actuarial Society. I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion.

   A member of the American Academy of Actuaries qualifying under paragraph 2(B) must attach the approval letter from the Academy.

   For a person other than a member of the American Academy of Actuaries or a member of the Casualty Actuarial Society, the opening paragraph of the opinion should contain the sentence:

   "I, (name and title), am an officer (employee) of (name of insurer), and I have demonstrated competency in loss reserving to the satisfaction of (regulatory official of domiciliary state). I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

   or

   "I, (name and title of consultant), am associated with the firm of (name of firm). I have demonstrated competency in loss reserving to the satisfaction of (regulatory official of domiciliary state). I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

7. The following are examples, for illustrative purposes, of language which in typical circumstances would be included in the remainder of the statement of actuarial opinion. The illustrative language should be modified as needed to meet the circumstances of a particular case, and the actuary should in any case use language which clearly expresses his or her professional judgment.

8. The scope paragraph should contain a sentence such as the following:

   "I have examined the actuarial assumptions and methods used in determining reserves listed below, as shown in the Annual Statement of the company as prepared for filing with state regulatory officials, as of December 31, 19__."

   The paragraph should list those items and amounts with respect to which the actuary is expressing an opinion. The list should include but not necessarily be limited to:

   A. Reserve for unpaid losses (Page 3, Item 1);

      Anticipated salvage and subrogation included as a reduction to loss reserves as reported in Schedule P - Analysis of Losses and Loss Expenses, Underwriting and Investment Exhibit - Part 3A and on Page 3 - Liabilities, Surplus and Other Funds, Line 1 and disclosed in Note #17 to the Financial Statements $_____________; and discount for time value of money included as a reduction to loss reserves and loss expense reserves as reported in Schedule P - Analysis of Losses and Loss Expenses, Part 3A - Underwriting and Investment Exhibit, and on Page 3 - Liabilities, Surplus and Other Funds, Lines 1 and 2 $

B. Reserve for unpaid loss adjustment expenses (Page 3, Item 2).

C. Reserve for unpaid losses - Direct and Assumed (Schedule P, Part 1, Cols. 13 and 15).

D. Reserve for unpaid loss adjustment expenses - Direct and Assumed (Schedule P, Part 1, Cols. 17, 19 and 21).

9. The scope paragraph should include a paragraph such as the following regarding the data used by the actuary in forming the opinion:

"In forming my opinion on the loss and loss adjustment expense reserves, I relied upon data prepared by the responsible officers or employees of the company or group to which it belongs. I evaluated that data for reasonableness and consistency. I also reconciled that data to Schedule P-Part 1 of the company's current annual statement. In other respects, my examination included such review of the actuarial assumptions and methods used and such tests of the calculations as I considered necessary.

10. The actuary should comment in the scope section, as appropriate, on relevant topics such as the following to the extent they affect, or could affect, the loss reserves; discounting, salvage/subrogation, loss portfolio transfers, financial reinsurance, and reinsurance collectibility. If the company reserves will create exceptional values using the NAIC IRIS tests, the actuary should include an explanation.

11. The opinion paragraph should include a sentence which covers at least the points listed in the following illustration:

"In my opinion, the amounts carried in the balance sheet on account of the items identified above

A. meet the requirements of the insurance laws of (state of domicile).

B. are computed in accordance with accepted loss reserving standards and principles.

C. make a reasonable provision for all unpaid loss and loss expense obligations of the Company under the terms of its policies and agreements."

Insurance laws and regulations shall at all times take precedence over the actuarial standards and principles.

12. If there has been any material change in the actuarial assumptions and/or methods from those previously employed, that change should be described in the statement of actuarial opinion by inserting a phrase such as:

"A material change in actuarial assumptions (and/or methods) was made during the past year, but such change accords with accepted loss reserving standards."

A brief description of the change should follow.

The adoption of new issues or coverages requiring underlying actuarial assumptions which differ from actuarial assumptions used for prior issues or coverages is not a change in actuarial assumption within the meaning of this paragraph.

13. If the actuary is unable to form an opinion, he or she should refuse to issue a statement of opinion. If the actuary's opinion is adverse or qualified, the actuary should issue an adverse or qualified actuarial opinion explicitly stating the reason(s) for such opinion.

14. The statement must include assurance that an actuarial report and underlying workpapers supporting the actuarial opinion will be maintained at the company and available for examination for seven years. The wording for an actuary employed by the company should be similar to the following:

> "An actuarial report and underlying workpapers supporting the findings expressed in this statement of actuarial opinion will be retained for a period of seven years in the administrative offices of the company and available for regulatory examination."

The wording for a consulting actuary retained by the company should be similar to the following:

> "An actuarial report and underlying workpapers supporting the findings expressed in this statement of actuarial opinion have been provided to the company to be retained for a period of seven years at its administrative offices and available for regulatory examination."

15. The statement should conclude with the signature of the actuary responsible for providing the opinion. The signature should appear in the following format:

____
Signature of actuary
Printed name of actuary
Address of actuary
Telephone number of actuary

ANNUAL AUDITED FINANCIAL REPORTS

The purpose of this Annual Statement instruction is to improve the surveillance of the financial condition of insurers by requiring an annual examination by independent certified public accountants of the financial statements reporting the financial position and the results of operations of insurers.

1. Audited Financial Report

All insurers shall have an annual audit by an independent certified public accountant and shall file an audited financial report as a supplement to the Annual Statement on or before June 1 for the year ended December 31 immediately preceding. The domiciliary Commissioner may require an insurer to file an audited financial report earlier than June 1 with ninety (90) days advance notice to the insurer.

2. Definitions

A. "Audited financial report" means and includes those items specified in Section 3 below.

B. "Accountant" and "Independent Certified Public Accountant" means an independent certified public accountant or accounting firm in good standing with the American Institute of Certified Public Accountants and in all states in which they are licensed to practice; for Canadian and British companies, it means a Canadian-chartered or British-chartered accountant."

Insurance Division
440 Labor & Industries Building, Salem, Oregon 97310 (503) 378-4271 FAX: (503) 378-4351

Oregon

DEPARTMENT OF
INSURANCE AND
FINANCE

June 17, 1992

Mr. Robert M. Solitro
Director of Examinations
New Hampshire Insurance Department
169 Manchester Street
Concord, NH 03301

Re: Statement of Actuarial Opinion: General Instruction 13
Annual Statement for Property/Casualty Companies
Proposals from the Casualty Actuarial Task Force for 1993

Dear Bob:

The NAIC Casualty Actuarial Task Force recommends some further changes to the Instructions relating to the Actuarial Opinion for property-casualty companies. I wish to describe the substantive changes for review by your Blanks Task Force members.

The revision concerning reliance on underlying data was already adopted by your Blanks Task Force for 1992 with a recommendation from the Casualty Actuarial Task Force. This change was a deletion of 1991 sections 9 and 10 and substituting a new section, which appears in the attached version as a new Section 10. Since this proposal has not been acted upon by either the NAIC Plenary Session or its Executive Committee, it appears as a new revision in this proposal document. It does not require further discussion or action.

We are proposing several substantive changes in Section 11 instructing the actuary to comment on several items affecting loss or loss expense reserves. Prior instructions listed six specific items and advised the actuary to comment on any, when appropriate. Many or most actuaries chose not to comment on several items, which left us with questions about the completeness of their reviews of reserves. We now want to require comment on each of the listed items. A new sentence is added near the end of the first paragraph to preserve the original intent of allowing the actuary to direct attention to any other contingencies or uncertainties deserving continuing attention without having to give a "qualified" opinion.

We have seen several 1991 opinions stating that the actuary could not review reserves for the company share of losses or expenses from underwriting pools and associations since underlying data is not available. We propose to add this matter to the list of items for which comment in required and to require disclosure of reserve amounts in a new Section 9. The NAIC should consider regulatory strategies for requiring pools to provide reserving information and actuarial opinions.

This paragraph has required actuaries to give an explanation of the change in reserves if that change has caused exceptional values on IRIS tests. Actuaries have been asking us which tests we want them to look at, claiming that their opinions often must be given to the companies before all statement items used in IRIS tests are finalized. We wish to specify tests 9,10, and 11, which deal with reserve development. Reserve changes which do not affect these tests are unlikely to be the primary reason for exceptional values on other tests.

Actuaries have been asking us what we mean by "loss portfolio transfers" and "financial reinsurance." These terms apparently have varieties of meanings. To give some guidance, to an extent we consider prudent, we are introducing definition of these two terms. The phrases in these definitions come from Chapter 22 of the Accounting Practices Manual.

Probably the greatest amount of inquiries have come to us about what we want the actuary to do regarding reinsurance collectibility. We do not believe the actuary should be the principal expert on this matter, but we do think the actuary should not naively assume all reinsurance claims will be honored and should know how much attention company management has given the matter. The final new paragraph in Section 11 lists some things the actuary should do before commenting.

The treatment given by the actuary to each item listed in Section 11 will be described in the actuarial report which will be available for regulators to examine on request (see new language in Section 15). Hence, a casual statement that each item was considered will not be sufficient.

We propose that the disclosure instructions for amounts of anticipated salvage and subrogation and reserve discounting, which were added as a subparagraph to Section 8.A. for 1991, be moved to a new Section 9. Disclosure of pool reserves is also required by this new section. The purpose of this change is better organization and also to clarify the scope of the opinion. Separate opinion on these disclosed amounts in not required, but is implicit in the net and gross reserves listed in Section 8. Comment on each of these specific items is required by Section 11.

The remaining proposals are less substantial. For instance, in the nature of business exemptions of Section 4, we wish to delete the final sentence which restricts the exemption to property insurers only. Some state(s) have approved exemptions for ocean marine insurers or mortgage guaranty companies. We do not wish to restrict commissioners ability to act. The intention was to exempt companies which write only fast-developing lines where the uncertainty of loss reserves is not a substantial issue.

Paragraph 2.C. allows an insurer to request approval to provide an opinion from someone who does not have credentials from the Casualty Actuarial Society or the American Academy of Actuaries. In such cases, states other than the state of domicile have no evidence of this approval. We propose to require a copy of the domiciliary state approval letter, just as we currently require a copy of the Academy letter from any of its members who are not CAS members (Section 6).

Last year, for 1992 opinions, we proposed changing the workpapers requirement in Section 15 to an "actuarial report" requirement. The Blanks Task Force and the EX4 Subcommittee added a phrase "and underlying workpapers" following "actuarial report" where it appears in three places. Our intent was to avoid requesting "workpapers" and getting a boxful of scratchpaper scribblings. Instead, we would be getting an organized presentation of how reserves were established. These reports will be subject to standards and guidelines adopted by the Actuarial Standards Board (ASB) and discipline imposed on CAS and Academy members. To make sure we got what we wanted, we added a crucial phrase to the ASB definition of actuarial report: "...and which documents the analysis underlying the opinion." The reports will show the development triangles and other quantitative mechanics of computing the reserves. We are proposing to delete the phrase "and underlying workpapers" for two reasons:

1. "Actuarial report" is the precise definition of what we want to see.

2. A requirement of "workpapers" may be troublesome to some auditors or actuaries employed by auditing firms.

Thank you for the opportunity to present the recommendations from our task force. We believe the Actuarial Opinion requirement for property-casualty companies has become a major tool for our efforts to promote sound insurer management for solvency.

Sincerely,

R. Michael Lamb, FCAS, MAAA
Casualty Actuary
Insurance Division
(503) 378-4271

RML:rml
INS5989

Enclosure
cc: Jean Olson, NAIC

ACTUARIAL OPINION

1. There is to be included or attached to Page 1 of the Annual Statement, the statement of a qualified actuary, entitled "Statement of Actuarial Opinion," setting forth his or her opinion relating to loss and loss adjustment expense reserves. The qualified actuary must be appointed by the Board of Directors, or its equivalent, or by a committee of the Board, by December 31 of the calendar year for which the opinion is rendered. Whenever the appointed actuary is replaced by the Board of Directors, the company must notify the domiciliary commissioner within 30 days of the date of the Board action and give the reasons for the replacement. The appointed actuary must present a report to the Board of Directors each year on the items within the scope of the opinion.

2. Definitions

"Qualified actuary" is a person who is either:

A. A member in good standing of the Casualty Actuarial Society, or

B. A member in good standing of the American Academy of Actuaries who has been approved as qualified for signing casualty loss reserve opinions by the Casualty Practice Council of the American Academy of Actuaries, or

C. A person who otherwise has competency in loss reserve evaluation as demonstrated to the satisfaction of the insurance regulatory official of the domiciliary state. In such case, at least 90 days prior to the filing of its annual statement, the insurer must request approval that the person be deemed qualified and that request must be approved or denied. The request must include the NAIC Biographical form and a list of all loss reserve opinions issued in the last 3 years by this person.

Notwithstanding the above, a domiciliary commissioner may, by bulletin or regulation, specify who may sign an opinion. Also, a domiciliary commissioner may require particular qualifications, including independence, for specific insurers.

"Insurer" means an insurer authorized to write property and/or casualty insurance under the laws of any state and includes but is not limited to fire and marine companies, general casualty companies, local mutual aid societies, statewide mutual assessment companies, mutual insurance companies other than farm mutual insurance companies and county mutual insurance companies, Lloyd's plans, reciprocal and interinsurance exchanges, captive insurance companies, risk retention groups, stipulated premium insurance companies, and non-profit legal services corporations.

"Actuarial report" means 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 insuring that the parties addressed are aware of the significance of the actuary's opinion or findings and which documents the analysis underlying the opinion.

"Annual Statement" means the annual financial statement required to be filed by insurers with the commissioner.

3. Content

The opinion shall be in the format of and contain the information required by this Section 13 of the Annual Statement Instructions: Property and Casualty.

4. Exemptions

An insurer who intends to file for one of the exemptions under this section must submit a letter of intent to its domiciliary commissioner no later than December 1 of the calendar year for which the exemptions is to be claimed. The commissioner may deny the exemption prior to December 31 of the same year if he deems the exception inappropriate.

A certified copy of the approved exemption must be filed with the annual statement in all jurisdictions in which the company is authorized.

Exemption For Small Companies

An insurer otherwise subject to the requirement that has less than $1,000,000 total direct plus assumed written premiums during a calendar year in lieu of the opinion required for the calendar year, may submit an affidavit under oath of an officer of the insurer that specifies that amount of direct plus assumed premiums written.

Exemption for Insurers under Supervision or Conservatorship

Unless ordered by the domiciliary commissioner, an insurer that is under supervision or conservatorship pursuant to statutory provision is exempt from the filing requirements contained herein.

Exemption for Nature of Business

An insurer otherwise subject to the requirement and not eligible for an exemption as enumerated above may apply to its domiciliary commissioner for an exemption based on the nature of business written. [~~This exemption is available to those companies writing property lines only.~~]

Financial Hardship Exemption

A. An insurer otherwise subject to this requirement and not eligible for an exemption as enumerated above may apply to the commissioner for a financial hardship exemption.

B. Financial hardship is presumed to exist if the projected reasonable cost of the opinion would exceed the lesser of:

(i) One percent of the insurer's capital and surplus reflected in the insurer's latest quarterly statement for the calendar year for which the exemption is sought; or

(ii) Three percent of the insurer's [~~projected net~~] direct plus assumed premiums written during the calendar year for which the exemption is sought as projected from [~~reflected in~~] the insurer's latest quarterly statements filed with its domiciliary commissioner.

5. Such a statement of opinion must consist of a paragraph identifying the actuary; a scope paragraph identifying the subjects on which an opinion is to be expressed in describing the scope of the actuary's work (see sections 8-11 below); and an opinion paragraph expressing his or her opinion with respect to such subjects (see sections 12-14 below). One or more additional paragraphs may be needed in individual cases if the actuary considers it necessary to state a qualification of his or her opinion or to explain some aspect of the annual statement which is not already sufficiently explained in the annual statement.

6. The opening paragraph should generally indicate the actuary's relationship to the company. For a company actuary the opening paragraph of the actuarial opinion should contain the sentence:

"I, (name and title of actuary), am an officer (employee) of (named insurer) and a member of the American Academy of Actuaries and meet its qualification standards. (and/or) I am a Fellow/Associate of the Casualty Actuarial Society. I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

For a consulting actuary, the opening paragraph of the actuarial opinion should contain the sentence:

"I, (name and title of actuary), am associated with the firm of (name of firm). I am a member of the American Academy of Actuaries and meet its qualification standards. (and/or) I am a Fellow/Associate of the Casualty Actuarial Society. I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

A member of the American Academy of Actuaries qualifying under paragraph 2.B. must attach the approval letter from the Academy.

For a person other than a member of the American Academy of Actuaries or a member of the Casualty Actuarial Society, the opening paragraph of the opinion should contain the sentence:

"I, (name and title), am an officer (employee) of (name of insurer), and I have demonstrated competency in loss reserving to the satisfaction of (regulatory official of domiciliary state). I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

or

"I, (name and title of consultant), am associated with the firm of (name of firm). I have demonstrated competency in loss reserving to the satisfaction of (regulatory official of domiciliary state). I was appointed by the Board of Directors (or equivalent authority) on (insert date) to render this opinion."

A person who is neither a member of the American Academy of Actuaries nor a member of the Casualty Actuarial Society and who has qualified under paragraph 2.C. must attach the approval letter from the insurance regulatory official of the domiciliary state.

7. The following are examples, for illustrative purposes, of language which in typical circumstances would be included in the remainder of the statement of actuarial opinion. The illustrative language should be modified as needed to meet the circumstances of a particular case, and the actuary should in any case use language which clearly expresses his or her professional judgment.

8. The scope paragraph should contain a sentence such as the following:

"I have examined the actuarial assumptions and methods used in determining reserves listed below, as shown in the Annual Statement of the company as prepared for filing with state regulatory officials, as of December 31, 19__."

The paragraph should list those items and amounts with respect to which the actuary is expressing an opinion. The list should include but not necessarily be limited to:

A. Reserve for unpaid losses (Page 3, Item 1).

[~~Anticipated-salvage-and-subrogation-included-as-a-reduction-to-loss reserves-as-reported-in-Schedule-P---Analysis-of-Losses-and-Loss Expenses,-Underwriting-and-Investment-Exhibit---Part-3A-and-on Page-3---Liabilities,-Surplus-and-Other-Funds,-Line-1-and-disclosed in-Note-#17-to-the-Financial-Statements-$______________;-and discount-for-time-value-of-money-included-as-a-reduction-to-loss reserves-and-loss-expense-reserves-as-reported-in-Schedule-P-- Analysis-of-Losses-and-Loss-Expenses,-Part-3A---Underwriting-and Investment-Exhibit,-and-on-Page-3---Liabilities,-Surplus-and-Other Funds,-Lines-1-and-2-$_____________.~~]

B. Reserve for unpaid loss adjustment expenses (Page 3, Item 2).

C. Reserve for unpaid losses - Direct and Assumed (Schedule P, Part 1, Totals from Cols. 13 and 15).

D. Reserve for unpaid loss adjustment expenses - Direct and Assumed (Schedule P, Part 1, Totals from Cols. 17, 19 and 21).

[~~9. If the actuary has examined the underlying records and/or summaries, the scope paragraph should also include a sentence such as the following:~~

~~"My examination included such review of the actuarial assumptions and methods used and of the underlying basic records and/or summaries and such tests of the calculations as I considered necessary."~~]

[~~10. If the actuary has not examined the underlying records and/or summaries, but has relied upon those prepared by the company, the scope paragraph should include a sentence such as one of the following:~~

~~A. "I relied upon data underlying loss and loss adjustment expense reserves prepared by the responsible officers or employees of the company or group to which it belongs. In other respects, my examination included such review of the actuarial assumptions and methods used and such tests of the calculations as I considered necessary."~~

~~B. "I relied upon company produced data underlying loss and loss adjustment expense reserves as reported upon by (name of accounting firm) on (date). In other respects, my examination included such review of the underlying actuarial assumptions and methods used and such tests of the calculations as I considered necessary."~~]

9. The actuary should state that the items in paragraph 8, on which he or she is expressing an opinion, reflect the following items:

A. Anticipated salvage and subrogation included as a reduction to loss reserves as reported in Schedule P - Analysis of Losses and Loss Expenses, Underwriting and Investment Exhibit - Part 3A and on Page 3 - Liabilities, Surplus and Other Funds, Line 1, $__________;

B. Discount for time value of money included as a reduction to loss reserves and loss expense reserves as reported in Schedule P - Analysis of Losses and Loss Expenses, Part 3A - Underwriting and Investment Exhibit, and on Page 3 - Liabilities, Surplus and Other Funds, Lines 1 and 2, $__________; and

C. The net reserves for loss and expense for the company's share of underwriting pools and associations unpaid losses and expenses which are included in reserves shown on Page 3 - Liability, Surplus and Other Funds, Lines 1 and 2, $__________.

10. The scope paragraph should include a paragraph such as the following regarding the data used by the actuary in forming the opinion:

> "In forming my opinion on the loss and loss adjustment expense reserves, I relied upon data prepared by the responsible officers or employees of the company or group to which it belongs. I evaluated that data for reasonableness and consistency. I also reconciled that data to Schedule P - Part 1 of the company's current annual statement. In other respects, my examination included such review of the actuarial assumptions and methods used and such tests of the calculations as I considered necessary."

11. The actuary should comment in the scope section on each of the following topics, describing the effect of each on loss or loss expense reserves: [~~, as appropriate, on relevant topics such as the following to the extent they affect, or could affect, the loss reserves:~~] discounting, salvage/subrogation, underwriting pools or associations, loss portfolio transfers, financial reinsurance, and reinsurance collectibility. The actuary should also comment on and describe the effects of any additional relevant topics which in the actuary's judgment materially affect loss or loss expense reserves. If the company reserves will create exceptional values using the NAIC IRIS tests 9, 10, and 11, the actuary should include an explanation.

    For the purpose of this instruction, "loss portfolio transfer" refers to any agreement which increases the transferring insurer's Surplus To Policyholders as a result of the transferee undertaking any loss obligation already incurred and for which the consideration paid by the transferring insurer is derived from present value or discounting concepts.

    "Financial reinsurance" refers to contractual arrangements for which credit is not allowed by the NAIC Accounting Practices and Procedures Manual for the ceding insurer because the arrangements do not include a transfer of both timing and underwriting risk by which the reinsurer undertakes in fact to indemnify the ceding insurer against loss or liability by reason of the original insurance.

    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 which 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.

12. The opinion paragraph should include a sentence which covers at least the points listed in the following illustration:

    "In my opinion, the amounts carried [~~in the balance sheet~~] on account of the items identified [~~above~~] in the scope paragraph

A. meet the requirements of the insurance laws of (state of domicile).

B. are computed in accordance with accepted loss reserving standards and principles.

C. make a reasonable provision for all unpaid loss and loss expense obligations of the Company under the terms of its policies and agreements."

Insurance laws and regulations shall at all times take precedence over the actuarial standards and principles.

13. If there has been any material change in the actuarial assumptions and/or methods from those previously employed, that change should be described in the statement of actuarial opinion by inserting a phrase such as:

"A material change in actuarial assumptions (and/or methods) was made during the past year, but such change accords with accepted loss reserving standards."

A brief description of the change should follow.

The adoption of new issues or coverages requiring underlying actuarial assumptions which differ from actuarial assumptions used for prior issues or coverages is not a change in actuarial assumption within the meaning of this paragraph.

14. If the actuary is unable to form an opinion, he or she should refuse to issue a statement of opinion. If the actuary's opinion is adverse or qualified, the actuary should issue an adverse or qualified actuarial opinion explicitly stating the reason(s) for such opinion.

15. The statement must include assurance that an actuarial report [~~and underlying workpapers~~] supporting the actuarial opinion <u>and describing how the actuary treated each of the topics listed in paragraph 11</u> will be maintained at the company and available for examination for seven years. The wording for an actuary employed by the company should be similar to the following:

"An actuarial report [~~and underlying workpapers~~] supporting the findings expressed in this statement of actuarial opinion will be retained for a period of seven years in the administrative offices of the company and available for regulatory examination."

The wording for a consulting actuary retained by the company should be similar to the following:

"An actuarial report [~~and underlying workpapers~~] supporting the findings expressed in this statement of actuarial opinion have been provided to the company to be retained for a period of seven years at its administrative offices and available for regulatory examination."

16. The statement should conclude with the signature of the actuary responsible for providing the opinion. The signature should appear in the following format:

____

Signature of actuary
Printed name of actuary
Address of actuary
Telephone number of actuary

INSPA693/698

DELTA HOLDINGS, INC. *VS.* NATIONAL DISTILLERS AND CHEMICAL CORPORATION

(Reprinted from the Federal Reporter*)*

DELTA HOLDINGS, INC.,
Plaintiff–Appellee,

v.

NATIONAL DISTILLERS AND CHEMICAL CORPORATION,
Defendant–Appellant.

No. 355, Docket 90–7528.

United States Court of Appeals,
Second Circuit.

Argued Dec. 6, 1990.
Decided Oct. 1, 1991.

Buyer of reinsurance corporation brought action against seller, alleging securities violations, common-law fraud and breach of express warranties. The United States District Court for the Southern District of New York, John F. Keenan, J., awarded buyer 24.3 million dollars in damages plus prejudgment interest and ordered rescission of entire transaction. Seller appealed. The Court of Appeals, Winter, Circuit Judge, held that: (1) evidence did not support district court's finding that reinsurance corporation's president knew of its insolvency at time of acquisition; (2) reports of actuarial firm regarding reinsurer's loss reserves were not material at pertinent time, so as to impose duty on president under securities laws and warranty in stock purchase agreement to disclose reports; (3) there was no violation of securities laws or reinsurer's promise to provide access to books and records in connection with reinsurer's failure to take position on magnitude of error in using dates of claim reports to ceding companies or brokers, rather than dates of claim reports to reinsurer, in estimating liability for incurred-but-not-reported (IBNR) claims; and (4) warranties in stock purchase agreement did not constitute guaranty by seller that loss reserve estimates on reinsurer's books would prove in future to be substantially accurate.

Reversed.

1. Fraud ⇐58(2)
Securities Regulation ⇐60.63(2)

Evidence did not support district court's finding that president of reinsurance company knew of company's insolvency at time of its acquisition, such as would have lent support to findings of securities violations, common-law fraud and breach of contract, despite preacquisition request that actuarial firm not calculate precise loss reserve figure for incurred-but-not-reported (IBNR) claims and president's failure to disclose firm's reports; absent highly implausible scheme, of which there was no evidence, president could not have suspected company's insolvency after he constructed loss projections erroneously based on improper computer data. Securities Exchange Act of 1934, § 10(b), 15 U.S.C.A. § 78j(b); Securities Act of 1933, § 12(2), 15 U.S.C.A. § 77*l*(2).

2. Corporations ⇐120
Securities Regulation ⇐60.28(11)

Actuarial firm's report concerning reinsurance corporation's loss reserve for incurred-but-not-reported (IBNR) claims was not material at pertinent times to purchase of reinsurance corporation, so as to impose duty on corporation's president under securities laws and warranty in stock purchase agreement to disclose report; accounting firm and actuarial firm evaluating reserves in connection with purchase were familiar with accounting method described in report and calculations possible from worksheets appended to report would not have been of interest at time balance sheet was prepared. Securities Exchange Act of 1934, § 10(b), 15 U.S.C.A. § 78j(b); Securities Act of 1933, § 12(2), 15 U.S.C.A. § 77*l*(2).

3. Securities Regulation ⚖60.28(11)

Actuarial firm's report concluding that there was deficiency of nearly $11,000,000 in reinsurance corporation's loss reserves for incurred-but-not-reported (IBNR) claims was not material at pertinent times in connection with purchase of corporation, so as to impose duty on corporation's president under securities laws and warranty in stock purchase agreement to disclose report; problem with treaties in question was revealed by president, attempt to remedy deficiency was disclosed and fact that report contained facts concerning problem was not significant. Securities Exchange Act of 1934, § 10(b), 15 U.S.C.A. § 78j(b); Securities Act of 1933, § 12(2), 15 U.S.C.A. § 77*l*(2).

4. Securities Regulation ⚖60.27(1), 60.45(1)

Liability under § 10(b) requires material misrepresentation and showing of scienter. Securities Exchange Act of 1934, § 10(b), 15 U.S.C.A. § 78j(b).

5. Securities Regulation ⚖60.28(13)

Reinsurance corporation's personnel were ignorant of ramifications of using dates claims were reported to ceding companies or brokers, rather than dates claims were reported to reinsurer, in estimating liability for incurred-but-not-reported (IBNR) claims, and of relevance of actuarial firm's reports to that problem, precluding finding of § 10(b) violation for failure to disclose reports or to take position as to magnitude of error resulting from using improper data in connection with sale of corporation. Securities Exchange Act of 1934, § 10(b), 15 U.S.C.A. § 78j(b).

6. Securities Regulation ⚖60.28(13)

Failure of reinsurance corporation's personnel to characterize use of dates claims were reported to ceding companies or brokers, rather than dates claims were reported to reinsurer, in estimating liability for incurred-but-not-reported (IBNR) claims as causing distortion of any particular magnitude was not "misleading omission," so as to constitute securities violation in connection with sale of corporation; reinsurer was known to lack actuarial sophistication and, thus, silence of its nonactuaries could not have lead professional actuary evaluating loss reserves to believe problem was trivial. Securities Act of 1933, § 12(2), 15 U.S.C.A. § 77*l*(2).

See publication Words and Phrases for other judicial constructions and definitions.

7. Securities Regulation ⚖60.28(13)

Reinsurer did not behave unreasonably in connection with its sale when it failed to probe magnitude of error in using dates claims were reported to ceding companies or brokers, rather than dates claims were reported to reinsurer, in estimating liability for incurred-but-not-reported (IBNR) claims when inquiry was made as to reasons for numbers changing in loss development projections and, thus, there was no "misleading omission" constituting securities violation; buyer's agents, including firms with actuarial experience and knowledge far exceeding that of any personnel at reinsurer, were conducting independent inquiry into reinsurer's financial status, with particular concern for adequacy of its loss reserves. Securities Act of 1933, § 12(2), 15 U.S.C.A. § 77*l*(2).

8. Fraud ⚖27

Seller of reinsurance corporation did not make material misrepresentation concerning improper reliance on dates of claim reports to ceding companies or brokers, rather than dates of claim reports to reinsurer, in estimating liability for incurred-but-not-reported (IBNR) claims that was relied upon in any way by buyer, so as to constitute common-law fraud; injury to buyer was caused by its misunderstanding of problem, which in no way resulted from seller's conduct.

9. Corporations ⇐120

Any omission by reinsurer regarding magnitude of error in using dates of claim reports to ceding companies or brokers, rather than dates of claim reports to reinsurer, in estimating liability for insured-but-not-reported (IBNR) claims did not violate its promise in stock purchase agreement to provide reasonable access to its books and records; reinsurer's personnel were ignorant of ramifications of that problem and of relevance of actuarial firm's reports to that problem.

10. Corporations ⇐120

Promise to provide reasonable access to books and records in connection with stock purchase agreement cannot extend to matters of which party is ignorant but which might indirectly be revealed by otherwise immaterial records.

11. Corporations ⇐120

Warranties in stock purchase agreement for sale of reinsurance corporation did not constitute guaranty by seller that loss reserve estimates on reinsurer's books would prove in future to be substantially accurate; provisions in question warranted only that no material item had been omitted, that each item was accurately described and that balance sheet was prepared in accordance with generally accepted accounting principles.

12. Corporations ⇐120

Reinsurance corporation's balance sheet conformed with generally accepted accounting principles with respect to its estimation of liability for incurred-but-not-reported (IBNR) claims for purposes of determining sufficiency of loss reserves and, thus, there was no violation of warranty in stock purchase agreement; informed guesswork was accepted basis for determining loss reserves, and reinsurer's books were based on such guesswork.

Joseph P. Dailey, New York City (Loren F. Selznick, James T. Southwick, Breed, Abbott & Morgan, of counsel), for defendant-appellant.

David Klingsberg, New York City (Paul J. Curran, Alan F. Goott, Michael Braff, Joshua N. Lief, Kaye Scholer, Fierman, Hays & Handler, of counsel), for plaintiff-appellee.

Before KAUFMAN, NEWMAN and WINTER, Circuit Judges.

WINTER, Circuit Judge:

This factually complex litigation arises out of a dispute over the disclosure of documents, representations, and warranties made by National Distillers and Chemical Corporation ("Distillers") in connection with the sale of its wholly-owned subsidiary, Elkhorn Re Insurance Company ("Elkhorn"), to Delta Holdings, Inc. ("Delta"). Following a bench trial before Judge Keenan, the district court held that Distillers violated federal securities law, committed common law fraud, and breached various express warranties. The district court awarded Delta $24.3 million in damages plus pre-judgment interest and ordered rescission of the entire transaction. We find as a matter of law that Distillers neither omitted to disclose material facts, made material misrepresentations, nor breached its warranties. We therefore reverse.

BACKGROUND

Distillers, now named Quantum Chemical Corporation, is a diversified company primarily engaged in the business of producing chemicals and liquefied petroleum gases. Elkhorn was originally established for the purpose of acquiring and developing operating insurance or reinsurance subsidiaries to insure casualty and property risks of Distillers. Sometime thereafter, Elkhorn began to reinsure risks underwritten by other companies. The principal factual and legal issues on this appeal relate to contemporaneous (with the acquisition) determinations of the adequacy of financial reserves set aside by Elkhorn to cover future claims. An understanding of these issues requires a lengthy description of the evidence at trial, beginning with an overview of the methodologies of estimating loss reserves in the reinsurance industry.

1. *Loss Reserves and Reinsurance*

Risk-pooling is a form of diversification that reduces the dispersion or volatility of losses and is the essence of insurance. Reinsurance is the pooling among secondary insurers of portions of risks previously underwritten by primary insurers. In typical reinsurance transactions, primary insurers first underwrite risks in exchange for premiums from the insureds. To spread the underwritten risks further, primary insurers transfer or "cede" a portion of their risks to reinsurers, who accept the risks in exchange for premiums from the ceding companies. Reinsurers, in turn, may cede portions of their risks to secondary reinsurers or "followers" in what are commonly referred to as retroactive cessions.

Reinsurance contracts typically fall into two categories. A "treaty" is an agreement under which a reinsurer accepts a percentage participation in all risks of a certain type or class underwritten by the primary insurer (or another reinsurer) during a specified period of time. A "facultative contract" is an agreement under which a reinsurer assumes specific risks instead of an entire class of risks.

Reinsurers assume many types of risk by treaty or facultative contract. These include death (*e.g.*, life insurance), property loss (*e.g.*, fire insurance), and liability to third parties for personal injury or property damage (*e.g.*, professional malpractice insurance). The underwriting of third-party liability, known as "casualty risks," leads to complex problems of financing and accounting because assumption of third-party liability risks involves substantial delays or "tails" in the discovery and reporting of claims. These delays, as lengthy as fifteen or twenty years with some policies, such as medical malpractice insurance, inevitably create considerable uncertainty as to the calculation of future claims and of the reserves that must be set aside to pay those claims. Such calculations are at the heart of the present dispute.

In preparing periodic financial statements, a reinsurer must treat amounts of earned premiums as current income and amounts of future claims as offsets to current income. These loss reserves often represent the largest liability item on a reinsurer's balance sheet, and particularly the balance sheet of a casualty risk reinsurer. Loss reserves must be established for known claims ("case reserves") as well as for incurred-but-not-reported claims ("IBNR reserves"). Case reserve estimates are less conjectural than IBNR reserves because case reserves are established immediately after a specific claim is reported. Case reserves are thus sums set aside to cover estimated losses based on reported claims. In contrast, IBNR reserves are sums set aside to cover losses for which claims have not been reported but must be estimated so the company can pay future claims. For that reason, reinsurers that underwrite casualty risks with long discovery or reporting delays often carry IBNR reserves that dwarf case reserves.

Under generally accepted accounting principles ("GAAP"), a reinsurer is obligated to make a reasonable estimate of IBNR liabilities. However, GAAP neither specifies a precise actuarial method nor requires that the reinsurer retain an independent actuary to prepare or review loss reserve estimates. Pertinent to the instant matter are three methods of estimating IBNR reserves: (1) the incurred loss development method; (2) the loss ratio method; and (3) the Bornhuetter-Ferguson method ("B-F Method"). Each of these methods is well known within the reinsurance industry.

The incurred loss development method projects future claims by using data from past claims experience. Judgment calls as to selection of pertinent data and its use are inherent in the incurred loss development method. The loss ratio method utilizes a flat percentage of loss for each dollar of premium. Under that method, the percentage may be applied to the reinsured risks as a whole or different percentages may be applied to particular categories of risk or treaties with other companies. The selection of the particular percentage(s) is also a judgment call(s) and based largely on the selector's view of future losses. Many of the judgment calls needed to implement the loss development or loss ratio methods rely upon historical data as to loss reporting patterns.

The B-F Method is a hybrid of the incurred loss and loss ratio methods. It divides expected underwriting losses for each year into two categories—expected unreported claims and expected losses based on reported claims. As an account year matures, estimates of unreported claims are replaced by reported claims, thereby improving the accuracy of the ultimate estimate. To apply the B-F Method, therefore, a reinsurer must consider two parameters—first, the initial expected loss ratio and, second, the expected reporting pattern for a particular account year. The initial-expected loss ratio is selected on the basis of a variety of factors such as the general performance of the industry, the reinsurer's own historical loss ratio, the break-even loss ratio, and a comparison of expected reported losses with actual reported losses in previous years. However, because the initial-expected loss ratio is used only to the extent that claims are unreported, the ratio's importance for a particular account diminishes over time. In recent account years, the initial-expected loss ratio represents the lion's share of the final liability estimate, whereas in older account years, the ratio has a diminished effect on the final estimate because increasingly larger portions of the losses incurred during those years resulted from claims that have already been reported.

The second parameter in B-F analysis is the percentage of total losses, past and future, reported to date. This percentage is estimated on the basis of historical reporting patterns—*i.e.*, the same reporting patterns that can be used to make direct extrapolations under the incurred loss development method. Reliable historical data on loss reporting patterns is thus even more essential to use of the B-F method than it is to use of the loss development and loss ratio methods.

Among the methods of presenting historical loss reporting patterns are formatted data sheets known as "loss development triangles." Such triangles consist of a left-hand column of account dates (*i.e.*, years in which policies covered by the reinsurance treaty were underwritten); a column to the immediate right stating claims reported during the first year; and additional columns to the right stating cumulative reported claims several years into the "aging" of a particular account. So arranged, the data resemble a triangle because cumulative claims figures are available for several years with respect to the oldest accounts but for one less year with respect to accounts beginning in the succeeding year, and so on. A hypothetical loss development triangle (000's omitted), prepared in 1986 and reflecting data through December 31, 1985, might appear as follows:

Fig. 1

Account Year	*1*	*2*	*3*	*4*	*5*
1981	7000	7700	9400	9600	9700
1982	5000	6400	7100	7700	
1983	7200	8100	8900		
1984	8100	9800			
1985	7900				

Loss development triangles simplify the task of identifying patterns in claim reporting by clarifying numerical trends. For example, in the hypothetical one can divide cumulative total reported claims in one year of an account into cumulative total claims reported by the next year to obtain loss development ratios. Based on the hypothetical triangles, such ratios would appear as follows:

Fig. 2

	1	*2*	*3*	*4*
Account Year	*2*	*3*	*4*	*5*
1981	1.100	1.221	1.021	1.010
1982	1.280	1.109	1.085	
1983	1.125	1.099		
1984	1.210			
1985				

Averaged ratios serve as a means of predicting future losses.

Similarly, given reported losses in Fig. 1 during the first year of 1981 accounts of $7 million and reported losses at the end of five years of $9.7 million, one might conclude, applying the incurred loss development method, that for every $7 million in first-year reported losses, $2.7 million should be set aside as IBNR reserves to cover losses anticipated during the subsequent four years. Or, for purposes of the B–F Method, one might estimate from Figs. 1 and 2 that a particular percentage of total losses will be incurred within a given number of years. All of the calculations described along with others may also be used to arrive at the percentage(s) to be used under the loss ratio method.

Judgments must inevitably be made in the use of these calculations. For example, if loss development ratios regularly rise from one year to the next, an average of those ratios would probably understate future losses. Selection of a development factor based on the latest ratio and the rate of annual increase rather than the average would seem more reliable.

It must be emphasized that no actuarial method is so accurate that it eliminates conjecture in the calculation of IBNR liabilities. Even case reserve decisions involving reported claims entail uncertainty as to the amount of final loss. IBNR reserves, however, are far more conjectural because they must be calculated without knowing even the number of claims. Overly conservative loss estimates are no answer. Overestimated reserves are harmful because reinsurance premiums are competitive and a competitive return on investment is necessary to attract investors. Methods that cause substantial excess reserves to be set aside may cause losses to a reinsurer for lack of underwriting or investment.

Finally, in the reinsurance industry history may be an imperfect guide to the future, particularly with regard to casualty risks. The incidence of claims may change, the costs of defense may increase, and inflation may lead to unexpectedly high losses per claim. Even the conservative B–F Method relies on assumptions as to future events and conditions, that, if wrong, will lead to substantial errors in the final estimate.

Consequently, regardless of the actuarial method used, the preparation of, and reliance upon a net worth calculation in a balance sheet for a casualty risk reinsurer is based in large part upon informed guesswork. One cannot, therefore, expect equivalent certainty in a balance sheet's statement of loss reserves and its statement of more determinable items, such as outstanding principal and interest on debt instruments. It is for that reason that GAAP neither specifies a precise method of estimating loss reserves nor even requires that an actuary prepare or review loss reserve estimates. Although this opinion entails extensive discussion of loss development triangles, GAAP does not require that they be used in determining appropriate loss reserves.

This extended discussion of loss reserves and the reinsurance industry is in part only a prelude to an explanation of a final detail regarding loss development triangles central to the instant dispute. Because such triangles are designed to assist in estimating the amount of unreported claims as of specific dates, the triangles must accurately incorporate the lag in the reporting of claims to reinsurers if unreported claims are to be estimated reliably. Underwriting claims should thus be tallied in the year in which the reinsurer actually learns of the claims.

To illustrate, if, by some chance, claims amounts in Fig. 1 were based on the date of the report of claims to ceding companies or brokers—*e.g.*, some claims reported to the reinsurer in 1982 would be listed under 1981, when the ceding company or broker learned of them, and so on through each year—the numbers listed in Fig. 1 might appear as follows:

Fig. 3

Account Year	*1*	*2*	*3*	*4*	*5*
1981	7300	8700	9500	9675	9700
1982	5800	6800	7500	7700	
1983	7800	8500	8900		
1984	9100	9800			
1985	7900				

Fig. 2, involving loss development ratios based on Fig. 1, would then appear as follows:

Fig. 4

Account Year	*1* / *2*	*2* / *3*	*3* / *4*	*4* / *5*
1981	1.192	1.092	1.018	1.003
1982	1.172	1.103	1.027	
1983	1.090	1.047		
1984	1.077			
1985				

It is readily apparent from a comparison of Figs. 1 and 2 with Figs. 3 and 4 that use of the date on which a claim is reported to a ceding company or broker rather than the date on which it is reported to the reinsurer will understate the historic lag in reporting to the reinsurer and will, if not compensated for, cause an underestimation of future unreported claims.

A final word is necessary on the detection of the use in loss development triangles of dates of claims reports to ceding companies or brokers instead of dates of reports to reinsurers. An actuary using Fig. 3 on the assumption that the cumulative losses listed for each account year were based on dates of reports to reinsurers would be unable to detect an error in that assumption simply by analyzing Fig. 3. However, if a new triangle including data for 1986 were constructed, the error would become apparent. Most of the loss amounts for the latest year in Fig. 3 would be increased as some of the claims reported to the reinsurer in 1986 would be allocated to 1985, the year in which those claims were reported to the ceding company or broker. (This assumes that the date of report to the reinsurer is never more than a calendar year later than the date of the report to the ceding company or broker.) The new triangle might appear thusly:

Fig. 5

Account Year	*1*	*2*	*3*	*4*	*5*	*6*
1981	7300	8700	9500	9675	9715	9720
1982	5800	6800	7500	7825	7950	
1983	7800	8500	9100	9200		
1984	9100	10150	10400			
1985	9000	10000				
1986	8100					

Because conventional loss development triangles use final year-end (or other completed time periods) reported-claims figures, the difference between the emphasized numbers in Fig. 5 and the corresponding figures in Fig. 3 would alert an actuary to a problem. Finally, we note that while the only numbers changing in Figs. 3 and 5 might be for claims reported in the year 1985—note that this is not the date 1985 in the left-hand column, which reflects the date of the beginning of an account, but rather the aging year at the top that is 1985 for the particular account—the skewed historic lag period would be built in for all prior years. For example, if yet a new triangle were constructed with 1987 figures and the parenthesized assumption held true, the numbers that are emphasized in Fig. 5 would be stable, but the numbers in the succeeding year would now change. Nevertheless, the figures for each account year would contain losses that had been reported in a later year.

2. *Elkhorn's Reinsurance Activities*

In 1972, when Elkhorn, which was licensed in Kentucky and New York, began to broaden its business by reinsuring third-party risks, Robert Norton became its president. Norton joined Distillers as an accountant in 1946. He became an executive in 1949 and a corporate officer in 1963. Norton had no actuarial training or managerial experience in the reinsurance industry.

Elkhorn's third-party underwriting continued to expand until, by 1983, outside business represented the largest portion of Elkhorn's activities. A substantial portion of Elkhorn's outside or "assumed" business consisted of reinsuring casualty and ocean marine risks with long delays or "tails" in the reporting of losses. As a result, assessments of Elkhorn's net worth substantially depended upon projections of future claims liability. To calculate IBNR reserves, Elkhorn used the loss ratio method. It recorded sixty-five percent of earned premiums as IBNR reserves unless a ceding company recommended another IBNR reserve level with regard to a particular treaty, in which event Elkhorn followed the ceding company's recommendation. The loss ratio method—specifically, the sixty-five percent formula with a later modification by which incurred losses were retained in loss reserves—remained Elkhorn's method for determining IBNR reserves until its acquisition by Delta.

As early as 1981, however, Norton and other Elkhorn executives became concerned over the accuracy of their loss reserve estimates. In October 1981, Norton asked an outside actuarial firm, Tillinghast, Nelson & Warren ("Tillinghast"), to study Elkhorn's loss reserves and to recommend a more sophisticated actuarial method. As part of Tillinghast's written project outline, Greg Leonard, a Tillinghast actuary, proposed that Tillinghast recommend an actuarial method and calculate an appropriate level of loss reserves. After reviewing Leonard's proposal, Norton and Ramsey Joslin, Elkhorn's chief financial officer, instructed Leonard to proceed with the study and recommendation but not to calculate a suggested level of loss reserves.

In February 1982, Tillinghast completed its study and delivered three bound sets of a two-volume report ("February Report") to Norton. Norton gave one copy of the Report to Elkhorn's controller, James

McGurty. Norton testified that he gave another copy to the company's chief underwriter, Terry Brewer, but at trial Brewer could not recall whether he actually received a copy. Norton kept the third set for his own use, placing it in the credenza in his office. McGurty kept the Report in his files.

The February Report did not explicitly state that Elkhorn's loss reserves were deficient. However, its discussion and exploration of methodologies did suggest problems with Elkhorn's IBNR reserve estimates. Addressing the merits of various actuarial methodologies, the February Report: (i) observed that the incurred loss development method "can lead to erratic and unreliable projections" because "a small swing in early reporting results in a very large swing in ultimate projections"; (ii) cautioned that the loss ratio method, with which Elkhorn was calculating its loss reserves, "has the advantage of stability, but ... ignores actual results as they emerge"; and (iii) recommended that in the future Elkhorn determine its IBNR reserves by the B-F Method, which it described in detail.

Among various appendices to the report were detailed worksheets from which Elkhorn's IBNR reserves could be calculated according to the B-F Method. These calculations were *not* completed. The worksheets were based on loss development triangles prepared manually from Elkhorn's accounting records by Tillinghast. There was evidence at trial that, if the calculations had been completed, they would have disclosed an IBNR loss reserve deficiency of approximately $10 million. The February Report also noted that, when data based on treaty categories became available through computerized bookkeeping, a refined B-F analysis based on such data would be even more informative than the use of the worksheets in the appendices. As an interim measure, while Elkhorn would be computerizing its bookkeeping, Tillinghast recommended increasing Elkhorn's assumed loss ratio from sixty-five percent to roughly eighty percent.[1]

Norton testified that he never completed the calculations demonstrating a $10 million deficiency in IBNR reserves because that calculation would have become obsolete as soon as treaty-category data became available upon Elkhorn's planned conversion to computerized bookkeeping. However, based on McGurty's testimony that Norton had stated that the February Report estimated a $10 million deficiency, the district court disbelieved Norton's denial of such a calculation, a finding that is not clearly erroneous.

Norton requested that Tillinghast prepare another report on three cancelled reinsurance treaties (collectively, the "Barrett Treaties") that had not been included in the February Report. In April 1982, Tillinghast delivered this second report ("April Report"), which, unlike the earlier one, included all requisite calculations and explicitly stated that Elkhorn faced IBNR losses on the Barrett treaties of approximately $13.2 million. Elkhorn at that time was carrying on its books IBNR reserves of only $2.3 million for these treaties. The total deficiency in IBNR reserves estimated by completing the worksheets appended to the February Report and by the April Report was thus about $20 million. After consulting with Brewer about the deficiency revealed by the April Report, Norton purchased a $10 million loss transfer policy from the Continental Insurance Company (the "Continental Agreement") to cover the Barrett Treaties in exchange for a $5 million premium.

The seeds from which the present dispute germinated were planted in late 1982 when the computerization of Elkhorn's bookkeeping was completed. This computerization was based on software called STREAM which Elkhorn purchased from another reinsurer. (The computer was in Kentucky and used for Distillers' other

1. Squabbling over the proper characterization of the February Report has marked this litigation. The Report's text discusses nothing but methodology. The appended worksheets, however, which indicate how to test Elkhorn's loss reserves under the B-F Method, would justify the district court's characterization of the Report as "more than a methodology study." We will not enter this unproductive squabble but let the contents of the Report, as described in the opinion, speak for themselves.

businesses, Elkhorn being too small to have its own system). STREAM allowed treaty-category analysis as recommended by the February Report, and Norton generated treaty-category data from STREAM to construct loss development triangles as of December 31, 1982. Using these triangles, Norton estimated a deficiency far below $10 million. Although there is no evidence or district court finding that Norton realized it at the time, the triangles were, as he testified at trial, "all wrong."

The problem with Norton's triangles lay in STREAM. Whatever merits STREAM might have had as a system for maintaining and retrieving records or for analyzing data for other purposes, it had a serious deficiency so far as the construction of loss development triangles was concerned. Dates of the reports of claims to Elkhorn were in a STREAM file but were not separately retrievable. Dates of reports of claims to ceding companies or brokers were separately retrievable as report dates. The only report date retrievable by STREAM was thus not the date of a report of a claim to Elkhorn, "book date," but rather the date of a report of a claim to the ceding companies or brokers, in the lexicon of this litigation, "account date." STREAM data thus produced triangles like Fig. 3, *supra*, instead of like Fig. 1.

John Cascio, Elkhorn's assistant controller, understood that STREAM reported claims reports as of account dates but did not discuss this issue with Norton. Cascio had no knowledge of the effect such data had on loss development triangles. For Norton's part, he may have known (Norton denied knowing, Cascio "assumed" Norton knew) that account-date data was being used but, if he did, there is no evidence that he knew that it would impair the predictive value of the triangles.

3. *Delta's Acquisition of Elkhorn*

At the time of Delta's acquisition of Elkhorn, the reinsurance industry had been suffering a protracted slump attributable to excess underwriting capacity and widespread inflation. Many reinsurance companies, especially followers unable to dictate terms and premiums, were battered by stiff price competition and underwriting losses. Elkhorn was no exception. From 1979 to 1982, the company suffered a series of underwriting losses, posting modest overall profits only because investment income exceeded those losses. Consequently, by 1980, Norton and other senior executives at Distillers began to believe that Elkhorn's business was, as the district court put it, "going sour."

In April 1983, Distillers discontinued all new third-party underwriting and began to explore ways of liquidating or selling its reinsurance business. Early that month, Norton contacted Arthur Deters of American Risk Management, Inc. ("ARM"), the entity then responsible for Delta's day-to-day management and later responsible for managing Delta's operating subsidiaries. At a meeting with Deters on April 6, 1983, Norton and Joslin disclosed Distillers' decision to discontinue Elkhorn's third-party underwriting and asked if ARM could assist Elkhorn in one of three ways—(1) managing an orderly wind-down (or "run off") of Elkhorn's reinsurance treaties, (2) making private and discreet inquiries about possible buyers for Elkhorn, or (3) proposing to Delta that it purchase Elkhorn's third-party reinsurance business.

ARM chose to pursue the third option, and in early May representatives of ARM and Distillers met in New York where they agreed to explore the possibility of selling Elkhorn to Delta for the book value price of $18 million. In June, senior underwriters from ARM, Lawrence Bell and Bryan Murphy, and an actuary from Peat Marwick, Alan Kaufman, visited Elkhorn's offices on Delta's behalf, interviewed the Elkhorn staff and reviewed various underwriting records. They were told about Elkhorn's problems with the Barrett Treaties and about the $10 million Continental Agreement. Norton showed his December 31, 1982 loss development triangles, based on STREAM data, to Kaufman and indicated that Tillinghast had educated him as to the B–F Method. Norton did not reveal the existence of either Tillinghast Report but rather stated that he had learned the B–F Method without having to pay for a study.

Bell reported to Delta that Elkhorn was rather disorganized, that errors were found in computerized data regarding two randomly selected treaties, and that "a thorough audit ... on all major accounts" was necessary. His report concluded with the statement that "a thorough IBNR review must be made." Kaufman reported to ARM that he disagreed with the methodology by which Elkhorn was estimating loss reserves and concluded that, on a brief review of methodology and subject to several "unknowns," those reserves were deficient by some $5 million.

After further meetings, on July 19 Distillers and Delta reached an agreement in principle to sell the capital stock of Elkhorn for the book value price of $18 million. At the time, the book value shown on Elkhorn's June 30, 1983 balance sheet was $26,472,000—a figure that included both Elkhorn's third-party reinsurance business, which Delta wished to buy, and its captive business, which Distillers intended to retain. Consequently, the parties agreed that Distillers would prepare a June 30 balance sheet segregating third-party and captive business specifically for the merger. These terms and conditions were incorporated in a letter of intent dated July 25, 1983.

For Delta, the two most important aspects of Elkhorn's financial health were the value of its bond portfolio and the adequacy of its loss reserves. Kaufman testified that, like most companies of comparable size, Elkhorn did not have an actuary. John Ryan, an ARM executive who represented that firm in the Elkhorn acquisition, testified that he also knew that Elkhorn lacked actuarial expertise.

As a result, Delta's acquisition was conditioned on receiving an opinion from an outside actuarial firm, Conning & Co. ("Conning"), as to the adequacy of Elkhorn's loss reserves, and an opinion from an outside accounting firm, Peat Marwick, Mitchell & Co. ("Peat Marwick"), as to the accuracy of Elkhorn's June 30, 1983 balance sheet, including of course Peat Marwick's view of the adequacy of loss reserves. Delta offered to allow Distillers to name an actuary to participate in the loss reserves examination, but Distillers stated that it was satisfied with Conning.

The Stock Purchase Agreement contained numerous protective warranties by Distillers, discussed in greater detail *infra*. In Section 4 of the Agreement, Distillers agreed to give Delta's actuarial and auditing representatives "reasonable access" to its books and records. In Section 5(f), Distillers warranted the completeness of its books and records, the fact that they had been maintained in accord with accepted insurance practices, and their accurate reflection of Elkhorn's financial status. In Section 5(g), Distillers warranted that the June 30, 1983 balance sheet was maintained in accord with GAAP and fairly presented Elkhorn's financial position. Elkhorn further guaranteed in Section 8(g) that all tax liabilities had been provided for and guaranteed that the market value of its bond portfolio would be no more than $1,635,000 below its book value as of August 31, 1983. Finally, in Section 12 it was also agreed that, within roughly two weeks after the acquisition, Delta would prepare a balance sheet for September 30, 1983, and Distillers would reimburse Delta for any difference between the net worth as shown on that balance sheet and $18 million. Any dispute over the balance sheet was subject to a binding decision by Peat Marwick.

Delta's representatives thereafter examined Elkhorn's books and records and Norton explained the business and actuarial practices of his company to Delta's representatives. In an August meeting with Ryan of ARM, Robert Brian, the actuary heading up Conning's study, and Gary Ransom, also of Conning, Norton explained that Elkhorn had been calculating its loss reserves either by applying the flat sixty-five percent loss ratio or by following the recommendation of a ceding company. In that conversation, he mentioned that he had tested Elkhorn's loss reserves by applying the B–F Method which, he said, he had learned from Tillinghast. According to Ryan, Norton said he obtained this instruction without having to pay for it and never mentioned the existence of either Tillinghast Report, although he was asked whether Elkhorn had had actuarial studies done. It is agreed that, at no time prior to the acquisition, were the Tillinghast Reports physically given to representatives of Delta.

On August 26, 1983, Conning delivered a written report to ARM concluding that Elkhorn had a loss reserve surplus of approximately $7.5 million as of December 31, 1982. Shortly thereafter, Conning revised its estimate and opined that Elkhorn's reserve surplus was about $1.6 million, adding the caveat that actual losses "may vary significantly from our estimates since underlying data is quite variable and difficult to project." Conning appears to have been using loss development triangles based on STREAM, and thus on account-date data.

During the same period in which Conning was preparing its assessment of Elkhorn's loss reserves, Peat Marwick's auditors spent some 327 hours examining Elkhorn's books and records. In the course of this effort, loss development triangles based on claims up to June 30, 1983 were developed from STREAM data. In mid-September, Amy Factor, a Peat Marwick actuary, noticed that some amounts of reported claims on the December 31, 1982 loss development triangles differed from the amounts of reported claims for the same time periods on the June 30, 1983 triangles, differences similar to the changes illustrated in Figs. 3 and 5, *supra*. Of course, the very fact of changes in amounts of reported claims for closed time periods revealed a problem, as described *supra* in connection with Figs. 3 and 5.

When Factor asked Norton why loss amounts for closed time periods were changing, he had no answer but referred her to other Elkhorn personnel. They in turn explained to Factor that the changes occurred because STREAM retrieved account rather than book dates for reported claims data. Factor informed either Kaufman or David Wasserman, another Peat Marwick actuary, of her discovery. At their instructions, she attempted to contact Conning but apparently never got through. Kaufman testified that he left a message at Conning for Brian detailing the facts concerning STREAM's use of account rather than book dates. Brian denied ever learning of this fact before Delta's acquisition of Elkhorn. Kaufman also testified that he informed Ryan of ARM about the Elkhorn triangles being based on account-date data. Ryan denied ever learning of this problem before the acquisition of Elkhorn.

In the glow of hindsight, the parties agree that calculating loss development triangles based on account-date data will, if not compensated for, result in a serious understatement of IBNR reserves. One of Distillers' own experts testified that proper corrections for the account-date distortion caused by Elkhorn's computer program might have revealed a loss reserve deficiency of as much as $108 million as of the date that Elkhorn's books represented a net worth of $18 million. The account-date distortion was, therefore, indisputably significant.

However, no substantial corrective action was taken as a result of Factor's discovery. Other than increasing loss reserves for the year 1982, Peat Marwick took no steps in response to the problem. (Brian of Conning and Ryan of ARM denied ever learning of it.) The failure of Conning to revise its prior reported opinion or to react to his phone message appears not to have troubled Kaufman. Kaufman did not perceive, or take steps to learn of, the peril in relying upon account-date data. There is no evidence of any effort to determine how the account-date data might be compensated for. No inquiry appears to have been made at the time of the possibility of altering STREAM to use book-date data. Moreover, STREAM output was based on raw data in Elkhorn's files and manual retrieval of book dates was obviously possible, as Tillinghast had done before Elkhorn computerized its bookkeeping in late 1982. However, Kaufman never sought, or even inquired about, manual assembly of book-date data. As noted above, had that data been obtained and incorporated into the loss development triangles, Elkhorn's insolvency would have been revealed.[2] Nor, apparently, was consideration given to delaying the acquisition until book-date data was acquired.

One reason for the casual reaction to Factor's discovery appears to have been Kaufman's belief that the account-date problem affected only the loss amounts for the year 1982. He thus compensated for a possible underestimation of loss reserves only for that year. According to Kaufman's testimony, he and Wasserman conferred and "agreed that the loss ratios looked reasonable except for 1982 and the 1982 loss ratio out of the data did not look reasonable and we had adjusted it so we thought we had a reasonable conclusion." (This testimony speaks volumes about the degree of guesswork that goes into estimates of loss reserves). Of course, the account-date problem affected every year, as the discussion in connection with Figs. 3–5 explains. Although the issue does not affect our ruling, it is possible that Factor's discovery may have been based on numbers changing only in the year 1982. (The illustrations in her testimony concerned that year.) Kaufman may thus have assumed that claims reports for only that year were affected, missing the facts that account dates were built into prior years and reporting lags were thus understated throughout.

Kaufman testified that his belief that the account-date problem was limited to 1982 was based upon Factor or Wasserman having been so informed by Norton. This hearsay testimony—seemingly at odds with an auditor's responsibilities to carry out an independent investigation—was objected to and properly admitted solely to explain Kaufman's actions and not for its truth. Factor did not substantiate Kaufman's story and testified that Norton indicated that he did not understand the problem and referred her to Elkhorn personnel who accurately informed her as to what data was being used. Wasserman did not testify. (A memorandum by Factor states that Wasserman believed that use of account dates was "not a problem" and could be compensated for.) There is thus no competent evidence, nor did the district court find, that Norton or anyone else at Elkhorn misrepresented the nature or implications of the account-date data from STREAM on which the loss development triangles were based.

Thereafter, Peat Marwick certified Elkhorn's loss reserves. It concluded that Conning's estimates were somewhat optimistic and that Elkhorn would face an IBNR loss reserve shortfall of $3.5 million. In addition, Peat Marwick decided to adjust Elkhorn's bookkeeping on the Continental Agreement, thereby adding another $5 million deficiency to the $3.5 million IBNR deficiency. Based on these estimates, Peat Marwick advised ARM that it could not certify Elkhorn as fully reserved unless future liabilities were discounted to reflect the earning potential of Elkhorn's invested assets, a less conservative approach that, although arguably permissible under GAAP, had not been used by Elkhorn in the past. Only after Delta had agreed to discount future liabilities on the June 30, 1983 segregated balance sheet did Peat Marwick certify Elkhorn's reserves adding an explicit caveat that "[i]nsurers who establish claim reserves by applying selected loss ratios to earned premium (such as Elkhorn) often understate IBNR due to management's optimism in making loss ratio selections."

On September 30, 1983, Delta's acquisition of Elkhorn closed in Hamilton, Bermuda. Norton remained as president of the renamed entity, Delta Re; McGurty remained as controller. During the post-acquisition period, Peat Marwick reviewed the September 30 balance sheet pursuant to Section 12 of the Stock Purchase Agreement. Peat Marwick concluded that the balance sheet was in accord with GAAP and stated that it was unaware of any

2. This statement must be qualified by the observation that a conclusion of insolvency would have been premised upon the loss development triangles being an accurate predictor of the future. Had the actual claims experience in the future been substantially more favorable than that predicted by the triangles, insolvency might not have resulted. With hindsight, however, we can say that properly prepared triangles would have led to an accurate prediction.

appropriate modifications. Delta therefore did not request reimbursement on the ground that Elkhorn's net worth was less than $18 million on that date.

Although the inadequacy of account-date data was recognized by Delta and a project was undertaken to convert Delta Re's computerized bookkeeping to use of book dates, there was little urgency about the matter, and Delta Re continued to rely upon account-date data until the latter part of 1984, as Delta's own computers were gradually put into use. In fact, there is little evidence of any interest on the part of Delta's top management in the account-date problem until May 1984, when it was explored by Delta's advisory committee prior to a board of directors meeting. Even at this point, however, no one at Delta seems to have appreciated the full significance of the continued use of account-date data. In this period of time, Brian of Conning made further estimates of loss reserves based on loss development triangles containing STREAM data. Just as Kaufman thought that only the year 1982 was affected in Factor's triangles, Brian took corrective measures on his 1984 triangles only for the year 1983.

Meanwhile, Delta Re's fortunes declined further, as did those of the reinsurance industry generally, as a result of underestimated loss reserves. In July 1984, special examiners from the Kentucky Insurance Department began an investigation into Delta Re's financial condition, eventually concluding that the company's loss reserves had been deficient by some $38 million at the end of 1982. During the course of that investigation, state examiners told Norton that they planned to ask Tillinghast to perform a more detailed loss reserve analysis. Norton made no mention to anyone at Delta Re that Tillinghast had done work for Elkhorn in 1982.

On September 14, 1984, Norton resigned. John Ryan succeeded Norton as president, and, two months later, found the February Report in the credenza behind Norton's former desk. In early January 1985, Delta Re discovered the April Report elsewhere in Elkhorn's records.

On May 29, 1985, the State of Kentucky seized Delta Re's assets and commenced liquidation proceedings. According to state examiners, the company had been insolvent since the end of 1982. By the time that the company was seized, Delta had contributed some $6.3 million to its acquisition above and beyond the $18 million purchase price paid to Distillers.

4. *The Proceedings in the District Court*

On May 3, 1985, Delta commenced the instant litigation. The complaint alleged breach of various warranties contained in Sections 5 and 12 of the Stock Purchase Agreement ("SPA") (Count I); common law fraud and deceit (Count II); violations of Section 12(2) of the Securities Act, 15 U.S.C. § 77*l* (Count III); violations of Section 10(b) of the Securities Exchange Act, 15 U.S.C. § 78j, and Rule 10b-5 promulgated thereunder, 17 C.F.R. § 240.10b-5 (Count IV); a pattern of racketeering under the Racketeer Influenced and Corrupt Organizations Act ("RICO"), in violation of 18 U.S.C. § 1962(c) (Count V); violations of the New York General Business Law (Count VI); and negligent misrepresentation (Count VII).

On April 8, 1988, the district court granted summary judgment in favor of Distillers on Delta's claim for breach of Section 12 of the SPA. Observing that Section 12's net worth guarantee, see Note 4 *infra*, was accompanied by a host of procedures and remedies, including "final and conclusive and binding" arbitration before Peat Marwick. Judge Keenan held that Section 12 created no independent cause of action for breach of warranty beyond the procedures enumerated in the provision itself. The district court also granted summary judgment in Distillers' favor on Delta's racketeering claim, concluding that the misrepresentations, if any, were made in connection with a single acquisition and were insufficient to constitute the requisite pattern of "racketeering" acts under RICO.

The district court denied Distillers' motion for summary judgment on Delta's remaining claims, explaining that "[a]lthough Delta Holdings [through its agents, Peat

Marwick and Conning] knew that Elkhorn used an account date basis to formulate its loss reserves, Delta Holdings was unaware of certain facts that could have altered its view of Elkhorn as an acquisition." Among these, suggested the court, were the "depth of Norton's knowledge" of the account-date problem and its effect on loss data from older account years; "whether Norton produced truly representative [broker] statements [from earlier account years], or whether certain statements were chosen in an effort to mollify [Peat Marwick's account-date] concerns"; and the circumstances surrounding "the non-disclosure of the Tillinghast documents." The district court also rejected Distillers' statute-of-limitations defense to Delta's claim under Section 12(2) of the Securities Act, reasoning that, under the adverse interest exception to the law of agency, Norton's knowledge may not have been attributable to Delta and that material questions of fact existed as to Delta's own knowledge.

Following a bench trial, the district court ruled in Delta's favor, based on (i) Norton's failure to disclose the Tillinghast Reports, which, in the court's view, would have disclosed Elkhorn's $20 million loss reserve deficiency and insolvency to Delta, and (ii) the court's conclusion that Distillers had guaranteed the accuracy of the June 30, 1983 and September 30, 1983 balance sheets' estimates of loss reserves. The district court found that Elkhorn was insolvent at those times, based on the "most credible and compelling explanations" given by Delta's expert witnesses of Elkhorn's conditions on those dates. It further found that Norton knew of Elkhorn's insolvency. This finding was based on Norton's request that Tillinghast not calculate actual loss reserve liabilities in the February Report and his concealment of both Tillinghast Reports. The court noted that use of account-date data rather than book-date data understated loss reserve liabilities. However, it found no deception in connection with use of the STREAM software.

The court held that Distillers, through its agents Norton and Joslin, violated Section 10(b) of the Securities Exchange Act and Section 12(2) of the Securities Act, committed common law fraud, breached Elkhorn's promise to give Delta access to Elkhorn's books and records, and breached its warranties of accuracy as to the June 30, 1983 and September 30, 1983 balance sheets. To restore Delta to its pre-purchase position, Judge Keenan rescinded the acquisition and awarded pre-judgment interest on the purchase price running from September 30, 1983. Moreover, because Delta's post-purchase capital contribution reasonably could have been anticipated at the time of the acquisition, and because Kentucky's seizure of the company had resulted in the complete loss of that $6.3 million contribution, the court awarded damages in the full amount of Delta's capital contribution and interest from May 29, 1985, the date Kentucky seized Delta Re's assets. This appeal followed.

DISCUSSION

We briefly summarize our holdings. The contents of the Tillinghast Reports were either not material in the context of this transaction or were disclosed. The February Report contained information on the B-F Method that was well known to actuaries, including those at Conning and Peat Marwick. The projections that might have been made from its worksheets were stale at the latest by December 1982. The substance of the April Report, if not its existence, was disclosed to ARM and Peat Marwick at the earliest opportunity.

We conclude that the district court's finding that Norton knew that Elkhorn was insolvent is clearly erroneous. Disclosure and scrutiny of the February Report might have alerted an actuary to the account-date problem. However, Peat Marwick knew of this problem before the acquisition, and Elkhorn was under no duty to make an independent study of the effect of the use of account dates. Finally, we hold that Distillers did not guarantee the adequacy of Elkhorn's loss reserves estimates.

1. *The District Court's Conclusions Regarding the Tillinghast Reports*

The district court's finding that Norton failed to disclose the February and April

1982 Tillinghast Reports to Distillers and knew of Elkhorn's insolvency was the basis for its conclusion that Delta violated Sections 10(b) and 12(2), committed common law fraud, and breached the agreement to provide access to Elkhorn's books and records. The district court believed the Tillinghast Reports demonstrated Elkhorn's $20 million loss reserves deficiency and insolvency and were concealed for that reason. As noted, the district court found that neither Delta nor its representatives were told of either Tillinghast Report and that this non-disclosure was accompanied by "affirmative misstatements by Elkhorn–Distillers representatives to [Delta's] people." These misrepresentations concern Norton's statements regarding his learning of the B–F Method from Tillinghast. Judge Keenan thus placed great weight on Kaufman's recounting of a meeting with Norton in which Norton casually joked about learning the B–F Method from Tillinghast "without having a study from them ... [and] without having to pay for it."

[1] The district court's finding that Norton knew of Elkhorn's insolvency at the time of the acquisition is clearly erroneous. This finding was based on Norton and Joslin's request that Tillinghast not calculate a precise loss reserve figure in the February Report and Norton's subsequent concealment of both Tillinghast Reports. The finding thus dates Norton's knowledge of insolvency as beginning in *October 1981*, when the February Report was commissioned with a request that a loss reserve figure not be calculated, and continuing for some two years until the Delta acquisition. It is not supported by the record.

Assuming Norton could "know" of Elkhorn's insolvency in 1981—given the imprecision of loss reserve estimates, Norton's basic ignorance of actuarial methodology, and the paucity of evidence that Elkhorn was actually insolvent in October 1981—such a finding assumes the existence of a highly sophisticated, even fantastic, plot that has no evidentiary basis in the record. Such a scheme would have to have begun almost a year before there was any discussion with third parties concerning a sale of Elkhorn. It also would have to have involved knowledge of the effect of the use of STREAM software data on loss development triangles.

Based on STREAM data, Norton constructed loss development triangles for December 1982 that showed a relatively negligible loss reserve deficiency. If Norton knew of Elkhorn's insolvency from October 1981 to September 1983, then he would have had to have known of the account-date problem and of the magnitude of its effect on his December 31, 1982 triangles. Such a plot would have had to rely on the hope that a proposed purchaser learning of the account-date problem would not seek book-date data before going on with the acquisition. Moreover, to succeed, such a scheme would require the cooperation of others at Elkhorn, at least McGurty and Cascio, who would have had to join in the fraud on the purchaser, a firm that was about to become their employer. There is no evidence of such a highly implausible scheme.

The evidence is that STREAM was purchased by Elkhorn in order to computerize its bookkeeping. Based on this record, no one anywhere knew at the time that STREAM would not produce the most reliable data for loss development triangles[3] or, until the events leading to this litigation, ever focused on that problem. As a general bookkeeping software, STREAM had many uses, and there is no evidence that Distillers' purchase of STREAM was anything but innocent. The record indicates that in 1982 reinsurers of Elkhorn's size generally had neither computerized bookkeeping nor an actuary. There is no evidence that Elkhorn's contemplation of a conversion to computerized bookkeeping, which began before delivery of the February Report, ever took the construction of loss development triangles, a novelty at Elkhorn, into account. No suspicion can

3. The district court's opinion treated the use of account dates as a known alternative to the use of book dates. The actuaries testified at trial, however, that they had never before encountered the use of account dates in loss development triangles.

thus attach to the acquisition of bookkeeping software that was not well-designed for preparing loss development triangles.

The district court did not, of course, find that any such plot existed. Nevertheless, absent such a scheme, Norton cannot be found even to have suspected Elkhorn's insolvency after he constructed the December 31, 1982 triangles. We therefore conclude that the finding as to his knowledge of insolvency at the time of the acquisition is clearly erroneous.

The fact that Norton did not know that Elkhorn was insolvent at the time of Delta's acquisition did not, of course, release him from a duty to disclose the Tillinghast Reports if they contained material information. Before addressing the materiality of the Tillinghast Reports, we note that the district court's findings concerning the concealment of the Tillinghast Reports are not clearly erroneous. However, because inferences regarding materiality may be drawn from concealment, we summarize the record concerning that concealment.

With regard to the February Report, all witnesses seem to agree that Norton indicated that he had learned of the B-F Method from Tillinghast. Kaufman's testimony that Norton indicated he had learned the B-F Method without having to pay for a study differs only in detail from Norton's story that Joslin ordered only a methodology study without paying for calculations that Elkhorn could do itself. Norton, of course, testified that he mentioned both Reports to Delta's representatives. Ransom, a Conning actuary, testified that, at a meeting in August 1983, Norton said, in Ryan's presence, that Elkhorn had gotten a methodology study from Tillinghast. (The district court rejected Norton's testimony but did not mention Ransom's.) Also, it is undisputed that Norton gave McGurty a copy of the February Report without restriction as to filing or distribution. McGurty testified that he kept the February Report in his files and would have shown it to anyone from Delta who asked for it before or after the acquisition. (The district court did not discuss the undisputed evidence concerning McGurty's copy.) Brewer may also have received a copy, although the record is unclear. Finally, Norton neither destroyed nor took the February Report with him when he left. Rather, he left it where it would inevitably be found by Delta personnel. Norton may not have disclosed the existence of the Tillinghast Reports, but the record does not suggest any strenuous efforts to conceal them.

With regard to the April Report, it is undisputed that Norton informed Bell and Kaufman in June 1983 of the loss reserve deficiency resulting from the Barrett Treaties and of his attempt to resolve that problem by the purchase of the $10 million loss transfer policy from Continental. Although the existence of the April Report was not mentioned, the substance of its contents was thus disclosed at the first opportunity.

We make these observations concerning the record only to note the frailty of any inference of materiality that might be drawn solely from the apparent concealment. In truth, apart from light they might have shed on the account-date problem, the Tillinghast Reports are red herrings.

[2] The applicable legal standard regarding the materiality of omitted information is whether "there is a substantial likelihood that a reasonable shareholder would consider it important" or "a substantial likelihood that the disclosure ... would have been viewed by the reasonable investor as having significantly altered the 'total mix' of information made available." *TSC Industries, Inc. v. Northway, Inc.*, 426 U.S. 438, 449, 96 S.Ct. 2126, 2132, 48 L.Ed.2d 757 (1976). We note that the application of this standard in the instant matter concerns the estimate of Elkhorn's loss reserves and the value of the omitted information to Peat Marwick and Conning, firms with actuarial expertise hired to make an independent inquiry with regard to the adequacy of those loss reserves.[4]

4. We do not address the materiality of documents such as the Tillinghast Reports in the

We conclude that as a matter of law the Tillinghast Reports were not material at the pertinent times.

The February Report described the B-F Method in detail, recommended its use, and appended work papers that would assist in applying it to Elkhorn. However, the B-F Method was in the public domain, and it is undisputed that Conning and Peat Marwick were fully aware of it. To the extent the February Report described the B-F Method and contrasted it with the loss ratio method, it would have been no more informative to Conning and Peat Marwick than a discussion of the differences between cash and accrual methods of accounting.

Moreover, the precise calculations that might have been made from the worksheets appended to the February Report would not have been of interest sixteen months later in June 1983. By the very terms of the Report, the February calculations would be stale by December 1982. First, the February Report explicitly stated that treaty-category analysis was superior to the treaty-by-treaty analysis employed on the appended worksheets. Treaty-category analysis was available in late 1982. Second, the data available for constructing the December 31, 1982 triangles was more current by at least a year than the data used in the appended worksheets. An actuary coming upon the February Report would not have bothered to complete the appended worksheets but would simply have assumed that any relevant data contained in the appended worksheets would either be reflected in the December 31, 1982 and June 30, 1983 triangles or supplanted by treaty-category data. The fact that the later triangles contained account-date data merely underlines the fact that the account-date problem, not the lack of access to the February Report, caused the injury to Delta.

To put the matter another way, if the June 30, 1983 loss development triangles had been based on book data, no one could claim even marginal relevancy for the February Report. Peat Marwick and Conning would have made their respective actuarial judgments based on those triangles. If their opinions were negative, the acquisition would have been halted or proceeded at a lower price. If their opinions were favorable and thus too optimistic, the acquisition would have proceeded with the resultant loss to Delta. In such circumstances, however, no blame could have attached to non-disclosure of the February Report. The sole relevance of the February Report is thus in the light it might have accidently shed on the account-date problem.

[3] The existence of the April Report was similarly immaterial. In applying the B-F Method to the Barrett Treaties, the Report concluded there was a deficiency of $10.9 million in loss reserves with respect to those treaties. However, the problem with the Barrett Treaties was revealed by Norton to Bell of ARM and Kaufman of Peat Marwick at their initial meeting in June 1983. Norton disclosed the purchase of the $10 million loss transfer policy from Continental as his attempt to remedy the deficiency resulting from the Barrett Treaties. The fact that a document contained the facts concerning the problem with the Barrett Treaties was not significant.

The district court appeared to take the view that Norton's opining as to the adequacy of the loss transfer policy as a means of redressing the deficiency resulting from the Barrett Treaties was a misrepresentation. Even assuming that Norton's opinion was material in the context of independent investigations by professionals with more expertise than he possessed, Delta was not injured. Peat Marwick deemed the Continental arrangement inadequate under GAAP and compensated for it in certifying the reserves. It can hardly be contended, therefore, that material facts concerning the April Report were withheld.

The only significance of the Tillinghast Reports would thus have consisted in whatever light they might have shed on the account-date problem. The February Report might have been significant to an actuary who completed the appended work-

context of a differently structured transaction or less sophisticated investors.

sheets, if the pertinent loss reserves figures in the February Report could be compared with those in Factor's June 30, 1983 triangles. Whether these figures could be compared is unclear because the worksheets employed treaty-by-treaty analysis while Factor's triangles used treaty-category analysis. If they were comparable—a matter not settled on this record—such an actuary would have noticed the changing numbers—much as the differences between Norton's December 1982 triangles and Factor's June 1983 triangles led her to discover the account-date problem.

The testimony of both Kaufman and Mary Hennessey of Towers Perrin indicated that the materiality of the February Report lay in whatever aid it might have given in illuminating and overcoming the account-date problem. Similarly, at oral argument, counsel for Delta conceded, as he had to, that the Tillinghast Reports contained nothing new so far as the B–F Method was concerned but argued that the disclosure would have revealed the account-date problem. Others, such as Brian, said that actuary reports showing a loss reserve deficiency of $20 million would have been "of interest." That testimony, which assumed that the appended worksheets would have been completed, does not alter the fact that the only pertinent matter that would ultimately have been revealed was the account-date problem. (The section immediately following discusses the relevance of what the February Report would have disclosed concerning the use of account dates.)

However, the argument that the Tillinghast Reports were material because of the light they would have shed on the data on which the December and June triangles were based does not sustain the district court's conclusion regarding their materiality. The district court found that the Tillinghast Reports were material because they facially demonstrated Elkhorn's insolvency, not because they would have revealed the account-date problem. In fact, the court did not find a material misrepresentation or omission concerning the account-date problem.

To reiterate, putting aside the account-date issue, the relevant portions of the February Report were either in the public domain (the B–F Method), stale (1981 treaty-by-treaty figures), or known to Peat Marwick (the Barrett Treaties, Continental transaction). Except for what light might have been shed on the use of account dates, disclosure of these Reports would not have changed events. The district court's theory of the materiality of the Tillinghast Reports, therefore, cannot be sustained, and no liability exists under Section 10(b) of the '34 Act or Section 12(2) of the '33 Act based on that theory. Similarly, the district court's view that Distillers' failure to provide the Tillinghast Reports to Delta breached Distillers' warranty in the Stock Purchase Agreement to provide "reasonable access ... to all of Elkhorn's ... work papers, books and records ... for purposes of review and inspection" and to "furnish (Delta) with all such reasonable information concerning Elkhorn's affairs as the buyer may request" cannot be sustained. Because the district court's theory of materiality is erroneous and we do not view the warranty as covering immaterial information, we hold that, putting aside the account-date issue, the warranty was not breached.

2. *Distillers' Liability for the Account-Date Problem*

Because of the centrality of the account-date problem to this appeal, we will assess the legal significance of Elkhorn's entire conduct—including but not limited to the non-disclosure of the Tillinghast Reports—concerning the use of account dates.

It is undisputed that Peat Marwick knew, before certifying Elkhorn's reserves, that the Elkhorn loss development triangles were based on account rather than book dates. Norton turned over his December 1982 triangles to ARM and Peat Marwick at the first opportunity in June 1983. It was Factor's comparison of the December triangles with June 30, 1983 triangles that revealed the erroneous nature of the data produced by STREAM. After Factor made that comparison, no one at Elkhorn sought to conceal the cause of the observed discrepancies. Because the use of account dates was disclosed, the only material information not revealed concerned the magnitude of the distortion that use of account dates caused in loss development triangles. However, no one at Elkhorn suggested that the magnitude of the error introduced by the use of account dates was of large, small or any particular dimension. Nor is there evidence that anyone at Elkhorn knew that use of account dates would distort loss development triangles, much less that they knew the direction or size of that distortion.

With regard to the February Report's relevance to the account-date problem, extended scrutiny of the differences between its worksheets and the triangles based on STREAM data might, if the numbers were comparable, have disclosed the magnitude of the distortion. However, that can also be said with regard to scrutiny of the differences between Norton's December 31, 1982 triangles and Factor's June 30, 1983 triangles. (The fact that both Norton and Factor were using STREAM data would not have prevented discovery of the magnitude of the distortion because that magnitude results from the built-in feature of account-date data, as discussed in connection with Figs. 3 and 5.) Finally, and really stretching, the February Report would have revealed that book-date data could be assembled manually. However, Peat Marwick knew that STREAM output was based on raw data in Elkhorn's files but showed no interest in manual retrieval after Factor's discovery of the account-date problem. The Tillinghast Reports thus would have added nothing material to the information about the account-date problem that Peat Marwick had by September 1983.

[4, 5] Nevertheless, given the importance of the account-date problem, we examine Elkhorn's entire conduct regarding that problem in light of relevant legal criteria. We turn first to the question of whether Distillers may be liable under Section 10(b) of the Securities Exchange Act. Liability under Section 10(b) [5] requires a material misrepresentation and a showing of scienter. *See Ernst & Ernst v. Hochfelder,* 425 U.S. 185, 96 S.Ct. 1375, 47 L.Ed.2d 668 (1976). That test has not been met. For reasons stated, Elkhorn's personnel were ignorant of the ramifications of the account-date problem and of the relevance of the Tillinghast Reports to that problem.

Liability under Section 12(2) [6], however, is more easily established. Again, because the only material information not provided concerned the magnitude of error caused by the account-date problem, the pertinent questions are: (i) whether Distillers' failure to take any position on the magnitude of error was an omission of a fact necessary to make statements that were made not misleading, and (ii) whether, if so, Distillers carried its burden of showing that in the exercise of reasonable care it could not estimate the error's magnitude. We conclude that Distillers prevails as a matter of law on both questions.

5. Section 10(b) reads in pertinent part:

> It shall be unlawful for any person, directly or indirectly ...
>
> (b) To use or employ, in connection with the purchase or sale of any security ... any manipulative or deceptive device or contrivance in contravention of such rules and regulations as the Commission may prescribe as necessary or appropriate in the public interest or for the protection of investors.

15 U.S.C. § 78j(b) (1988).

6. Section 12(2) reads in pertinent part:

> Any person who—
>
> (2) offers or sells a security ... by means of a prospectus or oral communication, which includes an untrue statement of a material fact or omits to state a material fact necessary in order to make the statements, in the light of the circumstances under which they were made, not misleading (the purchaser not knowing of such untruth or omission), and who shall not sustain the burden of proof that he did not know, and in the exercise of reasonable care could not have known, of such untruth or omission,
>
> shall be liable to the person purchasing such security from him, who may sue either ... to recover the consideration paid for such security with interest thereon, upon the tender of such security, or for damages if he no longer owns the security.

15 U.S.C. § 77*l*(2) (1988).

[6] Elkhorn personnel did not characterize the use of account dates as causing a distortion of any particular magnitude. We see no basis for concluding that this was a misleading omission. Elkhorn was known to lack actuarial sophistication, the very reason why Delta had insisted on favorable independent opinions from Conning and Peat Marwick as conditions of the acquisition. The silence of the non-actuaries at Elkhorn could not, therefore, have led a professional actuary to believe the problem was trivial.

[7] Moreover, Elkhorn carried its burden of showing that it did not behave unreasonably in failing to probe the magnitude of the account-date problem when Factor inquired as to the reasons for the numbers changing in the loss development triangles. Delta's agents, including two firms with actuarial experience and knowledge far exceeding that of any personnel at Elkhorn, were conducting an independent inquiry into Elkhorn's financial status, with particular concern for the adequacy of its loss reserves. Elkhorn personnel had no reason to expect that their views would be welcome on a matter as to which they were far less knowledgeable than either Conning or Peat Marwick, and might reasonably assume that such questions were for Peat Marwick and Conning to resolve. Elkhorn therefore exercised reasonable care and is not liable under Section 12(2).

[8] For similar reasons, we conclude that Distillers did not commit common law fraud. There was no material misrepresentation by Distillers concerning the account-date problem that was relied upon in any way by Delta. The injury to Delta was caused by its misunderstanding of the problem, which was in no way the result of Distillers' conduct.

[9, 10] Finally, any omission by Elkhorn regarding the magnitude of the account-date distortion did not violate its promise to provide reasonable access to its books and records. Such a promise cannot extend to matters of which a party is ignorant but which might indirectly be revealed by otherwise immaterial records.

3. *The June 30, 1983 Balance Sheet: Breach of Warranty*

In the Stock Purchase Agreement, Distillers made two representations pertinent to the instant appeal regarding the segregated balance sheet of June 30, 1983. In Section 5(f), Distillers warranted that

> [t]he books and records of Elkhorn are complete in all material respects and have been maintained in accordance with good business and accepted insurance practices and accurately reflect the financial condition and results of the operation of Elkhorn

In Section 5(g), Distillers represented that

> the June 30th Balance Sheet and related statement of income are complete and accurate in all material respects, were prepared in accordance with Generally Accepted Accounting Principles ("GAAP"), and the June 30th Balance Sheet presents fairly the financial position of Elkhorn as at that date.

The district court found Distillers in breach of both warranties because (1) "Elkhorn had incurred substantial loss reserve obligations as of September 30, 1983 which were not disclosed in full," and (2) "[t]he June 30, 1983 Balance Sheet showed a net worth of $18 million rather than Elkhorn's true condition[,] which was insolvency." "Based on information available as of June 30 and September 30, 1983," the court explained, two expert witnesses "demonstrated that the loss reserve liability figures in Elkhorn's balance sheets were understated and the net worth correspondingly overstated." The court further reasoned that, under New York law, a plaintiff suing for breach of a warranty need not prove express reliance such as a change of position in reliance on a misrepresentation. *CBS, Inc. v. Ziff-Davis Pub. Co.*, 75 N.Y.2d 496, 554 N.Y.S.2d 449, 452, 553 N.E.2d 997, 1000 (1990). Instead, any reliance is satisfied by "the express warranty ... being part of the bargain between the parties." *Id.* at 453, 553 N.E.2d at 1001. Relying on this principle, the district court held that Delta had purchased the promise "that warranties contained in the Stock Purchase Agreement were true," and rescinded the Elkhorn acquisition "[i]n view of Distillers' breaches of material portions of the Stock Purchase Agreement."

We do not disagree with the district court's finding, based on the testimony of Delta's expert witnesses, that Elkhorn was insolvent as of June 30, 1983 and that this insolvency was due to the underestimation of loss reserves. *But see* the qualifications stated in Note 2, *supra.* We also do not disagree that the underestimation could have been detected from information available as of that date. Indeed, as noted above, had book-date data been derived manually or STREAM converted to produce such data when the account-date problem was discovered, the insolvency would have been disclosed subject again to the qualifications stated in Note 2, *supra.*

[11] However, we disagree with the district court's view that the warranties quoted constituted a guarantee by Distillers that loss reserve estimates on Elkhorn's books would prove in the future to be substantially accurate. Taking an overview of the deal, Delta refused to go forward without obtaining independent opinions from Conning and Peat Marwick as to, *inter alia,* the adequacy of Elkhorn's loss reserves as of June 30, 1983. Delta also bargained for and received a period of time after the acquisition to reexamine Elkhorn's net worth as of September 30, 1983 and to be entitled to whatever reimbursement Peat Marwick determined.

Delta knew that Elkhorn lacked actuarial expertise, and its initial inquiries revealed a need for a thorough audit and raised serious questions about both Elkhorn's methodology and conclusions as to the adequacy of its loss reserves. Delta's knowledge of Elkhorn's lack of expertise and insistence upon independent actuarial and accounting opinions and post-acquisition arbitration, in an acquisition where the price was set at book value, hardly suggests that Distillers had agreed to guarantee loss reserves. Such an agreement would have been so one-sided so as to be implausible—one in which Distillers could do no better than break even. As the district court viewed the contract, Delta would reap handsome profits if the loss reserves proved excessive. If book value decreased as a result of the underestimation of loss reserves, Delta's losses would be covered by Distillers. An agreement so fraught with downside risk to Distillers and no hope of gain seems unlikely in light of Elkhorn's actuarial ignorance, of the substantial uncertainty regarding estimates of loss reserves, and of Delta's insistence on favorable actuarial opinions as a condition of the acquisition.

Although the district court relied heavily upon the analysis of Elkhorn's financial condition at relevant dates by Mary Hennessey of Towers Perrin and John Creamer of Arthur Young & Co., Delta never explains what Hennessey and Creamer did that Conning and Peat Marwick could not have done in the course of their July–October inspections of Elkhorn. Nor does the record. Delta thus asks us to construe this contract to allow recovery of the full purchase price based on professional expert testimony in court that disagrees with the contemporaneous professional opinions expressed by Conning and Peat Marwick, firms hired by Delta itself to render such opinions.

Turning to the precise terms of the Stock Purchase Agreement, we find no support for that extraordinary view of the Agreement. The language of Section 5(f) warrants the maintenance of Elkhorn's books and records according to accepted practices in the industry so as to reflect accurately its financial condition. There is nothing in that language suggesting that estimated items such as future losses are guaranteed as to future adequacy. What is warranted is that the loss reserves stated have been set aside. Section 5(g) on its face warrants only that the June 30, 1983 balance sheet was consistent with GAAP and does not guarantee the accuracy of estimates of future claims to any extent beyond that required by GAAP.

Moreover, the Agreement contained specific guarantees of balance sheet items that would have been superfluous if Sections

5(f) and (g) guaranteed the accuracy of all estimated items on the balance sheet. For example, Distillers explicitly warranted that "[a]ll material tax liabilities ... are adequately provided for" and agreed to defend and satisfy liabilities in excess of Elkhorn's tax reserves. Distillers also certified that "the book value of the bond portfolio ... did not, at August 31, 1983, exceed the market value thereof by more than $1,635,000," thereby minimizing the risk to Delta that Elkhorn's assets were inflated on the June 30 balance sheet. This warranty is significant because, in June 1983, ARM viewed the two greatest risks with regard to the acquisition of Elkhorn as the possible overvaluation of its bond portfolio and the possible inadequacy of its loss reserves, both of which are balance sheet items.

Finally, Section 12, which we set out in the margin,[7] provided Delta with a post-purchase right to challenge the book value of Elkhorn. Under that provision, Delta was allowed to deliver no later than October 17, 1983 its own balance sheet setting forth Elkhorn's financial condition as of September 30, 1983. If Delta's balance sheet showed a net worth in excess of $18 million, Delta would pay Distillers a dividend equal to the excess amount; if it showed a net worth of less than $18 million, Distillers was required either (1) to remit to Delta the amount of the deficit by October 31, 1983 or (2) to submit the valuation dispute to Delta's outside accountant, Peat Marwick, for "final and conclusive and binding" resolution. Thus, Section 12 afforded Delta a binding, post-purchase opportunity to arbitrate book value, and thus the adequacy of Elkhorn's loss reserves, before Delta's chosen accountant.

We cannot, therefore, stretch the basic accounting warranties of Section 5 to serve as guarantees of the future adequacy of loss reserves without upsetting the allocation of risk deliberately established by the Stock Purchase Agreement. It is axiomatic that "[t]he term 'generally accepted accounting principles' should not be interpreted *in vacuo* but only in relation to the particular type of business involved." *Pittsburgh Coke & Chemical Co. v. Bollo*, 560 F.2d 1089, 1092 (2d Cir.1977). Likewise, the phrase "complete and accurate in all material respects" should not be divorced from the commercial context in which it is used. The presence of unequivocal warranties as to the adequacy of Elkhorn's tax reserves and the market value of its bond portfolio—items included in the June 30 balance sheet—strongly indicate that the parties viewed Section 5 as being no more than what its language says, a warranty as to accounting accuracy and regularity, not a blanket guarantee of net worth.

Under New York law, "[a] specific provision will not be set aside in favor of a catchall clause." *William Higgins & Sons, Inc. v. State of New York*, 20 N.Y.2d 425, 284 N.Y.S.2d 697, 699, 231 N.E.2d 285, 286 (1967). "Definitive, particularized con-

7. Section 12 provided:

12. *Adjustments to the Purchase Price.* No later than October 17, 1983, Buyer shall deliver a balance sheet of Elkhorn as at September 30, 1983 (the "September 30th Balance Sheet"), prepared in accordance with GAAP and on the same basis as used in the preparation of the June 30th Balance Sheet. The book value of all Bonds, Preferred and Common Stocks included in the September 30, 1983 Balance Sheet will be determined by Princeton Financial Systems Inc. and shall be binding on all parties. Seller guarantees to Buyer that the Net Worth of Elkhorn, as at September 30, 1983 shall not be less than $18,000,000.

In the event that the Net Worth of Elkhorn is greater than $18,000,000 as shown on the September 30th Balance Sheet, then Elkhorn shall pay a dividend to the Seller on or before the 28th October 1983 in an amount sufficient to reduce the Net Worth of Elkhorn to $18,000,000 in accordance with Clause 10 hereof.

In the event that the Net Worth of Elkhorn as shown on the September 30th Balance Sheet is less than $18,000,000, then Seller shall pay such deficit to the Buyer at Fort Lee, New Jersey, on or before the 31st of October, 1983, or if such Balance Sheet shall be disputed (as below provided) then payment shall be made promptly after the settlement of such dispute.

In the event Seller disputes the September 30th Balance Sheet, Seller shall advise the Buyer not later than the 25th October, 1983 and any such dispute, if not resolved promptly between the parties, shall be resolved by the opinion of Peat, Marwick, Mitchell & Co., which said opinion shall be final and conclusive and binding on all parties hereto.

tract language takes precedence over expressions of intent that are general, summary, or preliminary." *John Hancock Mutual Life Ins. Co. v. Caroline Power & Light Co.*, 717 F.2d 664, 669 n. 8 (2d Cir. 1983) (applying New York law).[8] If either Section 5 or Section 12 of the Stock Purchase Agreement is a guarantee of Elkhorn's net worth and creates rights of challenge to the June 30 balance sheet, Section 12 is obviously the more "specific provision" and Section 5, by comparison, the "catchall clause." *William Higgins & Sons*, 284 N.Y.S.2d at 699, 231 N.E.2d at 286.

For these reasons, we believe Sections 5(f) and (g) warranted only that (i) no material item had been omitted; (ii) each item was accurately described, *e.g.*, amount of loss reserve; and (iii) the June 30 balance sheet was prepared in accordance with GAAP. So read, Section 5 neither duplicates other warranties of specific balance sheet items nor undercuts the conditional guarantee and right of challenge provided by Section 12. So read, Section 5 affords Delta a right to challenge the propriety of Distillers' accounting under GAAP on the June 30 balance sheet, whereas the right to challenge loss reserve estimates otherwise consistent with GAAP is subject to the terms and remedies enunciated in Section 12.

Because the district court believed that Sections 5(f) and (g) guaranteed that the June 30 balance sheet statement of loss reserves would, with an excess of $18 million, be adequate to cover future claims, it never explained how—or even whether—Elkhorn's June 30 balance sheet ran afoul of GAAP. Although the district court found that "the actuarial analyses of Towers Perrin, as presented by Mary Hennessey, and the conclusions of Arthur Young & Co., as presented by John Creamer, were the most credible and compelling explanations concerning Elkhorn's true financial picture as of June 30," Section 5 never warranted that the June 30 balance sheet represented the "most credible and compelling" portrayal of Elkhorn's "true financial condition." The district court's findings and conclusions thus have no relevance to the question of whether the June 30 balance sheet conformed with GAAP. We turn now to that question, the most easily resolved issue in this complex matter.

[12] Delta does not claim, and the district court did not find, that the June 30 balance sheet was incomplete or inaccurate in any respect other than that its estimated loss reserves were too low. Peat Marwick certified that balance sheet as well as the September 30, 1983 balance sheet as consistent with GAAP. Delta's witnesses testified to no gaps or inaccuracies in the data base provided by Elkhorn's records, on which the June 30, 1983 balance sheet entries were based, apart from STREAM's failure to afford separate retrieval of book dates. However, Sections 5(f) and (g) do not warrant easy computerized preparation of loss development triangles, and no claim is made that the raw data in Elkhorn's files regarding book dates was inaccurate. GAAP does not require actuarial review of loss reserves estimates, much less the use of loss development triangles.

With regard to the estimate of loss reserves, Delta does not even argue that the actuarial method employed by Elkhorn—the loss ratio method—was inherently unreasonable or inconsistent with GAAP. As our extended discussion *supra* noted, GAAP does not require that reinsurers use any particular actuarial method, and the loss ratio method was recognized as acceptable.

Nor can it be maintained that the specific loss ratio employed by Elkhorn—sixty-five percent or the ceding company's recommendation—was at the time viewed by pro-

8. In its summary judgment decision in the instant matter, the district court described Section 12 of the Stock Purchase Agreement as "clear and unambiguous"—"guarantee[ing] the net worth of Elkhorn" but "intertwined with procedures and remedies lucidly set forth within that section," namely the exchange of a post-purchase balance sheet and submission of any dispute to binding arbitration. Given this earlier ruling, with which we agree, the district court's later reading of Section 5 as providing a second, and unqualified, guarantee of the balance sheet seems anomalous.

fessionals as so overly optimistic as to violate GAAP. Delta presented no such evidence at trial and, had that been the case, Conning and Peat Marwick, both of which were fully aware of Elkhorn's methodology of estimating loss reserves, would have concluded their studies in less than an hour. As noted, loss reserves are not like a debt with fixed payments of principal and interest. Informed guesswork is an accepted basis for determining such reserves, and Elkhorn's books were based on such guesswork.

We therefore reverse.

EXCERPT FROM
DIARY OF THE CIVIL WAR, 1860-1865

George Templeton Strong
edited by Allan Nevins
(introduction by Eugene McGovern)

George Templeton Strong (1820-75) was a New York lawyer who during the Civil War worked heroically for the United States Sanitary Commission. No private citizen did more for the Union cause, and his is the most famous, and the most important, of the diaries that survive from those years.

Sincerely,

Gene McGovern

Eugene McGovern

Authentic story about E. B. Elliott, whilom actuary to the Sanitary Commission. He has much talent for mathematics and a great faculty of working with entire concentration on abstract questions, but he is quite without common sense. He called on Dr. Woodward, United States Army, to find fault with certain blanks Dr. Woodward has been issuing to army surgeons calling for information as to the medical history of the war.

"Dr. Woodward," said Elliott, "I have looked over these forms of yours very hastily, but I am shocked to discover at the first glance omissions in your list of diseases that must deprive the returns of all scientific value." Woodward requests to hear it, and begs for particulars. "Why, sir, in your catalogue of fevers—malarious, typhoid, and so on—you have omitted and overlooked a most important form of fever, a fever which according to foreign statistics constitutes 8.2376948" (or whatever it may be) "per cent of the aggregate of febrile cases. What will foreign statisticians think of us if we publish returns founded on so imperfect a classification???? I have studied the subject thoroughly and exhaustively and feel it my solemn duty to warn you that this oversight destroys the worth of all your work."

"Gracious goodness!" said Woodward. "You don't mean it—do tell me what species of fever has been forgotten." "Why, puerperal fever," said Elliott, "and here are the tables that shew the percentage," and so on. "But soldiers cannot have puerperal fever," quoth Woodward. "I don't see why they are not as much exposed to it as civilians," replied Elliott, and Woodward told him why, in very vigorous Saxon English. Elliott fled in consternation.

-entry for Jan 14, 1865
Diary of the Civil War 1860-1865
by George Templeton Strong
ed Allan Nevins (Macmillan, 1962)

"THE STING," A NEW MUSICAL COMEDY

David Skurnick

[redacted]

THE STING

A New Musical Comedy

Book & Lyrics by David Skurnick

Music by Jerry Bock, Mark Charlap, Noel Gay, Scott Joplin, Cole Porter, Richard Rodgers, and Guiseppe Verdi

David Skurnick and the Casualty Actuarial Society

present

A New Musical

THE STING

Book and Lyrics by David Skurnick

Music by Jerry Bock, Mark Charlap, Noel Gay, Scott Joplin, Cole Porter, Richard Rodgers, and Guiseppe Verdi

Producer
DAVID SKURNICK

Director
ERICH PARKER

Musical & Vocal Direction
ROBERT GARDNER

Musical Arrangements
ROBERT GARDNER

Chorus Master
TOM MYERS

Choreography
KARIN QUINTANO

Additional Dialogue
JENNIFER SKURNICK

Set Design
ERICH PARKER

Make-Up & Hair Design
EILEEN JOHN

Set Construction
JANE TAYLOR & MIKE DOLAN

Cover & Program Design
RENEE COX

General Manager
JANE TAYLOR

Dedication

THE STING is dedicated to the regulators and employees who have tirelessly and often without recognition worked to end fraud in the insurance industry.

A Special Note of Thanks

Space does not permit us to name everyone who has generously contributed time and talent to make this production possible. To all of you, our heartfelt thanks.

CAST

(in order of appearance)

Jill Bunkum .... SHERRY GARDNER
a managing general agent just a touch, shall we say, on the dishonest side
Jack Bunkum .... ERICH PARKER
a master swindler and president of The Bunkum Agency
Harold Young .... TOM MYERS
a young actuarial trainee who doesn't have a clue
Clyde Fixer .... ERWIN WOLF
an actuary who . . . well, his name says it all
Paul Dormouse .... SUE MILLER
an actuary as old as Methuselah
The Godfather .... RICH QUINTANO
a Mafia chieftain
Suzanne Ravishing .... KARIN QUINTANO
a real babe and vice president of American Galactic Insurance Company
Charlie Fry .... DAVID SKURNICK
president of American Galactic
Barbara Sterling .... BARBARA COOK
executive vice president of American Galactic
Commissioner of Insurance .... JANE TAYLOR
of your home state
Broker .... NORM BENNETT
placing the reinsurance
Appraiser .... CHAP COOK
of real estate
Examiner .... MEL PINTO
of the insurance department
Attorney General .... JIM HALL
of the state
Employees
NORM BENNETT, JEAN BLAKINGER, MIKE CAULFIELD, CHAP COOK, MIKE DOLAN, EILEEN JOHN, SUE MILLER, JOANNE OTTONE, MEL PINTO, PATTI SANDMAN, JOAN SKURNICK, ERWIN WOLF

Understudies
for **Jill**, Sue Miller; for **Jack**, Tom Myers; for **Harold**, Erwin Wolf; for **Clyde**, Mike Caulfield; for **Paul**, Joan Skurnick; for **Godfather**, Mike Caulfield; for **Suzanne**, Sue Miller; for **Charlie**, Erwin Wolf; for **Barbara**, Sue Miller; for **Commissioner**, Joan Skurnick; for **Broker**, Mike Caulfield; for **Appraiser**, Joan Skurnick; for **Examiner**, Joan Skurnick; and for **Attorney General**, Mike Caulfield.

Ushers and Stage Crew
Boca Raton only: Ross Currie, **Head Usher**; Scott Augutis, Jim Gilbert, Chris Harris, Jim Mahoney, and Chris Mariani, **Crew.**

SCENES AND MUSICAL NUMBERS

in which the audience follows the schemes, plots, secrets, and fates of our characters.

THE STING will be performed without an intermission.

Scene 1: The offices of The Bunkum Agency.
Headhunter.........Jill
Tom, Dick or Harry.........Jill, Harold, Clyde & Paul
Ah! Don't Say No Today.........Jack

Scene 2: The Bunkum Agency a few weeks later.
Thinking Nothing of No One but Me.........Suzanne & Jack

Scene 3: A Conference Room at American Galactic Insurance Company.
The Swindlers.........Barbara & Charlie

Scene 4: Hearing Room of the Department of Insurance.
Anything Goes.........Jill, Jack, Harold & Ensemble

Pause for Scene Change.

Scene 5: On Their Way to American Galactic.

Sceme 6: The Chairman's Office at American Galactic.
Credits, Debits.........Barbara, Charlie & Ensemble
You're Fired.........Suzanne & Employees
Many a New Day.........Barbara & Employees

Scene 7: In Limbo.
Headhunter (reprise).........Barbara & Employees

Scene 8: The Chairman's Office a few weeks later.
You're the Top.........Suzanne & Jack
You're Fired (reprise).........Jill, Suzanne & Jack

Scene 9: The Chairman's Office a few weeks later.
I Enjoy Cheating a Gull.........Jill & Jack

Scene 10: The Chairman's Office.
Anything Goes (reprise).........Jill, Suzanne, Barbara, Jack & Ensemble

THE STING
by David Skurnick
May 30, 1992

Dedicated to the regulators and employees, who have worked to fight fraud in the insurance industry.

JILL BUNKUM	A dishonest managing general agent. Jill is a tough, straight-talking babe, who is often mad at her husband.
JACK BUNKUM	A master swindler. Jack and Jill operate the Bunkum Agency. You can tell if he's lying by whether his lips are moving.
THE GODFATHER	A Mafia chieftain.
HAROLD YOUNG	A young and very naive actuarial trainee.
CLYDE FIXER	A dishonest actuary.
PAUL DORMOUSE	A very old actuary.
SUZANNE RAVISHING	Vice President at American Galactic Insurance Company. She is a lovely, blond vamp, who is also selfish and scheming.
CHARLIE FRY	Long-time President of American Galactic Insurance Company.
BARBARA STERLING	Executive Vice President of American Galactic. She is honest, upright and effective.
STATE INSURANCE COMMISSIONER	
REINSURANCE BROKER	A pompous international broker.
APPRAISER	A Real Estate appraiser.
EXAMINER	A naive State Insurance Department Examiner.
THE ATTORNEY GENERAL	This bastion of righteousness is serious and intense.
EMPLOYEES	of American Galactic Insurance Company.

The action takes place in the present time at the Bunkum Agency, the State Insurance Department and American Galactic Insurance Company.

INTRODUCTION

Our story today is adapted from fact.
It's about MGA's and a firm they attacked.

Now, managing general agents are trusted,
To underwrite, then to get losses adjusted.

But, Jack and Jill Bunkum have no inhibitions,
They underwrite junk, just to get the commissions.

If claims fill the air at the end of a caper,
These villains don't care; it's the company's paper.

Now, Jill, who invents the astonishing plot,
Is soft-spoken, gentle and courteous -- **NOT!**

And, Jack's speechifying could use improving,
You can tell if he's lying -- his lips are moving.

So, laugh at our show; it's a comic revue.
But, crime fighters know - -it could happen to you.

OVERTURE

SCENE 1

[Curtain rises on the crummy office of the Bunkum Agency. There are two desks side by side in a shallow *V*. JACK is resting with his feet on his desk (on the left). JILL stands looking out the window upstage right. She turns toward JACK.]

JILL: (Upset and angry at JACK) Jack, they're repossessing our Cadillac!

JACK: (ingenuous) I'm sure it's *their* mistake, darling.

JILL: [overlap JACK's final word] You didn't make the payments, did you?

JACK: (calmly; diverting the discussion) Jill, for managing general agents like us, it's *dog-eat-dog.*

JILL: Oh, yeah? Then the dog ate us. (bitter) The damn company we represented wised up and dumped us.

JACK: They even took out newspaper ads to rescind the agency agreement.
That's slander.

JILL: I told you not to forge their policies.

JACK: Other companies *never* stopped us from writing.

JILL: (bitter) Until they went bankrupt!

JACK: (defensive) We could have come away with a profit. Why did they *sue* us?

JILL: (sarcastic) Oh, I can't imagine. Just because we cut the rates in half? Wrote crud? Insured crooks? *Or,* [laugh at JACK] maybe because we kept all the money?

JACK: (defensively) I was prepared to negotiate in *good faith*. (with sincerity) I offered to reinsure their entire exposure into another company.

JILL: Did you have another company?

JACK: Well, no.

JILL: (suddenly very excited, as she gets back to the main argument) And, you *still* don't have a company! **So, we're outa business, *right!***

JACK: Don't worry, dear. An insurance company is nearly ready to give us their pen.

JILL: **Who?** (Contemptuously challenging him. She knows he's lying.)

JACK: (in a fake virtuous tone) Jill, I am not permitted to divulge their identity.

JILL: (furious at this obvious evasion) Jack Bunkum! I don't care how many suckers you've swindled; **you can't con** ***me***! We're *busted* and you're *stuck*!

JACK: You *may* be correct, dear. I'll just keep pitching. [to audience] "...We can help your company grow in a niche market. Our underwriting expertise and access to reinsurance will lead ... "

JILL: [Overlap "will lead"] **No!** [pause] We'll buy our own company.

JACK: *Buy* a company? That would cost millions. And, the Department would never approve. (condescending) *I'll* find the pigeon; *you* [pause] do the typing.

JILL: (angry at the put-down) Forget it! Multi Global is selling American Galactic. *We're* buying it.

JACK: (angry and sarcastic) Don't be ridiculous! How could we do that?

JILL: [Now, JILL is calm and superior] First, I'll hire an agreeable actuary.

JACK: (scornfully) An *actuary*! You want to spend all day listening to fancy double talk?

JILL: [pause to glare at JACK] I *already do!*

[JILL picks up a phone and dials. Maybe rings on the 1st beat of the last 3 or 4 measures of the introduction. JACK sits down at his desk.]

HEADHUNTER

to the tune of MATCHMAKER

Lyrics by Sheldon Harnick, Music by Jerry Bock

JILL: Headhunter, headhunter, hunt me a mind;
Catch me a catch; find me a find.
Locate the applicants I want to see,
And earn your enormous fee.
Headhunter, headhunter here are the specs,
Try not to use age, race or sex,
All that I really require is that he
Should always agree with me.
For pricing, let him be high;

For reserving, let him be low;
For planning, let him predict
That the corporate earnings will grow and grow.
Headhunter, headhunter, turn on the speed,
Start making calls; chase every lead.
Don't stop to check what their resumes say,
Just, send them to me right away.

[HAROLD enters SL and hands JILL his application. JILL is genial and pleasant with the three applicants.]

HAROLD: Hi, I'm Harold Young. You're looking for an accounting clerk, right?

JILL: An actuary. (a bit suspicious) Can you identify yourself?

HAROLD: Yes. [picks up a mirror and looks at himself] It's me all right.

JILL: [points to application] You went to Kankakee Community College. What was your major?

HAROLD: Major? [amazed laugh] I bailed after a semester.

JILL: What makes you think you could do the job?

HAROLD: I'm trustworthy, loyal, brave, clean, and reverent.

JILL: That's good. And, who's this?

[CLYDE enters SL.]

CLYDE: Hello! I'm Clyde Fixer, here to fix your actuarial reports. [He hands Jill his application.]

JILL: You were the actuary at Equity Funding. Then there's a gap in your resume.

CLYDE: I was with L. I. C.

JILL: L. I. C.?

CLYDE: Leavenworth Inmates Club.

JILL: You'll fit right in.

[PAUL enters SL and hands Jill his application, with shaking hands.]

PAUL: Good day, young lady. I'm looking for a job to supplement my Social Security.

JILL: The way we pay, you'll need a second income.

PAUL: [Hands JILL his application] I've had long years of experience.

JILL: [Reading] Let's see. You invented the first retro rating plan. (She is impressed)

PAUL: (proudly) I also created *experience* rating. [point at application]

JILL: It's wonderful to find an applicant who's so *qualified*. Oh, your address is missing. Just fill it in right here. [points to the application]

PAUL: I can't remember where I live.

[JILL does a double take.]

JILL: Hmm ... which one should I hire?

TOM, DICK OR HARRY
to the tune of TOM, DICK OR HARRY
by Cole Porter

HAROLD:
I recently dropped out of junior college.
I never got a grade as high as a D.
If you prefer a total lack of knowledge,
Hire me, hire me, hire me.

CLYDE:
My resume displays a past that's checkered.
I served a stretch in jail, but as a trustee.
So, if you would not mind a criminal record,
Hire me, hire me, hire me.

PAUL:
I am the very oldest of old-timers,
I'm fretful and forgetful to a degree.
If you give health insurance for Alzheimer's,
Hire me, hire me, hire me.

PAUL: Hire me!
HAROLD & CLYDE: Hire me!
PAUL: Hire me!
HAROLD & PAUL: Hire me!
CLYDE: Hire me!
HAROLD: Hire me!
ALL 3: Hire me!

REFRAIN 1

JILL:	We need one actuary, And will take with no qualm, Any Tom, Dick or Harry, Any Harry, Dick or Tom. We need one actuary, And will take double quick, Any Tom, Dick or Harry, Any Tom, Harry or Dick.

REFRAIN 2

HAROLD:	I'm your new actuary,
JILL:	This is work, not a prom.
CLYDE:	I'm your new actuary,
JILL:	Are you Harry, Dick or Tom?
PAUL:	I'm your new actuary.
JILL:	Are you dull?
CLYDE:	No, I'm slick.
JILL:	Are you Tom, Dick or Harry?
PAUL:	Call me Tom, Harry or Dick.

REFRAIN 3

[The three applicants don straw hats.]

JILL & APPLI-CANTS:	I need (she needs) one actuary, Who will not be contrary. Yes, it's most necessary, For reserves commentary. I need (she needs) one actuary, And will take double quick, Any Tom, Dick or Harry, Any Tom, Harry or Dick A dicka dick, A dicka dick, A dicka dick, A dicka dick, A dicka dick, A dicka dick.

JILL: Harold, this is your lucky day. The Bunkum Agency has awarded you an *internship*. You can work here by paying a tuition of only $1000 a month.

HAROLD: That sounds kind of expensive for Dad.

JILL: [matter-of factly] You can play Tetris on our computer.

HAROLD: [without thought] I'll take it.

JILL: Start tomorrow. (to Harold) Sorry, boys. (to CLYDE and PAUL)

[All three applicants leave SL.]

JACK: That was masterful. Now, how do we pay for the company?

[Piano plays Theme from THE GODFATHER under dialogue.]

JILL: We start with a short term loan of seven million dollars. The bank issues junk bonds to finance the purchase. Multi Global also gives us a loan. As soon as we're in control, we use the company's money to repay the seven million. We're long gone when the other debts come due.

JACK: Yeah! [Pause for thought] But, where do we get the seven million?

JILL: (light-hearted) You borrow it from your friend Don Corleone.

JACK: The Godfather!!? (frightened) [JILL nods.] But we never paid him back.

JILL: (light-hearted) Well, he's on his way over.

JACK: (petrified) He'll kill me! [Heads for door at SR]

[GODFATHER enters SR and JACK backs up. JILL sits at her desk. JACK might stumble as he's backing up and deliver his first line from the floor.]

GODFATHER: Where's the money you owe me?

JACK: Good morning, Godfather. It was exceedingly kind of you to visit my meager office.

GODFATHER: Where's the money you owe me?

JACK: [gets up] I can't pay you right now. We had some unexpected difficulties.

GODFATHER: (angry) Where's the money you owe me?

JACK: But, I've got a new plan that will make you even more money.

GODFATHER: Jack, why do you treat me so disrespectfully?

JACK: The thing is, I need another seven million.

GODFATHER: No!

JACK: Please lend me the money. Of course, I'll pay your standard daily rates.

GODFATHER: I can have my boys take care of you [pause] and collect on the life insurance.

JACK: (pleading) I've got no one else to turn to.

GODFATHER: **NO!**

AH DON'T SAY *NO* TODAY
to the tune of LA DONNA E MOBILE
by Guiseppe Verdi

[During Verse 1, GODFATHER is shaking his head *no*. By Verse 2, he becomes positive and enthusiastic, due to the beautiful aria and the offer of equity.]

VERSE 1

JACK: Ah, don't say *No* today, I need your dough today.
I'm filled with woe today. I'm in a pickle.
I'm in distress, today. Please acquiesce, today,
Won't you say *Yes* today. Don't be so fickle.
We don't need much money. We don't want a billion,
Only seven million, just for a week or two.
Just for a week or two. Ah. Just for a week or two.

VERSE 2

You have a bank account; I need to use it.
Lend me the capital. I will not lose it.
You can have ownership, if you should choose it.
Make me an offer; I can't refuse it.
We don't need much money, we don't want a billion,
Only seven million, just for a week or two.
Just for a week or two. Ah. Just for a week or two.

GODFATHER: (deeply moved) Jack, that's my favorite aria. I'll help you.

JACK: Oh, thank you, Godfather. [JACK leans over and kisses his hand.]

GODFATHER: And, Jack, make a big profit, [pause] or you'll sleep with the fishes.

[JACK reacts with fear. GODFATHER exits SL.]

JILL: [during GODFATHER'S exit] Now, that's what I call **risk**-based capital.

CURTAIN

SCENE 2

[The curtain rises on the Bunkum Agency office, a few weeks later. JACK is sitting at his desk. SUZANNE enters. JACK looks up.]

SUZANNE: Hello. (as woman to man) I'm Suzanne Ravishing. [shakes hands with JACK]

JACK: (smitten with her beauty) Well, hello, cutie. Come right in. Sit down. Would you like a donut?

SUZANNE: No, thanks. I'm watching my figure. (seductive wiggle)

JACK: Me, too! (enthusiastically) Now, what can I do for you?

SUZANNE: I'm Vice President at American Galactic Insurance.

JACK: (suddenly worried) What are you doing here?

SUZANNE: Relax, Jackie. I've got a proposition for you.

JACK: Oh, really?

SUZANNE: I'm in a very good position to give you the intimate details of how management is fighting the takeover.

JACK: (interested) Yeah? What are they up to right now?

SUZANNE: They just told Multi Global and the Insurance Department about your reputation as an MGA.

JACK: (thinking out loud) Hmmm..... Multi Global won't be a problem. They don't care whose money they take.

SUZANNE: For an insurance man, you're sinfully handsome.

JACK: The Department will support us, if we engage <u>Hillary Clinton's law firm</u>. {*or,* <u>the right law firm</u>}

SUZANNE: This is fascinating.

JACK: Suzanne, if you do this for me, what can I offer you?

SUZANNE: Barbara Sterling is supposed to follow Charlie Fry as President. Give *me* the job.

JACK: You mean *President*?

SUZANNE: I love mahogany panelling! [She kisses him.]

JACK: It's a deal!

THINKING NOTHING OF NO ONE BUT ME

to the tune of THINKING NOTHING OF NO ONE BUT ME
Words by Douglas Furber, Music by Noel Gay

SUZANNE: I make men so fond -- their pulses all stir;
And I'll be the blond that Jack will prefer.
I'll tell him the secrets that he needs to learn;
A little investment, and plenty of return.

Me -- I'll be a big VIP;
Just you look on and you'll see,
What's going to happen to me.
I -- want my career to fly.
You may be just standing by;
I'll make my limit the sky.
What if I'm a traitor? There's a payoff later.
I'll be CEO, with plenty of power and plenty of dough.
Me -- just you look up and you'll see,
Me at the top of the tree,
Thinking nothing of no one but me.

JACK: I am such a charming and goodlooking man,
My je ne sais quoi has enchanted Suzanne.
So, she will deliver the goods to my door;
She'll be my informant, and maybe something more.

SUZANNE: Me -- I'll be a big VIP,
Just you look on and you'll see,

JACK: (spoken) She'll be a cat's paw for me.

SUZANNE: I -- want my career to fly,
I'll make my limit the sky,

JACK: (spoken) I'll be a very rich guy. [points to himself]

SUZANNE: When the buyout's over, I will lie in clover;
I'll be President,

JACK: (spoken) But she doesn't know I will steal every cent!

SUZANNE: Me -- just you look up and you'll see
Me at the top of the tree,
Thinking nothing of no one but me.

CURTAIN

SCENE 3

[A conference room at American Galactic, a few weeks later. The scene is played in front of the curtain. CHARLIE, BARBARA and EMPLOYEES enter SL carrying 4 chairs. They mill about, wondering how they and the buyers will impress each other, etc. SUZANNE enters SR]

SUZANNE: The buyers will be here any minute, so would you please find a seat. [Four EMPLOYEES sit, the others stand behind them. CHARLIE and BARBARA are to the right of the group.]

You all know that our company is for sale. I've been contacted by a highly successful investment team, who plan to bid for us. They asked to meet with our management, so I invited them over today. [SUZANNE looks to her right. JACK and JILL enter SR, followed by HAROLD.]

Here they come. I am now proud to introduce those two outstanding entrepreneurs, Jack and Jill Bunkum!

[HAROLD, SUZANNE and a couple of EMPLOYEES applaud. SUZANNE moves downstage.]

JACK: We'd like to thank Mr. Fry [he nods], Ms. Sterling [she nods] and management for the opportunity to speak with you. [CHARLIE and BARBARA are **not** impressed.] We need to discuss a very serious matter. You may be disturbed by what you hear.

Look at the last two years' earnings. [HAROLD displays Chart 1.] With results like this, do you know how much longer the firm can survive? [pause] Two years.

JILL: In two years, your company will lose its license, your customers will lose their insurance, and *you* will *lose your job*. [HAROLD displays Chart 2.]

JACK: That is stark reality. [pause] But, something can be done about it.

JILL: You'll get an A rating, when Jack and I add a hundred million dollars to surplus.

EMPLOYEES: Wow! Ah!

JACK: We will manage this company with entrepreneurial leadership, dynamic, customer-driven programs, and guts! The hours will be long and the work will be demanding, but **we will succeed!** [HAROLD turns Chart 2 CCW by 90 degrees.] Do you want to be a part of this venture?

EMPLOYEES: YES!

SUZANNE: Wait a minute! When you have the IPO, the *private* stock will be worth a fortune. *We* want some!

EMPLOYEES: Yeah!

JACK: (enthusiastic) You're right. That stock is a winner...a gold mine...a bonanza! (suddenly disappointed) But, I'm afraid it's fully subscribed. You can't buy any.

EMPLOYEES: (disappointed) Ahh.

JILL: (to Jack) Jack, couldn't we sell them some of our shares?

[JACK thinks. The EMPLOYEES lean forward in excitement.]

JACK: All right, we'll do it. [EMPLOYEES jump to their feet.] Come with us.

[JACK and EMPLOYEES hurry off to right.]

JILL: (happily) Make your checks payable to Jack and Jill Bunkum. [exits SR]

CHARLIE: Come back!

BARBARA: We need to warn you...

THE SWINDLERS
To the tune of THE ENTERTAINER
by Scott Joplin

CHARLIE and BARBARA:
When the swindlers begin their pitch,
They make you think that you're going to be rich.
They make promises by the bunch,
But, they never pay off, 'cause there is no free lunch.
You had better proceed with care,
You ought to know it's a jungle out there.
You can never get rich,
Within a criminal niche,
Whenever swindlers have started their pitch.

[CHARLIE and BARBARA exit SL.]

SCENE 4

[The curtain rises on a hearing room at the State Insurance Department, the next month. JACK, JILL, SUZANNE, EMPLOYEES, GODFATHER, COMMISSIONER, BROKER, HAROLD, CHARLIE, BARBARA, and APPRAISER are seated on stage. (Four people move the chairs on the apron back into position.)]

COMM: This is a hearing under the Uniform Insurance Holding Company Act, to rule on the sale of American Galactic Insurance Company. Ms. Bunkum, please explain your financial plan.

JILL: [stands] We'll complete the purchase with 80% debt and 20% equity. Ownership will be held 49% by Bunkum Partners and 51% by Cosa Nostra, Inc. [sits]

BROKER: [stands] I'm the reinsurance broker. We've placed the reinsurance for a loss portfolio transfer. By reflecting the time value of money, this transaction will increase surplus by twenty million dollars.

HAROLD: [stands] Before we transfer those reserves, we'll discount them. That's *another* twenty million.

COMM: Does that loss portfolio deal contain sufficient risk transfer?

JACK: If you don't approve it, *you* risk transferring 500 workers onto unemployment.

HAROLD: (aside to BROKER) Gee, who did you find to cover such a weak company ?

BROKER: I filled the slip at Lloyd's of London. You see, Lloyd's Accounting protects the Names.

HAROLD: The *what*?

BROKER: That's what they call investors, over there.

COMM: [strikes gavel] Why don't you explain Lloyd's Accounting to everybody.

BROKER: It's been done the same way for 300 years. A syndicate closes after the third year and reinsures the losses forward, so the Names are *always safe*.

JILL: (aside, seated) As long as they find a bigger fool to assume their losses.

BROKER: [gives JILL a dirty look] Yes, in the last few years, some syndicates *have* been unable to close.

HAROLD: (wide eyed innocence) Will those names have to pay *300 years of losses*?

[EMPLOYEES et al. chuckle at HAROLD's naivete]

COMM: [strikes gavel. HAROLD and BROKER sit down.] Order! Now, will there be any other capital infusions?

JACK: Yes. We will give the company a fifty million dollar office building in Houston, in exchange for thirty million in stock and twenty million in cash.

COMM: (impressed) That's *thirty million* of capital.

CHARLIE: [stands] That building isn't worth *fifty* million; they just bought it for *ten*! [sits]

COMM: [looks at JACK] Do you have a real estate appraiser?

APPRAISER: [stands and clears his throat. This speech is delivered hesitantly and uncertainly] If we *assume*... an orderly real estate market, ...lower interest rates,...a sufficiently protracted period of time, and, perhaps [pause] a return of the oil boom,... then the structure could *possibly* yield fifty million dollars. [sits]

HAROLD: [seated] (enthusiastically) That's *terrific,* for a vacant building.

BARBARA: (jumps up in desperation) Your Honor, Jack Bunkum is a criminal! He's been convicted of a felony!

SUZANNE: Mr. Bunkum's minor infraction was the result of a mere technical oversight.

JILL: (jumps to her feet) Forget the past. We're going to save American Galactic.

JACK: (jumps to his feet) And make the employees rich.

EMPLOYEES: Yeah! Approve the deal! Go for it! [make noise until the gavel strikes]

COMM: [strike gavel] This purchase is APPROVED.

[Everyone is happy, except CHARLIE and BARBARA, who stalk out SL.]

ANYTHING GOES
To the Tune of ANYTHING GOES
by Cole Porter

VERSE

JILL: Times have changed.
And we've often rewound the clock,
Since directors first got a shock,

When they started to issue stock.
If today,
Any shock they should try to stem,
'Stead of selling more common stock,
Why, the firm would just sell them.

REFRAIN 1

In olden days those great big losses
Were looked on as albatrosses,
But now, God knows,
Anything goes.
Good underwriters once were thrifty,
Now, they run a hundred fifty
Loss ratios.
Anything goes.
Just think of those shocks you've got,
And those knocks you've got,
From those blocks you've got,
Of penny stocks you've got,
And the gunk you've got,
And all the junk you've got,
In your bond portfolios.
Jersey folk react like maniacs as
They're whacked with those zany taxes,
Of Florio's.
Anything goes.

[Tap dance routine between Refrains 1 and 2, and also between Refrains 2 and 3. During the latter dance, the Commissioner will tap dance in front, wearing her robe and wig.]

REFRAIN 2

HAROLD: When MGA's can make a killing
By secretly overbilling
On bordereaux.

ALL: Anything goes.

HAROLD: Investors who are out on bail
Can scare owners, and get greenmail,
In their LBO's.

ALL: Anything goes.

HAROLD: Just look at that broker, he'll [indicates BROKER]
Tell a joke with zeal.

He can stroke your feelings,
Provoke a deal.
He'd forsake romance for
A chance to transfer
Those loss portfolios.
At Lloyd's the names watch losses mounting,
But can't use three year accounting,
When years won't close.

ALL: Anything goes.

REFRAIN 3

JACK: When buyout artists so appalling,
See companies [RHYTHM] quickly falling,
Like dominoes.

ALL: Anything goes.

JACK: A swindler, who has served a term in the pen
Can acquire a firm and then
Thumb his nose.

ALL: Anything goes.

JACK: If changes abrupt you like,
To disrupt you like,
To corrupt you like,
To interrupt you like,
If cooked books you like,
And dapper crooks you like,
Why, nobody will oppose.

JACK and JILL: We made our case with great precision,
Resulting in this decision,
As hearings close: [Hold *close* only two beats.
COMMISSIONER bangs gavel on the third beat.]

COMM: Anything goes!

ALL: Anything goes.

CURTAIN

PAUSE FOR VIDEO CASSETTE CHANGE

[Play some quiet music, perhaps part of *The Entertainer*.]

SCENE 5

[The next day. JACK, JILL, HAROLD, and SUZANNE enter SL in front of the drawn curtain. During this scene they gradually move across the stage toward SR. They are excited.]

JILL: Everything's signed. We own the company. [holds up contract]

HAROLD: Wow! Can we eat in the executive dining room?

JILL: We can sell the food.

JACK: And the assets.

HAROLD: I'll feed my brother a ten dollar lunch.

JILL: I'll feed my brother a ten million dollar loan!

JACK: Say, when can we meet with the executives?

SUZANNE: They're all at Charlie's retirement party.

JILL: Let's go, then.

HAROLD: Yeah, let's crash the party. I'll get the brewskies.

JACK: No need, Harold. They'll share with *us*.

SUZANNE: I'll tell them who's boss now. *Me*!

JACK: OK. But, remember: change is pain.

JILL: Speak with P. M. A.

JACK: A Positive Mental Attitude.

HAROLD: We're outa here.

[All exit SR]

SCENE 6

[The Chairman's office at American Galactic, one hour later. The curtain rises on a sedate party, which is nearly over. Balloons, banners and signs are hanging. There are bright table cloths on the desks and tables, with glasses and bottles on them. BARBARA and CHARLIE are standing upstage, center. The employees are milling about, partying.]

BARBARA: Would you all gather round, please. [EMPLOYEES gather round] This party has been in honor of Charlie Fry, the most outstanding executive I've ever had the privilege of working with. Starting as a humble accounting clerk, he rose to become a great leader at American Galactic...

EMPLOYEES: [Hands on hearts, as they interrupt, enthusiastically] Hmmmmm.

[JACK, JILL, HAROLD and SUZANNE enter SR]

BARBARA: He's hanging up the ax, ringing down the curtain, and sailing off into the sunset, leaving a pair of big shoes to fill.

CHARLIE: Not at all, Barbara. You'll be the best President yet.

BARBARA: Charlie, you provided a model of Prudence, Integrity, and Sound Underwriting, which we all will seek to emulate. Now you can enjoy a well-earned retirement in Boca Raton. As a token of your many contributions to American Galactic...

EMPLOYEES: [Hands on hearts] Hmmmmm.

BARBARA: ...I hereby present this beautiful, gold-plated watch.

[EMPLOYEES applaud as she hands him the watch.]

CREDITS, DEBITS

To the tune of SUNRISE, SUNSET
Lyrics by Sheldon Harnick, Music by Jerry Bock

BARBARA: [Walk to front of stage, sing directly to the audience.]

Is this the baby-faced accountant?
Is this the eager, young trainee?
I don't remember getting older,
When did he?
When did his face become so wrinkled?
When did his head lose all its hair?
Wasn't it yesterday his hair was there?

ALL: Credits, debits, credits, debits,
Calmly flow the days,
Doing exactly what they tell me,
Hoping to get another raise.
Credits, debits, credits, debits,
Till the end of time.
Slaving to make a little profit.
Watching each nickel and each dime.

CHARLIE: Now I'll be living in a condo, [Walk downstage, sing to audience.]
Wear only shoes of shiny white.
I'll eat my dinner at four thirty, every night.
I'll wait for visits from the children,
Watch Oprah Winfrey on TV.
I'm a proud member of AARP.

ALL: Credits, debits, credit, debits, [ALL move downstage]
Calmly flow the days,
Doing exactly what they tell me,
Hoping to get another raise.
Credits, debits, credits, debits,
Slowly crawl the years,
One day exactly like another,
Work that is boring me to tears.

CHARLIE: Thank you for this beautiful, engraved time-piece. This lovely memento shows [pause to glance at the watch] that it's past my bed time. Good night. [exits in front of group, SR]

BARBARA: Would the new owners like to speak?

[JACK moves to center. Group moves back slightly. JILL, HAROLD and SUZANNE are nearby.]

JACK: [reads matter-of-factly] As you can all appreciate, our number one priority will be to analyze the financial condition of the Company. The outcome of this effort will result in the repositioning of some of our units, so it is important that we do not further aggravate our cost position. Therefore we are implementing a rapid program of redeployment and destaffing.

[EMPLOYEES make confused noises.]

EMPLOYEE: *{Mel}* (puzzled) **What does that mean?**

JACK: [aside to SUZANNE, as they switch places] Remember: *P. M. A.*

YOU'RE FIRED
To the tune of I'M FLYING
Lyrics by Carolyn Leigh, Music by Mark Charlap

SUZANNE:	You're fired.		
EMPLOYEE 1:	(spoken) Fired?	*{Sue}*	(Shocked and questioning)
EMPLOYEE 2:	(spoken) Fired?	*{Mike}*	"
EMPLOYEE 3:	(spoken) Fired?	*{Joan}*	"

SUZANNE: Here's the deal; all pink slips, [shows the pink slips like a bridge hand]
It's for real; read my lips.
You're fired.

You're fired.

EMPLOYEE 1:	(spoken) Fired?	*{Sue}*	(Angry and questioning)
EMPLOYEE 2:	(spoken) Fired?	*{Mike}*	"
EMPLOYEE 3:	(spoken) Fired?	*{Joan}*	"

SUZANNE: Disappear, take your stuff,
You've been here long enough;
You're fired.
Please turn out your light, turn in your key.
We don't need to fight; you're history.
You're fired.

POP [sound of balloon being popped]
POP
POP

SUZANNE: You're all canned, I'm still here,
I feel grand, I could cheer.
You are unemployed; I am overjoyed;
You're fired.

[The employees sing with great enthusiasm, thanks to P. M. A.]

EMPLOYEES: We're fired.

EMPLOYEE 1: (spoken) Fired! *{Sue}* (Happy and liberated)
EMPLOYEE 2: (spoken) Fired! *{Mike}* "
EMPLOYEE 3: (spoken) Fired! *{Joan}* "

EMPLOYEES: It is all for the best,
We can crawl home and rest,
We're tired.

We're fired.
EMPLOYEE 1: (spoken) Fired! *{Sue}* (Exhausted and resigned)
EMPLOYEE 2: (spoken) Fired! *{Mike}* "
EMPLOYEE 3: (spoken) Fired! *{Joan}* "

EMPLOYEES: It's no joke, we're in debt,
We'll be broke till we get
Rehired.
We've all done our best, you wouldn't scoff.
So, we'll take the rest of the day off.
We're fired.

EMPLOYEE 1: (spoken) Fired! *{Sue}* (Tipsy and resigned)
EMPLOYEE 2: (spoken) Fired! *{Mike}* "
EMPLOYEE 3: (spoken) Fired! *{Joan}* "

EMPLOYEES: We're discharged, we're dismissed,
By and large, we're all pissed.
When we leave today, with our two weeks' pay,
Either we'll get drunk or we'll prepare our resume;
We're fired.

[EMPLOYEES and BARBARA march in place starting with "When we leave...", then march out left as they sing the last line.]

JACK: Well done, *President* Ravishing!

JILL: The whole company is in our hands.

[JACK, JILL, HAROLD, and SUZANNE exit right. BARBARA and EMPLOYEES then sneak back on stage from left. P. M. A. has *definitely* worn off. They pour drinks.]

EMPLOYEE 1: {Rich} Those *bastards*!

EMPLOYEE 2: {Joan} After all we've done for American Galactic.

EMPLOYEES: [put hands on hearts] Hmmmm.

EMPLOYEE 3: {Mel} At least, *they're buying.* [All drink]

EMPLOYEE 4: {Sue} This is horrible.

EMPLOYEE 5: {Norm} Where will I go now? [starts to cry]

EMPLOYEE 6: {Jean} Where's our golden parachute? [Starts to cry. All EMPLOYEES start crying, except BARBARA, who is bold, determined, upright and sober.]

EMPLOYEE 7: {Mike C.} This *never* would have happened if we had finished the **Data Base Project.**

EMPLOYEE 8: {Chap} I'll never get the tie tack with three diamond chips!

BARBARA: Friends, let's put the bitterness and lamenting behind us. We've encountered misfortune, but it's time to move forward. Let's go to my house for a resume writing party.

[BARBARA sits downstage center. EMPLOYEES stand around her in a tableau.]

MANY A NEW DAY

To the tune of MANY A NEW DAY
by Oscar Hammerstein II and Richard Rodgers

BARBARA: Why should a worker who is healthy and strong,
Blubber like a baby if her job goes away?
Cursing that the management has done her wrong,
That's one thing you'll never hear me say.
Never gonna think that the job I lost is the only job I can catch;
I won't complain that it wasn't fair,
I'll snap my fingers to show I don't care,
I'll wash that company out of my hair,
And start all over from scratch.

EMPLOYEES and BARBARA: Many a new duty will I try,
Many a new task will find me.
Never will I seek to alibi,
Over the lost job behind me.
Many a new job will brighten my career.
Always have I kept my resume
In up to date condition.
Never did I really think I'd stay
In the old position.
Ready to set forth and on my way,
Starting on my job search mission.

BARBARA: Many a new war <u>to fight</u>, (slower)

{NOTE: The four underlined words to be doubled by Sue Miller and/or Joan.}

EMPLOYEES: Ah, ah, ah (harmony)

BARBARA: Many a new risk <u>to write.</u>

EMPLOYEES: Ah, ah, ah

BARBARA: Many a new job will

UNISON: Brighten my career. (harmony)

CURTAIN

SCENE 7

[BARBARA and 5 female EMPLOYEES come in front of curtain as it is closing in Scene 6]

HEADHUNTER (reprise)

EMPLOYEES and BARBARA: (6 women)	Headhunter, headhunter, get me employed, I am depressed; I am annoyed. Start making phone calls; you know what I seek: A salary check each week. Headhunter, headhunter, I need to work. Sitting at home drives me berserk. Even if I get demoted to clerk, Just get me a chance to work.	
EMPLOYEE 1:	And, also, four weeks vacation,	*{Sue}*
EMPLOYEE 2:	An office, with a beautiful view.	*{Barbara}*
EMPLOYEE 3:	A bonus,	*{Joan}*
EMPLOYEE 4:	Deferred compensation,	*{Jean}*
EMPLOYEE 5:	A company car	*{Barbara}*
EMPLOYEE 6:	And a PS-2 [RHYTHM]	*{Sue}*
ALL:	Headhunter, headhunter, I want the best: Title and perks, all of the rest. If they're not offered, at home I will stay,	
EMPLOYEE 1:	Where I will resist,	*{Barbara}*
EMPLOYEE 2:	I will desist,	*{Sue}*
EMPLOYEE 3:	Simply exist,	*{Jean}*
EMPLOYEE 4:	Barely subsist,	*{Joan}*
ALL:	On my unemployment pay.	

[Three women exit SL, the other three exit SR]

SCENE 8

[Curtain rises on JACK and SUZANNE in the Chairman's office, a couple of weeks later. He sits at his desk, worried. She is flirtatious]

JACK: This is tougher than I thought. The Insurance Department is investigating us, the agents are denouncing us, and nobody knows the combination to the vault. I'm so discouraged.

SUZANNE: [sits in his lap] Jackie, forget the company. (suggestively) Jill is visiting a Branch. We have the whole day together.

JACK: How can *I* run an insurance company?

SUZANNE: Where's the old Bunkum confidence? You think other executives have one tiny fraction of your brains, your charm, your...

YOU'RE THE TOP

Based on YOU'RE THE TOP by Cole Porter

VERSE 1

SUZANNE: At words poetic I'm so pathetic,
That I always have found it best,
Instead of getting 'em off my chest,
To let 'em rest unexpressed.
I hate parading my serenading,
As I'll probably miss a bar.
But, if this ditty is not so pretty,
At least it'll tell you how great you are.

REFRAIN 1

You're the top, you're a high umbrella.
You're the top, you're a brand new fella'.
You're Ron Ferguson, who is number one at Gen Re.
You're John Hancock Tower, the hundredth power, you're Lotus 3.
You're the breeze, you're a Broadway tryout.
You're the fees in a leveraged buyout.
I'm a stock that's hit the rocks and gonna drop.
But if, baby, I'm the bottom, you're the top.

VERSE 2

JACK: Your words poetic are not pathetic,
On the other hand, babe, you shine.
And I can feel after every line,
A thrill divine, down my spine.

A gifted human like Steven Newman,
Might think that your song is bad.
And, I've got a notion to second the motion,
But, this is what I'm going to add:

REFRAIN 2

JACK: You're the top,
You're the wheel's inventor,
You're the top,
You're the World Trade Center
You're the faraway expertise of AIG,
You're a retro max
You're an auto fax,
You're Schedule P.
You're supreme,
You're the profit margin,
In a scheme,
Where we're overchargin',
I'm a carnivore in a little horror shop. (spoken) FEED ME
But if, baby, I'm the bottom, you're the top.

REFRAIN 3

SUZANNE: You're the top,
You're the regulator.
You're the top,
You're the numerator.

JACK: You're the walnut trim on a chauffeured limousine.
You're infinity,

SUZANNE: You're MacGinnitie,

JACK: You're a Harvard dean.

SUZANNE: You're the pay
That the Chairman's earning;

JACK: You're the day
That the cycle's turning.

SUZANNE: I'm a ne'er-do-well, an S and L gone pop,
But if, baby, I'm the bottom, you're the top.

[Brief dance interlude, perhaps to the tune of the verse.]

REFRAIN 4

JACK: You're the top,
You're the life eternal,

SUZANNE: You're the top,
You're the Wall Street Journal,

JACK: You're the lawsuit rate in the Golden State, out West,

SUZANNE: You're a new position,

JACK: You're an acquisition,

SUZANNE: You're the Part Ten test.

JACK: You're the top,
You're a Stradivary,

SUZANNE: You're the top,
You're an actuary,

JACK: I've a brain that fails like J. Dan Quayle's, a flop,

BOTH: But if, baby, I'm the bottom, you're the top.

[At the close of the song, they wind up in some affectionate pose. JILL suddenly appears. She is furious.]

JILL: I knew it!!

[JACK jumps to his feet to face JILL, spilling SUZANNE onto the floor.]

JACK: Jill, I can explain this. It isn't what you think. You see,...

JILL: (interrupting) Don't waste your breath, you philanderer. I heard the whole thing.

JACK: But I thought you were on an audit.

JILL: I was auditing **you**!

SUZANNE: Jill, you mind the business; *I'll* take care of Jack.

JILL: (even more furious) You've done your job. Now, get out!

YOU'RE FIRED (reprise)

JILL: You're fired.

SUZANNE: Fired? (spoken)

JACK: Fired? (spoken)

JILL: Fired! (spoken)

Change your plans, change your tack,
Keep your hands off of Jack!
I have made a cut.
Now your door is shut.
Pack up and get out of here,
You selfish little slut.
You're fired.

[SUZANNE walks toward the exit SR, then suddenly turns toward JACK and JILL.]

SUZANNE: (with vicious hatred) **I'll get even with you!**

CURTAIN

{Note: The curtain will rise for Scene 9 with no delay.}

SCENE 9

[The curtain rises on the Chairman's office at American Galactic, a couple of weeks later. JACK, JILL and HAROLD enter and seat themselves around a table or in a semi-circle.]

JACK: Have you implemented tough, new cost-saving measures?

HAROLD: Yes sir! We cut out vacations, holidays, raises, [pause; amazed or puzzled] and the *company magazine.*

JILL: Sales are 'way up. Low prices scared the competition, but *not us.*

HAROLD: I'm concerned about expenses, sir. We're paying an extra 30% override commission to the Bunkum Agency.

JACK: (With fake sincerity) No problem. We're writing the *best risks.*

JILL: [laughs] Just ignore him. (matter-of-factly) We're looting the company.

HAROLD: Oh. (vacantly)

JACK: Is the new surety contract in place?

JILL: Uh huh. We provided Financial Guarantee Insurance on Bank of Sark bonds.

HAROLD: What's the Bank of Sark?

JACK: (pompously) It's an offshore, non-bank bank.

HAROLD: Huh?

JILL: [laughs] The *Bank* of Sark is just some crooks who print phony letters of credit. They peddle 'em from an island near England.

HAROLD: Oh. (He is still confused, and is resigned to being confused.)

JACK: How about the investment report?

JILL: We've swapped our U. S. Treasury bills for Bank of Sark bonds.

HAROLD: (confused) But, how can those bonds be safe?

JACK: They're guaranteed.

JILL: [laughs] We insured 'em ourselves.

HAROLD: Uh oh. Here comes the State Examiner.

[EXAMINER enters SR]

EXAMINER: (meekly) Excuse me. The State Insurance Department sent me over to audit your books. What should I do?

JACK: Ah, yes. This is our Annual Statement. [hands him a large sized Annual Statement] It's supposed to give an accurate picture of the company's financial condition. But, it needs to be *verified.*
Here's the draft of the Statement. [indicates a voluminous draft]
Now, you go *verify* that they both have *exactly the same numbers.*

EXAMINER: I can handle that. [staggers out under a load of paper SR]

HAROLD: Gee, how did you guys learn to be so cunning?

JACK: [laughs] I may not be very smart, but the typical insurance person is *so* gullible.

JILL: He's a gull, asking to be cheated....

JACK: A mark, *begging* to be swindled...

I ENJOY CHEATING A GULL
to the tune of I ENJOY BEING A GIRL
Lyrics by Oscar Hammerstein II; Music by Richard Rodgers

JILL: I'm a crook, and by me that's really grand.
I am glad my morality is twisted,
With a pitch that is always underhand,
And promotions not easily resisted.
Yes a confidence game strikes me as funny.
If I lose, it is easy to recoup.
And, the deals keep my disposition sunny,
With the money I embezzle from a dupe.

JILL: I took bribes from a crooked lawyer,
So his claims I would not annul.
And laughed at my dumb employer.
I enjoy cheating a gull.
With insurance [TRIPLET] for offshore drilling,
I paid kickbacks to write the hull.
So the buyer would be more willing.
I enjoy cheating a gull.
I once was a junior claims adjuster.
The work was as dull as it could be.
The job finally gained a bit of luster,
When I thought of a way to pay some claims to *me*.
Don't forget that I'm always greedy;
Don't be fooled by my ballyhoo.
With a new reinsurance treaty,
I could toss all of the loss
Off to a gull like you. [point at HAROLD]

JACK: With an uninsured [TRIPLET] conflagration,
I kept everyone in the dark,
Then back-dated the application.
I enjoy cheating a mark.
When the balance sheet [TRIPLET] faced an audit,
I had bonds from the Bank of Sark.
And that foolish accountant bought it.
I enjoy cheating a mark.
I worked as an underwriting agent,
But, fronting a deal got me disgraced.
The cedent became a most dismayed gent,
When he learned that the reinsurance wasn't placed.

BOTH: Don't forget that we're always greedy,
Don't be fooled by our ballyhoo.
With a new reinsurance treaty,
We could toss all of the loss,
Off to a gull like you. [point at audience]

CURTAIN

SCENE 10

[The curtain rises on JACK and JILL in the Chairman's office. They are giddy with success. HAROLD enters SL with two huge sacks, with dollar signs on them.]

HAROLD: Here's the cash and bearer bonds, Mr. Bunkum.

JACK: The *investible assets*. [JACK and JILL laugh.]

JILL: The *surplus surplus*. [They laugh]

JACK: Who says you can't make money from *cash flow underwriting*? [They laugh]

JILL: *Hasta la vista*, Harold. We're off to Rio. [They laugh]

HAROLD: But, who's going to run the company?

JILL: The *Insolvency Fund*. [They laugh]

[GODFATHER enters SR]

GODFATHER: Where's the money you owe me?

JACK: Here it is. [extends a sack toward GODFATHER]

[SUZANNE enters SL; GODFATHER freezes]

SUZANNE: (brightly) Hello, everybody.

JILL: (coldly) What are you doing here?

SUZANNE: I just want you to meet my fiance...[AG enters SL]...the **State Attorney General.**

[GODFATHER hastily exits SR. JACK hides the sacks behind a desk.]

AG: Jack and Jill Bunkum, now I've finally got the goods on you! You're under arrest. Stand right there.

[AG points downstage right. JACK and JILL move downstage right. CHARLIE, BARBARA and EMPLOYEES enter SL.]

SUZANNE: The old employees came back to see you get yours. (nastily)

AG: These people worked with tenacious Insurance Department investigators to amass all the evidence. They are heroes.

[Piano plays *The Entertainer* leitmotif. AG approaches JACK and JILL.]

JACK: I've got an idea. Let us go; you can share the loot.

AG: (shocked) What? **Never!**

JILL: You moron! He's the law-and-order candidate for Governor.

JACK: (grasping for straws) Well, suppose we help your campaign?

AG: (suddenly interested) What could you do for me?

JILL: We can squeal on the Godfather.

AG: The *Godfather*? (amazed)

JACK: We can work with the State Anti-fraud Unit to ferret out white collar criminals.

JILL: Give us another chance.

JACK: We'll build your reputation as a two-fisted crime-fighter.

JILL: Think of your political future...

AG: [thinks] All right, we can do business together.

BARBARA: What about the company's money?

AG: Here it is. [He grabs the sacks and hands them to BARBARA. JACK and JILL look pained.] Barbara, this company needs a new Chairman. Will you head up American Galactic?

EMPLOYEES: [hands on hearts] Hmmmmm.

BARBARA: There'e no place to go but up! Are you with me?

EMPLOYEES: Yes! OK! Yay! Hooray!

EMPLOYEE 7: (happily) Now I can get back to the **Data Base Project.** *{Mike C.}*

SUZANNE: You're not letting these snakes go, are you, **dear**? (cracking the whip)

AG: Hold your tongue, Suzanne. They've joined my team.

JACK: (with great seriousness) We've learned our lesson. From now on, we'll be sworn enemies of those who would undermine the ethical practice of insurance.

ANYTHING GOES (reprise)

BARBARA, SUZANNE and JILL:
When a leader, who had once been fired
Can suddenly get re-hired,
Then, I suppose,

ALL:
Anything goes.

B, S & J:
When ex-employees get recruited
By a company that's been looted
It surely shows,

ALL:
Anything goes.

B, S & J:
The world has gone mad today,
And good's bad today
And black's white today
And day's night today,

JACK:
And a crook could be
An accessory
To top politicos.
We know you're a career advancer, {*or AG: I know I'm a career advancer*
And so we will hear you answer, *And so you will hear me answer*
When we propose, *When you propose*
Anything goes. *Anything Goes.*}

CHORUS:
The world has gone mad today,
And good's bad today
And black's white today
And day's night today,
And a crook could be
An accessory
To top politicos.
We know you're a career advancer,
And so we will hear you answer,
When we propose,
Anything goes.
Anything goes.

THE END