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Summer 1996
Including the Call Papers on Workers Compensation Reserving & Mega-Risk

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The Casualty Actuarial Society *Forum*
Summer 1996 Edition
Including the Call Papers on
Workers Compensation Reserving & Mega-Risk Liabilities

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4. Authors should avoid using gray-shaded graphs, tables, or exhibits. Text and exhibits should be in solid black and white.

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All comments or questions may be directed to the Committee for the Casualty Actuarial *Forum*.

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by Brian Z. Brown, FCAS
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TITLE: RECENT TRENDS IN WORKERS COMPENSATION COVERAGE

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RECENT TRENDS IN WORKERS COMPENSATION COVERAGE

ABSTRACT

As a line of business, workers compensation has undergone many significant changes in the last few years. Key elements at the forefront of change include the following:

- Increased levels of retained exposure by employers;
- Rapid growth in managed care initiatives; and
- State enactment of comprehensive system reforms.

Due to the above changes, actuaries involved in reserving workers compensation coverage will find it necessary to use new methodologies and assumptions to correctly estimate reserve levels because historical loss data may not accurately predict future cost levels and trends. When employers purchase large deductible insurance they retain the smaller more stable losses and leave the catastrophic exposures to the insurer. This creates increased severities, decreased frequencies and longer tailed reporting and payment patterns. Use of managed care techniques should decrease medical severities and should also decrease indemnity severities and will likely cause a shift in frequency among types of injuries. The impact of statutory benefit level reforms must be assessed before all affected claims are reported and settled. Thus the challenge will be to make well informed judgments as to the impact of such comprehensive changes on future reserve levels. The purpose of this paper is not so much to answer questions but rather to raise the types of questions the reserving actuary must ask in order to revise and revamp his or her approach to reserving workers compensation exposures.

RECENT TRENDS IN WORKERS COMPENSATION COVERAGE

INTRODUCTION

Several changes have occurred in the workers compensation marketplace in recent years. Three of the most significant changes which affect reserve levels are:

- Increased levels of retained exposure by employers;
- Rapid growth in managed care initiatives; and
- State enactment of comprehensive system reforms.

The first section of this paper describes how the increased retention of the exposure by insureds affects standard reserving techniques. This section also describes a relatively simple modification to the standard Bornhuetter-Ferguson procedure which is used in reserving excess/reinsurance products.

The second section discusses managed care initiatives and how they impact standard reserving assumptions. This section also provides a general discussion of the various roles of the insurance carrier, employer, employee, case manager, claim adjuster and medical provider in a managed care setting. In describing these roles we outline the managed care process and highlight some of the savings associated with managed care initiatives.

The third section discusses some special financial arrangements between insurance carriers and managed care organizations and discusses the effect these arrangements may have on reserve levels. As a natural extension of this section, we outline some techniques for measuring managed care savings in workers compensation.

The fourth section discusses how health insurance principles can be used to derive a capitated rate for workers' compensation medical costs.

Finally, we take a brief look at the types of workers compensation reforms that have occurred over the last few years and how these reforms may affect loss reserves.

I. HIGH DEDUCTIBLE RESERVING ISSUES

Starting in the early 1990's, many carriers began to offer high deductible policies to their workers' compensation insureds. These deductibles would usually range between $50,000 and $1,000,000 per occurrence. These products were offered to:

- Reduce the carriers' share of the highly unprofitable residual markets in several states;
- Compete with self-insurance and excess workers compensation products;
- Have the insured share in its own loss experience and directly benefit from effective risk management procedures and pay for ineffective procedures; and
- Market a product that fits in with some companies' strategic plans.

These policies create complications for many reserving analysts who previously may have only reserved "first dollar" workers compensation products. The extended and slow reporting patterns displayed by many workers compensation industry statistics is almost unfathomable. For example, recent data published by the Reinsurance Association of America implies that only 50% of the losses are reported 8 years after the beginning of the accident year[1].

If a primary company begins to write excess/high deductible workers compensation products and does not separately analyze this experience, reserve projection methods may produce biased results. We will illustrate this through an example where the reserve analyst uses a simple incurred loss projection method. However, instead of analyzing the data separately for high deductible products and primary products, the analyst assumes that the combined loss experience will be reflected in development factors and result in unbiased projections. This approach will significantly understate a company's estimated reserves.

To illustrate this point, assume:

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[1] 1995 edition of Reinsurance Association of America. The 8 year period assumes a relatively low per occurrence retention (e.g., $50,000 - 200,000). It would take longer than 8 years for one-half of the losses to be reported if the retention were higher. We would also note that reporting patterns differ significantly from company to company and some carriers (especially those who specialize in excess/high deductible workers compensation exposures) may display significantly quicker reporting patterns than average industry statistics as published by RAA. The reporting pattern is heavily dependent upon the carrier's case reserving philosophy (e.g., use of additional case reserves) and how quickly claims are reserved as permanent total disability cases.

- Company A has been in existence for 15 years and prior to year 10 only wrote first dollar workers' compensation coverage in 15 states.

- Starting in year 10 Company A began to offer high deductible policies, all with a deductible amount of $100,000.

- The high deductible premium represents 5% of total premium in year 10 and grows to 10% in year 11 and 15% in year 12 and subsequent years.

- Company A assumes that the high deductible policies are a small percentage of the total so it does not alter its reserving procedure (which consists mainly of an incurred loss development method based on the historical weighted average development factors).

- The incurred development projection produces an accurate estimate of reserves for years 9 and prior.

As the attached Exhibits 1-4 display, this approach will substantially underestimate reserve levels. The reserve underestimation represents over 30% of carried reserves at the end of year 15.

This example is based on a hypothetical block of workers compensation business and is intended to highlight the importance of separating the high deductible experience and analyzing it separately.

It should be noted that in addition to the reporting pattern difference, two other factors will affect the reserve shortfall using Company A's traditional approach:

1) The trend for excess losses exceeds the trend in primary losses; and

2) The ultimate undiscounted loss ratio for high deductible policies generally exceeds the loss ratio for primary policies. This is largely because investment income will be substantial for high deductible policies.

As the above example implies, the extended reporting pattern for excess/high deductible workers compensation products compels the actuary to place little weight on the unadjusted traditional incurred projection method.

We would recommend that the following techniques be utilized to estimate reserves for the carrier's high deductible exposures:

1) Counts times average severity [2];
2) Trended pure premium method[2];
3) Expected loss ratio method;
4) Bornhuetter-Ferguson method (B-F); and
5) B-F method - adjusted for off-balance.

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[2] See *Funding for Retained Workers Compensation Exposures* by Brian Z. Brown and Michael D. Price, CAS Forum, 1994 for a discussion of these methods.

Additionally, we would recommend that medical losses be analyzed separately from indemnity losses. These two types of losses have different development patterns and much of the excess development in the older accident years is usually attributable to medical losses.

Methods 1-4 are widely used and discussed in detail in the actuarial literature[3]. We believe that method 5 is also used but the particulars of this method are not as well published. Therefore, we will provide a brief description of this method.

There are two parameters (assumptions) which are needed to perform B-F calculations by accident year.

- A set of á priori loss ratios (which will vary by accident year based on rate adequacy as well as other factors); and

- An assumed reporting pattern for incurred losses.

When analysts select their assumptions, they use their best actuarial judgement; however, they will not know for many years (or possibly not even in their lifetime for excess workers compensation) if these assumptions are correct. Additionally, the assumptions need to be revisited

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[3] NCCI publishes data to assist in selecting excess frequency and severity assumptions - see Gillam, Retrospective Rating: Excess Loss Factors (PCAS LXXVIII). Additionally, many carriers can create historical excess experience by imposing phantom deductibles on previous first dollar claim experience. Methods 1 - 4 above refer to projections in the excess layer (i.e., for method 1 the counts and average severity are for the excess layer).

annually, and modified if indicated. The B-F off-balance method incorporates an additional step into the traditional B-F method. This adjustment is documented in Exhibit 5 and involves comparing actual reported losses to expected reported losses (for all accident years) and adjusting the á priori loss ratios for a portion of the difference in the ratio of actual to expected reported losses.

One potential shortcoming with the traditional B-F method is that if actual loss experience is worse (or better) than expected due to an understatement (or overstatement) in the á priori loss ratios, it may take a long time before this is reflected. The B-F adjustment, as displayed on Exhibit 5, corrects for this phenomenon by adjusting for 50% of the indicated off-balance (i.e., the percentage difference between the actual reported and expected reported losses).[4] We selected the 50% for illustrative purposes. We believe that it is important that the actual loss experience be used (at least partially) to modify the initial assumptions.

In our first example on Exhibit 5, we constructed a scenario where the analyst selected an á priori loss ratio of 80%, whereas the actual loss ratio is 100%. We then display the corresponding off balance calculations. For all accident years combined, we would have expected $1.2 million of losses to be reported; however, $1.5 million was actually reported. This should alert the analyst

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[4] It should be noted that analysis of the data may assist in selecting the off-balance weighting. For example, if the ratio of actual to expected losses is less than one for all accident years, it may imply that the á priori loss ratios are overstated (indicating an off-balance weighting near 1.00 or revision of the á priori loss ratios). However, if there is a trend in the ratio of actual to expected losses it may imply a bias in the reporting pattern (this would indicate a low off-balance weighting and a revision to the reporting pattern). In other cases, it may not be clear from analysis of the data which assumption is biased so a weighting near 50% may not be unreasonable.

that one (or both) of the underlying B-F assumptions may be incorrect. Underlying assumptions should be scrutinized, particularly if the ratio of actual to expected losses is either consistently less than 1.00 or greater than 1.00 for multiple accident years. However, it may be difficult or impossible to determine whether the á priori loss ratios should be modified or the reporting pattern should be modified. Therefore, we introduce the off-balance calculation.

In the example on Exhibit 5, the actual reported losses are 25% higher than the expected losses. Therefore, we adjust these á priori loss ratios upward by 12.5%, or one half of the off-balance. We theorize that since actual experience is not consistent with our expectations, either the á priori loss ratios are understated, the reporting pattern is too slow or the experience to date has a relatively large random element. We have assumed that 50% of the difference is attributable to the á priori loss ratio assumption. The bottom of Exhibit 5 displays the revised B-F calculation and the resultant loss ratio of 93% for all accident years combined. This adjusted B-F calculation produces results closer to the actual loss ratio of 100% than the initial unmodified B-F calculation which produces a loss ratio of 86% for all years combined.

The accuracy of the off-balance calculation is dependent upon many factors including:

- The accuracy of the initial assumptions; and

- The randomness associated with the actual reported losses to date.

As mentioned above, we believe that if the actual losses reported to date are consistently and significantly different than expectations, then the analyst should repeatedly review the assumptions underlying the B-F calculation. If the analyst does not have enough additional information to modify the assumptions, we believe that the B-F adjusted for off balance should be reviewed when selecting ultimate loss ratios. We have computed B-F calculations both with and without an adjustment for off-balance for the following scenarios (note that we have assumed that the "true" loss ratio is 100%):

Unadjusted B-F Loss Ratio - All Years			
Reporting Pattern	**Loss Ratio Assumptions**		
	Less Than Actual	**Equal to Actual**	**Greater than Actual**
Quicker than Actual	75%	86%	97%
Equal to Actual	86%	100%	114%
Slower than Actual	90%	105%	120%

The corresponding calculation for the adjusted B-F is as follows:

Adjusted (for off-balance) B-F Loss Ratio* - All Years			
Reporting Pattern	**Loss Ratio Assumptions**		
	Less Than Actual	**Equal to Actual**	**Greater than Actual**
Quicker than Actual	72%	77%	83%
Equal to Actual	93%	100%	107%
Slower than Actual	105%	113%	120%

*For 50% of the off-balance

For the examples we constructed, the adjusted B-F calculation produces more accurate indications when the expected reporting pattern is accurate. It is also generally more accurate when the á priori loss ratio is understated. As a note, understatement of the á priori loss ratios is often a concern for reserving actuaries.

II. MANAGED CARE INITIATIVES

Description of Managed Care Initiatives

The objective of workers compensation managed care can be summed up in one sentence; "To combine medical cost containment with optimal medical treatment and concurrently expedite worker re-entry into the work force." The process of managed care has many possible components, which is why there are many different definitions of managed care floating about. A comprehensive workers compensation managed care program requires committed participation from all interested parties: the insurance carrier or third party administrator (TPA), the medical provider (hospitals, physicians etc.), the case manager, the utilization review vendor, the employer and the employee. Each participant brings to the table a component of the managed care process. For example:

- Insurance carriers and TPA's must be dedicated to proper claims handling. Workloads per examiner should be reasonable (e.g. maximum of 150-200 lost time files per claims handler). Claims handling policies and procedures should foster pro-active, investigative, cooperative claims handling that is always focused on the ultimate goal of claim resolution and returning injured workers back to work.

- Via preferred provider organizations (PPO's) physicians, hospitals, durable equipment vendors, home health care providers etc. agree to provide medical goods and services at pre-negotiated discounts as long as one of the providers in the PPO is used. The pre-negotiated discounts are usually 15% to 25% below the charges allowed by the legislated workers compensation fee schedule for a given state, if one exists. If there is no fee schedule then the pre-negotiated discounts will be less than the usual and customary charges for the area. Discounts typically vary by type of provider. An orthopaedic surgeon will often give less of a discount than an internist simply due to the law of supply and demand. Providers must be focused not only on proper medical treatment for the injured worker but also in returning that worker to gainful employment as soon as feasible (in order to reduce indemnity payments). Thus it is not sufficient to simply use a typical health care PPO for workers compensation injuries. Workers compensation PPO's must include occupational medicine physicians, providers must be trained on return to work issues, and some types of speciality physicians, such as obstetricians, may not be necessary at all.

- Health maintenance organizations (HMO's) are also providers of workers compensation medical services. HMO's provide comprehensive medical care for a negotiated fixed fee per person, payable per month/year, called a capitated rate which is paid to physicians for delivery of all health services to injured workers. The capitated rate is fixed regardless of the amount/type of service rendered. Physicians and other health professionals are on salary or under contract with the HMO to provide such services at the capitated rate. Injured workers are steered by their employer to a primary care physician (gatekeeper) within the HMO who decides upon appropriate medical treatment and refers injured workers to specialists within the HMO if necessary.

A case manager is typically a registered nurse with a certified case manager (C.C.M.) designation and experience in handling industrial disability cases. The case manager ensures that proper medical treatment and return to work protocols are applied for a specific type of injury. Such protocols are available from several different sources including Milliman and Robertson, Interqual and the Commonwealth of Massachusetts Department of Industrial Accident Study. Many managed care organizations develop their own internal protocols as well. The case manager develops a treatment plan for the injured worker based on protocol and the particular set of circumstances, communicates it to the treating physician, employer, employee and claims handler and then constantly monitors the treatment process to keep it on track. The case manager will also work closely with the employer and perhaps a vocational rehabilitation specialist to develop appropriate light duty (return to work) programs where necessary.

- Utilization review is often outsourced to a vendor. The goal here is to influence, manage, assess, improve and review patient care on an individual case basis. Via utilization review, medical treatment is evaluated based upon frequency, duration, and medical reasonableness and necessity. Utilization review can be conducted on a prospective, concurrent or retrospective basis to pre-certify hospital admissions.

- The employer's role in managed care is pervasive. Employers should have well defined light duty work programs for injured workers including a video tape library of available jobs, job descriptions with applicable stated salary and defined duration of job availability. Employers should educate employees regarding the importance of reporting all injuries immediately to a supervisor and in explaining the workers compensation system and available benefits.

Supervisors must be trained to steer injured workers into the employer's PPO or HMO and to immediately report claims to the carrier or TPA. It is imperative that employers maintain effective communication with an injured employee via frequent telephone calls, personal visits, cards and inclusion in any company sponsored events so that the employee knows that the employer is genuinely interested in their return to good health. This will also tend to keep the employee/employer relationship from being adversarial, which often leads the employee to hire an attorney. Wellness programs should also be offered to all employees e.g. weight reduction programs, smoking cessation programs and newsletters/literature on pertinent health topics.

- The employee's willingness to be restored to good health and gainful employment is critical to the ultimate success of a managed care program. The claims examiner, case manager and employer must all work together to assure the employee that they are receiving the proper medical treatment and that the employer is ready for them to return to work the moment they are released to do so by their physician.

Obviously the most effective workers compensation managed care program is one where all participants are committed to the common goal of returning the injured worker to full health and thus to their job as quickly as possible. Now that we have described the basic elements of a managed care program, we will review the results of three different studies that measure the savings of different types of programs. We will then discuss the possible impact on reserving of different aspects of managed care.

Potential Cost Savings Due to Managed Care Initiatives

Findings of Actual Studies

Presented below are findings from various studies performed which measure savings generated by using managed care techniques on work related injuries.

Florida Insurance Department Workers Compensation Managed Care Pilot Project[5]

The pilot project consisted of two programs. The first involved 17,000 state government employees in south Florida. Half of these employees received medical care via an HMO and half through the traditional "fee-for-service" arrangement (known as the control group) where no managed care initiatives were used. The second program was for 7,500 privately employed workers in the Tampa-St. Petersburg area. Medical care for these workers was provided through a PPO. Loss data for the study consisted of payments on claims with accident dates between June 15, 1991 and March 15, 1993. Over 5,500 individual claims were included.

Findings

The authors of the study observed significant differences in the average costs of injuries treated under managed care versus the traditional "fee-for-service" arrangement. In general the differences were attributed to lower use of hospital services, lower incidence of indemnity claims and fewer and less costly use of physician services in a managed care environment.

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5) "Florida Managed Care Pilot Program; July 1, 1994 Final Report", prepared by Philip S. Borba, Ph.D., David Appel, Ph.D., and Matthew Fung, Ph.D of Milliman and Robertson, Inc.

HMO Results

Average claim costs for the HMO participants were 60% lower than the average claim costs in the control group. Of this 60% savings:

- 6-7 percentage points were attributable to lower incidence of indemnity claims and shorter duration of indemnity claims

- 8-12 percentage points were attributable to less frequent use of hospital services

- 0-5 percentage points were attributable to fewer days of treatment and fewer numbers of physician treatments

- 26-40 percentage points can be attributed to other aspects of managed care such as payments for medical services were discounted 15% off the Florida fee schedule and HMO participants were treated with a less costly mix of services.

PPO Results

Average claim costs for the PPO participants were 28% lower than the average claim costs in the control group after area factors were considered. Of the 28% savings:

- 7-8 percentage points were attributable to reduced incidence and duration of indemnity claims

- 12-13 percentage points were attributable to less frequent use of hospital treatments

- 2-7 percentage points were attributable to fewer days of service and medical treatments

New Hampshire Workers Compensation Assigned Risk Plan[6)]

On April 1, 1993, Liberty Mutual Insurance Company and Healthsource New Hampshire became the sole servicing carrier of the New Hampshire assigned risk plan. Healthsource directs the application of managed care techniques such as negotiated fee reductions with providers, use of less costly services, recommendations regarding optimal treatment patterns and review of invoices for reasonableness of charges both in regard to amount and appropriateness of procedures in light of diagnoses. Healthsource has also introduced wellness programs for employers. Both Liberty Mutual Insurance Company and Healthsource worked with employers to improve their return to work programs.

Findings

Paid loss ratios after April 1, 1993 were 20% to 27% lower than expected based on historical plan experience:

- 7 to 12 percentage points of the savings were attributable to lower than expected average claim costs

6) "A Preliminary Evaluation of Changes to the New Hampshire Worker's Compensation Assigned Risk Plan as of March 31, 1994" Prepared by Milliman and Robertson, Inc.

- 14 percentage points of the savings were attributable to fewer claims and/or more premium than expected. (i.e., the reduction is probably a result of loss prevention programs, wellness programs and an increase in the premium collected relative to historical levels.)

Intracorp/NCCI Methodology for Measuring Financial Impact of Workers Compensation Managed Care Techniques[7]

Since 1970, Intracorp has been providing workers compensation rehabilitation and managed care services across the United States and Canada. This study measures the impact of their Early Assessment workers compensation managed care product which combines early reporting and intervention with aggressive medical, utilization and return-to-work management by registered nurses using internal protocols. Potential savings from use of a PPO were not measured.

The NCCI studied 38,000 lost time claims in many states from several of Intracorp's largest customers including a multi-state self-insured employer and a state fund. 5,000 of these claims were managed by Intracorp, the others were not. The NCCI measured claim costs from these sources over identical time periods and controlled for variables influencing claim costs such as state legislation, medical and indemnity inflation, employee population, age and catastrophic claims experience.

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7) Intracorp/NCCI Methodology for Measuring Financial Impact of Workers Compensation Managed Care Techniques. December 1995.

Findings

- On average, claim costs dropped about 23% when case management intervention took place within three months of accident date.

- Managed claims closed 27% faster than those that were unmanaged.

- Savings are highest on the longest, most severe cases and Early Assessment successfully selects these cases for management.

While each study employed a different managed care model and focused on different cost drivers, one item commonly measured was the decrease in average claim cost.

Managed Care				
	Florida Study		NH Assigned Risk Plan	Intracorp
	HMO	PPO		
Average Claim Cost Change	-60%	-28%	-7% to -12%	-23%

In light of the findings of these studies, what would **you** say regarding the potential savings of a managed care program? One question rarely asked is "What were the baseline claims handling philosophies, processes and procedures before managed care techniques were applied?" What are we measuring from? If claims handlers were simply bill payers (as does happen sometimes) and a comprehensive managed care model was introduced to the process then a radical savings could be achieved. If claims handlers are adeptly performing their duties and applying certain aspects of managed care on their own already (e.g., trying to properly manage the medical component of a claim) then managed care techniques may have a lesser impact on cost.

Also, one element of the studies to keep in mind is that the evaluation periods were not long enough to capture all medical and indemnity payments on long-duration claims, which of course are the most expensive workers compensation claims. Even though the various studies displayed a wide variation in their estimates of managed care savings, all of the programs produced savings of some amount. Thus it appears likely that implementation of managed care in general will reduce future year's loss ratios. This information may be used in selecting á priori loss ratios for Bornhuetter-Ferguson calculations when estimating reserve levels.

Reserving Implications

As actuaries we must quickly become keenly aware of the cost savings potential of employing a comprehensive workers compensation managed care program. Indeed, we will (if we haven't already) be asked by our employers and co-workers to measure the savings under a given set of specific circumstances. We say "under a given set of specific circumstances" rather than "in general" because there is no way to accurately measure the savings "in general". Many questions must be asked before making a measurement. For instance;

- Is the claims examiner for the carrier or TPA cooperating with the case manager? Does the case manager give the claims examiner appropriate information so that the examiner can set medical and indemnity case reserves accordingly? Effective communication between the two individuals means more accurate and timely case reserves and increases the chances that the injured worker will be returned to work more quickly. This will potentially affect a company's reporting and payment patterns.

- If a PPO is used: What is the distribution of physicians by type of speciality? What is the discount by type of physician? What types of physicians are likely to be visited the most often (e.g. occupational medicine) and how will this affect the "average" physician discount likely to be achieved? Is there appropriate geographic coverage of the network? (e.g., what is the value of having three orthopaedic surgeons in the network, all of them residing in one urban area, if many of your exposures are in outlying rural areas at the other end of the state?) What hospital discounts are available? What is the distribution of medical costs between hospitals and physicians for the types of claims expected to be experienced? In general, the more comprehensive the PPO arrangement the greater the reduction in ultimate losses.

- If case management is used to what claims will it be applied, e.g., all claims including medical-only or all lost time claims or only catastrophic claims such as spinal cord injuries? Will case management decrease medical costs, on a percentage basis, more for smaller claims (temporary total and temporary partial) or for larger claims (permanent partial and permanent total)? If the decrease does vary by injury type then what will the average decrease be? Will case management increase or decrease disability duration? If the case management process works correctly it is likely that claims will be resolved quicker, which implies a speed up in reporting and payment patterns. Allocated loss adjustment expense may be reduced if employees are treated such that they do not feel the need to hire an attorney to help them through the workers compensation maze. Also, overall medical severities should decrease and the frequency of medical-only claims may increase as more injuries are kept from becoming temporary total.

- If utilization review is used is there a possibility of duplicative efforts between the case manager, the claims handler and the utilization review vendor? This may increase the need for ULAE reserves.

- How effective is the employer at steering injured employees into the PPO? Does the employer lack a return to work program so that even if managed care enables employees to come back to work more quickly there is no job waiting for them? Return to work programs with light duty jobs will reduce ultimate costs and the resulting needed reserves.

- Are employees satisfied with the quality of care they are receiving? Is the employee a willing participant in the process, e.g., do they show up for their medical and rehabilitation appointments? The more they cooperate, the lower ultimate costs will be.

- How were claims handled in the past? If the insurance carrier or TPA was doing little in terms of managed care, before they implemented a comprehensive program, the potential for cost savings is very large. If they were doing an excellent job of pro-active claims handling prior to managed care then the impact will be less.

The above are only samples of questions to be asked. The point is to know the specifics of the managed care model you are working with and attempt to determine how that particular model will affect reserves in reality versus how it might look in theory.

II. MANAGED CARE FINANCIAL ARRANGEMENTS

Contracts with a Managed Care Organization (MCO) can have significant impacts on estimating workers' compensation reserves. This section will briefly describe some MCO arrangements and their effects on estimating reserves.

A) **Discounted Fee For Services**

Discounted fee-for-service refers to a reduction from the providers normal fees for certain groups. Larger groups with significant bargaining power are frequently able to reduce medical fees in return for the commitment to channel a large number of injured workers to a particular provider. Many companies have been using this type of arrangement with medical providers for several years. Additionally, in some states, a fee schedule may function like a discounted fee for service arrangement. This type of arrangement is generally believed to have a small impact on total workers compensation costs, unless implemented with other procedures (i.e., utilization review). Providers may agree to discount services but increase utilization.

Discounted fee for service arrangements can be reflected by modifying á priori loss ratios and expected future development if the anticipated savings can be quantified.[8)]

B) **Case Rates**

Case rates refers to a flat fee per claim for medical costs. Typically the flat fee varies by type of injury (e.g., lower back sprain). One potential disadvantage of this method is that it may encourage providers to substitute "bed rest" as a treatment in place of other treatments to heal injured workers. Thus, case rates may cause a rise in indemnity costs if not properly managed. As discussed later, dividend compensation arrangements have been introduced as an attempt to offset this reduction in treatment incentive. Under this type of arrangement, the savings associated with an MCO are estimated and a percentage of the savings is paid to the MCO in the form of a dividend.

If the case rates are paid up front, this could dramatically speed up the workers' compensation medical reporting and payment patterns. Additionally, if case rates are fixed for the life of the claim, the analyst may consider extracting them from the data and treating them separately (since future medical development may be minimal). If the case rates are only fixed for 12 months of care after the date of injury (or if case rates are negotiated annually), standard reserve projection methods may not be as materially biased.

[8)] Brian Brown and Michael Price in "Funding for Retained Workers' Compensation Exposures" quantified the effect of a future 1% trend reduction for workers' compensation medical costs. IBID 2.

C) **Capitated Rates**

Capitated rates refers to a flat fee to be charged for all workers compensation claimants for certain or all medical expenses. Capitated rates require significant modification to reserve projection techniques. The extent of the modifications will vary depending on the extent of capitation. We will briefly describe the adjustments for various levels of capitation.

1) Full Capitation For All Workers Compensation Medical Costs

Under this arrangement, the workers compensation carrier pays a fee to an MCO and the MCO agrees to provide all medical services (for the life of the claim) for claims occurring during a certain time period. Under this arrangement, the carrier has in essence transferred its workers compensation medical exposure to the MCO. Therefore, the carriers' expected retained unpaid obligation is zero after it has paid the fee (ignoring credit risk and the fact that some claims will not be covered by the MCO arrangement).

The attached exhibit 6, which is based on a presentation given by Ms. Ruth Bauman of Blue Cross and Blue Shield of Oregon, illustrates the transfer of risk from employees to MCO's and finally to physicians under a capitation arrangement.

However, in most cases the MCO will not be responsible for:

- The lifetime of the claim;

- All claims (especially those occurring outside of the state); and

- The full medical expense on catastrophic claims.

Therefore the reserving analyst will need to estimate an accrual for the above items.

2) Partial Capitation

Under this arrangement the MCO may be responsible for:

- Most medical expenses for a 1 to 3 year period after the injury date of a claim; and

- The first portion (e.g., $50,000) of medical costs per claim.

In this case the reserving analyst is required to estimate a provision for:

- Claim payments made after the 1 to 3 year period for a given accident year; and

- Claim cost above $50,000.

Claim payments made 1 to 3 years after the accident date can be estimated based on the company's historical data, if available. For example, claim payments made after 3 years can be compared to payroll or premium (both should be adjusted to current cost and benefit levels). Additionally, an expected amount by claim, or type of claim, can be constructed from the company's historical data.

The expected medical payments above a threshold during the first 3 years can also be computed based on historical claim experience. Historical claims can be projected to ultimate values as well as to current cost levels, and an average provision by claim (or type of claim) can be estimated.

3) **Limited Capitation**

For this arrangement only certain types of claim procedures are subject to capitation, and the capitation is only effective for one year.

The procedures outlined above for Section C2 - Partial Capitation can be used to estimate reserves. A claim count times average severity method also may be well suited to estimate outstanding reserves after the 1 year capitation arrangement. The severity used in this case should be the medical severity for payments in years 2 and subsequent. Additionally, claim counts will correspond to all claims expected to remain open after the capitation arrangement has ended.

D) **Dividend Formulas Between Workers Compensation Carriers and the MCO**

It appears that many carriers and the MCO are using dividend plans for the following purposes:

- An incentive to the MCO to return injured workers back to work;
- To reward the MCO for effectively and efficiently managing care; and
- To have the MCO guarantee payments to carriers if loss experience is adverse.

We will describe two types of dividend programs:

1) An incurred loss ratio plan; and

2) An average severity method.

One form of the incurred loss ratio plan involves comparing the actual reported losses to a target loss provision at intervals 2, 3, and 4 years after the end of an accident year or policy year. The target loss provision is equal to the actual earned premium multiplied by a target loss ratio (adjusted to reflect the estimated percentage of losses expected to be reported at the evaluation interval). The dividend is equal to a portion of the amount by which actual losses are below the target losses. In other words, to the extent that the MCO is able to reduce costs, part of the savings will be shared with the MCO. As a technical note, claim payments above a certain threshold are usually excluded. Exhibit 7 displays a sample calculation.

This method has several limitations in measuring savings attributable to the MCO's involvement, because:

1) The frequency (i.e., the number of claims) is usually outside the control of the MCO; and

2) Claim costs vary depending on the type of injury, and injury type is also usually outside the control of the MCO.

Therefore, some dividend plans may develop expected costs based on an estimated severity (average cost per claim) for the prospective period, rather than in aggregate. The actual number of claims is then multiplied by the severity estimate to determine the target claim costs. This target claim cost can then be compared to the actual reported claim costs to derive the indicated dividend. Exhibit 8 displays the calculation for a sample program based on the average severity method.

This average severity plan may result in the MCO receiving a dividend even if actual total claim costs exceed initially targeted claim costs (calculated in aggregate based on the number of expected claims). In other words, the greater than expected number of reported claims is reflected in the target claim costs for this method. This is believed to be appropriate since claim counts are generally assumed to be outside the control of the MCO.

An additional modification to the average severity method would involve computing the target costs based on benchmark average claim costs by type of injury. For example, expected average severities could be computed by injury type (i.e, ICD-9 code combination). For this method, the target costs are computed by multiplying the actual number of claims for each injury type by the expected severity for that injury type. These products are then summed across all injury types to arrive at an aggregate target cost. The actual costs are compared to the target cost to estimate the projected savings (and a portion of the savings is returned to the MCO in the form of a dividend).

It is important for the reserving analyst to estimate an accrual for dividends to the MCO if the analyst's company is using these types of arrangements.

IV. DEVELOPING WORKERS COMPENSATION CAPITATED RATES

One approach used to estimate capitated rates for workers compensation medical costs which has been developed by health actuaries is to project the workers compensation medical costs for a group of injuries based on health insurance data. An average cost is then computed based on the probability of a certain condition and the associated costs of the treatment for the condition. We will illustrate this type of analysis for an industrial ankle injury.

The first step is to analyze the costs for ankle injuries in more detail. Possible combinations of ankle injuries include:[9]

1) Fractures or Dislocations
   ICD-9 Codes: 823.2X, 823.3X, 824.X, 837.0, 837.1, 928.21

2) Sprain, Sprain-Fracture or Contusion
   ICD-9 Codes: 845.0X, 924.21

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[9] Health insurance costs are captured by ICD-9 codes. The ICD-9 code refers to the 9th revision of the International Classification of Diseases.

3) Laceration
   ICD-9 Codes: 891.0, 891.1, 891.2

4) Tendinitis
   ICD-9 Codes: 726.71, 726.72, 726.79, 727.06, 727.67, 727.81, 845.09

5) Traumatic Arthritis, Acute Episodes
   ICD-9 Code: 716.17

6) Systemic Disease
   ICD-9 Codes: Multiple

Milliman & Robertson, Inc. has developed Healthcare Management Guidelines (HMG) based on data from managed care plans and input from employed physicians. These guidelines include ranges of time within which injured workers are expected to return to work by injury type (i.e., grouping of ICD-9 codes). An example of these guidelines is included as Exhibit 9. The guidelines also include ranges of the duration of care by injury type, as displayed on Exhibit 10.

The Healthcare Management Guidelines also include frequency and cost statistics for the procedures used in the course of treatment of various injuries. Procedure statistics are delineated by CPT code, which refers to the code assigned to a medical procedure under the Physicians Current Procedural Terminology.

Exhibit 11 outlines initial care statistics for ankle fractures and dislocations. As shown on Exhibit 11, it is expected that 80% of all cases will be initially treated by an office visit, and 20% will be treated in the emergency room. The probabilities of various procedures being used for treatment are then listed by CPT Code in Column (b). Based on these probabilities combined with the expected number of times each procedure will be required (Column (e)) and the expected price per service (Column (f)), the expected price for each course of treatment can be derived (i.e., by summing across all CPT codes the product of columns (b), (e), and (f). The $353 estimated total cost for initial care is then calculated (see Exhibit 11) by computing the weighted average cost across both courses of treatment using the treatment probabilities in column (a) as weights. The follow-up care for ankle fractures and dislocations may be treated in three fashions:

- Completely by primary care physicians;
- Closed surgery by a specialist; and
- Open surgery by a specialist.

Estimated costs for each of these courses of subsequent treatment are calculated in the same manner as the initial care cost estimate. These calculations are outlined on Exhibits 12, 13, and 14.

Based on optimal treatment patterns and the health insurance data outlined above, the following costs and treatment probabilities for an ankle fracture and dislocation are estimated:

Probability	**Course of Subsequent Treatment**	**Cost of Treatment***
71%	Therapy by Primary Care Physician	$1,280
4%	Closed Therapy by Specialist	2,900
25%	Open Surgery by Specialist	4,900
Average		$2,250

*Including the cost of initial care

It should be noted that this is the cost for an optimally managed case[10]. It is expected that care will not always be optimally managed and some workers will require more services than expected due to extreme cases. These factors could be built into the pricing by adding a loading for additional costs or procedures (or both).

The final element which is needed in estimating a capitated rate is the probability of a certain type of claim. This may be done through an analysis of historical claim data (e.g., claim frequency per $100 of payroll by injury type). The capitated rate could then be derived by multiplying the cost of each injury by the estimated probability of that injury and calculating the total across all types of injuries.

V. REFORMS OF WORKERS COMPENSATION SYSTEMS

From 1983 through 1992 workers compensation countrywide combined ratios ranged from 113% to 123%, residual market operating losses soared and several insurance carriers withdrew from writing voluntary coverage. These factors lead thousands of employers to opt for self-insurance to escape workers compensation insurance rate increases and the frustration of being unable to obtain coverage outside of an assigned risk pool. All system participants proclaimed the need for reforms that would alter the system to truly reduce the cost levels and trends of workers compensation benefits without sacrificing equitable compensation for the injured worker. Thus was born an era of change. From 1991 through 1995 approximately 60% to 65% of the states

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[10] The above example is based on a presentation by Richard Minifie, ASA, MAAA, of Milliman & Robertson, Inc., titled "Developing Capitation Rates Consistent with Clinical Practice Guidelines."

implemented some type of workers compensation reform, ranging from instituting medical fee schedules to totally overhauling all aspects of the benefit delivery system. Several other states are currently developing plans for reform.

Types of Reforms

Listed below are examples of different types of reform and the potential effect on loss reserves.

- Compensability can be restricted. Originally workers compensation benefits were for injuries that arose out of the course of employment. Over the years compensability has been interpreted more and more liberally by courts, for example, considering an injury to be compensable when it occurs at a softball game after work when the team is made up of employees from a common employer. Additionally, stress claims have been filed by employees due to fear or dislike of a fellow employee and some courts have deemed these to be work related claims. If a reform can bring compensability back into line with it's original intent then of course the number of compensable workers compensation claims should decrease. This reduction in frequency should reduce future year's loss ratios.

- Total disability. The duration for temporary total disability can be restricted to fewer weeks, which will lower indemnity severities. The definition of permanent total injuries has been narrowed considerably in some states, e.g., in Florida as of January 1, 1994 total disability is limited to injuries such as severe paralysis, amputation, major burns or other injuries that would qualify for Social Security disability benefits. This type of reform may increase indemnity and medical severities for permanent total injuries (because it removes the lower dollar cases from the permanent total category) while reducing their frequency. Some states escalate the indemnity portion of total disability benefits by an annual cost of living factor. Connecticut decided that for injuries occurring on or after July 1, 1993 the escalation factor would no longer apply. This change should greatly decrease indemnity severities and shorten the tail on payment patterns.

- Permanent partial disability. "Permanent partial disability claims represent the largest share of losses in many states, are among the most complex benefits to deliver, and bring more attorneys into the workers compensation system than any other type of claims."[11] These benefits vary greatly among states and can be based on the degree of impairment or wage loss or loss of earning capacity. Rather than delve into each type of compensation available suffice it to say that any major reform dealing with this injury type should be studied closely by reserving actuaries.

- Alternative dispute resolution/restriction of attorney involvement. Comprehensive reforms often include these areas. Alternative dispute resolution processes are meant to be a more informal, non-adversarial means to resolve claim disputes between employers and employees without the involvement of attorneys (for either side), i.e., without the need to go to court for a hearing. Other reforms specifically aimed at curbing attorney involvement include elimination of lump sum awards for claimants (because they are very enticing to plaintiff's

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[11] BNA's Worker's Compensation Report, July 24, 1995. "NCCI Report Examines State Differences in Permanent Partial Disability Benefits"

attorneys who usually get one third of the award). Some states have also limited attorney fees to much less than one third of the award. For instance, Florida's January 1, 1994 law limits awards to attorneys for indemnity payments to 20% of the first $5,000 in benefits, 15% of the next $5,000 and 10% of the remaining benefits payable within 10 years and 5% of benefits payable after that.[12] Obviously such reforms should greatly reduce allocated loss adjustment expense payments as fewer cases will work their way into the court system.

- Medical care cost containment. Various medical cost containment strategies have been implemented in most states including employer choice of physician, limited provider change, use of medical fee schedules, regulation of hospital charges, mandated utilization and/or bill review and use of other managed care techniques. The Workers Compensation Research Institute has examined the use of such cost containment strategies over the past five years. Exhibit 15 shows the types of cost containment measures that were in effect from 1991 to 1992.[13] 21 states limited the employee's initial provider choice and 40 states placed limits on an employee's ability to change providers. 27 states had medical fee schedules in place and 22 regulated hospital charges via statute. Only about 14 states mandated utilization and/or bill review by payers, the workers compensation agency and/or the state fund.

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[12] BNA's Worker's Compensation Report, November 22, 1993 "Lawmakers Approve Reform Package; Allows Managed Care, Limits Attorneys"

[13] WCRI's " Medical Cost Containment in Workers Compensation - A National Inventory 1991-1992

Exhibit 16 shows the status of such cost containment measures during 1995 and 1996.[14] It is interesting to note the changes between the two reports. 14 additional states now limit provider choice, 11 of which provide for the limitation via managed care arrangements. 40 states now have medical fee schedules, which is an increase of 48%. 35 jurisdictions now regulate hospital charges, which is up from 22 states in the prior study. The percentage of states mandating utilization review and bill review has increased 50% and 23% respectively. In the 1991-1992 study no mandated managed care statutes existed whereas 8 states now require that payers provide such programs. 12 states have completed development of treatment guidelines (i.e., treatment protocols for certain types of injuries such as low back injuries) and 9 other states are in the developmental stages.

Obviously the trend towards medical cost containment initiatives has increased dramatically over the last few years and will continue to do so as payers become more proficient at applying managed care techniques to workers compensation and as regulators and legislators recognize the value of such programs. Medical cost containment initiatives should reduce the absolute cost level and trends of the medical component of work related injuries. If medical costs can be held in check then medical payment will also be accelerated in the short run but reduced in the long run.

Reserving actuaries should take care to understand the types of major workers compensation reforms affecting individual states. Reforms, however, should not simply be taken at face value.

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[14] WCRI's " Medical Cost Containment in Workers Compensation - A National Inventory 1995-1996.

The statutory language of a reform has an intended purpose, but by the time it is interpreted by the courts and administrative law judges and scrutinized by plaintiff's attorneys, it may not reach it's original objective. Often an excellent source for insight into the true impact of a given state's reform is the workers compensation claims examiner responsible for that state. They work daily to practically apply the statutory language. Ask their opinion as to how reforms will play out in reality. Take their judgment as well as your own into account when estimating the impact of workers compensation reforms on a book of business.

VI. CONCLUSION

Several changes have occurred in the workers compensation marketplace in recent years including greater risk retention by employers, innovative financial arrangements between insures/self-insurers and medical care providers, increased emphasis on controlling costs, and a movement to integrate health insurance concepts into workers compensation pricing. These changes will require significant changes in many companies' current reserving procedures. But before new methods can be fully developed, reserving analysts must understand managed care principles and recent changes in financial arrangements. This paper has outlined many of these changes and attempted to describe how current reserving assumptions can be altered based on these new arrangements.

Company A
Incurred Losses 1)
Medical and Indemnity Combined
($000'S)
as of Year-end 10

Accident Year	Month of Development									
	12	24	36	48	60	72	84	96	108	120
1	400	800	990	1,111	1,115	1,125	1,130	1,130	1,130	1,130
2	510	902	1,096	1,151	1,160	1,170	1,170	1,190	1,190	
3	790	1,180	1,396	1,500	1,540	1,560	1,500	1,519		
4	901	1,391	1,501	1,559	1,570	1,590	1,690			
5	1,120	1,460	1,661	1,842	1,950	2,000				
6	1,401	1,701	1,900	2,011	2,110					
7	1,761	2,340	2,465	2,550						
8	1,700	2,316	2,675							
9	2,400	2,995								

Development Factors

Accident Year	Months of Development									
	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	
1	2.000	1.238	1.122	1.004	1.009	1.004	1.000	1.000	1.000	
2	1.769	1.215	1.050	1.008	1.009	1.000	1.017	1.000		
3	1.494	1.183	1.074	1.027	1.013	0.962	1.013			
4	1.544	1.079	1.039	1.007	1.013	1.063				
5	1.304	1.138	1.109	1.059	1.026					
6	1.214	1.117	1.058	1.049						
7	1.329	1.053	1.034							
8	1.362	1.155								
9	1.248									
Average	1.474	1.147	1.069	1.026	1.014	1.007	1.010	1.000	1.000	
Column Sum	1.373	1.132	1.065	1.030	1.015	1.008	1.010	1.000	1.000	
Selected Factors										Tail
Age to Age	1.373	1.132	1.065	1.030	1.015	1.008	1.010	1.000	1.000	
Cumulative	1.762	1.283	1.133	1.064	1.033	1.018	1.010	1.000	1.000	1.000

1) Includes ALAE

Notes:

These selected LDF's are assumed to produce accurate ultimate losses for all primary business.

Exhibit 2

Company A
Projection of Loss
Excess v. Primary
($000'S)

Accident Year	% of Premium: Excess	% of Premium: Primary	% of Loss: Excess	% of Loss: Primary	Total Loss	Excess Loss	Primary Loss
9	0.00%	100.00%	0.00%	100.00%	3,843	0	3,843
10	5.00%	95.00%	6.17%	93.83%	4,500	278	4,222
11	10.00%	90.00%	12.20%	87.80%	4,950	604	4,346
12	15.00%	85.00%	18.07%	81.93%	5,445	984	4,461
13	15.00%	85.00%	18.07%	81.93%	5,990	1,082	4,908
14	15.00%	85.00%	18.07%	81.93%	6,589	1,191	5,398
15	15.00%	85.00%	18.07%	81.93%	7,248	1,310	5,938
					38,565	5,449	33,116

Cumulative Development Factors

Accident Year	Excess	Primary
9	2.755	1.010
10	2.926	1.018
11	3.055	1.033
12	3.333	1.064
13	3.933	1.133
14	4.971	1.283
15	9.778	1.762

Loss Ratio Assumptions

Primary	80%
Excess	100%

Notes:
Ultimate primary and excess losses combined are assumed to total $4.5 million for accident year 10. Ultimate losses for subsequent accident years increase 10% per year

LDF's for primary losses are based on accident years 9 and prior while LDF's for excess losses are based on worker compensation reinsurance aggregate statistics

Company A
Incurred Losses 1)
Medical and Indemnity Combined
($000'S)

Accident Year	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	Column Sum CDF	Indicated Ultimate Loss
	Month of Development																
1	400	800	990	1,111	1,115	1,125	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1.000	1,130
2	510	902	1,096	1,151	1,160	1,170	1,170	1,190	1,190	1,190	1,190	1,190	1,190	1,190		1.000	1,190
3	790	1,180	1,396	1,500	1,540	1,560	1,500	1,519	1,519	1,519	1,519	1,519	1,519			1.000	1,519
4	901	1,391	1,501	1,559	1,570	1,590	1,690	1,707	1,707	1,707	1,707	1,707				1.000	1,707
5	1,120	1,460	1,661	1,842	1,950	2,000	2,016	2,036	2,036	2,036	2,036					1.000	2,036
6	1,401	1,701	1,900	2,011	2,110	2,142	2,159	2,180	2,180	2,180						1.000	2,180
7	1,761	2,340	2,465	2,550	2,627	2,666	2,687	2,714	2,714							1.000	2,714
8	1,700	2,316	2,675	2,849	2,934	2,978	3,002	3,032								1.000	3,032
9	2,400	2,995	3,390	3,611	3,719	3,775	3,805									1.010	3,843
10	2,425	3,346	3,795	4,050	4,177	4,242										1.018	4,318
11	2,530	3,509	3,988	4,265	4,405											1.033	4,550
12	2,634	3,676	4,187	4,488												1.065	4,780
13	2,898	4,045	4,607													1.136	5,234
14	3,186	4,447														1.289	5,732
15	3,504															1.783	6,248

Development Factors

Accident Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-132	132-144	144-156	156-168	168-180	Tail
	Months of Development														
1	2.000	1.238	1.122	1.004	1.009	1.004	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2	1.769	1.215	1.050	1.008	1.009	1.000	1.017	1.000	1.000	1.000	1.000	1.000	1.000		
3	1.494	1.183	1.074	1.027	1.013	0.962	1.013	1.000	1.000	1.000	1.000	1.000			
4	1.544	1.079	1.039	1.007	1.013	1.063	1.010	1.000	1.000	1.000	1.000				
5	1.304	1.138	1.109	1.059	1.026	1.008	1.010	1.000	1.000	1.000					
6	1.214	1.117	1.058	1.049	1.015	1.008	1.010	1.000	1.000						
7	1.329	1.053	1.034	1.030	1.015	1.008	1.010	1.000							
8	1.362	1.155	1.065	1.030	1.015	1.008	1.010								
9	1.248	1.132	1.065	1.030	1.015	1.008									
10	1.380	1.134	1.067	1.031	1.016										
11	1.387	1.137	1.069	1.033											
12	1.396	1.139	1.072												
13	1.396	1.139													
14	1.396														
Average	1.444	1.143	1.069	1.028	1.015	1.008	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Column Sum	1.383	1.135	1.067	1.031	1.015	1.008	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Selected Factors															
Age to Age	1.383	1.135	1.067	1.031	1.015	1.008	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Cumulative	1.783	1.289	1.136	1.065	1.033	1.018	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

1) Includes ALAE

Notes.
Actual development for years 10 and subsequent is assumed to follow the patterns outlined on the previous exhibit seperately for primary and excess losses

Exhibit 4

Company A
Comparison of Indicated Reserves to Actual Reserves
($000'S)
as of Year-end 15

Accident Year	Ultimate Loss Based on Incurred Method	Paid Loss	Indicated Reserve	Actual Ultimate Losses	Actual Reserve	Difference	% Difference
1	1,130	1,130	0	1,130	0	0	0%
2	1,190	1,190	0	1,190	0	0	0%
3	1,519	1,519	0	1,519	0	0	0%
4	1,707	1,707	0	1,707	0	0	0%
5	2,036	2,036	0	2,036	0	0	0%
6	2,180	2,180	0	2,180	0	0	0%
7	2,714	2,705	9	2,714	9	0	0%
8	3,032	3,000	32	3,032	32	0	0%
9	3,843	3,765	78	3,843	78	0	0%
10	4,318	4,176	142	4,500	324	182	56%
11	4,550	4,274	276	4,950	676	400	59%
12	4,780	4,192	588	5,445	1,253	665	53%
13	5,234	4,227	1,007	5,990	1,763	756	43%
14	5,732	3,916	1,816	6,589	2,673	857	32%
15	6,248	1,623	4,625	7,248	5,625	1000	18%
Total	50,213	41,640	8,573	54,073	12,433	3,860	31%

Bornhuetter-Ferguson Off Balance

(1) Accident Year	(2) Premium	(3) Expected Loss	(4) Expected Reported	(5) Actual Reported	(6) Initial Off Balance	(7) Indicated Ultimate	(8) Indicated Loss Ratio	Expected 3) Reporting Pattern
1	1,000	800	80	150	188%	870	87.0%	10.0%
2	1,000	800	160	300	188%	940	94.0%	20.0%
3	1,000	800	240	250	104%	810	81.0%	30.0%
4	1,000	800	320	400	125%	880	88.0%	40.0%
5	1,000	800	400	400	100%	800	80.0%	50.0%
Total	5,000	4,000	1,200	1,500	125%	4,300	86.0%	

A priori Loss Ratio	80%
Actual Loss Ratio	100%
Indicated Off Balance	125%

Adjusted Bornhuetter-Ferguson 1)

(1) Accident Year	(2) Premium	(3) Expected Loss	(4) Expected Reported	(5) Actual Reported		(6) Indicated Ultimate	(7) Indicated Loss Ratio	Expected Reporting Pattern
1	1,000	900	90	150		960	96.0%	10.0%
2	1,000	900	180	300		1,020	102.0%	20.0%
3	1,000	900	270	250		880	88.0%	30.0%
4	1,000	900	360	400		940	94.0%	40.0%
5	1,000	900	450	400		850	85.0%	50.0%
Total	5,000	4,500	1,350	1,500		4,650	93.0%	

adjusted 2)	90%
Actual Loss Ratio	100%

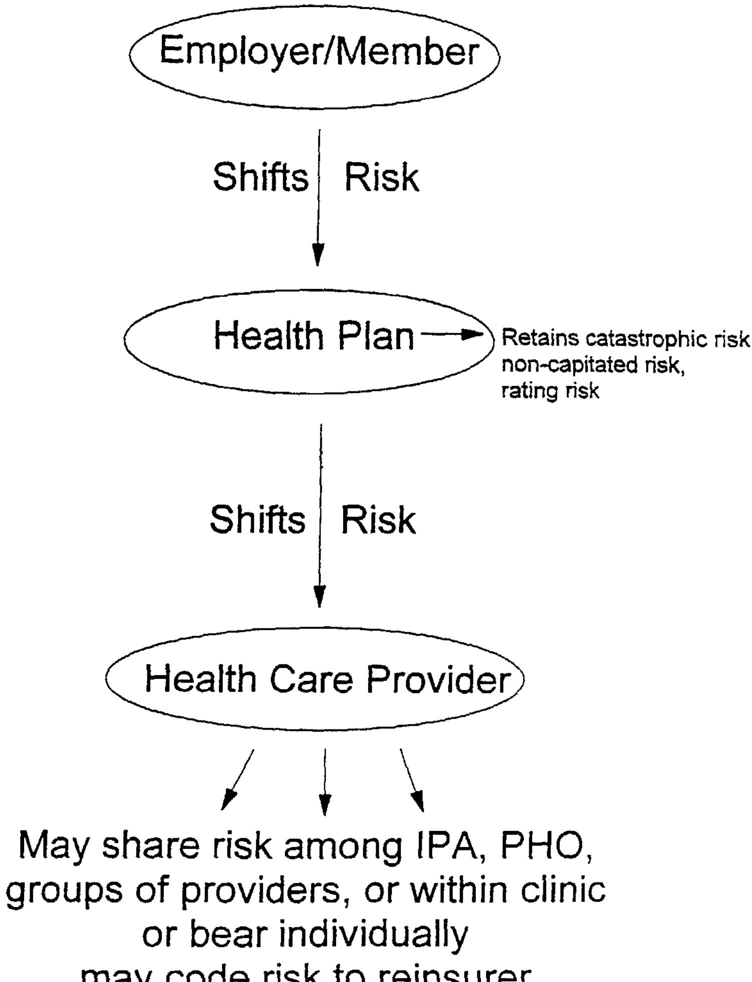
1) The adjustment is to adjust for half of the initial off balance, .5 x (1500/1200 - 1) = .125

2) The calculation is 80% x (1.125)

3) We have assumed this is the current reporting pattern but have incorporated some randomness into the reporting losses

Exhibit 6

THE SHIFTING OF RISK



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Note: This exhibit is extracted from a presentation given by Ms. Ruth Bauman of Blue Cross and Blue Shield-Oregon at a Global Business Research Seminar titled "Risk Sharing Arrangements in Workers' Compensation Managed Care...Toward Capitation"

LOSS RATIO DIVIDEND PLAN

1) *Assumptions*

- Projected loss ratio for prospective period based on trending and developing prior years' claim costs and comparing to premium at current rate level is: 75%

- Earned premium subject to MCO program: $100,000,000

- Claim costs above $100,000 are excluded from the dividend plan.
  Expected cost of losses above $100,000[1]: .184

- Expected Reporting Pattern at 12 months: 50%
  24 months: 75%
  36 months: 80%
  48 months: 90%

- Calculations performed
  at 36 months and
  30% of the savings
  returned to MCO

- Actual reported losses at 36 months = $45,000,000

[1] *PCAS Volume LXXVIII 1991; Retrospective Rating: Excess Loss Factors*, William R. Gillam, Pages 1-40

LOSS RATIO DIVIDEND PLAN

2) *Dividend Calculation*

1)	Earned Premium	$100,000,000
2)	Target Loss Ratio	75%
3)	Expected Ultimate Losses (1)x(2)	75,000,000
4)	Excess Ratio	.184
5)	Expected Ultimate Limited Losses (3)x(1-4)	61,200,000
6)	Expected Percentage of Losses Reported	.80
7)	Expected Limited Losses Reported	48,960,000
	36 months after the beginning of the accident year (5)x(6)	
8)	Actual Reported Losses	45,000,000
9)	MCO Savings (7)-(8)	3,960,000
10)	Dividend Sharing Percentage	30%
11)	Dividend Due MCO	1,188,000

Exhibit 8

AVERAGE CLAIM COST MODEL

1)	Expected Ultimate Severity (Based on trended and developed ultimate losses)	$4,500
2)	Relative severity at a 36 month evaluation:	.7
3)	Target severity at a 36 month evaluation (1)x(2)	3,150
4)	Actual number of claims reported	16,000
5)	Target claim costs (3)x(4)	50,400,000
6)	Actual Reported Losses	45,000,000
7)	MCO savings (5)-(6)	5,400,000
8)	Dividend Sharing Percentage	30%
9)	Dividend Due MCO (7) x (8)	1,620,000

EXHIBIT 9

ANKLE and LOWER LEG INJURIES	Return-to-Work (days) by Level of Activity at Work[1]					
	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Fracture of Ankle, Simple	0-14	0-21	0-28	14-56	21-63	28-77
ICD-9 Codes: 824.0, 824.2						
Fracture or Dislocation of Ankle, Closed Therapy	0-21	0-28	7-35	21-63	35-70	42-98
ICD-9 Codes: 824.0, 824.1, 824.2, 824.3, 824.4, 837.0						
Fracture or Dislocation of Ankle, Surgery[2]	14-28	14-35	21-42	42-70	56-84	63-112
ICD-9 Codes: 824.X, 837.0, 837.1, 928.21						
Fracture of Tibia, Shaft, Closed Therapy	14-35	21-49	35-70	63-98	70-119	84-140
ICD-9 Code: 823.20						
Fracture of Fibula, Shaft, Closed Therapy	4-21	7-28	21-42	42-56	42-70	56-84
ICD-9 Code: 823.21						
Fracture of Tibia & Fibula, Shaft, Closed Therapy	14-35	21-49	42-70	70-98	77-119	91-140
ICD-9 Code: 823.22						
Fracture of Tibia, Shaft, Surgery[2]	14-35	21-49	35-70	63-98	70-119	84-140
ICD-9 Codes: 823.20, 823.30						
Fracture of Fibula, Shaft, Surgery[2]	4-21	7-28	21-42	42-56	42-70	56-84
ICD-9 Codes: 823.21, 823.31						
Fracture of Tibia & Fibula, Shaft, Surgery[2]	21-35	28-42	49-70	77-98	84-119	98-140
ICD-9 Codes: 823.22, 823.32						
Sprain, Sprain-fracture, or Contusion, Grade I	0-3	0-5	0-10	0-14	0-21	0-28
ICD-9 Codes: 845.0X, 924.21						
Sprain, Sprain-fracture, or Contusion, Grade II	0-5	0-8	3-14	7-21	14-28	14-35
ICD-9 Codes: 845.0X, 924.21						
Sprain, Sprain-fracture, or Contusion, Grade III	7-10	7-14	14-21	21-28	28-42	35-63
ICD-9 Codes: 845.0X, 924.21						

[1] Each entry represents the number of days, since the date of injury, which the patient is expected to require to enter each Level of Activity at Work.
[2] Times noted are for operative and post-operative periods only.

ANKLE and LOWER LEG INJURIES	Duration of Care (days) by Percent of Patients Finished with Care		
	50%	75%	95%
Fracture of Ankle, Simple ICD-9 Codes: 824.0, 824.2	56	70	84
Fracture or Dislocation of Ankle, Closed Therapy ICD-9 Codes: 824.0, 824.1, 824.2, 824.3, 824.4, 837.0	70	84	112
Fracture or Dislocation of Ankle, Surgery[1] ICD-9 Codes: 824.X, 837.0, 837.1, 928.21	84	119	168
Fracture of Tibia, Shaft, Closed Therapy ICD-9 Code: 823.20	98	119	168
Fracture of Fibula, Shaft, Closed Therapy ICD-9 Code: 823.21	63	84	112
Fracture of Tibia & Fibula, Shaft, Closed Therapy ICD-9 Code: 823.22	98	119	168
Fracture of Tibia, Shaft, Surgery[1] ICD-9 Code: 823.20, 823.30	98	119	168
Fracture of Fibula, Shaft, Surgery[1] ICD-9 Code: 823.21, 823.31	63	84	112
Fracture of Tibia & Fibula, Shaft, Surgery[1] ICD-9 Code: 823.22, 823.32	98	119	168
Sprain, Strain, Sprain-Fracture, or Contusion, Grade I ICD-9 Codes: 845.0X, 924.21	7	14	21
Sprain, Strain, Sprain-Fracture, or Contusion, Grade II ICD-9 Codes: 845.0X, 924.21	14	28	42
Sprain, Strain, Sprain-Fracture, or Contusion, Grade III ICD-9 Codes: 845.0X, 924.21	56	70	84
Laceration, Simple ICD-9 Code: 891.0	10	14	21
Laceration, Intermediate ICD-9 Codes: 891.0, 891.2	14	21	28
Laceration, Complex ICD-9 Codes: 891.0, 891.1, 891.2	70	84	105
Tendonitis, Achilles Tendonitis ICD-9 Codes: 726.71, 727.81, 845.09	14	28	84
Tendonitis, Achilles Tendon Rupture, Surgery[1] ICD-9 Code: 727.67	133	147	168
Tendonitis, Anterior Tibial Tendonitis ICD-9 Codes: 726.72, 727.06	14	28	84
Tendonitis, Posterior Tibial or Peroneal Tendonitis ICD-9 Codes: 726.72, 726.79	14	28	84
Traumatic Arthritis, Acute Episode ICD-9 Code: 716.17	14	28	42

[1] Times noted are for operative and post-operative periods only.

Table 3a
Ankle Injuries - Optimally Managed
Fractures and Dislocations

EXHIBIT 11

Initial Care

Ankle Injuries : 4.23% **of Lost Work Day Cases**
Fractures and Dislocations : 11.50% **of Ankle Injuries**
Initial Care : 100.00% **of Ankle Fractures and Dislocations**

Charge Basis
Example Fee Schedule
Center Date: 7/1/96

Treatment Probabilities

(a) Treatment % of Total	(b) Procedure % of (a)	(c) Course of Treatment	(d) Procedure Code	(e) Number of Services	(f) Price Per Service
80.00%		**I. Office Visit**			
	75.00%	1. Office/Outpatient New Detailed Moderate	99203	1.0	$80.22
	25.00%	2. Office/Outpatient New Comp Moderate	99204	1.0	$114.60
	100.00%	3. X-ray Exam, Ankle-Complete	73610	1.0	$58.07
	70.00%	4. Pain Injection	90782	1.0	$14.33
	10.00%	5. Tetanus Toxoid Injection	90782	1.0	$14.33
	100.00%	6. Apply Short Leg Splint	29515	1.0	$63.13
	100.00%	7. Trilateral Splint (Plaster/Fiberglass)	AP032	1.0	$100.00
	100.00%	8. Crutches	AP001	1.0	$18.63
			Subtotal, Sum of (b) x (e) x (f):		$340.11
20.00%		**II. Emergency Room Visit**			
	50.00%	1. ER Visit Focused Mod Complex	99283	1.0	$94.55
	50.00%	2. ER Visit Severe Mod Complex	99284	1.0	$143.25
	100.00%	3. ER Charge - Ankle Fracture	ER002	1.0	$32.98
	100.00%	4. X-ray Exam, Ankle-Complete	73610	1.0	$58.07
	70.00%	5. Pain Injection	90782	1.0	$14.33
	10.00%	6. Tetanus Toxoid Injection	90782	1.0	$14.33
	100.00%	7. Apply Short Leg Splint	29515	1.0	$63.13
	100.00%	8. Trilateral Splint (Plaster/Fiberglass)	AP032	1.0	$100.00
	100.00%	9. Crutches	AP001	1.0	$18.63
			Subtotal, Sum of (b) x (e) x (f):		$403.17

Total Cost, Sum of (a) x Subtotal	**$352.72**

EXHIBIT 12

Table 3b
Ankle Injuries - Optimally Managed
Fractures and Dislocations

Subsequent Therapy by PCP

Ankle Injuries :	4.23%	**of Lost Work Day Cases**
Fractures and Dislocations :	11.50%	**of Ankle Injuries**
Subsequent Therapy by PCP :	71.00%	**of Ankle Fractures and Dislocations**

Charge Basis
Example Fee Schedule
Center Date: 7/1/96

Treatment Probabilities

(a) Treatment % of Total	(b) Procedure % of (a)	(c) Course of Treatment	(d) Procedure Code	(e) Number of Services	(f) Price Per Service
100.00%		***I. Therapy***			
	100.00%	1. Office/Outpatient Est Expanded Focused	99213	1.0	$51.57
	90.00%	2. Apply Cast Short Leg	29405	1.0	$84.18
	90.00%	3. Cast Materials, Short Leg	AP048	1.0	$75.00
	10.00%	4. Apply Short Leg Splint	29515	1.0	$63.13
	10.00%	5. Trilateral Splint (Plaster/Fiberglass)	AP032	1.0	$100.00
	80.00%	6. Pain Medication	RX001	7.0	$2.88
	60.00%	7. NSAIDs	RX002	10.0	$2.40
			Subtotal, Sum of (b) x (e) x (f):		$241.67
100.00%		**II. Follow-up Care**			
	100.00%	1. Office/Outpatient Est Expanded Focused	99213	4.0	$51.57
	100.00%	2. X-ray Exam, Ankle-Complete	73610	4.0	$58.07
	90.00%	3. Apply Cast Short Leg - Walking	29425	1.0	$105.22
	90.00%	4. Cast Materials, Short Leg - Walking	AP049	1.0	$90.00
	30.00%	5. Phys Med-Therapeutic Exercises	97110	5.0	$45.84
			Subtotal, Sum of (b) x (e) x (f):		$683.02

Total Cost, Sum of (a) x Subtotal	**$924.69**

CPM: Wcproto.xls-Ankle - Fractures 6/7/96

EXHIBIT 13

Table 3c
Ankle Injuries - Optimally Managed
Fractures and Dislocations

Therapy by Specialist

Ankle Injuries :	4.23%	**of Lost Work Day Cases**	**Charge Basis**
Fractures and Dislocations :	11.50%	**of Ankle Injuries**	Example Fee Schedule
Therapy by Specialist :	4.00%	**of Ankle Fractures and Dislocations**	Center Date: 7/1/96

Treatment Probabilities

(a) Treatment % of Total	(b) Procedure % of (a)	(c) Course of Treatment	(d) Procedure Code	(e) Number of Services	(f) Price Per Service
100.00%		**I. Pre-Therapy Care**			
	100.00%	1. ER Visit Severe Mod Complex	99284	1.0	$143.25
	25.00%	2. MRI, Lower Extremity Joint	73721	1.0	$1,016.26
	100.00%	3. X-ray Exam, Ankle-Complete	73610	1.0	$58.07
	3.00%	4. EKG	93000	1.0	$44.69
	3.00%	5. X-ray Exam, Chest-2 Views	71020	1.0	$66.37
			Subtotal, Sum of (b) x (e) x (f):		$458.72
12.50%		**II. Inpatient Therapy**			
	100.00%	1. Closed Reduction of Trimalleolar Fracture	27818	1.0	$683.93
	100.00%	2. Assistant Surgeon	27818-80	1.0	$136.79
	40.00%	3. Hospital - 1 Day - Ankle Closed Fracture	IS001	1.0	$1,026.44
	60.00%	4. OS Facility - Ankle Closed Fracture	OS001	1.0	$568.05
	100.00%	5. Anesthesia - Open Lower Leg Bone Surgery	1480	1.0	$519.53
	100.00%	6. Cast Materials, Short Leg	AP048	1.0	$75.00
			Subtotal, Sum of (b) x (e) x (f):		$2,166.66
87.50%		**III. Outpatient Therapy**			
	100.00%	1. Closed Reduction of Bimalleolar Fracture	27810	1.0	$526.10
	55.00%	2. OS Facility - Ankle Closed Fracture	OS001	1.0	$568.05
	55.00%	3. Anesthesia - Open Lower Leg Bone Surgery	1480	1.0	$519.53
	100.00%	4. Cast Materials, Short Leg	AP048	1.0	$75.00
			Subtotal, Sum of (b) x (e) x (f):		$1,199.27
100.00%		**IV. Post-Therapy Care**			
	100.00%	1. Follow-Up Visit, Post-Operative	99024	8.0	$0.00
	50.00%	2. Office/Outpatient Est Expanded Focused	99213	6.0	$51.57
	100.00%	3. X-ray Exam, Ankle-Complete	73610	5.0	$58.07
	100.00%	4. Cast Materials, Short Leg - Walking	AP049	1.0	$90.00
	50.00%	5. Ankle Brace - Air Cast	AP002	1.0	$40.00
	90.00%	6. Pain Medication	RX001	10.0	$2.88
	80.00%	7. NSAIDs	RX002	12.0	$2.40
	60.00%	8. Phys Med-Therapeutic Exercises	97110	6.0	$45.84
			Subtotal, Sum of (b) x (e) x (f):		$769.04

Total Cost, Sum of (a) x Subtotal	**$2,547.95**

EXHIBIT 14

Table 3d
Ankle Injuries - Optimally Managed
Fractures and Dislocations

Surgery by Specialist

Ankle Injuries :	4.23%	**of Lost Work Day Cases**	**Charge Basis**
Fractures and Dislocations :	11.50%	**of Ankle Injuries**	Example Fee Schedule
Surgery by Specialist :	25.00%	**of Ankle Fractures and Dislocations**	Center Date: 7/1/96

Treatment Probabilities

(a) Treatment % of Total	(b) Procedure % of (a)	(c) Course of Treatment	(d) Procedure Code	(e) Number of Services	(f) Price Per Service
100.00%		**I. Pre-Surgery Care**			
	100.00%	1. ER Visit Severe Mod Complex	99284	1.0	$143.25
	25.00%	2. MRI, Lower Extremity Joint	73721	1.0	$1,016.26
	15.00%	3. EKG	93000	1.0	$44.69
	15.00%	4. X-ray Exam, Chest-2 Views	71020	1.0	$66.37
			Subtotal, Sum of (b) x (e) x (f):		$413.97
60.00%		**II. Bimalleolar Fracture**			
	100.00%	1. Open Treatment of Bimalleolar Fracture	27814	1.0	$1,315.25
	100.00%	2. Assistant Surgeon	27814-80	1.0	$263.05
	100.00%	3. Anesthesia - Open Lower Leg Bone Surgery	1480	1.0	$519.53
	60.00%	4. OS Facility - Ankle Open Fracture	OS002	1.0	$568.05
	40.00%	5. Hospital - 1 Day - Ankle Open Fracture	IS002	1.0	$1,026.44
	100.00%	6. Cast Materials, Short Leg	AP048	1.0	$75.00
			Subtotal, Sum of (b) x (e) x (f):		$2,924.24
40.00%		**III. Trimalleolar Fracture**			
	100.00%	1. Open Treatment of Trimalleolar Fracture	27822	1.0	$1,525.69
	100.00%	2. Assistant Surgeon	27822-80	1.0	$305.14
	100.00%	3. Anesthesia - Open Lower Leg Bone Surgery	1480	1.0	$519.53
	50.00%	4. Hospital - 1 Day - Ankle Open Fracture	IS002	1.0	$1,026.44
	50.00%	5. OS Facility - Ankle Surgery - 23 hour	OS027	1.0	$568.05
	100.00%	6. Cast Materials, Short Leg	AP048	1.0	$75.00
			Subtotal, Sum of (b) x (e) x (f):		$3,222.61
100.00%		**IV. Post-Surgery Care**			
	100.00%	1. Follow-Up Visit, Post-Operative	99024	6.0	$0.00
	45.00%	2. Office/Outpatient Est Expanded Focused	99213	4.0	$51.57
	100.00%	3. X-ray Exam, Ankle-Complete	73610	4.0	$58.07
	100.00%	4. Cast Materials, Short Leg - Walking	AP049	1.0	$90.00
	50.00%	5. Ankle Brace - Air Cast	AP002	1.0	$40.00
	100.00%	6. Pain Medication	RX001	12.0	$2.88
	90.00%	7. NSAIDs	RX002	15.0	$2.40
	30.00%	8. Antibiotics	RX005	7.0	$6.84
	15.00%	9. Hardware Removal - Deep	20680	1.0	$420.88
	15.00%	10. OS Facility - Removal of Hardware	OS040	1.0	$654.61
	10.00%	11. Anesthesia	1999	1.0	$349.50
	90.00%	12. Phys Med-Therapeutic Exercises	97110	8.0	$45.84
	10.00%	13. Therapeutic Activities-Each 15 Min	97530	12.0	$28.65
			Subtotal, Sum of (b) x (e) x (f):		$1,077.13

Total Cost, Sum of (a) x Subtotal	**$4,534.69**

TABLE A
COMMON COST CONTAINMENT STRATEGIES IN WORKERS' COMPENSATION

Jurisdiction	Limited Initial Provider Choice	Limited Provider Change	Medical Fee Schedule	Hospital Charge Regulation	Utilization Review	Bill Review
Alabama	X	X				
Alaska		X	X			
Arizona*	X	X	X			
Arkansas	X	X	†			
California*	X	X	X	†		
Colorado	X	X	X	X		
Connecticut		X		X		
Delaware						
District of Columbia		X			X	
Florida	X	X	X	X	X	X
Georgia	X	X	X	†		
Hawaii		X	X	X		
Idaho	X	X				
Illinois		X				
Indiana	X	X				
Iowa	X	X				
Kansas	X	X	†	†		†
Kentucky			X			
Louisiana		X	†	†	X	X
Maine		X	X	†	†	
Maryland			X			
Massachusetts			X	X		
Michigan	X	X	X	X	X	X
Minnesota		X	X	X		
Mississippi						
Missouri	X	X				
Montana		X	X	X		
Nebraska		X	X	X		
Nevada#		X	X	X	X	X
New Hampshire			†	†	†	
New Jersey	X	X		X	X	
New Mexico*	X	X	†	X	X	
New York			X	X	X	
North Carolina	X	X	X	X		X

These strategies were in effect during 1991-92.

TABLE A (Continued)

Jurisdiction	Limited Initial Provider Choice	Limited Provider Change	Medical Fee Schedule	Hospital Charge Regulation	Utilization Review	Bill Review
North Dakota#		X	†	†	X	X
Ohio#			X		X	X
Oklahoma		X	X	X		
Oregon		X	X	X	†	X
Pennsylvania	X	X				
Rhode Island				X		
South Carolina	X	X	X	X		X
South Dakota		X				
Tennessee	X	X				
Texas		X	X	X	†	X
Utah	X	X	X		X	
Vermont						
Virginia	X	X				
Washington#			X	X	X	X
West Virginia#		X	X	X	X	X
Wisconsin		X				
Wyoming#		X	X	X	X	X
TOTALS (exclude †)	21	40	27	22	14	13

* Arizona and California divide initial provider choice between the employer and the employee. In New Mexico, the employer/insurer can control provider choice and change during the sixty days following the injury or after that period.

† Being developed.

Exclusive state fund.

NOTE: The table does not reflect strategies that the states have authorized, but rather strategies that the states have implemented.

TABLE A. COMMON COST CONTAINMENT STRATEGIES IN WORKERS' COMPENSATION, 1995*

Jurisdiction	Limited Initial Provider Choice	Limited Initial Provider Choice via MCO	Limited Provider Change	Limited Provider Change via MCO	Medical Fee Schedule	Hospital Payment Regulation	Mandated Managed Care	Mandated Utilization Review	Mandated Bill Review	Treatment Guidelines
Alabama	X		X		X	X				
Alaska			†		X	X				
Arizona	X•		X		X					
Arkansas	X		X		X	X	X•	X	X	
California	X•		X		X					‡
Colorado	X		X		X	[illegible]	X•	X		X
Connecticut		X	X		X					‡
Delaware										
District of Columbia			X							
Florida	X		X		X	X	X•	X	X	X
Georgia	X		X		X	X				§
Hawaii			†		X	X				X
Idaho	X		X							
Illinois			†							
Indiana	X		X							
Iowa	X		X							
Kansas	X		X		X	X			X	
Kentucky		X	†	X	X	X		X		‡
Louisiana			X		X	X		X	X	
Maine	X		†		X	X		X		‡
Maryland					X	X				
Massachusetts		X•	X		X	X		X		X
Michigan	X		†		X	X		X	X	
Minnesota		X	X		X	X				X
Mississippi			†		X			X	X	
Missouri	X		X							
Montana		X	X		X	X		X		‡

TABLE A. COMMON COST CONTAINMENT STRATEGIES IN WORKERS' COMPENSATION, 1995* (CONTINUED)

Jurisdiction	Limited Initial Provider Choice	Limited Initial Provider Choice via MCO	Limited Provider Change	Limited Provider Change via MCO	Medical Fee Schedule	Hospital Payment Regulation	Mandated Managed Care	Mandated Utilization Review	Mandated Bill Review	Treatment Guidelines
Nebraska	X*		X		X	X				§
Nevada		X	†		X	X	X*	X	X	X
New Hampshire		X		X	‡	‡	X*	‡		
New Jersey	X		X			X				§
New Mexico	X*		X		X	X		X		
New York		**		**	X	X				§
North Carolina	X		X		X	X			X	‖
North Dakota		X*	X		X	X	X*	X	X	
Ohio		†		‡	X	X		X	X	§
Oklahoma		X	X		X	X				‖
Oregon		X	X		X	X			X	‡
Pennsylvania	X		X		X	X				
Rhode Island				X	X	X		X		‡
South Carolina	X		X		X	X			X	
South Dakota		X	X		X		X*			X
Tennessee	X		X					X		
Texas			X		X	X		X	X	X
Utah	X		†		X			X		X
Vermont	X				X	X	X*			
Virginia	X		X							
Washington		**		**	X	X		X	X	X
West Virginia				X	X	X		X	X	X
Wisconsin			†		X	X				
Wyoming			X		X	X		X	X	X
TOTAL††	24	11	32	4	40	35	8	21	16	13

Workers Compensation Reserve Uncertainty

by Douglas M. Hodes, FSA
Sholom Feldblum, FCAS
Gary Blumsohn, FCAS, Ph.D.

Workers Compensation Reserve Uncertainty

(Authors)

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Workers Compensation Reserve Uncertainty

Introduction

Actuaries have developed a host of techniques for producing point estimates of indicated reserves. Current regulatory concerns, as reflected in the NAIC's risk-based capital requirements, and developing actuarial practice, as reflected in the American Academy's vision of the future role of the Appointed Actuary, now stress the uncertainty in the reserve estimates in addition to their expected values. This paper demonstrates how the uncertainty in property-casualty loss reserves may be analyzed, and it draws forth the implications for capital requirements and actuarial opinions.

Genesis of this Paper

The analysis in this paper has been stimulated by the NAIC's risk-based capital efforts and by the American Academy of Actuaries vision of the valuation actuary:

- The reserving risk charge, which measures the potential for unanticipated adverse loss development by line of business, is the centerpiece of the NAIC property-casualty risk-based capital formula, accounting for about 40% of total capital requirements before the covariance adjustment and about 50% after the covariance adjustment.[1] Because good actuarial analyses of loss reserve uncertainty are still lacking, the present reserving risk charges are based on simple extrapolations from past experience, with a large dose of subjective judgment to keep the results reasonable.

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[1] Readers might wonder: "Why should the percent of capital requirements attributable to the reserving risk charge differ between the before-covariance and the after-covariance figures?" The covariance adjustment sets the total capital requirements as

$$TCR = \text{total capital requirements} = (\Sigma\ C_i^2)^{0.5},$$

where the "C_i" are the capital requirements for each individual risk. The *marginal* capital requirements for any risk "j" equals

$$\partial TCR/\partial C_j = 0.5(\Sigma\ C_i^2)^{-0.5} * 2C_j.$$

In other words, the marginal (post-covariance) charge for an additional dollar of any pre-covariance risk charge is proportional to the total dollars in that risk category. Risk categories with large pre-covariance charges, such as reserving risk, provide a high post-covariance contribution *for each dollar of risk charge*. Risk categories with low pre-covariance charges, such as default risk, provide a low post-covariance contribution *for each dollar of risk charge*.

❷ The Appointed Actuary presently opines on the reasonableness of the Annual Statement's point estimate of loss and loss adjustment expense reserves. The American Academy of Actuaries envisions an expanded role, in which the actuary opines on the financial strength of company under a variety of future conditions. The greater the uncertainty in the reserves, the greater the range of reasonable financial conditions that the actuary must consider.

Issues Addressed

This paper focuses on the uncertainty in workers' compensation loss reserves. Specifically, it addresses the following issues:

❶ How should the uncertainty in loss reserves be measured? Many actuaries respond: "Uncertainty should be measured by the variability of the loss reserve estimates." This only begs the question: How might the variability in the loss reserve estimates best be quantified?

❷ What insurance characteristics, such as payment patterns and contract obligations, affect reserve uncertainty? For instance, average payment lags are about the same for general liability and workers compensation loss reserves. So why is the variability of general liability loss reserves so much greater than the variability of workers compensation loss reserves?

❸ How does the measure of variability that underlies risk-based capital requirements differ from the measure of variability that underlies the actuarial opinion? More specifically, how does the variability of the discounted, "net" reserves [i.e., loss obligations after consideration of return premiums and additional premiums on retrospectively rated policies, valued on an economic basis] differ from the variability of the undiscounted, "gross" reserves?

The Mixing of Lines

Why concentrate on workers compensation? Why not discuss property-casualty loss reserves in general, of which workers compensation is but one instance?

This is the primary error that has hampered past analyses of loss reserve variability. Many observers have contrasted short-tailed lines like Homeowners and Commercial Property with long-tailed lines like General Liability and Automobile Liability, and they have noted the greater reserve uncertainty associated with the latter lines of business. Consequently, they have reasoned that reserve uncertainty is associated with reserve "duration": that is, reserves with longer average payment lags have greater uncertainty.[2]

To see the error in this reasoning, let us extend the comparison to life insurance reserves. Single premium traditional life annuities have the longest reserve duration of all insurance products. Yet these products have low reserving risk, since the benefits are fixed at policy inception and mortality fluctuations are low.[3]

The bulk of workers' compensation loss reserves that persist more than two or three years after the accident date are lifetime pension cases. These are disabled life annuities, with long duration and low fluctuation reserves. The longest workers' compensation reserves are often low risk reserves.[4]

The Peculiarities of Compensation Reserves

The quantification of reserve uncertainty must begin with the characteristics of the line of business. Four aspects of workers compensation reserves which affect the level of uncertainty are dealt with in this paper:

- *Duration and Discount:* The previous section noted that most compensation

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[2] We use the term "duration" here in its widespread sense, as a substitute for "average payment lag." Thus, we speak of "long duration" reserves to mean reserves with long average payment lags. In its more precise meaning, "duration" refers to the effect of interest rate changes on the market value of the asset or liability. Duration is not a measure of time (i.e., the loss payment lag) but of the magnitude of the correlation between interest rate changes and market value changes.

For fixed income securities with no call options, the magnitude of the correlation is a direct function of the average time to payment (calculated on a discounted basis). A bond with twice as long an average time to payment (where the payment dates are weighted by the present value of each payment), has twice as great a duration (in the correlation sense). This explains the association of "duration" with "payment lags." However, the duration (in the correlation sense) of assets (such as common stocks) or liabilities (such as casualty loss reserves) that vary with inflation is exceedingly difficult to determine.

[3] These products do have significant interest rate risk, which is indeed affected by the "duration" of the liabilities. For the quantification of interest rate risk for property-casualty insurance companies and the implications for risk-based capital requirements, see Douglas M. Hodes and Sholom Feldblum, "Interest Rate Risk and Capital Requirements for Property-Casualty Insurance Companies" (CAS Part 10 examination study note).

[4] See Sholom Feldblum, "Author's Reply to Discussion by Stephen Philbrick of 'Risk Loads for Insurers,'" *Proceedings of the CAS*, Volume 80 (1993), pages 371-373, which compares reserves uncertainty among four property casualty lines of business: workers' compensation, automobile liability, products liability, and property.

reserves that persist more than two or three years after the accident date are lifetime pension cases. We compared these to life annuities, which are low risk reserves. But the analogy is incomplete, since the statutory accounting treatment differs for these two types of business. Life annuities are discounted at rates close to current corporate bond rates.[5] Most companies discount the indemnity portion of workers' compensation lifetime pension cases at 3.5% or 4% per annum, which is well below their actual investment earnings. The low fluctuations in these reserves, combined with the large "implicit interest margin," create enormous hidden "equity" in statutory balance sheets.

❷ *Statutory Benefits:* What about non-pension cases? Do non-pension compensation reserves have the same uncertainty as General Liability and automobile liability reserves? After all, industry studies have found similarly strong underwriting cycles and "reserve adequacy" cycles in all these lines of business.[6]

Yes, underwriting results are driven by industry cycles, and so underwriting results vary greatly from year to year, whether in workers compensation, general liability, or automobile liability. But underwriting cycles reflect primarily the movement of premium levels, not fluctuations in loss experience. Reserve adequacy cycles are a secondary effect, which are driven by management desires to smooth calendar year operating results. They reflect the accounting treatment of company results, not the uncertainty inherent in the reserves themselves.

When a general liability or medical malpractice accident occurs, the claim may not be reported for some time. Even after the claim is reported, the case may not be settled until years later, and the amount of the loss liability depends on the vagaries of court decisions, societal opinion, and jury awards. This is the source of reserve uncertainty in the liability lines of business.

In workers compensation, almost all claims are reported immediately to the insurer. [It is hard for the employer to be unaware that a worker has been injured on the job and is on disability leave.] Benefits are mandated by statute, and disputes are

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5 The exact discount rate varies by type of product, as prescribed by the 1990 Standard Valuation Law. The discount rate rose as high as 13.25% in the early 1980's, when corporate bond yields were high. The statutory rate for single premium immediate annuities – the life insurance product most comparable to workers' compensation pension cases – issued in the first half of the 1990s is about 7% per annum.

6 See especially Robert P. Butsic, "The Underwriting Cycle: A Necessary Evil?" *The Actuarial Digest,* Vol. 8, No. 2 (April/May 1989).

generally resolved quickly by administrative judges.[7] The paid loss link ratios, or "age-to-age" factors, are extremely stable in workers' compensation, both for pension and for non-pension cases, unlike the comparable factors for the liability lines of business.

❸ *Tail Development:* But don't workers compensation reserve estimates need large "tail factors," just as liability reserve estimates need? And aren't these tail factors highly uncertain, even as the liability tail factors are?

The highly volatile General Liability tail factors reflect the emergence or the settlement of claims – often toxic tort and environmental liability claims – decades after the occurrence of the accident. This is true reserve uncertainty.

The volatility of workers compensation tail factors stems from two causes.

- First, changes in company philosophy regarding reserve margins and implicit discounts affects the selected tail factors. A company seeking stronger reserve margins may choose larger loss development tail factors. A company seeking to implicitly discount its reserves may choose smaller tail factors. Our primary interest here is the inherent uncertainty in the reserves. We are less interested in the accounting illusions caused by changing company philosophies.

- Second, workers compensation tail factors are affected by monetary inflation, both for cost of living adjustments to indemnity benefits and for all aspects of medical benefits. Inflation levels, especially for 30 or 40 years into the future, are extremely uncertain.

  Indeed, this creates great uncertainty in the undiscounted reserve, and the actuary opining on reserve adequacy for statutory statements should consider a wide range of "reasonable" estimates. But the economic value of the reserve is less affected by long-term inflation rates. In the short-term – that is, for periods less than a year or two – inflation rates and interest rates may differ from each other. Over the long-term, the "Fisher effect" holds: the inflation and interest rates are strongly correlated. If the loss reserve discount rate varies with the long-term inflation rate, then inflation-induced changes in the tail factor are offset by changes in the discount rate.[8]

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[7] The resolution may not be as quick as some claimants and companies would like, but they are much shorter than the delays in the liability lines of business.

[8] The appropriate discount rate is not the same as the statutory yield earned by the insurer on its investment portfolio. [The statutory investment yield, of course, does not necessarily move in tandem with inflation rates.] As Butsic argues cogently in "Determining the Proper Interest Rate for Loss Reserve Discounting: An Economic Approach," *Evaluating Insurance*

● *Loss Sensitive Insurance Contracts:* A high percentage of the workers compensation contracts covering large employers are retrospectively rated. That is, the premium paid by the employer (the insured) is a function of the losses actually incurred. On a retrospectively rated contract, loss liabilities and premiums receivable move in tandem. If loss reserves develop adversely, the insurer will collect retrospective premium adjustments from the employer.

For loss sensitive contracts, estimates of reserve uncertainty must be distinguished from their implications for capital requirements and actuarial opinions. Risk-based capital requirements reflect the equity needs of the insurer. Similarly, the envisioned future role of the appointed actuary is to opine on the financial strength of the insurer under various future conditions. If adverse loss development on a book of business is offset by favorable premium development, the financial condition of the insurer is unaffected, and there is no need for additional equity.

Summary: We may summarize the previous four points as follows: The novice actuary sees an insurer's large book of compensation reserves, notes the long payment lags and the strong underwriting cycles, and concludes: "There must be great uncertainty here. Moreover, unexpected development may severely affect the insurer's financial condition, so much additional capital is needed to guard against this risk." To which the experienced actuary replies: "No, because of the steady compensation payment patterns, the long duration of these claims, and the correspondence of adverse loss development with offsetting premium development, the reserving risk is so low that it is outweighed by the implicit interest margin in the reserves."

Reserve Uncertainty: Regulatory vs. Actuarial Measures

We have differentiated above between the inherent uncertainty in reserve estimates and the accounting illusions caused by discretionary adjustments of reported reserves. Similarly, we may differentiate between "actuarial" measures of reserve uncertainty and "regulatory" measures of reserve uncertainty.

The Solvency Regulator and the Actuary

Suppose that the solvency regulator sees wide fluctuation in reported reserve levels and concludes that there is great uncertainty in the reserve estimates. The company

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Company Liabilities (Casualty Actuarial Society 1988 Discussion Paper Program), pages 147-188, the economic value of loss reserves depends on the characteristics of the reserves, such as average payment lag, and characteristics of the financial markets, such as risk-free interest rates, not on the particular assets held by the insurer.

actuary responds that the actual reserve indications have been stable. The shift in reported reverse levels from year to year stems simply from a desire to smooth calendar year earnings.[9]

> *"What difference does that make?"* replies the solvency regulator. *"We are concerned that the reported reserves may not be sufficient to cover the loss obligations of the company. What difference does it make whether the insufficiency stems from an inherent uncertainty in the reserve indications or from discretionary adjustment of the reported reserves?"*

The regulator is correct. We must differentiate between two types of reserve fluctuations:

- The valuation actuary tells the company's management how much capital it should hold to guard against unexpected adverse events. Suppose the actuary's reserve analysis yields a point estimate of $800 million with a range of $650 million to $950 million, and the company is reporting $700 million on its statutory statements. The actuary's recommendation might be that the company needs $250 million of capital: $100 million for reserve "deficiencies" (the difference between the point estimate and the held reserves) and $150 million for reserve uncertainties.[10]

- The solvency regulator can not easily distinguish between adverse loss development stemming from unanticipated random occurrences and adverse loss development stemming from reserve inadequacies. The regulator estimates the variability of reported reserves and applies this figure to some base number.[11]

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[9] For an analysis of workers compensation reserve strengthening and weakening in accordance with industry underwriting cycles, see Kevin M Ryan and Richard I. Fein, "A Forecast for Workers Compensation," *NCCI Digest*, Volume III, Issue IV (December 1988), pages 43-50.

[10] Because of the statutory requirement to report even long-term claim reserves at undiscounted values, this is a common situation, particularly for toxic tort and environmental liability exposures. In practice, the implicit interest margin in statutory reserves must be included in the valuation actuary's recommendation. To complete the illustration in the text, the actuary might add that there is $200 million of implicit interest margin in the statutory reserves, so only $50 million of additional capital is needed.

[11] The "base number" might be the company's reported reserves (if believed by the regulator) or an independent estimate of the company's reserve needs (if the regulator lacks confidence in the company's financial statements).

Regulators concerned with reserve uncertainty take the latter viewpoint. Our primary interest in this paper is with the uncertainty inherent in the reserve indications themselves, the former viewpoint.

The difference is not in the *magnitude* of the uncertainty, but in the *method* of quantifying the uncertainty. The solvency regulator begins with the reserves reported by companies. How the companies determined these reserves is irrelevant. The actuary examines the factors used to quantify reserve needs, such as age-to-age "link ratios," to determine the uncertainty in the reserve indications. How various companies deviate from the reserve indications in their financial statements is irrelevant.

Measures of Uncertainty

Finding a measure to quantify reserve uncertainty is not easy. The appropriate measure is a probability distribution – but probability distributions are opaque to most reviewers of a company's reserves. One might convert the results to a simple percentile distribution – showing perhaps the 95th percentile, the mean, and the 5th percentile. But this produces only a few figures, and it discards the information conveyed by the shape of the probability distribution. Moreover, it is often hard to find meaning in these numbers. We need a yardstick to measure reserve uncertainty.

We use two measures of reserve uncertainty, one in the text of this paper and one in the appendix. For the analysis in the text of the paper, we use the "expected policyholder deficit" (EPD) concept developed by Robert Butsic as the yardstick for the uncertainty in the reserve estimates.[12] The EPD ratio allows us to translate "reserve uncertainty" into a "capital charge," thereby transforming an abstruse actuarial concept into concrete business terms. In the appendix to this paper, we discuss the "worst case year" concept used to measure reserve uncertainty and thereby to determine the reserving risk charge in the NAIC risk-based capital formula.[13]

Some readers will rightfully ask: "The NAIC worst case year concept is a simple but

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[12] See Robert P. Butsic, "Solvency Measurement for Property-Liability Risk-Based Capital Applications," *Journal of Risk and Insurance*, Volume 61, Number 4 (December 1994), pages 656-690.

[13] For the NAIC worst case year concept, see Allan M. Kaufman and Elise C. Liebers, "NAIC Risk Based Capital Efforts in 1990-91," *Insurer Financial Solvency* (Casualty Actuarial Society 1992 Discussion Paper Program), Volume I, pages 123-178, or Sholom Feldblum, "Risk-Based Capital Requirements" (CAS Part 10 Examination Study Note, Second Edition, 1995).

arbitrary yardstick that is not supported by financial or actuarial theory. Why include it even in the appendix of an actuarial paper?"

The answer is important. This paper demonstrates that the implicit interest margin in full-value workers compensation reserves exceeds the capital needed to guard against unexpected reserve volatility. Some readers, aware of the 11% workers compensation reserving risk charge in the NAIC's risk-based capital formula, may mistakenly conclude that the "regulatory" and "actuarial" approaches to this problem yield different answers.

This is not so. The NAIC "regulatory" approach yields a similar result to that arrived at here. However, the workers compensation charges were subjectively modified to produce capital requirements that seemed more reasonable to some regulators. In fact, the "unreasonableness" of the NAIC formula indications to these regulators stemmed from a misunderstanding of statutory accounting and of the risks of workers compensation business, not from any artifacts in the risk-based capital formula. A full discussion of the NAIC approach to reserve uncertainty embodied in the risk-based capital formula is presented in Appendix A.

The Quantification of Uncertainty

Attempts to measure reserve "uncertainty" often dissolve for failure to make clear (i) what exactly we seek to measure and (ii) how we ought to measure it. This task is particularly difficult because of the variety of loss reserve estimation procedures and the slipperiness of "uncertainty."

This paper combines three elements to analyze the uncertainty of loss reserve estimates:

❶ A statistical procedure to quantify the uncertainty, relying on a stochastic simulation of the loss reserve estimation process.
❷ A yardstick to measure the uncertainty, relying on the expected policyholder deficit ratio.
❸ A set of factors that explain the amount of uncertainty, focusing on payment patterns, inflation and interest rate effects, and loss sensitive contracts.

Actuarial Procedures

Loss reserve estimates stem from empirical data, such as reported loss amounts or paid loss amounts, combined with actuarial procedures, such as chain ladder development methods. Loss reserve uncertainty stems from both of these components.

- Random loss fluctuations may cause past experience to give misleading estimates of future loss obligations.
- Imperfect actuarial analysis of the data may lead to invalid reserve estimates.

The two causes are intertwined. The ideal reserving actuary is ever watchful of data anomalies and will adjust the reserving procedures to avoid the most likely distortions.[14]

In this paper we do not measure the uncertainty stemming from imperfect actuarial practice. Rather, we assume a standard reserving technique which often used for workers' compensation: a paid loss chain ladder development method.[15]

In practice, reserving actuaries use a variety of techniques. Even when employing a paid loss chain ladder development method, rarely does the reserving actuary follow the method by rote, with no analysis of unusual patterns. To the extent that actuarial judgment improves the reserve estimate, this paper "overestimates" the reserve uncertainty. To the extent that actuarial "judgment" masks the true reserve indications, one might say that this paper "underestimates" the reserve uncertainty.

Let us clarify: this paper measures the uncertainty inherent in the empirical data used to produce actuarial reserve estimates. It does not attempt to measure the "uncertainty" added or subtracted by the quality of actuarial analysis.

Empirical Data

How should we measure the uncertainty inherent in the empirical data? Two methods have been used:

❶ We may simulate experience data, develop reserve indications, then continue the

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[14] See, for instance, James R. Berquist and Richard E. Sherman, "Loss Reserve Adequacy Testing: A Comprehensive Approach," *Proceedings of the Casualty Actuarial Society*, Volume 64 (1977), pages 123-185, and the discussion by J. O. Thorne, Volume 65 (1978), pp. 10-34.

[15] We choose this technique, rather than a reported loss chain ladder development technique or Bornhuetter-Ferguson (expected loss) techniques, because it is dependent on claim payment patterns, not on individual company case reserving practices. Thus, we are measuring the uncertainty caused by fluctuations in actual claim patterns, not by changes in company case reserving practices.

simulation to see how accurately the indications forecast the final outcomes.[16] This method is entirely theoretical. The amount of "uncertainty" depends on the simulation procedure, which is not always grounded in actual experience.

❷ We may look at actual experience, develop reserve indications at intermediate points in time, and then compare the indications with the actual outcomes.[17] This method is "practical" – so practical, in fact, that the uncertainty measurements are generally overwhelmed by historical happenstance.

Our procedure charts a middle course. We use stochastic simulation of the experience data to ensure statistically valid results. But the simulation parameters are firmly grounded in 25 years of actual paid loss histories from the country's largest workers compensation carrier.

We describe the three elements of the analysis: (i) the stochastic simulation, (ii) the expected policyholder deficit ratio "yardstick," and (iii) the explanatory factors.

The Stochastic Simulation

We begin with 25 years of countrywide paid loss workers compensation experience, separately for indemnity and medical benefits, for accident years 1970 through 1994. From these data we develop 22 columns of paid loss "age-to-age" link ratios, as shown in Exhibits C-1 and C-2.[18]

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16 See, for instance, James N. Stanard, "A Simulation Test of Prediction Errors of Loss Reserve Estimation Techniques," *Proceedings of the Casualty Actuarial Society*, Volume 72 (1985), pages 124-148, and the discussion by John P. Robertson, pages 149-153.

17 This is the procedure used by the NAIC risk-based capital formula to estimate reserve uncertainty by line of business.

18 Analysis of the uncertainty inherent in workers compensation loss reserve estimates must be grounded in actual workers compensation experience. The empirical data is the experience of the country's largest workers compensation carrier, with about 10% of the nation's experience during the historical period. To ensure confidentiality of the data, the dollar figures are normalized to a $100 million indicated undiscounted reserve.

Upon reviewing an earlier version of this paper, Stephen Lowe points out that "Because of its large market share, [your company's] experience probably does not respond to changes in mix of business by hazard group or state. . . . For smaller companies, changes in mix of business may add uncertainty beyond what is captured in your model."

This view is consistent with Allan Kaufman's recommendation that a "small company charge" be added to the risk based capital formula because small companies experience greater fluctuation

We fit each column of "age-to-age" link ratios to lognormal curves, determining "mu" (μ) and "sigma" (σ) parameters for each.[19] We perform 10,000 sets of stochastic simulations. Each simulation produces 22 "age-to-age" link ratios (one for each column).[20] These are the age-to-age factors that drive the actual loss payments.[21]

The 10,000 simulations produce 10,000 reserve amounts. We ask: "How tight is this distribution of reserve amounts?" We answer in two ways.

☛ We show the standard deviation, the mean, and two other percentiles of the

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in underwriting results and in adverse reserve development. For political reasons, the small company charge was never added to the risk-based capital formula; see Feldblum, "Risk-Based Capital Requirements" (op. cit.). In a review of the 1994 risk-based capital results, Michael Barth, a senior research associate in the NAIC's research department, similarly concludes that "the R4 RBC [i.e., reserving risk] for companies with large reserves may be higher than necessary, relative to smaller companies" (see Michael Barth, "Risk-Based Capital Results for the Property-Casualty Industry," *NAIC Research Quarterly,* Volume II, Issue I (January 1996), pages 17-31).

Lowe, Kaufman, and Barth are correct. Small companies, or companies entering new markets or developing new products, may experience greater reserve uncertainty than implied here.

19 We use the method of moments to fit lognormal curves to the development part of each set of observed paid loss "age-to-age" link ratios: i.e., to the link ratios minus one. We performed the same analysis using other curve families, particularly the Gamma. We chose the lognormal for our final analysis to add conservatism to our results. The lognormal family gave the greatest amount of "uncertainty." Our analysis shows that the uncertainty in workers' compensation reserve estimates is low. In particular, the capital that would be needed to ensure a 1% EPD ratio is substantially less than the "implicit interest margin" in undiscounted (or even partially discounted) workers' compensation reserves. This result would be all the more true if we had used Gamma curves to fit the paid loss "age-to-age" link ratios.

20 Twenty-five accident years yields 24 columns of "age-to-age" factors. The last two columns contain only 2 and 1 historical factors, so instead of fitting these columns to lognormal curves we include these development periods in the "inverse power curve" tail. See Appendix C for a full description of the reserve estimation and simulation procedures.

21 To simplify the mathematics, we assume that the same "actual" age-to-age factor will occur in each subsequent accident year. For instance, Exhibit C-5 shows a simulated indemnity plus ALAE age-to-age factor of 1.113 in the "48 to 60 months" development period for one of the 10,000 simulations. We assume that the 1.113 factor occurs in each subsequent accident year: that is, for accident years 1991, 1992, 1993, and 1994. A more complex procedure would be to perform separate simulations for each subsequent accident year. Our procedure is "conservative." Using separate simulations for each future accident year would dampen the effects of outlying factors, making the distribution of required reserves more compact.

distribution (5% and 95%). For instance, the table below shows that for discounted reserves with no adjustments for inflation, the mean reserve amount is $52.7 million, the standard deviation is $3.4 million, the 95th percentile is $58.7 million, and the 5th percentile is $47.9 million.

- To facilitate the comparison of reserve uncertainty with other types of risk, we use the "expected policyholder deficit (EPD) ratio" as a yardstick. We ask: "How much additional capital must the insurer hold to have a 1% EPD ratio?" The table below shows that for discounted reserves with no adjustments for inflation, the required capital for a 1% EPD ratio is $2.4 million.[22]

	Average Reserve Amount	Standard Deviation of Reserve	95th Percentile of Reserve	5th Percentile of Reserve	Capital Needed for 1% EPD Ratio
Undiscounted	100.0	19.5	135.3	74.0	31.0
Discounted: 6.75%	52.7	3.4	58.7	47.9	2.4

Trends and Correlations

The simulation procedure skips quietly over two issues of importance to reserving actuaries: correlations among link ratios and trends in link ratios.

1. *Correlations*: The simulation procedure assumes that the link ratio in any column is independent of the preceding link ratio in the same row. If the link ratios are not independent, the results may be overstated or understated.

   For instance, suppose that accident year 1988 shows a high paid loss link ratio *from 24 to 36 months. Should one expect a higher than average or a lower than* average link ratio from 36 to 48 months?

   The answer depends on the cause of the high 24 to 36 month link ratio. If it is caused by a speeding up of the payment pattern, but the ultimate loss amount has not changed, then one should expect a lower than average link ratio from 36 to 48 months. If it is caused by higher ultimate loss amounts (e.g., because of lengthening durations of disability for indemnity benefits, or because of greater utilization of medical services), then one should expect a higher than average link

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22 For a complete explanation of the expected policyholder deficit calculations and analysis, see Appendix B.

ratio from 36 to 48 months.[23]

- *Trends*: Our procedure uses unweighted averages of all observed link ratios in each column. During the 1980s, industry-wide paid loss link ratios showed strong upward trends, though this trend has ceased in the early 1990s.[24] How would the

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23 For further explanation, see the discussion by H. G. White to Ronald L. Bornhuetter and Ronald E. Ferguson's, "The Actuary and IBNR," in the *Proceedings of the Casualty Actuarial Society*, Volume 60 (1973), pages 165-168, as well as J. Eric Brosius, "Loss Development Using Credibility" (CAS Part 7 examination study note, December 1992).

Compare also Randall D. Holmberg, "Correlation and the Measurement of Loss Reserve Variability," *Casualty Actuarial Society Forum* (Spring 1994), Volume I, pages 247-278:

> *There are different reasons we might expect development at different stages to be correlated. For instance, if unusually high loss development in one period were the result of accelerated reporting, subsequent development would be lower than average as the losses that would ordinarily be reported in those later periods would have already been reported. In this instance, correlation between one stage and subsequent stages would be negative. Positive correlation would occur if there were a tendency for weaker-than-average initial reserving to be corrected over a period of several years. In that case, an unusually high degree of development in one period would be a warning of more to come.* (page 254)

Holmberg looks at incurred loss development. To circumvent the effects of company case reserving practices on the variability of reserve estimates, we use paid loss development chain ladder estimates in this analysis.

Holmberg also discusses possible correlation among accident years. Our procedure uses the same projected link ratios for all future accident years, thereby overstating the potential variability in the reserve estimates. Choosing different simulated link ratios in each column for each future accident year, and incorporating any correlations among the accident years, would show slightly less variability in the total reserve estimate. Since the computational effort involved is enormous, and this would only marginally strengthen the conclusions in this paper, we have not undertaken the analysis.

Roger Hayne also discusses the possible correlations in the reserve estimation procedure, though he deals with them in a different fashion; see his "A Method to Estimate Probability Level for Loss Reserves," *Casualty Actuarial Society Forum* (Spring 1994), Volume I, pages 297-356.

Roger Bovard, commenting upon an earlier draft of this paper, says: *"According to my eye . . . the columns of development factors are not independent . . . I would not characterize it as a lockstep, but the development factors appear to move up and down together."* Bovard's observation is correct; see below in the text of the paper for the cause of this phenomenon.

24 See Sholom Feldblum, "Workers' Compensation Ratemaking" (Casualty Actuarial Society Part 6 examination study note), section 7, and the references cited therein.

recognition of such trends affect the variability of the reserves estimates as discussed here?[25]

These two issues are related. First, the observed correlations among the columns of link ratios in the historical data result from the trends in these link ratios. When the trends are removed, the correlations largely disappear. Second, the trends affect the proper reserve estimate. The reserving actuary must investigate these trends and their causes, and then project their likely effect on future loss payments. That is not our interest in this paper. Rather, we ask: "What is the inherent variability in the reserve estimation process itself?"

Let us take each of these issues in turn.

➊ *Correlations*: Suppose one has two columns of observed link ratios, each from accident years 1971 through 1993, from 12 to 24 months and from 24 to 36 months, and that they are *not* correlated. We then apply a strong upward trend to both columns. That is, we increase the accident year 1972 link ratios by 1.02, the accident year 1973 link ratios by $(1.02)^2$, the accident year 1974 link ratios by $(1.02)^3$, and so forth.

The resulting link ratio show a strong positive correlation. Indeed, we observe such a correlation in the historical link ratios used in our simulation. But if we remove the trend, the correlation disappears.

This trend was caused primarily by the increasing liberalization of workers compensation benefit systems between the mid-1970s and the late 1980s. This liberalization, along with its associated effects (increasing paid loss link ratios, statewide rate inadequacies, growth of involuntary markets) ceased by the early 1990s, and has even reversed in many jurisdictions.

➋ *Trends*: Yes, there were trends, at least in the 1980s. Moreover, there are

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25 Roger Bovard notes these trends as well: *"My eye tells me that the actual data contains trends and turning points . . . A trend means that a development factor occurring far into the future could be materially above its estimate calculated in the present from a historical average. A turning point means that history could be pointing in one direction while the actual result is in the other direction."*

Similarly, Stephen Lowe, in a review of an earlier draft of this paper, says: "The model looks at one reserving methodology, paid loss development. Suppose that I were able to take the *same data* and use a different method on it, and that an unbiased application of that method produced a *mean undiscounted reserve indication* of 140.0 rather than the 100.0 produced by the paid loss method." Lowe's implication is that the use of a solitary reserving method underestimates the reserve volatility. See the comments in the text for further discussion of this subject.

multiple reserving methods. The mark of the skilled actuary is to take the various reserve indications and the manifold causes for discrepancies between them and to project an estimate as close as possible to the true, unfolding loss payments.

In our analysis, we have used the full column of observed link ratios to fit the lognormal curve, and then we have compared the simulated loss payments with their averages. Had we incorporated the "trends," and had we ignored old link ratios (because they are not relevant for today's environment), we might have produced tighter reserve distributions.

If one places faith in the skills of reserving actuaries, then the use of a solitary reserving method overstates the uncertainty of the reserving process. Suppose the simulation produces actual loss payments considerably higher than the reserve estimate. Oftentimes, the experienced actuary would have noted signs that the paid loss estimate was underestimating the actual reserve need, and that other methods were giving higher indications. By combining the indications from several methods, the actuary would come closer to the actual reserve need, thereby reducing the uncertainty in the estimates.

Our analysis, however, is based on science, not on faith. Perhaps uncertainty can be reduced by actuarial judgments of trends and by actuarial weighing of various indications. Our question is simpler: even in rote applications of basic reserving techniques, how much uncertainty is produced by the fluctuations in loss data?

Reserve Discounting

We are primarily concerned with the economic values, or discounted values, of the reserves, not with undiscounted amounts. Much of the variation in statutory reserve requirements stems from fluctuations in "tail factors." This fluctuation depends in part on inflation rates. For discounted reserves, the effects of changes in the long-term inflation rate are offset by corresponding changes in the discount rate. Moreover, tail factor uncertainty has a relatively minor effect on the present value of loss reserves, even if the discount rate is held fixed. Thus, the distribution of discounted loss reserve amounts is more compact than the distribution of undiscounted loss reserve amounts.

Exhibits 1 and 2 show the shapes of the probability distributions for the discounted and the undiscounted reserves. Exhibit 1 has no adjustment for expected inflation. Rather, the inflation implicit in the historical link ratios is presumed to continue into the future. Exhibit 2 uses explicit assumptions about future inflation rates, as discussed below in the text (and in Appendix D).

A common view is that discounted reserves are simply smaller than undiscounted reserves, but they exhibit the same degree of variability. This is not correct. As Exhibits 1 and 2 show, the probability distributions for undiscounted reserves are wide, whereas the corresponding probability distributions for discounted reserves are far more compact. The rationale for this is that much of the reserve variability comes from uncertainty in distant "tail" factors, which strongly wag estimates of undiscounted reserves but have relatively little effect on discounted reserve estimates.

Because statutory accounting mandates that insurers hold undiscounted reserves, we show results both for discounted and for undiscounted reserves in the exhibits. Moreover, the difference between the discounted and undiscounted reserve amounts is the "implicit interest margin" in the reserves, which is important for assessing the implications of the reserve uncertainty on the financial position of the insurance company.

Length of the Development

The paid loss development for 25 years is based on observed data. Workers' compensation paid loss patterns extend well beyond 25 years. For each simulation, we complete the development pattern as follows:

- ❶ Given the 22 paid loss "age-to-age" link ratios from the set of stochastic simulations on the fitted lognormal curves, we fit an inverse power curve to provide the remaining "age-to-age" factors.[26] This fit is deterministic.
- ❷ The length of the development period is chosen (stochastically) from a linear *distribution of 30 to 70 years.*

The EPD Yardstick

Probability distributions developed from simulation runs are hard to grasp. The user is left to wonder: "What do the results mean?"

As a yardstick to measure reserve uncertainty, we use the "expected policyholder deficit" (EPD) ratio developed by Robert Butsic for solvency applications. The EPD ratio allows us to

- ☛ Compare reserve uncertainty across different lines of business,
- ☛ Compare reserve uncertainty with either explicit margins in held reserves or with the "implicit interest margins" in undiscounted reserves,

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26 On the use of the inverse power curve, see Richard Sherman, "Extrapolating, Smoothing, and Interpolating Development Factors," *Proceedings of the Casualty Actuarial Society*, Vol 71 (1984), pages 122-192, as well as the discussion by Stephen Lowe and David F. Mohrman, Vol 72 (1985), page 182, and Sherman's reply to the discussion, page 190.

- Quantify the effects of various factors (such as loss sensitive contracts) on reserve uncertainty, and
- Translate actuarial concepts of reserve uncertainty into more established measures of financial solidity.[27]

The Expected Policyholder Deficit

Were there no uncertainty in the future loss payments, then the insurer need hold funds just equal to the reserve amount to meet its loss obligations. Since future loss payments are not certain, funds equal to the expected loss amount will sometimes suffice to meet future obligations and will sometimes fall short.

When the future loss obligations are less than the funds held by the insurance company to meet these obligations, the "deficit" is zero. When the future loss obligations are greater than the funds held, the "deficit" is the difference between the two. The "expected policyholder deficit" is the average deficit over all scenarios, weighted by the probability of each scenario. In the analysis here, the expected deficit is the average deficit over all simulations, each of which is equally weighted.

Let us illustrate with the workers compensation reserve simulations in this paper. Suppose first that the company holds no capital besides the funds supporting the reserves. For the discounted analysis, the average reserve amount is $52.7 million. About half the simulations give reserve amounts less than $52.7 million. In these cases, the deficit is zero. The remaining simulations give reserve amounts greater than $52.7 million; these give positive deficits. The average deficit over all 10,000 simulations is the expected policyholder deficit, the EPD. The "EPD ratio" is the ratio of the EPD to the expected losses, which are $52.7 million in this case.

Clearly, if the probability distribution of the needed reserve amounts is "compact," or "tight," then the EPD ratio will be relatively low. Conversely, if the probability distribution of the needed reserve amounts is "dispersed" – that is, if there is much uncertainty in the loss reserves – then the EPD ratio will be relatively great.

We have two ways of proceeding:

- We could assume that the company holds no assets besides those needed to support the expected loss obligations and compare EPD ratios for different lines of business or operating environments.

- We may "fix" the EPD ratio at a desired level of financial solidity and determine how

[27] Fur further comments on the benefits of the EPD yardstick for measuring uncertainty, see Appendix B.

much additional capital is needed to achieve this EPD ratio.

The second approach translates EPD ratios into capital amounts, which are more readily understood by business managers, so we follow this approach. We use a 1% EPD ratio as our benchmark, since this is the ratio which Butsic uses for risk-based capital applications. Since our interest here is in reserve uncertainty, not in capital requirements, any EPD ratio will suffice, as long as we hold it constant throughout the analysis.

Suppose the desired EPD ratio is 1%. If the reserve distribution is extremely compact, then even if the insurer holds no capital beyond that required to fund the expected loss payments, the EPD ratio may be 1% or less. If the reserve distribution is more dispersed, then the insurer must hold additional capital to achieve an EPD ratio of 1%. The greater the reserve uncertainty, the greater the required capital.

Results

The results for the base case, with discounted reserves and no adjustments for inflation, are shown in Exhibit 2. The average discounted reserves are $52.7 million, and additional capital of $2.4 million is needed to achieve a 1% EPD ratio.

The corresponding full value reserves are $100.0 million. Statutory accounting permits tabular discounts on life-time pension cases at discount rates between 4% and 5%. Most insurers discount at least the indemnity portion of "identified" pension cases at a rate between 3.5% and 5%. Some insurers also use tabular discounts on "unidentified" pension cases or "implicitly discount" long-term medical benefits, by not fully accounting for future inflation. Industry practices vary. In general, most insurers would report reserves between $80 million and $90 million in this situation.

A common view is that workers compensation reserve estimates are highly uncertain, because of the long duration of the claim payments and because of the unlimited nature of the insurance contract form. This uncertainty creates a great need for capital to hedge against unexpected reserve development. In fact, the opposite is true. There is indeed great underwriting uncertainty in workers compensation, and regulatory constraints on the pricing and marketing of this line of business have disrupted markets and contributed to the financial distress of several carriers. But once the policy term has expired and the accidents have occurred, little uncertainty remains. The difference between the economic value of the reserves and the reported (statutory) reserves, or the "implicit interest margin," is many times greater than capital that would be needed to hedge against reserve uncertainty.[28]

Statutory Benefits

On average, workers compensation reserves have about the same payment lags as General Liability reserves. There is great uncertainty in GL reserves, as an equivalent analysis to that shown in this paper would show.[29] The causes of the GL reserve uncertainty illuminate the reasons for the compactness of the workers compensation reserve distribution.

❶ *IBNR Emergence*: Many GL claims are not reported to the insurer until years after the accident. For toxic tort and environmental impairment exposures, claims are still being reported decades after the exposure period.[30] In contrast, most workers compensation claims are known to the employer within days of the accident, and insurance companies are notified soon thereafter.

❷ *Claim Payment Patterns*: General Liability loss costs depend upon judicial decisions and jury awards. Ultimate costs may not be known until years after the claim has been reported to the insurer. Even cases settled out-of-court are often settled

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28 The implications for capital allocation to lines of business are important. For companies which carry adequate statutory reserves, the capital needed to support compensation reserves is negative, though positive capital is needed to support workers compensation underwriting operations. This is indeed the capital allocation procedure used in our own company, which carries strong statutory reserves but which seeks markets in all jurisdictions, even when regulatory restraints and legislative changes hamper underwriting operations. It is in contrast to the statutory accounting procedures used in NCCI's surplus allocation method in its internal rate of return pricing model; see Sholom Feldblum, "Pricing Insurance Policies: The Internal Rate of Return Model" (Casualty Actuarial Society Part 10A Examination Study Note, May 1992), as well as the Cummins/NCCI dispute there on the proper funding of the underwriting loss in this model.

29 A full actuarial study of reserve uncertainty would apply the techniques used in this paper to all lines of business and compare the reserve distributions, EPD ratios, or capital requirements among them. A serious analysis must take into account the factors specific to each line that affect reserve fluctuations. For instance, just as we examine loss sensitive contracts for workers compensation, we must examine latent injury claims, such as those stemming from asbestos and pollution exposures, for general liability. The extent of such analysis, of course, puts it beyond the scope of this paper.

30 For current reviews of pollution reserves and loss costs, see the Insurance Services Office December 1995 report, "Superfund and the Insurance Issues Surrounding Abandoned Hazardous Waste Sites" (and the references cited therein) and the January 1996 *BestWeek* report by Eric M. Simpson, W. Dolson Smith, and Cynthia S. Babbitt, "P/C Industry Begins to Face Environmental and Asbestos Liabilities."

"on the courthouse steps," after pre-trial discovery and litigation efforts have provided good indications of the probable judicial outcome.

Workers compensation benefits, in contrast, are fixed by statute, both in magnitude and in timing. The benefits may be determined either by agreement between the insurer and the injured worker or by a workers compensation hearing officer. The major uncertainty in indemnity benefits is the duration of disability on non-permanent cases and the mortality rates on permanent cases. For sufficiently large blocks of business, both of these show relatively compact distributions. The major uncertainty for medical benefits is the rate of inflation and the extent of utilization of medical services. Over a large enough block of business, these risks also show relatively compact distributions, particularly when reserves are valued on a discounted basis.

Inflation

The preceding discussion, which shows highly compact distributions for workers compensation reserves, still *overstates* the uncertainty in these reserves. Proper actuarial analysis of two further items, the effects of inflation on the reserve estimates and the effects of loss-sensitive contracts on the net financial results of the company, further reduce the uncertainty in the loss reserves.

Inflation affects workers compensation medical benefits through the payment date. In about half of the U.S. jurisdictions, indemnity payments that extend beyond two years have cost of living adjustments that depend on inflation.[31]

Unadjusted paid loss development patterns combine true development with the effects of inflation. If future expected inflation rates are not equal to past inflation

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31 On the effects of inflation through the "payment date" versus through the "accident date," see Robert P. Butsic, "The Effect of Inflation on Losses and Premiums for Property-Liability Insurers," in *Inflation Implications for Property-Casualty Insurance* (Casualty Actuarial Society 1981 Discussion Paper Program), pages 51-102, and the discussion by Rafal J. Balcarek, pages 103-109.

The statutory rules for cost of living adjustments for indemnity benefits vary greatly by state. Some states have no COLA adjustments. Among the states which do have COLA's, most apply them only to disabilities extending beyond a certain time period, such as two years. In addition, many of these states cap the COLA's at specific levels, such as 5% per annum.

Properly quantifying the effect of the COLA adjustments on workers compensation indemnity reserve indications requires extensive work. For this paper we applied the inflation adjustment to medical benefits only, where a single index can be used countrywide. Performing a similar analysis for indemnity benefits would further reduce the uncertainty in the loss reserve indications, though the effect is not great.

rates, a rote application of a paid loss chain ladder development technique produces misleading reserve indications. A more sophisticated reserving technique would "strip" out past inflation from the historical triangles, determine the paid loss "age-to-age" link ratios, then restore expected future inflation to the indicated (future) link ratios.

Inflation Rates and Discount Rates

To account for the effects of inflation, we make the following adjustments to the stochastic simulation:

❶ We convert the paid losses to "real dollar" amounts by means of an appropriate inflation index. For workers compensation medical benefits, we use the medical component of the CPI.[32] We then determine paid loss "age-to-age" link ratios from the deflated figures, fit lognormal curves to each column, and run the simulation 10,000 times to determine the future link ratios.

❷ For each simulation, we select three (3) future inflation rates: 4%, 6%, and 8% per annum. We combine the simulated link ratios and the future (expected) inflation rate to determine the required reserves. For instance, one set of simulated link ratio may show required reserves of $75 million at a 4% future inflation rate and of $100 million at an 8% future inflation rate.

❸ For each set of simulated link ratios and expected future inflation rate, we determine three (3) required reserve amounts.

- The undiscounted (full value) reserve,
- The reserve discounted at the company's current investment yield, which was 6.75% per annum at the time of our analysis, and
- The reserve discounted at a rate midway between the company's current investment yield and the expected (future) inflation rate.

The third method in the list above is the most meaningful. It mimics the response of investment yields to the assumed future inflation rate. The investment yield is not fully responsive to inflation because (i) yields on long-term investments do not rise immediately with inflation and (ii) the assumed inflation rate applies only to medical inflation, not to overall inflation, which would be more closely correlated with interest rates.

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32 Actuaries differ on the appropriate deflator for each line of business. Our concern in this paper is the method of measuring uncertainty in loss reserves, not with specifying the proper deflator. Consistency and reasonableness in the choice of deflator are important. Slight differences in the index numbers have no significant effect on the measure of uncertainty.

❶ For each future inflation rate and discounting procedure, we obtain a distribution of required reserve amounts. As before, we determine the mean, the standard deviation, the two percentiles (5% and 95%), and the required (additional) capital to achieve a 1% EPD ratio. These figures are shown in the table below.

Medic Infla-tion		Average Reserve Amount	Standard Deviation of Reserve	95th Percentile of Reserve	5th Percentile of Reserve	Capital Needed for 1% EPD Ratio
4%	Undisc	77.2	11.1	96.4	61.6	14.0
4%	Disc: 6.75%	45.0	2.6	49.2	41.3	1.5
4%	Disc: 5.375%	48.6	3.0	53.6	44.2	1.9
6%	Undisc	86.8	16.7	117.1	64.4	25.0
6%	Disc: 6.75%	46.7	2.7	51.2	42.7	1.7
6%	Disc: 6.375%	47.7	2.8	52.4	43.4	1.8
8%	Undisc	105.9	32.3	166.5	68.2	63.0
8%	Disc: 6.75%	49.2	3.2	54.5	44.3	2.2
8%	Disc: 7.375%	47.1	2.8	51.8	42.9	1.8

To see the effects on reserve uncertainty, let us consider the middle case: historical inflation is removed from the paid loss "age-to-age" link ratios and then expected future inflation of 6% per annum is restored to the indicated link ratios. The required reserves are discounted at a 6.375% rate, which is midway between the current investment yield of 6.75% and the expected inflation rate of 6%.[33]

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33 Some readers, citing Butsic's work, may wonder: "Should we not use a 'risk-adjusted discount rate,' which would be less than the risk-free rate and presumably less than the midpoint of the current investment yield and the expected inflation rate?" Butsic assumes that the reserves are uncertain, and he uses the risk adjustment to compensate the company or its investors for the uncertainty in these reserves. We want to first measure the uncertainty; for this purpose, we must use a discount rate that is not adjusted for risk. Once we have quantified the uncertainty, we proceed in one of two paths:

A. We may require additional capital, held by the company "below the line" (i.e., in the surplus account), or

B. We may discount the reserves at a lower rate, thereby holding additional funds "above the line" (i.e., in the reserve account).

The discounted reserves are $47.7 million. The full value (undiscounted) reserves are $86.8 million. Most companies use tabular discounts for lifetime pension indemnity benefits, and some companies do not fully account for inflation of medical benefits. For most companies, the held statutory reserves would be between $70 million and $80 million, for an "implicit interest margin" of about $30 million.

The additional capital required to achieve a 1% EPD ratio because of the reserve uncertainty is $1.8 million, which is only a small fraction of the "implicit interest margin" in the reserves themselves. Removing historical inflation from the observed link ratios, and then restoring expected future inflation to the indicated link ratios, makes the loss reserve distribution more compact and reduces the "uncertainty."

Loss-Sensitive Contracts

In the preceding sections, we have examined the uncertainty in the loss reserves. For business written on loss-sensitive contracts, such as retrospectively rated plans for large workers compensation risks or reinsurance treaties with sliding scale reinsurance commissions, companies are concerned with the uncertainty in the net reserves, or the future loss payments after adjustment for retrospective premiums and variable commissions.[34]

It would be "double-counting" to first discount the reserves at a risk-adjusted rate and then determine the additional capital needed to achieve a 1% EPD ratio.

Our approach, in concept, is similar to that use by Stephen Philbrick in his "Accounting for Risk Margins" (*Casualty Actuarial Society Forum* (Spring 1994), Volume I, pages 1-90). Philbrick first discounts reserves at the risk-free rate, and he uses Butsic's "expected policyholder deficit" procedure to determine the needed risk margins. He then adds part of this risk margin to the reserves (i.e., "above the line"), and he places the remaining portion in an allocated surplus account (i.e., "below the line"). As he notes, the portion of the risk margin that he places "above the line" is equivalent to discounting the loss reserves at a rate lower than the risk-free rate. For the equivalence of Butsic's and Philbrick's results, compare Butsic's derivation of the risk-adjustment in his "Determining the Proper Interest Rate for Loss Reserve Discounting: An Economic Approach" (*Evaluating Insurance Company Liabilities* (Casualty Actuarial Society 1988 Discussion Paper Program), pages 147-188) with Philbrick's derivation of the "narrow risk margin" in his "Accounting for Risk Margins." Both Butsic and Philbrick produce figures that allow investors to achieve their desired returns even when the insurance company's investments are yielding only a risk-free rate.

34 The effects on loss sensitive contracts on reserve uncertainty has become a significant regulatory and actuarial issue in recent years. The NAIC risk-based capital formula contains an offset of 15% to 30% to the reserving risk charge for business written on loss-sensitive contracts, based upon analysis begun by the authors of this paper and continued by the American

When the retrospective rating plan contains loss limits or premium maxima/minima, reserving risk remains, though it is dampened. These plans are more risky in some ways and less risky in other ways than traditional first dollar coverages are. The "pure insurance portion" of the plan is more risky, since

- The consideration paid by the insured is the "insurance charge" and

- The benefits paid by the insurer are the difference between (a) the value of the uncapped and unbounded premium and (b) the value of the capped and bounded premiums.[35]

The "pure insurance portion" is like excess-of-loss reinsurance, where the loss limit provides coverage like that of per-accident excess-of-loss and the premium bounds

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Academy of Actuaries task force on risk-based capital; see Sholom Feldblum, "Risk-Based Capital Requirements," *op cit.* For the 1996 Annual Statement, a new Part 7 has been added to Schedule P to measure the premium sensitivity to losses on loss-sensitive contracts; see Sholom Feldblum, "Completing and Using Schedule P," third edition (CAS Part 7 examination study note, 1996).

The text of this paper assumes familiarity with retrospective rating plans and with their parameters, such as loss limits and premium maximums and minimums, as well as with standard reserving techniques for retrospective premiums. More detailed information on the retrospective rating plan pricing parameters may be found in LeRoy J. Simon, "The 1965 Table M," *Proceedings of the Casualty Actuarial Society*, Volume 52 (1965), pages 1-45; David Skurnick, "The California Table L," *Proceedings of the Casualty Actuarial Society*, Volume 61 (1974), pages 117-140; Yoong-Sin Lee, "The Mathematics of Excess of Loss Coverages and Retrospective Rating - A Graphical Approach," *Proceedings of the Casualty Actuarial Society*, Volume 75 (1988), pages 49-78; William R. Gillam and Richard H. Snader, "Fundamentals of Individual Risk Rating" (1992); and Robert K. Bender, "Aggregate Retrospective Premium Ratio as a Function of the Aggregate Incurred Loss Ratio," *Proceedings of the Casualty Actuarial Society*, Volume 81, Numbers 154 and 155 (1994), pages 36-74, along with the discussion by Howard C. Mahler, pages 75-90. The retrospective premium reserving techniques that underlie the analysis in this paper are discussed in Walter J. Fitzgibbon, Jr., "Reserving for Retrospective Returns," *Proceedings of the Casualty Actuarial Society*, Volume 52 (1965), pages 203-214; Charles H. Berry, "A Method for Setting Retro Reserves," *Proceedings of the Casualty Actuarial Society*, Volume 67 (1980), pages 226-238; and Michael T. S. Teng and Miriam Perkins, "Estimating the Premium Asset on Retrospectively Rated Policies" (*Proceedings of the Casualty Actuarial Society*, forthcoming).

[35] *"Caps" refer to the loss limits; "bounds" refer to the premiums maximum and* minimum. "Ratable losses" are paid by the insurer but reimbursed by the employer, so there is no insurance risk. Acquisition expenses, underwriting expenses, and adjustment expenses are paid by the insurer but reimbursed in the basic premium and in the loss conversion factor, again eliminating most of the risk to the insurer.

provide coverage like that of aggregate excess-of-loss. The variability of reserves for excess layers of coverage, per dollar of reserve, is generally greater than the corresponding variability of reserves for first dollar coverage.

If the retrospectively rated policy is considered as a whole – both the insurance portion and the "pass-through" portion – the retrospectively rated plan is less risky, per dollar of loss, than traditional first dollar coverage. In fact, if there are no loss limits and no maximum or minimum bounds on the premium, then the insurance contract becomes simply a financing vehicle and the insurance company serves as a claims administrator, not as a risk-taker. There is no underwriting or reserving uncertainty at all.[36]

Premium Sensitivity

How potent are loss sensitive contracts in reducing "net" loss reserve uncertainty? [By "net" loss reserve uncertainty, we mean the variability in the insurer's total reserves, or loss reserves minus retrospective premium reserves. "Accrued retrospective premium reserves" are carried as an asset on statutory financial statements, whereas loss reserves are carried as a liability.] The answer depends on the "premium sensitivity" of the plan: that is, the amount of additional premium generated by each additional dollar of loss.

We quantify the net loss reserve uncertainty in the same fashion as we did earlier, by asking: "How does reserve uncertainty affect the financial condition of the insurer?" For instance, if the required reserves turn out to be 15% higher than our current estimates, how much additional funds will the company need to meet its loss obligations?

For business which is not written on loss sensitive contracts, the answer is simple. The additional funds needed equal the additional dollars of loss minus the amount of any implicit interest cushion in the reserves.[37]

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[36] There is still "credit risk." In the event of a large loss, the insured may be unable or unwilling pay the additional premiums, though the insurer is still liable to the injured employee for benefit payments. The credit risk may be mitigated by obtaining letters of credit to secure the insurance commitments. For further comments on the credit risk, see Howard W. Greene, "Retrospectively-Rated Workers Compensation Policies and Bankrupt Insureds," *Journal of Risk and Insurance*, Volume 7, No. 1 (September 1988), pages 52-58.

[37] As noted above, a more sophisticated analysis is needed if the amount of the implicit interest cushion varies with the magnitude of the adverse development, as is true for workers compensation, where both the size of the tail factor and the amount of implicit interest cushion vary with inflation.

For business written on loss sensitive contracts, the answer is more complex, as the following illustration shows. Suppose that the indicated workers compensation reserves are $800 million. As a conservative range to guard against reserve uncertainty, the valuation actuary chooses an upper bound of $1,050 million as the worst case reserve estimate. The actuary estimates that there would be about $200 million of implicit interest margin in this scenario, so the capital needed to guard against reserve uncertainty is $50 million.[38]

Suppose now that half of the company's workers compensation business is written on retrospectively rated policies, of two types.

- Large accounts have plans with wide swings: loss limits and premium maximums are high, so each additional dollar of loss generates about a dollar of premium.

- Small and medium-size accounts have plans with narrower swings. Loss limits and premium maximums are lower and constrain the retro premiums. On average, each additional dollar of loss generates about 65¢ of additional premium.

For the entire book of retrospectively rated contracts, the premium sensitivity is 80%: that is, each additional dollar of loss generates about 80¢ of additional premium.

How much capital should this insurer hold to guard against reserve uncertainty? Well, suppose the needed reserves increase to the "worst case" scenario of $1,050 million. Half of this business is written on retrospectively rated plans, and the average premium sensitivity is 80%. In other words, of the adverse loss development of $250 million, $125 million occurs on retrospectively rated business. With a premium sensitivity of 80%, adverse loss development of $125 million generates $100 million of additional premium.

We add the $100 million of additional premium to the $200 of implicit interest margin to arrive at a solvency cushion of $300 million. Since the worst case adverse loss development is $250 million, the company already has a $50 million surplus solvency

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38 For ease of illustration, we assume here that the company wishes to hold a margin for reserve uncertainty even greater than the implicit interest margin. The preceding sections of this paper show that for workers compensation this implies a very low EPD ratio. Alternatively, using a "probability of ruin" perspective, the valuation actuary may desire to hold a margin such that there is an extremely low probability that the reserves plus the margin will be insufficient to pay the claims.

cushion in the carried reserves, so no additional capital is needed.[39]

In sum, loss sensitive contracts have potent implications for the quantification of reserve uncertainty. We examine this subject from two perspectives:

- A theoretical perspective, showing the factors affecting the risks in loss sensitive contracts, and

- A simulation perspective, showing the effects of loss sensitive contracts on our measures of reserve uncertainty.

Underwriting Risk and Reserving Risk

Our primary concern in this report is with reserve uncertainty. We can not answer this question empirically; rather, we must use simulation techniques, as we do in the previous sections of this paper.

The practical actuary is skeptical of simulation. So let us broaden our inquiry and ask: "To what extent do retrospectively rated policies mitigate underwriting uncertainty?" We can answer this question empirically, by comparing the variability of standard loss ratios and net loss ratios on a large and mature book of retrospectively rated workers' compensation policies.

- *Standard loss ratios* are incurred losses divided by standard earned premium. These loss ratios are influenced by random loss occurrences and premium rate fluctuations, and they vary considerably over time.

- *Net loss ratios* are incurred losses divided by the final earned premiums, as modified by retrospective adjustments. These adjustments counteract both the random loss occurrences and the fluctuations in manual rate levels, so the net loss ratios should be more stable over time.

Exhibit 3 shows these loss ratios for retrospectively rated policies issued by a large workers' compensation insurer. Only mature policies are used in this comparison, to

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39 Depending on the type of retrospective rating plan, an adjustment may be needed to bring the accrued retrospective premiums to present value. For "incurred loss" retro plans, the additional premium is billed and collected when the case reserves develop adversely, so no adjustment is needed. For "paid loss" retro plans, the additional premium is collected only when the losses are paid, so the present value of the retro premium is less than $100 million. In this illustration, the implicit interest margin in the loss reserves is $200 million ÷ $1,050 million, or 19%. If all the retro plans in this illustration were paid loss retros, and the additional premium is collected when the losses are paid, the present value of the additional premiums is $81 million.

ensure that the net loss ratios are not subject to significant additional retrospective adjustments.[40]

As expected, the mean loss ratios are similar for standard and net: 77.0% for standard and 78.8% for net. [The net loss ratios are slightly higher, since more retrospective premiums are returned than are collected.] The variances and standards deviations, however, differ greatly. The standard loss ratios show a variance of 46.9% and a standard deviation of 68.5%. Retrospective rating dampens the fluctuations in the loss ratios, leading to a variance of 11.2% and a standard deviation of 33.4%.

Reserve Uncertainty

Exhibit 3 deals with (prospective) underwriting risk, or the risk that future underwriting returns will be lower than anticipated.[41] Let us return now to reserving risk. We ask "To what extent is adverse development on existing losses mitigated by loss sensitive contracts?"

To resolve this issue, we must know the premium sensitivity of the retrospective rating plans, or the amount of additional premium received for each dollar of additional loss. Let us examine the variables that affect the premium sensitivity: the plan parameters, the current loss ratio, and the maturity of the reserves.[42]

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40 An earlier exhibit from this same book of business, produced by Dr. J. Eric Brosius, was provided by the authors to the American Academy of Actuaries task force on risk-based capital. It was used by the Tillinghast consulting firm to support the recommendations of the task force regarding a loss-sensitive contract offset to the reserving and underwriting risk charges in the NAIC risk-based capital formula. The exhibit in this paper, along with the variances and standard deviations, was produced by Miriam Perkins.

41 The NAIC risk-based capital formula called this "written premium" risk, since the capital requirements are dependent on the most recent year's premium volume. Part of the risk is that premium collections will be lower than expected, because of, say, underwriting cycle downturns or severe marketplace competition, and part of the risk is that losses will be higher than expected, because of, say, misestimation of claim frequency or severity or simply random loss occurrences.

42 Compare Robert K. Bender, "Aggregate Retrospective Premium Ratio as a Function of the Aggregate Incurred Loss Ratio," *Proceedings of the Casualty Actuarial Society*, Volume 81, Numbers 154 and 155 (1994), pages 36-74: "The aggregate premium returned to a group of individual risks that are subject to retrospective rating depends upon the retrospective rating formula, the aggregate loss ratio of the risks, and the distribution of the individual risks' loss ratios around the aggregate" (page 36).

● Plan Parameters

If the retrospective rating plan had no loss limits and no constraints on the final premium, then the premium sensitivity would equal the loss conversion factor, which is equal to or greater than unity. In most cases – and particularly for smaller risks – the loss limits and the premium maximums constrain the swing of the plan, and the premium sensitivity is lower than unity.

Generally, larger insureds choose retrospective rating plans with wide swings, while smaller insureds choose more constrained plans. To quantify premium sensitivity, therefore, the book of business should be divided into relatively homogeneous groups by size of risk, such as between medium sized risks and "national accounts."[43] [Small risks rarely use retrospective rating plans.]

The differences are dramatic. National accounts in our own book of business, with annual premium of $2 million or more per risk, almost always have wide swing plans, and the average premium sensitivity is close to unity. Medium sized risks, with more constrained plans, have an average premium sensitivity of about 65%.[44]

There are several additional items which should also be examined for a complete analysis of the effects of loss-sensitive contracts on reserve uncertainty. As noted earlier, we should look at the effects of "incurred loss" retros versus "paid loss" retros on the implicit interest margin in the accrued retrospective premiums. For ease of analysis, we assume here that all plans are paid loss retros: since the additional loss payments and the additional premium collections occur at the same time, the age-to-age link ratios can simply be adjusted for the premium sensitivity. This analysis is conservative. Incurred loss retros would show even greater dampening of the loss reserve uncertainty: since the premiums have less implicit interest margin, the effective premium sensitivity is greater than a nominal dollar analysis indicates.

In addition, a complete analysis should look at the effects of the plan parameters on the credit risk of the company and on the size of the implicit interest margin. The accrued retrospective premiums are a receivable, not an investable asset. As is true for losses, they are held on statutory financial statements at ultimate value, not at present value. If loss reserves are backed by accrued retrospective premiums, then either these premium reserves should be reduced to present value or the implicit interest margin in the loss reserves should be reduced.

[43] This subdivision of the data by size of insured or by "underwriting market" is generally available in company files. Of course, if the company keeps data by type of plan (wide swing plans vs. narrow swing plans and so forth), this more accurate subdivision is preferable.

[44] These are empirical figures, using actual ratios of retrospective premium collected to historical loss development. Robert Bender, "Aggregate Retrospective Premium Ratio as a Function of the Aggregate Incurred Loss Ratio," *Proceedings of the Casualty Actuarial Society*, Volume 81, Numbers 154 and 155 (1994), pages 36-74, using theoretical relationships

❷ Loss Ratio

The premium maximum and the loss limits constrain the swing of the plan. Ideally, we wish to know whether adverse loss development causes the retrospectively rated premium on each policy to hit the premium maximum or the loss to hit the loss limit. However, we do not have information on each individual change in reported losses. Actuaries estimate from aggregates, not from details. We must determine what aggregate statistics predict the average amount of retrospective premium that will be collected.

Given the parameters of any retrospectively rated plan, the loss ratio determines whether retrospective premium will be capped at the maximum. Given a distribution of loss ratios in a book business, all of which are written on similar retrospectively rated plans, we can determine the percent of plans which will hit the maximum premium. If the shape of this distribution does not depend significantly upon the average loss ratio of the book of business, and if we know the average loss ratio, then we can determine the percent of plans which will hit the maximum premium.

Premium sensitivity declines as the aggregate loss ratio increases. During poor underwriting years, when loss ratios are higher, adverse loss development leads to less additional premium than in good underwriting years, when loss ratios are lower.

❸ Reserve Duration

In workers' compensation, adverse loss development at early maturities stems from delayed reporting of some cases and primarily from the reclassification of non-serious cases to serious cases. For instance, almost all lower back sprains are initially classified as short-term temporary total cases. Significant case reserve development is expected in the first two or three years, as some of these claims develop into

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based on the NCCI's "Table M," estimates premium sensitivity for various risk sizes. Bender's analysis is a useful check on our procedure, but it is not a substitute. His analysis posits that the Table M relationships are correct, and that compensation carriers actually use the NCCI Table M insurance charges to price their retrospectively rated policies. In practice, insurers use a variety of plans for their large insureds, and they often negotiate the loss limits, premium maximum, and plan parameters in each case for their national accounts. We rely, therefore, on the actual results of the plans sold "on the street," not on *a priori* actuarial expectations.

As emphasized in Howard Mahler's discussion of Bender's paper (pages 75-90 of *PCAS*, Volume 81), the premium sensitivity is strongly dependent on the size of the risk. Bender analyzes primarily small risks, where the premium sensitivity is weak. The sensitivity rises rapidly with the size of the risk; see especially Bender's Table 5 on page 50, which shows the "slope" of the plan as a function of the "loss group," and Mahler's comments on pages 76-78.

permanent partial or permanent total cases. Much of this development is within the "ratable" area of the retrospective rating plan: for instance, a $10,000 claim is reclassified as a $100,000 claim, so premium sensitivity is high.

At later maturities, adverse loss development stems primarily from re-estimation of the costs of permanent cases. For a plan with low or even moderate loss limits, almost all the adverse loss reserve development after five or six years occurs in the "non-rateable" portion of the retrospective rating plan. For instance, a $300,000 claim is re-estimated at $400,000, where average premium sensitivity is low.

Furthermore, many companies "close" their retrospective rating plans after, say, five or seven years, with a final accounting between the company and the insured. Adverse development occurring after this date would not affect the retrospective premiums.

Effects on the Simulation

For the simulation, we use premium sensitivity factors based on observed long-term patterns by market and by reserve duration in our countrywide book of business.[45]

❶ The market dimension is binary: large (national) accounts vs medium-sized accounts. As noted above, our national accounts have wide swing plans with high premium sensitivities. Our medium sized accounts have more constrained plans with more moderate premium sensitivities.

❷ For reserve duration, we use annual periods demarcated by retrospective premium adjustment points. In other words, we look at the change in incurred losses from first to second retrospective premium adjustment, from second to third adjustment, and so forth, and we match these with the change in retrospective premium from first to second adjustment, from second to third adjustment, and so forth. There is a delay of about 4 to 5 months between the loss change and the corresponding premium change. That is, the standard workers compensation first retrospective adjustment may be done at 21 months subsequent to policy inception, using losses evaluated at 18 months, with the additional or return

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[45] To avoid undue complexity, we do not use aggregate loss ratio in the simulation analysis. To incorporate the aggregate loss ratio dimension, we would have to evaluate the effect of each simulated link ratio on the new accident year loss ratio, and determine a new premium sensitivity factor for every cell in every simulation. Moreover, since we are using paid loss age-to-age factors, we would have to convert paid loss ratios to incurred loss ratios. The benefits from these refinements is far less than the additional effort.

premium booked in the 23nd or 22rst month.[46]

From the empirical data we produce two curves, each showing premium sensitivity by reserve duration, one for national accounts and one for medium-sized risks. We weight these two curves by the volume of business in these two markets.

In the simulation analysis, we first repeat the steps outlined earlier. Based upon historical experience, we estimate (deterministically) the amount of case reserves associated with each cumulative paid loss amount at each duration. From the change in reported losses, we determine the change in retrospective premiums, and thereby the change in "net reserves."

For the exhibits in this paper, we vary this procedure. The effects of loss sensitive contracts vary greatly by type of plan and by company practice. As some reviewers of an earlier draft of this paper have pointed out to us: "Your company writes primarily large accounts and uses highly sensitive, wide swing plans. For this type of business, the "net" reserve uncertainty is clearly mitigated. What about other companies, which use less sensitive plans, recognize the adverse development later, and close their plans after several years? Would they also show a significant reduction in net reserve uncertainty?"

This criticism is legitimate. For the exhibits in this paper, we make three adjustments, to model the loss sensitive contracts often used for smaller risks:

- *The retrospective plans are relatively insensitive. In fact, for the most recent* accident year, the assumed premium sensitivity is 49%.
- We assume that most adverse development is recognized late.
- We assume that the plans are closed, on average, about five to ten years after policy inception. With the late recognition of the adverse development and the relative early closure of the plans, even the limited premium sensitivity is markedly reduced for earlier accident years.

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46 See the paper by Teng and Perkins, "Estimating the Premium Asset on Retrospectively Rated Policies" (*op. cit.*) for a complete discussion of this. In truth, the premium sensitivity is the change in booked premium between the 23rd and the 35th month compared to the change in incurred losses between the 18th and the 30th month. Because we have data only for quarter-end points, and because premiums bookings on some risks are late, we use either a two quarter or a three quarter lag, not a five month lag.

As noted above, premium sensitivity varies by plan and by company. The new Part 7 of Schedule P, which is designed to measure premium sensitivity on loss sensitive contracts, has no lag; see Sholom Feldblum, "Completing and Using Schedule P, Third Edition (1996), for a more complete discussion of this. Thus, the aggregate industry data provided by Schedule P, Part 7, will not be of much aid in estimating premium sensitivities.

Even with these adjustments, the projected reserve distribution is more compact, and there is less "reserve uncertainty." The table below compares the results for the loss-sensitive contracts versus non-loss-sensitive contracts, for discounted reserves.

As before, the figures are normalized to an undiscounted "gross" loss reserve of $100 million. The discounted "gross" (i.e., loss only) reserve is $52.7 million, whereas the discounted "net" (i.e., loss minus premium) reserve is $46.5 million, for a reduction of 12%. The capital needed to achieve a 1% EPD ratio decreases from $2.4 million to $1.9 million, for a reduction of 21%. In other words, the required capital declines from about 5% of required reserves to about 4% of required reserves.

Discounted reserves at 6.75% annual rate:	Average Reserve Amount	Standard Deviation of Reserve	95th Percentile of Reserve	5th Percentile of Reserve	Capital Needed for 1% EPD Ratio
Loss only	52.7	3.4	58.7	47.9	2.4
Loss – premium	46.5	2.8	51.3	42.6	1.9

We now combine the effects of loss sensitive contracts with the inflation adjustments discussed earlier. The table below shows the results for discounted and undiscounted reserves, with inflation stripped out and then built back in at 4%, 6%, and 8% per annum. These figures should be compared with the figures shown in the previous section for the "gross" (loss only) reserve uncertainty.

Medic Inflation		Average Reserve Amount	Standard Deviation of Reserve	95th Percentile of Reserve	5th Percentile of Reserve	Capital Needed for 1% EPD Ratio
4%	Undisc	69.4	9.9	86.8	55.4	12.4
4%	Disc: 6.75%	36.1	2.2	39.6	32.5	1.5
4%	Disc: 5.375%	39.4	2.5	43.4	35.7	1.6
6%	Undisc	77.3	14.7	104.4	57.8	21.7
6%	Disc: 6.75%	37.4	2.2	41.1	33.9	1.3
6%	Disc: 6.375%	38.4	2.2	42.1	34.9	1.3
8%	Undisc	93.6	27.5	145.8	60.8	52.3
8%	Disc: 6.75%	40.1	2.1	43.7	37.1	1.1
8%	Disc: 7.375%	38.4	2.0	41.8	35.4	1.1

Exhibit 4 graphs these probability distributions, for

- Loss sensitive versus non-loss sensitive contracts, and
- Both discounted and undiscounted reserves, with
- Future inflation projected at 6% per annum, and
- A 6.75% discount rate (for the discounted reserves).

The probability distributions for the loss sensitive contracts are not just shifted to the left, since the "net" (loss minus premium) reserve is less than the "gross" (loss only) reserve. Rather, the probability distributions for the loss sensitive contracts are also more compact; there is less uncertainty.

Conclusions

Casualty actuaries have developed numerous methods of estimating required loss reserves. But reserves are uncertain, and actuaries are now being asked to quantify the uncertainty inherent in the reserve estimates.

Many past attempts to address this subject have foundered on one of two shoals. Some attempts are silver vessels of pure theory: loss frequencies are simulated by Poisson functions, loss severity is simulated by lognormal distributions, inflation is simulated by Brownian movements, and the results are much prized by hypothetical companies. Other attempts are steel vessels of actual experience: actual reserve changes, taken from financial statements, reveal how companies have acted in the past, though they offer imperfect clues about the uncertainties inherent in the reserve estimation process itself.

This paper glides between the shoals. Loss reserve uncertainty must be tied to the line of business. The uncertainty in workers' compensation reserves is different from the uncertainty in general liability reserves even as it is different from the uncertainty in life insurance or annuity reserves. We begin with extensive data: twenty five years of experience from the nation's premier workers compensation carrier.

These data allow the actuary to develop reserve indications. Our concerns in this paper are different. We fit these data to families of curves to develop probability distributions of required reserves. The power of stochastic simulation techniques enables us to develop thousands of potential outcomes that are solidly rooted in the empirical data.

The analysis shows that workers compensation reserves, when valued on a discounted basis, have a highly compact distribution. To measure uncertainty, we use an "expected policyholder deficit (EPD) ratio" yardstick. For workers' compensation, the amount of capital needed to achieve a 1% EPD ratio is only a small fraction of the "implicit interest margin" in the reserves themselves.

The vicissitudes of inflation are a major cause of workers compensation reserve fluctuations, particularly for full value (undiscounted) estimates. The paper shows the effects of different future expected inflation rates on the uncertainty inherent in the reserve estimates.

Insurers are risk averse, even as other economic actors are. They use policy exclusions and contract provisions to mitigate the risks that they undertake. The paper shows how the use of retrospectively rated workers' compensation policies dampen the uncertainty in the reserve estimates.

The combination of rigorous actuarial theory with an extensive empirical database enables us to examine the uncertainty in the reserves themselves. Similar analyses should be performed for other lines of business, such as automobile insurance or general liability. Comparisons among the lines, as well as comparisons of reserve uncertainty with underwriting risks and with asset risks, would allow us to exchange preconceived notions with well-supported facts.

EXHIBIT 1

Distributions of Reserves, Without Inflation Adjustments

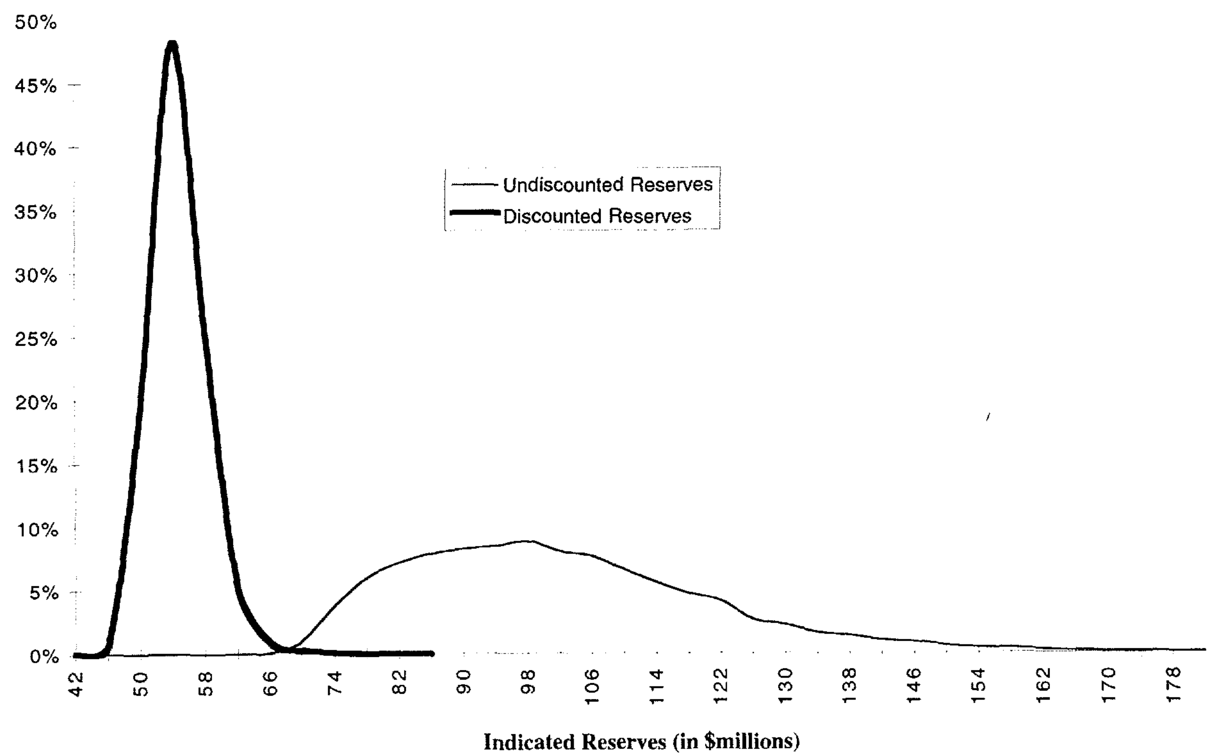


EXHIBIT 2

Distributions of Reserves, with Inflation Stripped Out and Built Back at the Specified Rates

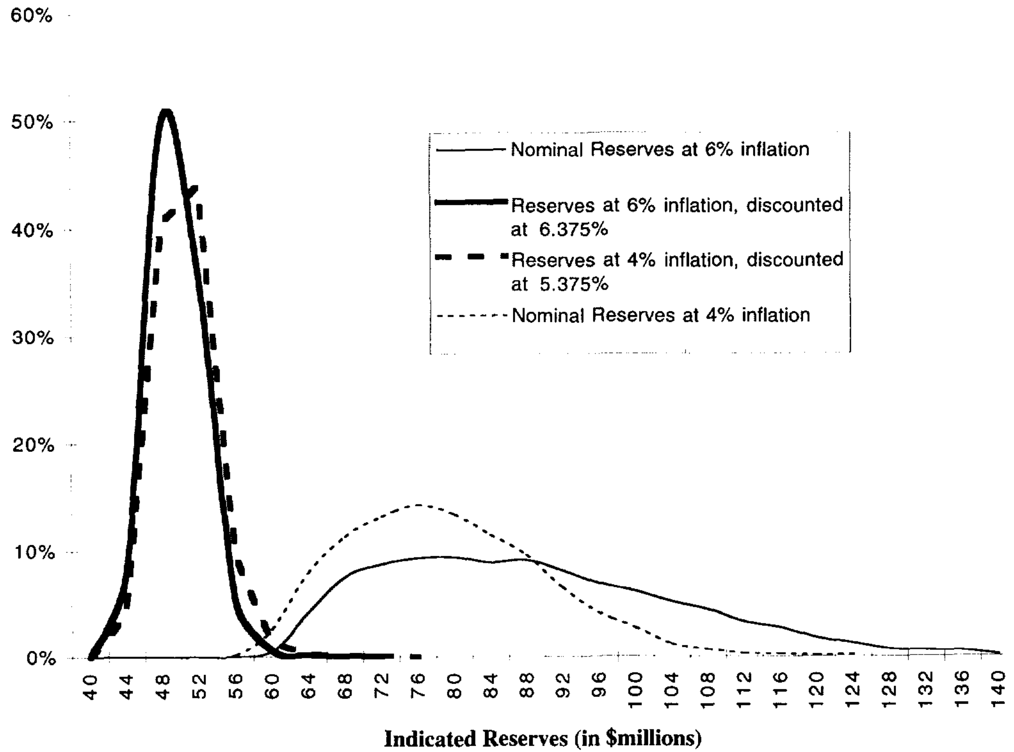


EXHIBIT 3

WORKERS COMPENSATION
NATIONAL ACCOUNTS RETRO POLICIES

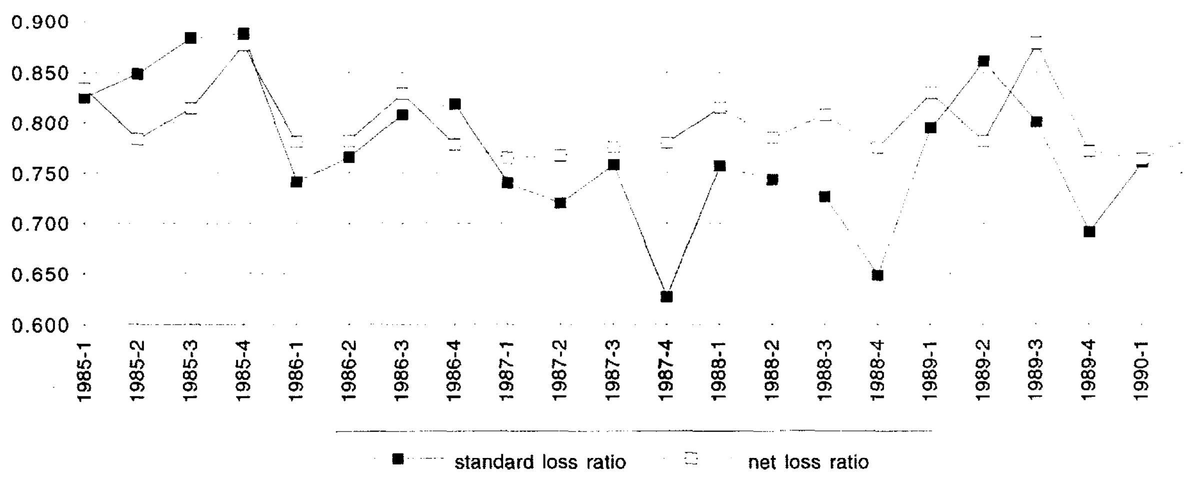
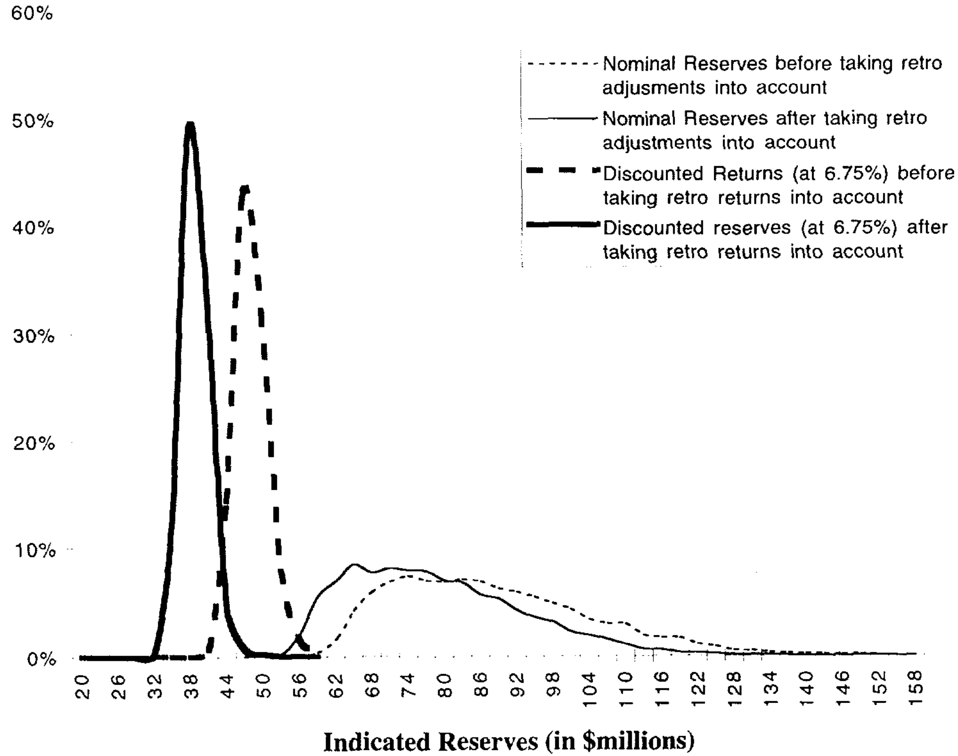


EXHIBIT 4

Distributions of Reserves, With and Without Retro Adjustments (Assuming Inflation at 6%)



Appendix A: Workers Compensation Reserves and Risk-Based Capital Requirements

The text of this paper distinguishes between "regulatory measures" of reserving risk, as used in the NAIC's risk-based capital formula, and "actuarial measures" of reserving risk, as quantified here. The analysis in this paper shows that the volatility inherent in workers compensation reserve estimates is well below the implicit interest margin in statutory (undiscounted) reserves. The NAIC risk-based capital formula, however, has a reserving risk charge of 11% for workers compensation, even after incorporation of the expected investment income on the assets supporting the reserves.

An actuary unfamiliar with the development of the workers' compensation reserving risk charge in the risk-based capital formula might conclude that "regulatory measures" of workers compensation reserving risk give high capital charges whereas "actuarial measures" give low charges. This is not correct. The risk-based capital formula gives a low charge for workers compensation reserving risk, even as the actuarial analysis in this paper provides. The final 11% charge in the risk-based capital formula is an *ad hoc* revision intended to provide more "reasonable" capital requirements.

The workers compensation reserving risk charge was one of the most contested aspects of the risk-based capital formula, and the derivation of the final 11% charge was never publicly revealed. This appendix explains the issues relating to the workers' compensation reserving risk charge, and it shows the charge resulting from the NAIC "worst-case year" method.

Adverse Development and Loss Reserve Discounting

The reserving risk charge in the risk-based capital formula bases the capital requirements on the historical adverse loss development in each line of business. The "worst-case" industry-wide adverse loss development as a percentage of initial reserves is determined from Schedule P data, and this figure is then reduced by a conservative estimate of expected investment income.

For workers compensation, the original risk-based capital formula produced a charge of 0.4%.[47] Current Best's *Aggregates and Averages* data show a gross "worst-case year" adverse development of 24.2%, as derived in Exhibit A-1.

Two considerations related to loss reserve discounting complicate the estimation of the reserving risk charge for workers compensation.

- Statutory accounting conventions for property-casualty insurers are conservative, particularly with regard to the reporting of loss reserves. Life insurers show discounted loss reserves, with sufficient margins in the valuation rate to ensure that benefit obligations are met. Property-casualty insurers show undiscounted reserves, leaving a large margin in the reserves themselves, particularly for long-tailed lines of business.

  In other words, property-casualty insurers have two potential margins to ensure adequacy of loss reserves: an implicit interest margin in the reserves themselves, and an explicit capital requirement provided by the reserving risk charge. To avoid "double counting," the risk-based capital formula offsets the implicit interest margin against the explicit reserving risk charge.

- The "double margin" occurs when reserves are reported on an undiscounted basis. But some property-casualty reserves are reported on at least a partially discounted basis. For instance, many carriers use tabular discounts for workers compensation lifetime pension claims. The special statutory treatment of workers compensation lifetime pension cases necessitates adjustments to the reserving risk charge.

Both the NAIC Risk-Based Capital Working Group and the American Academy of Actuaries task force on risk-based capital spent months working on these two topics. The issues are complex, and no clear explanation is available for either regulators or for industry personnel. Some actuaries, in fact, presume that the 11% charge for workers compensation results from the effects of tabular reserve discounts. To clarify the issues, this appendix discusses the treatment of the implicit interest margin in statutory reserves and the adjustments needed for tabular loss reserve discounts in workers' compensation.

Payment Patterns and Discount Rates

The amount of the implicit interest margin, or the difference between undiscounted (full-value) reserves and discounted (economic) reserves, depends on two items: the

[47] For a full description of the risk-based capital reserving risk charges, see Sholom Feldblum, "Risk-Based Capital Requirements" (Casualty Actuarial Society Part 10 examination study note).

payout pattern of the loss reserves and the interest rate used to discount them.

For most lines of business, the NAIC risk-based capital formula uses the IRS loss reserve payment pattern along with a flat 5% discount rate. These choices were made for simplicity. Using the IRS discounting pattern avoids the need to examine loss reserve payout patterns, and using a flat 5% discount rate avoids the need to examine investment yields. For some lines of business, these choices are acceptable proxies for good solvency regulation. For workers' compensation, greater complexities arise.

- *Payment Pattern*: The IRS procedure assumes that all losses are paid out within 15 years. Moreover, the pattern is based on the industry data for the first 10 years as reported in Schedule P.

  For short-tailed lines of business, this is not unreasonable, since most losses are indeed paid out before the Schedule P triangles end. Workers compensation reserves, however, have a payout schedule of about 50 years, since permanent total disability cases – which are a small percentage of the claim count but a large percentage of the dollar amount – extend for the lifetime of the injured worker.

- *Discount Rate*: For its discount rate, the IRS uses a 60 month rolling average of the federal midterm rate, which is defined as the average yield on outstanding Treasury securities with maturities between 3 and 9 years. Since 1986, the IRS discount rate has ranged between 7 and 8%.

  Actual portfolio yields have been about 100 to 200 basis points higher, since insurance companies invest not only in Treasury securities but also in corporate bonds, common stocks, real estate, and mortgages. However, these latter investment vehicles have additional risks, such as default risks, market risks, and liquidity risks. As a loss reserve discounting rate, many casualty actuaries would prefer the 7 to 8% "risk-free" Treasury rate to the 8 to 10% portfolio rate, particularly for statutory financial statements, which emphasis solvency.

  The NAIC risk-based capital formula uses a flat 5% discount rate. A variety of justifications have been given, such as

  - The 5% rate is simple, obviating any need to examine actual investment yields and cutting off any arguments about the "appropriate" rate.

  - The 5% rate adds an additional margin of conservatism, since it is 2 to 3 points lower than the corresponding IRS rate.

  For lines of business where the implicit interest margin in the reserves is small, the difference between the 5% NAIC rate and the 7 to 8% IRS rate is not that important in setting capital requirements. For a line of business like workers compensation, however, where the discount factor ranges from 60% to 83%, depending upon the assumptions, the choice of discount rate has a great effect.

We begin the analysis below with the current NAIC risk-based capital assumptions to see the unadjusted charge produced by the formula. We then turn to actual payment patterns and investment yields to address the fundamental questions: "What is the risk associated with workers compensation loss reserves? And how much capital ought insurance companies to hold to guard against this risk?"

The IRS Discount Factor

The IRS determines the loss reserves payout pattern by examining the ratio of paid losses to incurred losses by line of business for each accident year from Part 1 of Schedule P. The data are drawn from Best's *Aggregates and Averages*, and the payout pattern is redetermined every five years.

Schedule P shows only 10 years of data, though several lines of business, such as workers compensation, have payout schedules extending up to 50 years. The IRS allows an extension of the payout pattern beyond the 10 years shown in Schedule P for up to an additional 6 years. The extension of the payout pattern does not rely on either empirical data or financial expectations. Rather, the payout percentage in the tenth year is repeated for each succeeding year until all reserves are paid out.

Accident Years vs. Aggregate Reserves

The IRS determines a discount factor for each accident year. Companies determine discounted reserves by multiplying the statutory reserves by the discount factor for the appropriate line of business and accident year. The risk-based capital formula uses a single discount factor for all accident years combined. Thus, one must use a weighted average of the discount factors, based on the expected reserves by accident year.[48]

Exhibit A-2 shows the workers compensation payment pattern using the IRS procedures and the most recent Best's *Aggregates and Averages* Schedule P data.

☛ The left-most column shows the payment year. Because workers' compensation

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[48] For simplicity, the calculations in this paper assume that the volume of workers compensation business is remaining steady from year to year. A theoretical refinement would be to use the actual volume of industry wide workers compensation reserves in each of the past ten years, though there is no significant difference in the result.

reserves are paid out so slowly, the IRS extends the payment schedule for the full 16 years. It is still far too short, particularly for lifetime pension cases.

- The middle column shows the payment schedule for an individual accident year. This payment schedule says that 22.34% of an accident year's incurred losses are paid in the first calendar year, 28.36% in the next calendar year, and so forth.

- The right-most column shows the payment schedule for the aggregate reserves, assuming no change in business volume over the 16 year period. This payment schedule says that 25.42% of the reserves will be paid in the immediately following calendar year, 16.14% in the next calendar year, and so forth.

The graph below shows the payout patterns for an individual accident year and for the aggregate reserves. The horizontal axis represents time since the inception of the most recent accident year. The accident year payout pattern begins with the first losses paid on the policy, soon after the inception of the accident year. The valuation date of the reserves in the graph is the conclusion of the most recent accident year, so the payout pattern begins in the second year since inception.

The payout pattern is combined with an annual interest rate to give the discount factor, or the ratio of discounted reserves to undiscounted reserves. With an interest rate of 5% per annum, the discount factor for the reserves is 82.98%. The risk-based capital formula would therefore indicate a reserving risk charge of

$$[1.242 * 82.98\%] - 1 = 3.06\%.$$

The 3% reserving risk charge depends upon the conservative 5% annual interest rate the short IRS payment pattern. More realistic interest rates and payment patterns, even when still containing margins for conservatism, lead to a negative charge. We discuss these in conjunction with tabular loss reserve discounts below.

Discounted Reserves

What if an insurer holds discounted reserves, or partially discounted reserves? How should the reserving risk procedure described above be modified to account for the reserve discount?

This question is most relevant for workers compensation. Statutory accounting normally requires that insurers report undiscounted, or full-value, reserves. An exception is made for workers compensation lifetime pension cases, where insurers are allowed to value indemnity (lost income) reserves on a discounted basis. State statutes often mandate conservative discount rates, usually between 3.5% and 5% per annum, with the most common being 4%. These reserve discounts are termed "tabular" discounts, since they are determined from mortality tables, not from aggregate cash flow analyses.

Adverse Development and Interest Unwinding

The combination of three factors – (a) adverse development, (b) the unwinding of interest discounts, and (c) weekly claim payments – produces intricate results that are difficult even for the most technically oriented readers to follow. So let us begin with a simple example, which illustrates the concepts discussed above.

Suppose we have one claim, which will be used for determining both the "worst case" adverse loss development and the interest discount factor. The claim occurred in 1987, and it will be paid in 1997 for $10,000.

Suppose first that the company accurately estimates the ultimate settlement amount and sets up this value at its initial reserve. Adverse loss development in this "worst case year" is 0%. Since there is a substantial implicit interest offset – the claim is paid 10 years after it occurs – the final reserving risk charge will be negative.[49]

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[49] In practice, there are no negative charges in the NAIC risk-based capital formula, since all charges are bounded below by 0%. However, the example in the text is a heuristic illustration. It is meant to demonstrate the principles, not to reflect actual industry experience or all aspects of the NAIC formula. For instance, the industry "worst case year" would not be determined from one claim, and the "implicit interest margin" is based on the IRS loss reserve discounting procedure, not the cash flow pattern of the losses. As the illustrations proceed, however, we remove the unrealistic assumptions, so that readers can see the actual workers' compensation industry-wide loss reserve payment patterns.

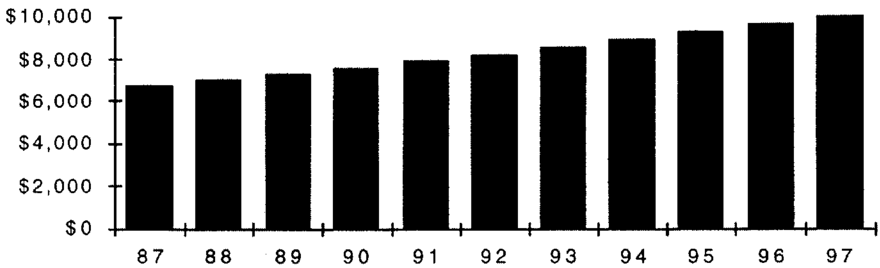
How large is the offset for the implicit interest discount? For a claim that is paid ten years after it occurs, with a 5% per annum discount factor, the offset is $1 \div (1.05)^{10}$ = 61.39%. The final reserving risk charge in this simplified illustration is –38.60%.

What if the company holds the reserve on a discounted basis, using a 4% per annum discount rate? In 1987, the company sets up a reserve of [\$10,000 $\div$ $(1.04)^{10}$], or \$6,756. In 1988, the discounted reserve increases to [\$10,000 $\div$ $(1.04)^{9}$], or \$7,026. In 1989, the discounted reserve increases to [\$10,000 $\div$ $(1.04)^{8}$], or \$7,307.

The increases in the held reserve, from \$6,756 to \$7,026 in 1988, and from \$7,026 to \$7,307 in 1989, stem from the "unwinding" of the interest discount. However, they show up in Schedule P of the Annual Statement just like any other adverse development.[50]

The chart below shows the unwinding of the 4% interest discount over the course of the ten years that the reserve is on the company's books. Between 1987 and 1992, the held reserve increases from \$6,756 to \$8,219, for observed adverse loss development during this period of 21.67% [= (8,219 – 6,756) ÷ 6,756].

Held reserve



The unwinding of the interest discount during 1987 through 1992 is reflected in the observed adverse development, so it is picked up by the NAIC calculation of the reserving risk charge. That is,

- A valuation basis that uses undiscounted reserves shows no adverse loss

50 This was true for the *pre-1995* Schedule P, when Part 2 was net of tabular discounts, though it was gross of non-tabular discounts. In 1995 and subsequent Annual Statements, Part 2 of Schedule P is gross of all discounts, so the unwinding of the interest discount no longer shows up as adverse development. The NAIC risk-based capital reserving risk charges were derived from the 1992 Schedule P.

development on this claim.

- A valuation basis that uses reserves discounted at a 4% annual rate shows 21.67% of observed loss development.

The higher risk-based capital reserving risk charge generated by the discounted reserves is offset by the lower reserves held by the company.

Future Interest Unwinding

The unwinding of the interest discount continues from 1992 through 1997. Since this future unwinding is not yet reflected in the Schedule P exhibits of historical adverse loss development, a modification of the standard reserving risk charge calculation is needed.

What adjustment is needed? Consider the assumptions underlying the reserving risk charge. The derivation of the reserving risk charge said:

> *Let us select the "worst case" adverse loss development that happened between 1983 and 1992, and let us assume that it might happen again.*

This procedure assumes that the 1992 reserves are adequate. That is to say, we should not *expect* either adverse or favorable development of the 1992 reserves.[51]

This is the proper assumption for the risk-based capital formula. The observed adverse loss development is meant to capture unanticipated external factors that cause higher or lower settlement values for insurance claims. A line of business may show adverse loss development even if the initial reserves were properly set on a "best estimate" basis. If a company is indeed holding inadequate reserves, it is the task of the financial examiners of the domiciliary state's insurance department to correct the situation. This is not the role of the generic risk-based capital formula.

If the reserves are valued on a discounted basis, however, they will continue to show (apparent) adverse development until all the claims are settled. In the example above,

- The unwinding of the interest discount between 1987 and 1992 is reflected in the observed adverse loss development, and no further adjustments are needed.

- The unwinding of the interest discount between 1992 and 1997 is not reflected

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51 We do not *expect* either adverse or favorable development of the 1992 reserves. The risk-based capital requirement guards against *unexpected* adverse development of the reserves.

anywhere, so an adjustment to the calculation procedure must be made.

Alternative Adjustments

There are two ways to make this adjustment: either in the "worst case year" industry adverse loss development or in the offset for the implicit interest discount.

➊ *Adverse loss development*: One might add the expected future unwinding of the interest discount that will occur after the final valuation date to the "worst case year" observed adverse loss development. In the example above, the observed adverse loss development from 1987 to 1992 is $1,464, giving a factor of +21.7% as a percentage of beginning reserves. We expect further adverse loss development of $1,781 from 1992 to 1997 because of continued unwinding of the interest discount. The total adverse loss development is therefore $3,245, or +48.0% as a percentage of beginning reserves.

➋ *Implicit interest discount*: The further unwinding of the actual interest discount in the reserves may be used to reduce the offset for the implicit interest discount. In the example above, the observed adverse loss development is offset by ten years of implicit interest discount at a 5% annual rate. However, there are five years of unwinding of the actual 4% interest discount that are still to come (1992 through 1997), and that are not reflected in the observed adverse development.

In our illustration, ten years of implicit interest discount at a 5% annual rate gives a discount factor of 61.4%. Five future years of actual interest unwinding at a 4% annual rate gives a discount factor of 82.2%. The interest margin that should offset the "worst case year" adverse loss development is the *excess* of the implicit interest cushion over the actual interest discount, or 74.7% [= 61.2% ÷ 82.2%].

Diversity and other Obstacles

In practice, the needed adjustments for tabular discounts are difficult to determine, for a variety of reasons.

➊ *Industry Practice*: There is great disparity among insurance companies in the use of tabular reserve discounts. The prevalent practice is to use tabular discounts on indemnity benefits for lifetime pension cases. But there are companies that do not use tabular reserve discounts at all, and that report aggregate loss reserves on a full-value basis.[52]

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52 More precisely, the case reserves generally show the tabular discounts. However, these discounts are "grossed up," or eliminated, by the actuarial "bulk" reserves.

❷ *Pension Identification*: Some companies show tabular discounts only for claims that have been identified as lifetime pension cases. Other companies show tabular discounts for the expected amount of claims that will ultimately be coded as lifetime pension cases.

The distinction between "identified" and "unidentified" lifetime pension cases is analogous to the distinction between "reported" and "IBNR" claims. A workers' compensation claim may be reported to the company soon after it occurs, but it may remain "unidentified" as a lifetime pension case for several years.[53]

❸ *Indemnity vs. Medical Benefits*: Workers compensation benefits comprise two

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53 An example should clarify this. Suppose an insurer has 100 claims at the conclusion of a given accident year:

- Ten of the claims are lifetime pension cases, with undiscounted reserves of $300,000 apiece. These is a $100,000 tabular discount on each claim, so the discounted reserves are $200,000 apiece.
- The other 90 non-pension cases are given case reserves of $5,000 apiece.
- Based upon historical experience, the company's actuaries expect that five of these "non-pension" claims will eventually become lifetime pension cases, since the injured workers will prove unable to return to work. These five cases will require $300,000 of undiscounted reserves apiece, or $200,000 of discounted reserves.

Number	Case Reserves		Revised Reserves	
of Claims	Undiscounted	Discounted	Undiscounted	Discounted
10	300,000	200,000	300,000	200,000
85	5,000	—	5,000	—
5	5,000	—	300,000	200,000

The total case reserve initially held by the company is

$$(10 * \$200,000) + (90 * \$5,000) = \$2,045,000.$$

An actuarial bulk reserve is needed for the adverse development on known cases, or the required reserve minus the case reserve. But how large a bulk reserve is needed here? Is it

$$[5 * (\$300,000 - \$5,000)] = \$1,475,000,$$

or

$$[5 * (\$200,000 - \$5,000)] = \$975,000?$$

In other words, should one consider the tabular reserve discount only on claims that have *already* been identified as pension cases or also on the expected number of claims that will *ultimately* be identified as lifetime pension cases?

parts: indemnity benefits, which cover the loss of income, and medical benefits, which cover such expenses as hospital stays and physicians' fees.

Lifetime pension cases may show continuing payments of both types. For instance, an injured worker who becomes a quadriplegic may receive a weekly indemnity check for loss of income as well as compensation for the medical costs of around-the-clock nursing care.

Some insurers will discount only the indemnity benefits, since the weekly benefits are fixed by statute.[54] Other insurers will discount the medical benefits as well, since the payments are regular and do not vary significantly, even if they are not fixed by statute.

❹ *Interest Rates*: The interest rate use for the tabular reserve discounts varies by company and by state of domicile. Some companies use a 3.5% annual rate, since this is the interest rate used in the NCCI statistical plan. Several New York and Pennsylvania domiciled companies use a 5% annual rate, since this is the rate permitted by statute in these states. Other companies may use a 4% annual rate, since this is the most common rate in other state statutes.

Pension Discounts

The 3.06% reserving risk charge calculated above uses the conservative 5% interest rate in the risk-based capital formula and the short IRS payment pattern. But our interest extends beyond simply replicating the formula results. We want to analyze the actual reserving risk, and to determine how much capital an insurance company must hold to guard against this risk.

As we have discussed above, the NAIC reserving risk charge presumes that loss reserves are reported at undiscounted values. If reserves are valued on a discounted basis – as is true for certain workers compensation cases – then one expects future "adverse development," so the NAIC procedure is incomplete.

What is the expected effect of tabular discounts on the reserving risk charge for workers compensation? Analysts unfamiliar with workers' compensation are tempted to say: *It should increase the charge.*

This would indeed be true if lifetime pension cases had the same payment pattern as other workers compensation claims and the only difference between pension cases and other compensation claims were that the pension cases are reported on a

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54 In some states, the indemnity benefit may depend on cost of living adjustments, so the amounts are not entirely "fixed."

discounted basis whereas the other compensation claims are reported on an undiscounted basis. But this is not so. In fact, the very reason that tabular reserve discounts are permitted for lifetime pension cases is that they are paid slowly but steadily over the course of decades.

In other words, to properly incorporate tabular discounts into the workers' compensation reserving risk charge, two changes are needed:

- One must increase the "worst case year" adverse development to include the future unwinding of the interest discount on the pension cases. Alternatively, one may adjust the "implicit interest discount" offset to account for the discount already included in the reported reserves.

- One must adjust the payout pattern from the IRS sixteen year pattern to the longer pattern appropriate for lifetime pension cases.

The net effect is to reduce the reserving risk charge. In fact, the indicated charge becomes negative, so it would be capped at 0% by the NAIC formula rules.

This is expected. The NAIC risk-based capital formula imposes a reserving risk charge when the "worst case" adverse development exceeds the implicit interest margin in the reserves. For lines of business like products liability and non-proportional reinsurance, the potential adverse development may far exceed the implicit interest margin, so companies must hold substantial amounts of capital to guard against reserving risk. For workers compensation "non-pension" cases, the mandated statutory benefits reduces the risk of adverse development while the slow payment pattern increases the implicit interest discount, so that the latter almost entirely offsets the former, resulting in the 3% charge calculated above with the RBC formula's exceedingly conservative assumptions. For workers compensation lifetime pension cases, true adverse development practically disappears, since mortality rates do not fluctuate randomly, and only the unwinding of the tabular discount remains. Because of the extremely long payout pattern for lifetime pension cases and the low interest rate allowed for tabular discounts, the implicit interest margin in lifetime pension reserves is well in excess of the "worst case" adverse development.

What is the appropriate reserving risk charge for workers compensation, after taking into consideration the tabular discounts on lifetime pension cases? To calculate this charge, we make the two adjustments discussed above.

1. We replace the IRS payment pattern with a 50 year payment pattern derived from the historical experience of the nation's largest compensation carrier. At a 5% per annum interest rate, the present value of the reserves is 65.6% of the ultimate

value, as shown in Exhibit A-3.[55]

❷ We increase the "worst case year" adverse development to incorporate the future interest unwinding on lifetime pension cases. The observed "worst case year" adverse development is 24.2% of initial reserves, from the 1985 statement date to the 1992 statement date. This includes the unwinding of tabular interest discount between 1985 and 1992. The post-1992 unwinding of interest discount on these pension cases adds between 6 and 8% to this figure. To be conservative, we use the 8% endpoint, giving a total adverse development of 34.1%.[56]

❸ The resulting reserving risk charge is (1.341 *x* 0.656) – 1, or –14.1%. In other words, industry-wide workers compensation reserves have always been adequate on a discounted basis, even during the worst of years.

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55 Are statistics from a single carrier, no matter how large, a valid proxy for industry-wide figures? For loss ratios, expense ratios, and profit margins they are not appropriate, since each carrier has its own operating strategy. But workers compensation payment patterns *are determined by statute; they do not differ significantly among companies.*

56 For the unwinding of the tabular interest discount, it is no longer appropriate to use a *single company's experience as a proxy for the industry. Insurers vary in whether they use* tabular discounts at all, what types of benefits they apply the discounts to, and what interest rate they use to discount the reserves. The "6 to 8%" range in the text results from extended observation of reserving practices in workers compensation, along with detailed analysis of one company's own experience. With the reporting of tabular discounts in the 1994 Schedule P, more refined estimates of industry-wide practice may soon be available.

EXHIBIT A-1

NAIC METHOD

Consolidated Industry 1992 Schedule P, Part 2D (Workers Compensation)
Incurred Losses and ALAE

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
All Prior	18,141,872	18,124,544	18,133,835	18,522,890	18,876,893	19,168,300	19,695,156	20,083,948	20,568,671	21,085,073
1983	10,285,007	10,518,014	10,615,001	10,800,631	10,904,709	11,053,667	11,087,456	11,163,710	11,309,445	11,364,446
1984		11,935,500	12,483,704	12,996,457	13,398,843	13,641,258	13,807,452	13,890,249	14,025,270	14,170,486
1985			13,506,212	14,148,315	14,560,000	15,036,193	15,289,931	15,451,016	15,648,178	15,824,280
1986				15,657,270	16,137,074	16,618,301	16,738,489	16,875,565	17,142,404	17,341,361
1987					18,543,543	18,630,232	18,849,648	18,945,479	19,228,271	19,492,604
1988						21,144,056	21,525,659	21,824,122	22,103,365	22,403,642
1989							23,337,805	23,983,219	24,549,997	24,863,843
1990								25,687,116	26,642,155	26,948,591
1991									27,107,842	27,477,716
1992										25,391,687
Total Incurred	28,426,879	40,578,058	54,738,752	72,125,563	92,421,062	115,292,007	140,331,596	167,904,424	198,325,598	226,363,729
Latest View of Incurreds	32,449,519	46,620,005	62,444,285	79,785,646	99,278,250	121,681,892	146,545,735	173,494,326	200,972,042	226,363,729
Adverse Development	4,022,640	6,041,947	7,705,533	7,660,083	6,857,188	6,389,885	6,214,139	5,589,902	2,646,444	0

Consolidated Industry 1992 Schedule P, Part 3D (Workers Compensation)
Paid Losses and ALAE

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
All Prior	0	3,644,371	6,120,130	7,945,566	9,435,974	10,681,184	11,778,823	12,725,216	13,559,492	14,283,870
1983	2,595,880	5,414,887	6,989,233	8,016,341	8,714,150	9,206,673	9,565,906	9,842,305	10,035,523	10,182,271
1984		3,098,456	6,475,507	8,592,479	9,951,477	10,858,138	11,474,586	11,929,005	12,268,081	12,519,733
1985			3,307,517	7,223,536	9,609,598	11,175,251	12,188,709	12,884,942	13,409,641	13,785,641
1986				3,399,423	7,693,744	10,430,068	12,205,296	13,319,794	14,100,702	14,642,580
1987					3,823,180	8,916,751	12,037,953	13,992,209	15,236,501	16,062,480
1988						4,517,537	10,522,224	14,272,224	16,542,809	17,976,821
1989							4,923,056	11,851,679	16,021,809	18,519,232
1990								5,283,149	12,856,717	17,435,376
1991									5,481,562	12,644,529
1992										4,795,009

Consolidated Industry 1992 Schedule P, [(Part 2D) - (Part 3D)] (Workers Compensation)
Loss and ALAE Reserves

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
All Prior	18,141,872	14,480,173	12,013,705	10,577,324	9,440,919	8,487,116	7,916,333	7,358,732	7,009,179	6,801,203
1983	7,689,127	5,103,127	3,625,768	2,784,290	2,190,559	1,846,994	1,521,550	1,321,405	1,273,922	1,182,175
1984		8,837,044	6,008,197	4,403,978	3,447,366	2,783,120	2,332,866	1,961,244	1,757,189	1,650,753
1985			10,198,695	6,924,779	4,950,402	3,860,942	3,101,222	2,566,074	2,238,537	2,038,639
1986				12,257,847	8,443,330	6,188,233	4,533,193	3,555,771	3,041,702	2,698,781
1987					14,720,363	9,713,481	6,811,695	4,953,270	3,991,770	3,430,124
1988						16,626,519	11,003,435	7,551,898	5,560,556	4,426,821
1989							18,414,749	12,131,540	8,528,188	6,344,611
1990								20,403,967	13,785,438	9,513,215
1991									21,626,280	14,833,187
1992										20,596,678
Reserves Held (1)	25,830,999	28,420,344	31,846,365	36,948,218	43,192,939	49,506,405	55,635,043	61,803,901	68,812,761	[illegible]
Adverse Development (2)	4,022,640	6,041,947	7,705,533	7,660,083	6,857,188	6,389,885	6,214,139	5,589,902	2,646,444	
(2) / (1)	15.6%	21.3%	24.2%	20.7%	15.9%	12.9%	11.2%	9.0%	3.8%	[illegible]

Worst Year Development: 24.2%

EXHIBIT A-2

IRS Payment Pattern

Year	Payment Pattern (Single Accident Year)	Payment Pattern (Stationary Book)
	Accident Year Payout	Reserve Payout
1	22.34%	0.00%
2	28.36%	25.42%
3	15.49%	16.14%
4	8.23%	11.07%
5	5.14%	8.37%
6	4.16%	6.69%
7	2.41%	5.33%
8	2.31%	4.54%
9	0.52%	3.78%
10	0.96%	3.61%
11	0.96%	3.30%
12	0.96%	2.98%
13	0.96%	2.67%
14	0.96%	2.35%
15	0.96%	2.03%
16	5.25%	1.72%

EXHIBIT A-3

Workers Compensation Payment Pattern

Year	Payment Pattern (Single Accident Year)	Payment Pattern (Stationary Book)
1	0.190	
2	0.213	0.127
3	0.127	0.094
4	0.083	0.074
5	0.057	0.061
6	0.041	0.052
7	0.032	0.045
8	0.025	0.041
9	0.021	0.037
10	0.016	0.033
11	0.014	0.031
12	0.013	0.028
13	0.011	0.026
14	0.010	0.025
15	0.009	0.023
16	0.009	0.022
17	0.009	0.020
18	0.007	0.019
19	0.006	0.018
20	0.006	0.017
21	0.006	0.016
22	0.005	0.015
23	0.006	0.014
24	0.005	0.013
25	0.005	0.013
26	0.004	0.012
27	0.004	0.011
28	0.004	0.010
29	0.004	0.010
30	0.004	0.009
31	0.004	0.009
32	0.003	0.008
33	0.003	0.008
34	0.003	0.007
35	0.003	0.006
36	0.003	0.006
37	0.003	0.006
38	0.003	0.005
39	0.003	0.005
40	0.003	0.004
41	0.003	0.004
42	0.003	0.003
43	0.003	0.003
44	0.002	0.003
45	0.002	0.002
46	0.002	0.002
47	0.002	0.001
48	0.002	0.001
49	0.002	0.001
50	0.002	0.000
Total (Excluding first 12 months)	0.810	1.000
PV @ 5%	**0.767**	**0.656**

Appendix B: The "Expected Policyholder Deficit" Yardstick

Quantifying Reserve Uncertainty

Reserve uncertainty is a slippery concept, difficult to grasp and even more difficult to quantify. Actuaries are accustomed to estimating dollar figures, such as premium rates, reserve requirements, or company values. In truth, for each of these there is a range of reasonable values. But the actuary's skill is in forming a "best estimate" that accords with the data and that is appropriate for the particular business environment, such as the insurance marketplace for the premium rates, a statutory financial statement for the reserve requirements, or a merger transaction for the company valuation.

Quantifying reserve uncertainty is a more complex task. A statistician might discuss reserve uncertainty as a probability distribution. One might show the mean of the distribution, its variance, and its higher moments; one might show various percentiles; one might even try to fit the empirical distribution to a mathematical curve. Accordingly, the exhibits in this paper show the mean, the standard deviation, the 95th *percentile, and the 5th percentile of each of the distributions.*

Probability Distributions

Yet probability distributions are an awkward way of speaking about reserve uncertainty, for several reasons.

- Few non-actuaries are comfortable with standard deviations or higher moments of probability distributions. If actuarial analyses are to have much influence with other company personnel, they must be couched in language that others understand.

- Property-casualty reserves are uncertain by definition, since they are only estimates of future loss payments. Similarly, future underwriting results are uncertain, future stock returns are uncertain, and so forth. The question is not: "Are reserves uncertain?" Rather, the fundamental question is: "How does the uncertainty of loss reserves compare with the uncertainty in other parts of the company's operations?" To answer this question, we need a consistent measure of uncertainty that can be used for various types of risk.

- We want to measure the effect of various factors on reserve uncertainty. For instance, we want to quantify the effect of loss sensitive business on reserve uncertainty. It is hard to do this if we must speak about probability distributions. To facilitate the analysis, we seek a measuring rod for uncertainty.

Ideally, we seek a yardstick that expresses uncertainty (i) as a dollar figure and (ii) that has an intuitive meaning to other financial analysts. Moreover, the yardstick should apply to all sources of uncertainty, whether of assets or of liabilities.

Capital Requirements

In recent years, state and federal regulators have been setting capital requirements for financial institutions, such as for banks and insurance companies. In theory, "risk-based capital requirement" relate the capital requirements to the uncertainty in various balance sheet items. In practice, most of the risk-based capital formulas that have been implemented in recent years use crude, generic charges that are based more on *ad hoc* considerations of what constitutes a "reasonable" charge than on rigorous actuarial or financial analyses.

Risk-based capital theory, however, is a siren for some actuaries and academicians, who have examined the relationship between uncertainty and capital requirements. In an ideal risk-based capital system, capital requirements should be calibrated among the balance sheet items in proportion to the risk that each poses to the company's solvency. Suppose a company has $100 million of bonds and $100 of loss reserves, and the theoretically correct risk-based capital system says that the company needs $5 million of capital to guard against the uncertainty in the bond returns and $15 million of capital to guard against the uncertainty in the loss reserve payments. Then we can say that the uncertainty in the loss reserve portfolio is "three times as great" as the uncertainty in the bond portfolio.

Of course, we don't really mean that "uncertainty" is a absolute quantity that can be three times as great as some other figure. Rather, our measuring rod gives us a figure that we use as a proxy for the amount of uncertainty.

Moreover, our interest is not in absolute capital requirements but in the *relative* uncertainty among the company's various components. The regulator must indeed calibrate the absolute capital requirements, deciding between (i) $5 million of capital for bond risk and $15 million of capital for reserve risk versus (ii) $10 million of capital for bond risk and $30 million of capital for reserve risk. For the measurement of uncertainty, however, we are most interested in relative figures, such as the relative amount of capital needed to guard against reserve risk versus the amount needed to guard against bond risk, or the percentage reduction in capital for business written on loss sensitive contracts.

Calibrating Capital Requirements

There are two "actuarial" methods of calibrating capital requirements.

- The "probability of ruin" method says: How much capital is needed such that the chance of the company's insolvency during the coming time period is equal to or less than a given percentage?

- The "expected policyholder deficit" method says: How much capital is needed such that the expected loss to policyholders and claimants during the coming time period – as a percentage of the company's obligations to them – is equal to or less than a given *amount*?[57]

In this paper, we use the "expected policyholder deficit" (EPD) approach. The results would be no different if we used a "probability of ruin" approach.[58]

Computing the Expected Policyholder Deficit

The "expected policyholder deficit" is a relatively new concept, having first been introduced in 1992. Many casualty actuaries, even if they are conversant in reserve estimation techniques and familiar with curve fitting and Monte Carlo simulation, have little experience with EPD analysis. This appendix provides a brief outline of the EPD analysis used in the paper.

Let us repeat the underlying question, which (at first) sounds complex. The EPD

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57 The "probability of ruin" method is used in Chris D. Daykin, Teivo Pentikäinen, and M. Pesonen, *Practical Risk Theory for Actuaries*, First Edition (Chapman and Hall, 1994). Probability of ruin analysis has long been used by European actuaries; see especially R. E. Beard, T. Pentikainen, and E. Pesonen, *Risk Theory: The Stochastic Basis of Insurance*, Third Edition (London: Chapman and Hall, 1984), and Newton L. Bowers, Jr., Hans U. Gerber, James C. Hickman, Donald A. Jones, and Cecil J. Nesbitt, *Actuarial Mathematics* (Itasca, IL.: Society of Actuaries, 1986). The "expected policyholder deficit" method is discussed by Robert P. Butsic, "Solvency Measurement for Property-Liability Risk-Based Capital Applications," *Journal of Risk and Insurance*, Volume 61, Number 4 (December 1994), pages 656-690.

58 We use the expected policyholder deficit approach partly because it has already been calibrated to the NAIC's risk-based capital formula; see below in the text. In theory, the probability of ruin approach takes the company's perspective, whereas the expected policyholder deficit approach takes the policyholders' perspective. The company's management is concerned primarily with the company's survival. Since the company's officers are not liable for the company's debt upon its demise, they are not concerned with the potential magnitude of that debt. The policyholders, however, are concerned with how much they stand to lose if the company becomes insolvent, not simply with the probability of insolvency.

analysis says: "Given a probability distribution for an uncertain balance sheet item, how much capital must the company hold such that the ratio of the expected loss to policyholders to the obligations to policyholders is less than or equal to a desired amount?" The format of the analysis depends on the type of probability distribution.

- For a simple discrete distribution, we can work out by hand the exact capital requirement. The type of simple discrete distribution that we illustrate below never occurs in real life. We use it only as a heuristic example, since the same procedure is used in our simulation analysis.

- The full simulation analysis is a complex time-consuming procedure; see the next bullet item. If the empirical probability distribution can be modeled by a mathematically tractable curve, a closed-form analytic expression for the EPD can sometimes be found. In his previously cited paper, Robert Butsic does this for the normal and lognormal distributions, which can serve as reasonable proxies for many balance sheet items.

  For the analysis in this paper, we use as few preconceived assumptions about the probability distributions of loss reserves as possible. Thus, we avoid such statements as "Assume that loss frequency follows a Poisson distribution." Instead, we use the following method to determine the "expected policyholder deficit" ratio.

- The distributions in this paper are derived by means of stochastic simulation. Each distribution results from 10,000 Monte Carlo simulations, with each simulation using stochastic values for each of the 24 "age-to-age" link ratio and for the length of the tail. For each distribution we determine the amount of capital needed to achieve a desired EPD ratio, as explained below.

Let us begin with the first case, the simple discrete distribution, to illustrate how the analysis proceeds. The extension to the full stochastic simulation merely requires greater computer power; there is no difference in the structure of the analysis.

Scenarios and Deficits

The distributions used in this paper are based on 10,000 simulations each. Think of this as 10,000 different scenarios. In fact, however, these simulations are *stochastic*. We do not know what these simulations are until after they have been realized. In other words, there are an infinite number of *possible* scenarios, 10,000 of which will be realized in the simulation.

It is cumbersome to follow a "pencil and paper" analysis of an infinite set of possible scenarios. So to clarify the meaning of the "expected policyholder deficit," let us assume that only two future scenarios are possible:

- In the *favorable* scenario, the company's assets are $350 million, and the company must pay losses of $200 million.
- In the *adverse* scenario, the company's assets are $250 million, and the company must pay losses of $300 million.

Suppose also that there is a 60% chance of the favorable scenario being realized and a 40% chance of the adverse scenario being realized.[59]

What is the expected policyholder deficit? In the favorable scenario, the company has a positive net worth at the end. Since we are concerned only with deficits, a positive outcome of any size is considered a $0 deficit.

In the adverse scenario, the final deficit is a $50 million deficit, or –$50 million. Since there is a 60% chance of a favorable outcome and a 40% chance of an adverse outcome, the expected policyholder deficit is

$0 million * 60% + (–$50 million * 40%) = –$20 million.

The EPD Ratio

The definition of the EPD ratio is as

The average insolvency cost per dollar of obligation to policyholders, or "the ratio of the expected policyholder deficit to expected loss."

The numerator of this ratio is the expected policyholder deficit. The denominator is the obligations to policyholders, or the "expected loss."

In the numerator, the expected policyholder deficit, the loss payments to policyholders and claimants enter as a probability distribution (either discrete or continuous). In the denominator, the "obligations to policyholders," or the "expected loss," is an

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59 In the simulation analysis in this paper, only reserves are uncertain; assets are not uncertain. However, the same type of analysis applies to both assets and liabilities. Indeed, a more complete model would examine the external (economic and financial) factors that lead to variability in ultimate loss reserves and it would analyze their effects on asset values as well.

In the simulation analyses used here, each simulation has a 0.01% chance of realization, since there are 10,000 equally likely runs. There is no need, however, for a uniform distribution along the range of possible outcomes, as shown by the example in the text.

absolute dollar amount. [In the simulation analysis in this paper, the "expected loss" is the mean of the loss reserve probability distribution. When performing an EPD analysis for other risks (such as asset risk), the numerator and denominator of the EPD ratio may be unrelated.]

In the example above, there is a 60% chance of a $200 million payment to claimants and a 40% chance of a $300 million payment to claimants. Thus, the "obligations to policyholders" is

($200 million * 60%) + ($300 million * 40%) = $240 million.

These figures may be either "economic values" (i.e., discounted reserve values) or undiscounted ("ultimate") values. Moreover, the discounted values may use various discount rates, such as a "risk-free" rate, a "risk-adjusted" rate, or a new-money investment yield. We show the analysis for both undiscounted and discounted values in our exhibits. For the discounted values, we generally use the company's new-money investment yield as the discount rate.

Consistency

We use a 1% expected policyholder deficit ratio to determine the capital requirements. We use 1% to be consistent with the charges in the NAIC risk-based capital formula. In memoranda submitted to the American Academy of Actuaries task force on risk-based capital, Butsic estimates that the overall industry-wide reserving risk charge in the NAIC risk-based capital formula amounts to approximately a 1% EPD ratio.

This allows us to compare the workers' compensation loss reserve uncertainty to other sources of insurance company risk. If one believes that the overall capital requirements in the NAIC risk-based capital formula are reasonable, so a 1% EPD ratio is appropriate, then the degree of workers' compensation loss reserve uncertainty measured in this paper can be viewed in light of the other NAIC capital requirements. As Butsic says

> *The amount of risk-based capital for each source of risk (e.g., underwriting, investment, or credit) must be such that the risk of insolvency (or other applicable impairment) is directly proportional to the amount of risk-based capital for each source of risk.*

Discrete Distributions

Our purpose in this section is to understand how capital requirements are determined by means of an expected policyholder deficit analysis. So let us suppose that only liabilities (not assets) are uncertain, where

- X and Y are the two possible loss outcomes,
- p is the probability of the true loss being equal to X, and
- Z is the expected policyholder deficit ratio.

	Asset	Loss	Proba-	Loss	
	Amount	Amount	bility	Payment	Deficit
Scenario #1	A	X	p	E	G
Scenario #2	B	Y	(1−p)	F	H
Expected Value	C	D			
Capital		I			
EPD Ratio		Z			

We must calculate the risk-based capital amount, or C − D, which equals the assets minus the expected loss amount. Note that C = B = A in this example; i.e., the liability is uncertain, but the asset value is certain. This is the format of our simulation analysis as well, except that (i) there are 10,000 scenarios, (ii) the probability of each scenario is 0.01%, and (iii) the scenarios are stochastic, not deterministic.

An Illustration

To calculate the value of C − D, we must determine the other values in this chart: A through H. To make the explanation clear, let us fill in sample values for X, Y, p, and Z. Suppose we are told that

An insurance company faces a single uncertain loss. There is a 25% chance that the loss will be paid for $1,000 and a 75% chance that the loss will be paid for $5,000. The risk-based capital requirements use a 1% expected policyholder deficit (EPD) ratio. Using an EPD analysis, calculate the risk-based capital requirement for this risk.

The table below shows these input figures as well as the value for cell "D," the expected loss amount. We must "solve" this exhibit for the risk-based capital requirement.

	Asset	Loss	Proba-	Loss	
	Amount	Amount	bility	Payment	Deficit
Scenario #1	A	$1,000	25%	E	G
Scenario #2	B	$5,000	75%	F	H
Expected Value	C	$4,000			
Capital		I			
EPD Ratio		1%			

The expected loss is

"D" = 25% * $1,000 + 75% * $5,000 = $4,000.

If the expected loss is $4,000, then the company must hold *at least* $4,000 in assets. If the actual loss amount is $1,000, the company will be able to pay the entire claim and the "deficit" will be zero. Thus, cell "E" is $1,000, and cell "G" is $0.

The EPD ratio is the expected policyholder deficit divided by the obligations to policyholders. The denominator is the expected loss amount, or $4,000. The numerator is the EPD. The EPD is the deficit in cell "H" times the probability of 75%. In other words

EPD ratio = 75% * H ÷ $4,000 = 1%.

This gives

H = $4,000 * 1% ÷ 75% = $53.33.

The deficit is the loss amount minus the claim payment. Thus

$5,000 – claim payment = $53.33, or

Cell "F" = claim payment = $4,946.67.

The company makes a claim payment less than the claim amount only if it exhausts all its assets in doing so. Thus, cell "B" equals $4,946.67. Since the initial asset amount does not depend on the eventual claim payment, cells "A" and "C" also equal $4,946.67.

The company's capital is the asset value minus the expected loss payment, or

Cell "I" = capital = \$4,946.67 – \$4,000 = \$946.67.

These figures are shown in the table below.

	Asset Amount	Loss Amount	Proba-bility	Loss Payment	Deficit
Scenario #1	\$4,946.67	\$1,000	25%	\$1,000	\$0
Scenario #2	\$4,946.67	\$5,000	75%	\$4,946.67	\$53.33
Expected Value	\$4,946.67	\$4,000			
Capital		\$946.67			
EPD Ratio		1%			

Full Simulation

The full analysis in this paper proceeds in the same fashion. The 10,000 simulations are run, each of which produces a "realization" for the loss amount. The average of these 10,000 realizations is the expected loss. The probability of each realization is 0.01%.

We first assume that the asset amount equals the expected loss, and we determine the loss payment and the deficit in each realization.

- If the loss amount is less than the asset amount, then the loss payment equals the loss amount, and the deficit is zero.

- If the loss amount exceeds the asset amount, then the loss payment equals the asset amount and the deficit is the difference between the loss amount and the asset amount.

We sum the deficits in the 10,000 realizations, and we divide by 10,000. This gives the *expected policyholder deficit. We then divide by the expected loss amount to give* the EPD ratio.

If the probability distribution for the loss reserves is extremely compact, then the EPD ratio may be less than 1% even if no additional capital is held. For instance, suppose that the probability distribution is uniform over the range \$100 million ± \$4 million. Then the expected policyholder deficit is 1% if no additional capital is held.[60] This makes sense: if the loss payments are practically certain, there would be no need for additional capital.

In practice, of course, the loss payments are not certain, and the EPD ratio would be greater than 1% if no additional capital is held. We proceed iteratively. We add capital and redetermine the loss payment and deficit in each scenario. This gives a new expected policyholder deficit and a new EPD ratio. If the EPD ratio still exceeds 1%, we must add more capital. If the EPD ratio is now less than 1%, we can subtract capital. With sufficient computer power, we quickly converge to a 1% EPD ratio.

60 If the actual loss is less than \$100 million, then the deficit is zero. If the actual loss exceeds \$100 million, then the deficit is uniform over [\$0, \$4 million], for an average of \$2 million. The expected deficit over all cases is therefore \$1 million, for an EPD ratio of 1%.

Appendix C: The Simulation Procedure

Casualty actuaries are accustomed to providing point estimates of indicated reserves. The traditional procedures – such as a chain ladder loss development using 25 accident years of experience, supplemented by an "inverse power curve" tail factor – provide a sound basis for estimating workers' compensation reserve needs. The actuary's task is to examine the historical experience for trends, evaluate the effects of internal (operational) changes on case reserving practices and settlement patterns, and forecast the likely influence of future economic and legal developments on the company's loss obligations.

Our perspective in this paper is different. We are not determining a point estimate of the reserve need; rather, we are determining a probability distribution for the reserve need. We use the same procedure and the same data as we would use for the point estimate: a chain ladder loss development based on 25 accident years of experience, along with a tail factor based on an inverse power curve fit. But now each step turns stochastic, and the probability distribution is determined by a Monte Carlo simulation.

The traditional procedures for determining point estimates are documented in various textbooks. This appendix shows the corresponding procedures for determining the probability distribution.

Data

We use a chain ladder *paid* loss development, since payment patterns for workers' compensation are relatively stable whereas case reserving practices often differ from company to company and from year to year. This enables readers to replicate our results using their own companies' data.

We begin with 25 accident year triangles of cumulative paid losses, separately for indemnity (wage loss) and medical benefits. Indemnity and medical benefits have different loss payment patterns, and they are affected by different factors. For instance, medical benefits are strongly affected by medical inflation and by changes in medical utilization rates.[61]

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[61] Numerous other segmentations of the data can be used. For instance, many companies divide their experience by type of injury, separating lifetime pension cases (i.e., fatalities and permanent total disabilities cases) from other claims. Similarly, other reserving techniques can be used, such as incurred loss development chain ladder procedures and various types of "expected loss" (Bornhuetter-Ferguson) procedures. The analysis in this paper can be extended to other data sets and other reserving procedures, as required by individual company

From the historical data we determine paid loss "age-to-age" factors (or "link ratios). Exhibit C-1 shows 22 columns of paid loss age-to-age factors for countrywide indemnity plus ALAE benefits. For instance, the column labeled "12-24" shows the ratio of cumulative paid indemnity losses at 24 months to the corresponding cumulative paid indemnity losses at 12 months for each accident year. Similarly, Exhibit C-2 shows the paid loss age-to-age factors for countrywide medical benefits.

Point Estimates versus Realizations

The reserving actuary, when determining a point estimate, would examine these factors for trends. For instance, the average of the most recent five factors in the indemnity plus ALAE "12 to 24 months" column in Exhibit C-1 is 2.514, whereas *all* the previous factors are less than 2.500. For a point estimate, the reserving actuary might use an average of the most recent five factors, instead of an average of all the factors in the column.

In this paper, our goal is to estimate the uncertainty in the reserve indications. Just as there was an upward trend in the age-to-age factors during the 1980s, there may be subsequent upward or downward trends in the 1990s. We therefore use the entire column of factors in our analysis. An "outlying" factor that is not a good estimator of the expected future value is an important element in measuring the potential variability of the future value.

We want to use the historical factors to simulate future "realizations." We do this by fitting the observed factors to a mathematical curve, thereby obtaining a probability distribution for the "12 to 24" age-to-age factors. Note carefully: This is *not* the probability distribution of the loss reserves, which will be the *output* of the simulation and which is *not* modeled by any mathematical function. This is the probability distribution of the age-to-age factors, which is the *input* to the simulation and is modeled by a mathematical curve.

Lognormal Curve Fitting

In this analysis, we used lognormal curves, which gave good fits to the data. Exhibit C-3 shows the curve fitting procedure for the first column of "indemnity plus ALAE" age-to-age factors.

For the lognormal curve, the probability distribution function is

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needs.

$$f(x) = \frac{e^{-.5[\frac{\ln(x)-\mu}{\sigma}]^2}}{x\sigma\sqrt{2\pi}}$$

and the cumulative distribution function is

$$F(x) = \Phi(\frac{\ln(x)-\mu}{\sigma})$$

We fit the function with the "development" part of the link ratios, or the "age-to-age factor minus one," as shown in column 2 of Exhibit C-3. Column 3 shows the natural logarithms of the factors in column 2. Using the method of moments to find the parameters of the fitted curve, the "mu" (μ) parameter is the mean of the figures in column 3 and the "sigma" (σ) parameter is the standard deviation of the figures in column 3.[62]

We do the same for each "age-to-age" development column. The fitted parameters shown in the box in Exhibit C-3 are carried back to the final two rows in Exhibit C-1. Thus, each column has its own lognormal probability distribution function. We do this for development through 276 months. There is still paid loss development after 276 months, but there is insufficient historical experience to generate the factors, so we use an inverse power curve to estimate the loss development "tail" (see below).

For each run, we use a random number generator [Excel's "RAND" built-in function] to obtain simulated "age-to-age" factors in each column. Column 3 of Exhibit C-4 shows the results of one simulation for indemnity plus ALAE payments.[63] For instance, the simulated age-to-age factor for 12 to 24 months of development is 2.409. The simulations for each of the 22 columns are independent of each other. For instance, the simulated 1.413 factor for "24 to 36" months in column 3 of Exhibit C-4 is independent of the simulated 2.409 factor for "12 to 24" months.[64]

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62 For a more complete discussion of curve fitting procedures, see R. V. Hogg and Stuart A. Klugman, *Loss Distributions* (Somerset, NJ: John Wiley and Sons, 1984).

63 For a more complete explanation of simulation techniques, see the Society of Actuaries study note 130-33-86, "An Introduction to Stochastic Simulation."

64 Our analysis assumes independence between columns and complete dependence among future accident years. Dependence among columns may raise or lower the reserve variability, depending on whether the columns are positively or negatively correlated with each other. See the text of this paper for further discussion of trends in "age-to-age" factors on any observed

Tail Development

Exhibit C-4 shows the fitting of the inverse power curve for one simulation. To clarify the procedure, let us *contrast* this with fitting an inverse power curve for a "best-estimate" reserve indication. For the "best-estimate" indication, we would use "selected" age-to-age factors in column 3, such as averages of the factors in each column, or averages of the most recent years, or perhaps averages that exclude high and low factors. For the indemnity plus ALAE "12 to 24" months factor, the overall average is 2.352 and the average of the most recent five factors is 2.514. For a "best estimate," we would probably choose a factor such as 2.500.

In our analysis, the 22 factors in column 3 are the results of *simulations* from the 22 fitted lognormal curves. For instance, the 2.409 factor is a simulation from the lognormal curve representing the probability distribution for the 12 to 24 month column.

From these *simulated* age-to-age factors, we fit an inverse power curve to estimate the "tail" development.[65] The inverse power curve will vary from simulation to simulation, since we have different "age-to-age" factors in each run.

The inverse power curve models the age-to-age ("ATA") factors as

$$\text{ATA} = 1 + at^{-b}$$

where "t" represents the "development year," and "a" and "b" are the parameters that we must fit. In workers compensation, the shape of the loss payment pattern differs greatly between the first several years and subsequent years. In early years, there are many temporary total claims, with rapid payment patterns. By the tenth year, most of the remaining reserves are for lifetime pension cases (fatalities and permanent total disability cases), with slow payment patterns. Therefore, we fit the inverse power curve using the simulated factors from the tenth through the 22nd

correlations between columns, as well as the paper by Randall Holmberg, "Correlation and the Measurement of Loss Reserve Variability" [*Casualty Actuarial Society Forum* (Spring 1994), Volume I, pages 247-278], for methods of quantifying these correlations.

65 For the rationale of using an inverse power curve for the tail development, see Richard Sherman, "Extrapolating, Smoothing, and Interpolating Development Factors," *Proceedings of the Casualty Actuarial Society*, Volume 71 (1984), pages 122-192.

columns only.[66]

Column 4 and 5 of Exhibit C-4 show the fitting procedure. Column (4) is the natural logarithm of the development year in column (2), and the column (5) is the natural logarithm of the "simulated age-to-age [ATA] factor minus one" in column (3). The inverse power curve can be written as

$$\ln (ATA - 1) = \ln (a) - b * \ln (t).$$

We use a least squares procedure to determine the parameters "a" and "b" from the figures in columns (4) and (5), giving ln (a) = 0.194, or a = 1.214, and b = 1.822, as shown in the box at the bottom of Exhibit C-4.

The fitted inverse power curve provides age-to-age factors for development years 23 through 70. We don't really know how long paid loss development continues for workers compensation. Moreover, the factors are small. For development years 30 through 39 in this simulation, the age-to-age factors are about 1.002, and for development years 40 through 70, the factors are about 1.001.[67] We therefore choose the length of the tail development stochastically; that is, the length of the total development is chosen randomly from a uniform distribution between 30 and 70 years.

Selected Factors

In the simulation shown in Exhibit C-5, the stochastic selection produced a development period of 54 years. We therefore have three sets of age-to-age factors:

- For development years 1 through 22, we use the simulated age-to-age factors generated by the lognormal curves for each column. For these development years, the "selected ATA" in column (4) equals the "simulated ATA" in column (2), not the "fitted ATA" in column (3).
- For development years 23 through 53, we use the age-to-age factors from the fitted inverse power curve. For these development years, the "selected ATA" in column (4) equals the "fitted ATA" in column (3).
- For development years 54 through 70, we use age-to-age factors of unity.

We now have all the age-to-age factors for this simulation. We "square the triangle"

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66 For actual reserve indications, one would probably segment the data between non-pension cases (temporary total and permanent partial cases) and lifetime pension cases (fatalities and permanent total cases).

67 The actual factors, of course, differ in the subsequent decimal places.

in the standard reserving fashion to determine ultimate incurred losses, and we subtract cumulative paid losses to date to obtain the required reserves.[68] Exhibit C-6 shows the determination of the required medical reserves for one simulation. The "ultimate paids" in Exhibit C-6 are the "paid-to-date" times the "age-to-ultimate" factors, and the "indicated reserves" are the "ultimate paids" minus the "paid-to-date." The right-most two columns of Exhibit C-6 show the determination of the present value of the reserves. The "present value factors" are discussed in Appendix D, which has a full explanation of inflation effects.

We perform this simulation 10,000 times, giving a complete probability distribution of the required reserves, and we determine the mean, standard deviation, 95th percentile, and 5th percentile of this distribution. For the manner of determining the "capital required to achieve a 1% expected policyholder deficit ratio" (the right-most column of the exhibits in the text of this paper), see Appendix B.

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[68] Note that we are using the same simulated age-to-age factors for each subsequent accident year. In theory, we could use separate simulations for each cell in the lower triangle of the square (i.e., for each age-to-age factor that we are forecasting). This would enormously complicate the work, particularly since we would have to fit separate inverse power curves for each accident year, without much gain in the quality of our results. Moreover, our procedure is "conservative." By assuming perfect dependence among the accident years that we are forecasting, we *increase* the variability in the loss reserve probability distribution.

EXHIBIT C-1

PAGE 1

Age-to-Age Factors for Indemnity and ALAE

Period	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120	120 - 132	132 - 144
1970 Dec					1.055	1.040	1.028	1.021	1.018	1.016	1.012
1971 Dec				1.094	1.055	1.041	1.026	1.024	1.016	1.011	1.010
1972 Dec			1.168	1.093	1.065	1.043	1.032	1.025	1.016	1.018	1.018
1973 Dec		1.386	1.169	1.096	1.062	1.049	1.033	1.025	1.020	1.017	1.012
1974 Dec	2.334	1.385	1.164	1.093	1.068	1.044	1.034	1.022	1.019	1.016	1.013
1975 Dec	2.310	1.398	1.190	1.116	1.076	1.051	1.037	1.026	1.021	1.016	1.013
1976 Dec	2.262	1.388	1.195	1.117	1.069	1.048	1.031	1.027	1.020	1.017	1.013
1977 Dec	2.192	1.397	1.191	1.111	1.070	1.048	1.031	1.023	1.019	1.016	1.015
1978 Dec	2.246	1.407	1.193	1.113	1.068	1.048	1.031	1.027	1.022	1.019	1.016
1979 Dec	2.199	1.409	1.192	1.109	1.068	1.045	1.036	1.027	1.023	1.020	1.019
1980 Dec	2.169	1.400	1.209	1.107	1.074	1.050	1.038	1.030	1.023	1.020	1.017
1981 Dec	2.191	1.400	1.185	1.115	1.075	1.055	1.041	1.032	1.025	1.019	1.017
1982 Dec	2.179	1.395	1.207	1.131	1.098	1.059	1.046	1.043	1.026	1.024	1.020
1983 Dec	2.283	1.437	1.227	1.140	1.088	1.064	1.048	1.037	1.025	1.022	1.017
1984 Dec	2.345	1.473	1.228	1.134	1.089	1.064	1.044	1.033	1.027	1.018	
1985 Dec	2.422	1.473	1.245	1.140	1.087	1.057	1.041	1.030	1.020		
1986 Dec	2.377	1.500	1.237	1.133	1.085	1.055	1.038	1.026			
1987 Dec	2.452	1.496	1.234	1.127	1.080	1.053	1.034				
1988 Dec	2.496	1.498	1.228	1.126	1.074	1.047					
1989 Dec	2.502	1.512	1.231	1.121	1.068						
1990 Dec	2.666	1.520	1.232	1.109							
1991 Dec	2.529	1.507	1.217								
1992 Dec	2.454	1.470									
1993 Dec	2.426										
1994 Dec											
Lognormal Parameters:											
mu [=avg. of ln(ATA-1)]	0.30	-0.82	-1.58	-2.16	-2.62	-3.00	-3.33	-3.59	-3.86	-4.03	-4.21
sigma = [std. dev. of ln(ATA-1)]	0.102	0.114	0.124	0.133	0.154	0.139	0.167	0.182	0.157	0.174	0.204

EXHIBIT C-1
PAGE 2

144 - 156	156 - 168	168 - 180	180 - 192	192 - 204	204 - 216	216 - 228	228 - 240	240 - 252	252 - 264	264 - 276
1.013	1.009	1.008	1.007	1.021	*1.001*	1.004	1.006	1.005	1.004	1.004
1.011	1.007	1.010	1.012	1.009	1.005	1.006	1.005	1.005	1.004	1.006
1.010	1.012	1.011	1.008	1.008	1.008	1.007	1.007	1.006	1.006	1.008
1.013	1.012	1.011	1.008	1.008	1.007	1.007	1.007	1.005	1.007	
1.010	1.013	1.009	1.008	1.009	1.007	1.006	1.008	1.007		
1.014	1.012	1.011	1.010	1.009	1.010	1.010	1.010			
1.013	1.012	1.008	1.011	1.009	1.009	1.009				
1.013	1.011	1.010	1.009	1.009	1.009					
1.014	1.012	1.012	1.011	1.009						
1.013	1.011	1.012	1.012							
1.017	1.011	1.011								
1.016	1.011									
1.015										
-4.34	-4.52	-4.61	-4.65	-4.64	-5.21	-5.00	-4.95	-5.19	-5.23	-5.12
0.163	0.177	0.161	0.170	0.291	0.986	0.280	0.229	0.190	0.226	0.280

EXHIBIT C - 2
PAGE 1

Development Factors (Medical)

Year	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120
1					1.013	1.011	1.010	1.008	1.005
2				1.019	1.015	1.014	1.008	1.010	1.010
3			1.045	1.026	1.018	1.014	1.013	1.012	1.009
4		1.105	1.044	1.030	1.017	1.017	1.012	1.012	1.011
5	1.895	1.108	1.050	1.028	1.021	1.013	1.013	1.010	1.014
6	1.898	1.122	1.055	1.034	1.023	1.019	1.017	1.014	1.011
7	1.893	1.113	1.056	1.035	1.026	1.019	1.016	1.016	1.014
8	1.865	1.119	1.055	1.035	1.020	1.021	1.014	1.013	1.011
9	1.912	1.122	1.057	1.036	1.025	1.018	1.019	1.016	1.014
10	1.869	1.120	1.056	1.036	1.025	1.020	1.016	1.015	1.013
11	1.849	1.126	1.063	1.031	1.030	1.023	1.017	1.016	1.014
12	1.836	1.127	1.054	1.037	1.028	1.021	1.018	1.018	1.015
13	1.808	1.126	1.063	1.040	1.025	1.022	1.020	1.016	1.013
14	1.898	1.135	1.071	1.041	1.030	1.028	1.022	1.020	1.018
15	1.948	1.158	1.072	1.047	1.036	1.027	1.024	1.020	1.013
16	1.949	1.156	1.081	1.048	1.035	1.028	1.022	1.016	1.015
17	1.808	1.162	1.082	1.051	1.032	1.026	1.019	1.015	
18	1.906	1.172	1.084	1.049	1.037	1.025	1.017		
19	1.871	1.178	1.083	1.051	1.030	1.021			
20	1.934	1.172	1.079	1.043	1.024				
21	1.898	1.171	1.071	1.036					
22	1.869	1.153	1.058						
23	1.773	1.126							
24	1.772								
Lognormal Parameters:									
mu [=avg. of ln(ATA-1)]	-0.14	-1.99	-2.77	-3.31	-3.71	-3.93	-4.14	-4.25	-4.41
sigma = [std. dev. of ln(ATA-1)]	0.060541	0.170376	0.204201	0.247302	0.286232	0.266582	0.292769	0.246563	0.276408
Simulated ATA	1.874	1.101	1.057	1.042	1.022	1.025	1.014	1.008	1.011

EXHIBIT C-2
PAGE 2

120 - 132	132 - 144	144 - 156	156 - 168	168 - 180	180 - 192	192 - 204	204 - 216	216 - 228	228 - 240	240 - 252	252 - 264	264 - 276
1.007	1.006	1.008	1.007	1.007	1.005	1.006	*1.001*	1.007	1.005	1.007	1.008	1.009
1.008	1.009	1.011	1.012	1.008	1.008	1.007	1.007	1.008	1.011	1.012	1.012	1.008
1.013	1.010	1.011	1.018	1.011	1.008	1.010	1.007	1.009	1.010	1.011	1.008	1.010
1.010	1.010	1.009	1.010	1.009	1.009	1.008	1.012	1.007	1.007	1.009	1.008	
1.009	1.009	1.011	1.010	1.007	1.014	1.014	1.009	1.009	1.007	1.012		
1.009	1.012	1.012	1.011	1.011	1.014	1.015	1.012	1.010	1.009			
1.014	1.012	1.009	1.010	1.010	1.010	1.011	1.010	1.009				
1.011	1.008	1.011	1.009	1.009	1.010	1.010	1.008					
1.013	1.017	1.015	1.014	1.013	1.012	1.012						
1.011	1.014	1.012	1.012	1.011	1.009							
1.014	1.013	1.010	1.017	1.011								
1.015	1.012	1.010	1.007									
1.013	1.010	1.009										
1.014	1.012											
1.010												
-4.49	-4.53	-4.56	-4.52	-4.66	-4.64	-4.63	-5.06	-4.79	-4.87	-4.61	-4.72	-4.68
0.218529	0.238770	0.158673	0.292236	0.213223	0.281293	0.308683	1.047670	0.151740	0.313104	0.233627	0.209965	0.119079
1.010	1.010	1.013	1.018	1.011	1.007	1.012	1.002	1.008	1.007	1.008	1.008	1.007

EXHIBIT C-3

Illustration of Fitting Lognormal Distributions to Age-to-Age Factors

	(1) 12-24 Factors for Indemnity & ALAE	(2) Age-to-Age Factor minus 1 (1) - 1	(3) Natural Logs of (Age-to-Age Factors minus 1) ln (2)
1974 Dec	2.334	1.334	0.288
1975 Dec	2.310	1.310	0.270
1976 Dec	2.262	1.262	0.232
1977 Dec	2.192	1.192	0.175
1978 Dec	2.246	1.246	0.220
1979 Dec	2.199	1.199	0.181
1980 Dec	2.169	1.169	0.156
1981 Dec	2.191	1.191	0.175
1982 Dec	2.179	1.179	0.165
1983 Dec	2.283	1.283	0.249
1984 Dec	2.345	1.345	0.297
1985 Dec	2.422	1.422	0.352
1986 Dec	2.377	1.377	0.320
1987 Dec	2.452	1.452	0.373
1988 Dec	2.496	1.496	0.403
1989 Dec	2.502	1.502	0.407
1990 Dec	2.666	1.666	0.510
1991 Dec	2.529	1.529	0.425
1992 Dec	2.454	1.454	0.375
1993 Dec	2.426	1.426	0.355
Average	2.352	1.352	0.296
Standard Deviation	0.139	0.139	0.102

Lognormal Parameters:	
mu [= mean of the logs of (ATA-1)]	0.296
sigma [= standard deviation of logs of (ATA-1)]	0.102

Simulated ATA*	2.464

* The simulated age-to-age factor is a single pick from a lognormal distribution with the fitted parameters. The factor is picked by inverting the cumulative density of a lognormal. The Excel formula for the simulated age-to-age factor is: 1+LOGINV(RAND(),mu,sigma). [Note that the "1+" at the start of the expression is needed because we fit the curve to (ATA - 1).]

EXHIBIT C-4

Illustration of Fitting an Inverse Power Curve to the Simulated Age-to-Age Factors

(1) Development Period	(2) Year	(3) Simulated ATA	(4) ln(year) ln(2)	(5) ln(ATA - 1) ln[(3)-1]	(6) Fitted ATA 1 + a x (2)^[-b]
12 - 24	1	2.409			2.214
24 - 36	2	1.413			1.343
36 - 48	3	1.272			1.164
48 - 60	4	1.113			1.097
60 - 72	5	1.068			1.065
72 - 84	6	1.042			1.046
84 - 96	7	1.029			1.035
96 - 108	8	1.022			1.027
108 - 120	9	1.031			1.022
120 - 132	10	1.021	2.303	-3.869	1.018
132 - 144	11	1.013	2.398	-4.374	1.015
144 - 156	12	1.017	2.485	-4.055	1.013
156 - 168	13	1.014	2.565	-4.258	1.011
168 - 180	14	1.009	2.639	-4.706	1.010
180 - 192	15	1.010	2.708	-4.634	1.009
192 - 204	16	1.007	2.773	-4.987	1.008
204 - 216	17	1.003	2.833	-5.971	1.007
216 - 228	18	1.008	2.890	-4.819	1.006
228 - 240	19	1.007	2.944	-4.978	1.006
240 - 252	20	1.004	2.996	-5.640	1.005
252 - 264	21	1.005	3.045	-5.246	1.005
264 - 276	22	1.007	3.091	-4.933	1.004

Fitting a least squares line to columns (4) and (5), with (5) as the dependent variable gives the following fitted paramenters:

slope = -1.822
Intercept = 0.194

Since the inverse power curve can be written in the form: ln(ATA-1) = ln(a) - b ln(t), we have the following parameters for the inverse power curve:

a = exp(intercept) = 1.214
b = -slope = 1.822

EXHIBIT C-5

Illustration of Selecting Age-to-Age Factors

(1)	(2)	(3)	(4)	(1)	(3)	(4)
Year	Simulated ATA	Fitted ATA	Selected ATA	Year	Fitted ATA	Selected ATA
		a= 1.214	Cut-off for tail*		a= 1.214	Cut-off for tail*
		b= 1.822	54		b= 1.822	54
1	2.409	2.214	2.409	36	1.002	1.002
2	1.413	1.343	1.413	37	1.002	1.002
3	1.272	1.164	1.272	38	1.002	1.002
4	1.113	1.097	1.113	39	1.002	1.002
5	1.068	1.065	1.068	40	1.001	1.001
6	1.042	1.046	1.042	41	1.001	1.001
7	1.029	1.035	1.029	42	1.001	1.001
8	1.022	1.027	1.022	43	1.001	1.001
9	1.031	1.022	1.031	44	1.001	1.001
10	1.021	1.018	1.021	45	1.001	1.001
11	1.013	1.015	1.013	46	1.001	1.001
12	1.017	1.013	1.017	47	1.001	1.001
13	1.014	1.011	1.014	48	1.001	1.001
14	1.009	1.010	1.009	49	1.001	1.001
15	1.010	1.009	1.010	50	1.001	1.001
16	1.007	1.008	1.007	51	1.001	1.001
17	1.003	1.007	1.003	52	1.001	1.001
18	1.008	1.006	1.008	53	1.001	1.001
19	1.007	1.006	1.007	54	1.001	1.000
20	1.004	1.005	1.004	55	1.001	1.000
21	1.005	1.005	1.005	56	1.001	1.000
22	1.007	1.004	1.007	57	1.001	1.000
23		1.004	1.004	58	1.001	1.000
24		1.004	1.004	59	1.001	1.000
25		1.003	1.003	60	1.001	1.000
26		1.003	1.003	61	1.001	1.000
27		1.003	1.003	62	1.001	1.000
28		1.003	1.003	63	1.001	1.000
29		1.003	1.003	64	1.001	1.000
30		1.002	1.002	65	1.001	1.000
31		1.002	1.002	66	1.001	1.000
32		1.002	1.002	67	1.001	1.000
33		1.002	1.002	68	1.001	1.000
34		1.002	1.002	69	1.001	1.000
35		1.002	1.002	70	1.001	1.000

* The cut off for the tail models the actuarial uncertainty in when to cut off the development from the invers power curve. The cut-off is based on a uniform distribution from 30 to 70.

EXHIBIT C-6

Calculation of Required Reserves for a Single Simulation (Medical Payments Only)

Year	Paid to date	Age-to-Ultimate	Ultimate Paids	Indicated Reserves	Present Value Factor	Present Value of Reserves
1994	1,787,601	3.203	5,725,294	3,937,693	0.675	2,659,636
1993	3,324,538	1.709	5,680,459	2,355,921	0.516	1,214,503
1992	4,208,871	1.551	6,528,911	2,320,040	0.470	1,089,486
1991	7,017,997	1.468	10,299,947	3,281,950	0.440	1,444,103
1990	7,547,277	1.408	10,627,859	3,080,582	0.414	1,274,652
1989	7,905,743	1.378	10,895,652	2,989,908	0.408	1,221,093
1988	8,507,321	1.345	11,442,028	2,934,707	0.394	1,156,938
1987	7,629,124	1.326	10,117,196	2,488,072	0.395	981,650
1986	6,621,638	1.315	8,709,026	2,087,388	0.405	845,872
1985	5,398,367	1.300	7,019,675	1,621,309	0.410	664,608
1984	3,997,086	1.288	5,147,204	1,150,117	0.418	480,222
1983	3,198,587	1.275	4,077,616	879,029	0.424	372,952
1982	2,895,279	1.258	3,642,920	747,641	0.424	316,754
1981	2,929,995	1.236	3,621,690	691,695	0.409	282,863
1980	2,704,128	1.222	3,304,949	600,822	0.406	244,159
1979	2,552,368	1.213	3,096,693	544,325	0.413	224,961
1978	2,375,139	1.199	2,848,514	473,374	0.407	192,665
1977	1,986,508	1.197	2,377,166	390,658	0.428	167,106
1976	1,680,001	1.187	1,994,188	314,187	0.432	135,664
1975	1,321,413	1.178	1,557,089	235,677	0.438	103,113
1974	1,154,614	1.169	1,349,561	194,947	0.440	85,775
1973	1,004,449	1.160	1,164,746	160,297	0.442	70,808
1972	908,372	1.152	1,046,035	137,663	0.446	61,378
1971	782,100	1.144	895,081	112,981	0.452	51,090
1970	776,907	1.138	883,852	106,945	0.459	49,083
Total	90,215,423		124,053,352	**33,837,929**		**15,391,133**

Appendix D: Inflation Adjustments

For certain long-tailed casualty lines of business, much reserve uncertainty stems from changes in the rate of inflation. For workers compensation medical benefits, as an example, the employer is responsible for all physician fees, which are affected by the rate of inflation up through the date that the service is rendered.

Paid loss development analyses often overstate the uncertainty in reserve indications, particularly if one is concerned with the economic value of the reserves, not their nominal value. For instance, suppose that the cumulative paid losses *in real dollar terms* will increase by 30% over the coming year, for a "real dollar" age-to-age factor of 1.300. If inflation is high, the nominal age-to-age factor may be 1.350. If inflation is low, the nominal age-to-age factor may be 1.320.

To some extent, this is "apparent" reserve uncertainty, not real reserve uncertainty. We can get a better estimate of reserve uncertainty by

- Stripping inflation out of the historical paid losses,
- Determining "age-to-age" factors in real dollar terms,
- Using the "real dollar" factors to produce all the simulations, and
- Restoring nominal inflation, based upon current inflation expectations, to determine ultimate losses.

These adjustments are even more important for standard "point estimates" of indicated reserves than for quantification of the uncertainty in the reserves. Nominal dollar paid loss "age-to-age" factors have the historical inflation rate built into them.[69] If future inflation is expected to be different from past inflation, a rote application of the paid loss chain ladder technique gives misleading reserve indications. By properly adjusting the reserve analysis for the actuary's estimate of future inflation, the reserve uncertainty is slightly reduced.

Exhibit D-1 shows the procedure used to put the paid loss experience into real dollar terms (at a 1994 price level). We demonstrate the procedure for medical benefits, which we assume to be fully inflation sensitive. Indemnity benefits, in contrast, are only partially inflation sensitive. About half the states have "cost of living" adjustments for wage loss benefits, but generally these adjustments apply only to certain cases (such as cases that extend for two years or more) and they are often capped (say, at 5% per annum).

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[69] See Charles F. Cook, "Trend and Loss Development Factors," *Proceedings of the Casualty Actuarial Society*, Volume 57 (1970) pages 1-26

We begin with the medical component of the Consumer Price Index, shown on the second row of Exhibit D-1. During the 1980s, the rate of increase in workers compensation medical benefits exceeded the medical CPI. This additional WC medical inflation is related to increases in utilization rates, or perhaps to the incurral of medical services to justify claims for increased indemnity benefits.

For ratemaking, we would need a "loss cost trend factor" for workers compensation medical benefits, of which the medical CPI is but one component. For our purposes, we are concerned only with medical inflation. Changes in utilization rates remain embedded in the paid loss development factors. If the reserving actuary believes that future changes in utilization rates will differ from past changes in utilization rates, this expected difference must be separately quantified.

We must convert the *incremental* paid losses during each calendar year to their "real dollar" (calendar year 1994) values. For ease of application, the one dimensional index in the second row of Exhibit D-1 is converted to a two-dimensional triangle. For instance, the "1.32" in column (2) for accident year 1989 means that accident year losses paid between 12 and 24 months (i.e., from January 1, 1990, through December 31, 1990) must be increased by 32% to bring them to 1994 levels. The 1.032 factor is derived from the inflation index: 1.032 = 1.0885 * 1.0805 * 1.0667 * 1.0536.

We now redo the entire simulation procedure, as documented in Appendix C, using the paid losses that have all been adjusted to a 1994 cost level. Exhibit D-2 shows the results of one such simulation. Lognormal curves were fitted to each column of "real dollar" age-to-age factors, 22 age-to-age factors (through 276 months of development) were generated stochastically from these lognormal curves, an inverse power curve was fitted to these simulated factors, and then a 36 year length for the full development was generated stochastically from a uniform distribution of 30 to 70 years. [These steps are not shown in Exhibit D-2, since the procedure is identical to that discussed in Appendix C.]

The "age-to-ultimate" factors in column (3) are the backward product of the "simulated age-to-age" factors in column (2). For instance, the 2.446 factor in year 1 is the product of 1.378 (column 3, year 2) and 1.776 (column 2, year 1); the 1.378 factor in year 2 is the product of 1.247 (column 3, year 3) and 1.105 (column 2, year 2); and so forth.

The "payment pattern" in the fourth column is derived directly from the "age-to-ultimate" factors in the third column. The 2.446 "age-to-ultimate" factor for year 1 means that for every dollar paid so far, we expect another $1.446 to be paid in the future. Thus, the percentage paid so far is $1 ÷ ($1 + $1.446) = 0.409, or 40.9%.

The 1.378 "age-to-ultimate" factor for year 2 means that for every dollar paid through the end of year 2, we expect another $0.378 to be paid in the future. Thus, the percentage paid so far is $1 ÷ ($1 + $0.378) = 0.726, or 72.6%. Since 40.9% is paid in the first year, the difference is assumed to be paid in the second year: 72.6% – 40.9% = 31.7%, or 0.317.

The same procedure is used for all the entries in the column. The entries sum to unity, except for slight rounding discrepancies.

Restoring Inflation

This "payment pattern" is derived from paid loss histories where are dollar amounts are put on 1994 levels. It is as though there were no inflation in the past, and no inflation will occur in the future.

To properly estimate reserves, we must "restore" future inflation, at the rate assumed by the reserving actuary. This exhibit illustrates an expected future medical inflation rate of 6% per annum. [The tables in the text of this paper show results for expected future inflation rates of 4%, 6%, and 8%.]

Consider the entries for year 1. If there is no inflation, then 40.9% of losses have been paid by the end of year 1, and the age-to-ultimate factor is 2.446. What is the proper age-to-ultimate factor if future losses will inflate at a 6% annual rate?

For simplicity, we assume that losses are paid in mid-year. To clarify the procedure, let us suppose that the ultimate losses in real dollar terms are $1,000,000. By the end of the first year, 40.9% of losses have been paid, or $409,000. In the next calendar year, an additional 31.7% of the losses will be paid, or $317,000 in real dollar terms. Since these losses will be paid in mid-year, inflation will affect them for half a year, so the nominal payment will be $317,000 * $(1.06)^{0.5}$, or $326,371. In the next calendar year, an additional 7.6% of losses will be paid. This is $76,000 in real dollar terms, or $76,000 * $(1.06)^{1.5}$ = $82,942 in nominal terms.

We continue in this fashion to determine all the future expected payments in nominal terms. Summing these payments gives $1,206,500. Since $409,000 is paid by the end of the first year, the percentage paid is $409,000 ÷ $1,206,500 = 33.9%, or 0.339, which is the entry for year 1 in column (5), captioned "cum % paid."

The "inflated ATU" in column (6) is the reciprocal of the "cum % paid" figure. It is the "age-to-ultimate" factor appropriate for a paid loss pattern where there is *no* past inflation but there is 6% per annum future inflation. This factor is applicable to the analysis in this paper: it assumes that past payments have been brought to current monetary levels but future payments will inflate at the assumed rate. [It is *not* a loss development factor that is proper for loss payment patterns that are either on an entirely nominal basis or on an entirely real dollar basis.]

An explanation of the factors for subsequent years should clarify this. Consider the entries for year 3. Cumulative payments by the end of year 3, when all payments are at 1994 monetary levels, are 40.9% + 31.7% + 7.6% = 80.2%. Supposing, as before, that total payments are $1 million, $802,000 has been paid so far.

The future payments, assuming 6% annual inflation and payments made in mid-year, are

$$
\begin{aligned}
& \$4{,}600 * (1.06)^{0.5} \\
+\ & \$3{,}900 * (1.06)^{1.5} \\
+\ & \$2{,}000 * (1.06)^{2.5}, \text{ and so forth.}
\end{aligned}
$$

The total payments are $1,138,000, giving a "cumulative percentage paid" of 70.5%. The "inflated ATU" is the reciprocal of this figure, or 1.419. This factor assumes *no* inflation for the three years of history and 6% annual inflation for future payments.

Payment Patterns

The present value factors in the right-most column of Exhibit D-2 are derived from the appropriate payment pattern for each accident year. Column (5), which is labeled "Cum % paid," looks like a payment pattern, but it is *not* a payment pattern.

Think of a matrix, where each column is a payment pattern. The first column is the appropriate payment pattern when there is no inflation in year 1 but 6% inflation in subsequent years; the second column is the appropriate payment pattern when there is no inflation in years 1 and 2 but 6% inflation in subsequent years; and so forth. The first column is the appropriate payment pattern for the most recent accident year in our analysis; the second column is the appropriate payment pattern for the previous accident year; and so forth. The column labeled "Cum % paid" in Exhibit D-2 is the diagonal of this matrix, as shown below.

Accident Year:	X	X–1	X–2	X–3	X–4	X–5
Development Yr						
1	0.339	.....	.....	.....	.....	.....
2	.....	0.625	.....	.....	.....	.....
3	.....	.....	0.705	.....	.....	.....
4	.....	.....	.....	0.758	.....	.....
5	.....	.....	.....	.....	0.804	.....
6	.....	.....	.....	.....	.....	.....

The "present value factors" in the right-most column of Exhibit D-2 *are not* determined from the *diagonal* of factors that is shown in the "Cum % paid" column of Exhibit D-2. Rather, the present value factor for the current accident year's reserves (the 01754 in column 7 of Exhibit D-2) is determined from the payment pattern for accident year "X" in the box directly above this paragraph. Similarly, the next present value factor, *or 0.635, is derived from the payment pattern for accident year* "X–1."

The full matrix is not shown in this appendix. In fact, the matrix changes for each simulation, since it is determined from the "simulated age-to-age" factors.[70]

Present Value Factors

The present value factors in Exhibit D-2 *use a 6.375% discount rate.* The discount rate was chosen as the average of the assumed future inflation rate and the company's "new-money" investment yield, which was 6.75% when this analysis was performed. This assumes that the appropriate discount rate moves with the inflation rate but is not perfectly correlated with it.

The present value factors are calculated as follows. Suppose there are 5 years in the payment stream, with the payment pattern being 30% – 25% – 20% – 15% – 10%. [The present value factors in Exhibit D-2 use 70 year payment patterns, but the *procedure is the same.]* Again, *we assume that all payments are made in mid-year.*

At the end of the first year, 30% of payments have been made and 70% of losses are still unpaid. The discounted amount of these unpaid losses is

$$25\%*(1.06375)^{-0.5} + 20\%*(1.06375)^{-1.5} + 15\%*(1.06375)^{-2.5} + 10\%*(1.06375)^{-3.5}$$
$$= 24.2\% + 18.2\% + 12.9\% + 8.1\% = 63.4\%.$$

The discount factor for these reserves is therefore 63.4% ÷ 70.0% = 90.5%.

70 In the spreadsheet used for this analysis, the matrix is a matrix of formulas. In each run, the simulated "age-to-age" factors are determined, the inverse power curve is fit, the formulas in the matrix are replaced by figures, and the "present value factors" are derived.

EXHIBIT D-1

Stripping Medical Inflation from the Losses

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Medical Inflation	6.65%	6.40%	4.75%	3.65%	6.65%	10.65%	10.75%	9.55%	9.00%	8.80%	10.10%	10.85%	11.15%	10.20%	7.50%	6.25%	6.90%	7.05%	6.55%	7.10%	8.35%	8.85%	8.05%	6.67%	5.36%

Index for use in Calendar Year

(Multiplying the corresponding element in the triangle by this factor puts the loss at the 1994 medical price level)

Accident Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1970	6.26	5.89	5.62	5.42	5.08	4.59	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00
1971	5.89	5.62	5.42	5.08	4.59	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00	
1972	5.62	5.42	5.08	4.59	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00		
1973	5.42	5.08	4.59	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00			
1974	5.08	4.59	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00				
1975	4.59	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00					
1976	4.15	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00						
1977	3.79	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00							
1978	3.47	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00								
1979	3.19	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00									
1980	2.90	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00										
1981	2.62	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00											
1982	2.35	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00												
1983	2.14	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00													
1984	1.99	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00														
1985	1.87	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00															
1986	1.75	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00																
1987	1.63	1.53	1.43	1.32	1.21	1.12	1.05	1.00																	
1988	1.53	1.43	1.32	1.21	1.12	1.05	1.00																		
1989	1.43	1.32	1.21	1.12	1.05	1.00																			
1990	1.32	1.21	1.12	1.05	1.00																				
1991	1.21	1.12	1.05	1.00																					
1992	1.12	1.05	1.00																						
1993	1.05	1.00																							
1994	1.00																								

EXHIBIT D-2

Building Medical Inflation at 6% into the Projected Losses

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cut-off for tail					**6.0%**	
36				Cum % paid, assuming future		PV Factor for
		0%		inflation, but no past inflation [NOT		Reserves from
Year	Simulated ATA	Age-to-Ultimate	Payment Pattern	a payment pattern, since it applies	Inflated ATU	AY
				separately to each accident yr.]		**6.375%**
1	1.776	2.446	0.409	0.339	2.954	0.754
2	1.105	1.378	0.317	0.625	1.601	0.635
3	1.057	1.247	0.076	0.705	1.419	0.595
4	1.046	1.180	0.046	0.758	1.320	0.565
5	1.023	1.128	0.039	0.804	1.244	0.524
6	1.013	1.103	0.020	0.831	1.203	0.505
7	1.010	1.088	0.012	0.850	1.176	0.501
8	1.008	1.077	0.010	0.866	1.154	0.499
9	1.004	1.068	0.008	0.880	1.136	0.501
10	1.007	1.064	0.004	0.890	1.124	0.518
11	1.005	1.057	0.006	0.901	1.110	0.521
12	1.005	1.052	0.005	0.911	1.098	0.529
13	1.005	1.047	0.004	0.920	1.087	0.538
14	1.003	1.042	0.005	0.929	1.077	0.544
15	1.003	1.038	0.003	0.936	1.069	0.556
16	1.003	1.035	0.003	0.942	1.062	0.570
17	1.002	1.032	0.003	0.948	1.055	0.582
18	1.002	1.030	0.001	0.952	1.050	0.606
19	1.003	1.028	0.002	0.957	1.045	0.624
20	1.002	1.024	0.003	0.963	1.039	0.633
21	1.002	1.022	0.002	0.967	1.034	0.649
22	1.002	1.020	0.002	0.971	1.030	0.668
23	1.002	1.018	0.002	0.975	1.026	0.681
24	1.002	1.016	0.002	0.978	1.023	0.700
25	1.002	1.014	0.002	0.981	1.020	0.720
26	1.002	1.012	0.002	0.983	1.017	0.741
27	1.001	1.011	0.002	0.986	1.014	0.763
28	1.001	1.009	0.001	0.988	1.012	0.785
29	1.001	1.008	0.001	0.990	1.010	0.809
30	1.001	1.007	0.001	0.992	1.008	0.833
31	1.001	1.005	0.001	0.994	1.007	0.858
32	1.001	1.004	0.001	0.995	1.005	0.885
33	1.001	1.003	0.001	0.996	1.004	0.912
34	1.001	1.002	0.001	0.998	1.002	0.940
35	1.001	1.001	0.001	0.999	1.001	0.970
36	1.000	1.000	0.001	1.000	1.000	#DIV/0!

A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation

by Kay Kellogg Rahardo, FCAS

A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation

This paper will describe a new methodology for determining a reserve for unallocated claim expenses. While the discussion will focus on workers compensation claims, the methodology is equally applicable to other lines of business. This paper will describe both a methodology to determine the reserve for all claims (including IBNR claims) as well as a procedure to determine the reserve for claims reported to date (excluding IBNR claims).

This is an important issue for workers compensation because the length of time for which workers compensation claims remain open, i.e., the duration, has been increasing over the last several years. As duration increases, so does the expense of handling the claim for the remainder of the claim's life.

Self-insurance and large deductible plans have become a commonplace means of financing risk. However, few self-insureds handle their own claims. The expense of handling claims is one of which risk managers are increasingly aware. As insurance companies and third party administrators are under tremendous pressure to cut expenses, the need to know the total cost for handling claims becomes increasingly important. Companies that understand the cost of handling claims will be more successful in reducing costs.

It is no longer acceptable for companies to estimate unallocated loss adjustment expense (ULAE) and, in particular, claim expense reserves by using paid to paid ratios. The paid to paid methodology assumes that claims incur expense only when initially opened and when closed. While this may not be an unreasonable assumption for claims from short-tailed lines, this is definitely not true for liability claims. Moreover, the paid to paid ratio itself is subject to distortion when a company is growing or shrinking or when a line of business is in "transition", as was the case for workers compensation throughout the early 1990s as many large customers moved to deductible policies or towards self-insurance.

Automated work measurement is one way of estimating the expense of handling various types of claims. Moreover, there are differing levels of work effort necessary for claims in the first 30 days than on claims that have been open for, say, five years. These differences will be discussed.

Building upon the techniques presented in this paper, a methodology for pricing claims-handling services which is applicable to third party administrators or insurance companies will be discussed. The implications of pricing claims-handling services on a handle-to-conclusion basis versus pricing claims-handling services on a limited time handling basis will be discussed.

Finally, the paper will discuss a methodology for tracking the duration so that the rate of claim closing can be monitored. This, in turn, will allow for targets to be set. Departments that are interested in implementing new techniques for driving down *the duration can use the monitoring techniques to determine if their new claim-closing techniques are successful or not.*

A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation

This paper will describe a methodology for setting an unallocated loss adjustment expense (ULAE) reserve. The method is straightforward and it opens the door to several related issues, specifically, a claim department's monitoring of closing claims and the pricing of claims service. Although this methodology is applicable to any line of business, this discussion and the examples that follow will focus on workers compensation and, in particular, on lost time claims.

A **DEFINITIONS** section is included as an appendix.

Description of Reserve Methodology

The reserve methodology in its simplest form is outlined below. Additional complexities will be introduced after the initial explanation of the methodology. The steps are, as follows:

- produce created and closed claim count triangles and make loss development factor (LDF) selections;
- use the LDFs to project ultimate claims;
- calculate the projected open claims;
- estimate the number of open claims during a quarter;
- calculate the reserve for each year by multiplying the number of open claims by the outstanding cost per claim.

Each of these steps will be discussed further.

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A Methodology for Pricing and Reserving for Claim Expenses in Workers Compensation

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Each of these steps will be discussed further.

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Produce created and closed claim count triangles and make loss development factor (LDF) selections. These triangles should have quarterly evaluations. Ideally, the created claim counts and the closed claim counts will be net of both canceled claims and claims closed with no payment. Either accident year, report year, or policy year triangles may be used, but I prefer the report year version because the accompanying statistics are more useful. Later in the paper, I will discuss some of these statistics, e.g., the number of months claims will remain open.

Use the LDFs to project ultimate claims. Since the example uses report year claims, the ultimate number of claims is identical to the claims reported after twelve months. However, because there are reopenings and also re-assignment of initially medical only claims to lost time claims (and vice versa), the number of report year claims could change after the end of the report year.

With accident year data, one could use either closed claims, created claims, or a combination of these to project the ultimate number of claims.

Calculate the projected open claims. There are at least two methods that could be used to calculate the projected open claims. The first would be to "fill in" the bottom of each of the created and closed triangles, i.e., use the LDFs from step one above, to estimate the future created claims and use a similar procedure to estimate the future closed claims. Taking the difference of the projected created and the projected closed claims provides the projected open claims. In my experience, this can lead to some unreasonable results, e.g., more than 10% of claims remaining open after ten years for a line where this is not reasonable, which necessitates re-selection and re-re-selection and so on, of the LDFs.

My preferred method for projecting the open claims is to calculate another triangle which is the ratio of the (actual) open claims to the ultimate claims. By selecting the percentage of open claims at each evaluation and then applying this percentage to the ultimate number of claims for each year, one derives the projected number of open claims. This is illustrated in Exhibit 2.

Estimate the number of inforce claims during a quarter. One way of estimating the number of inforce claims during a quarter is to average the number of open claims at the beginning and end of a quarter as shown in Exhibit 3.

Calculate the reserve for each year by multiplying the number of open claims by the outstanding cost per claim. Multiplying the average number of open claims in each quarter by the outstanding cost per claim per quarter gives the cost of handling claims in that particular quarter. Note that this produces the incremental cost per quarter as shown in Exhibit 4. Summing all of these costs after a particular point in time, e.g., four quarters, results in the reserve for claim expenses as of the fourth quarter *only for claims open through ten years* as shown in Exhibit 4.

The example shown assumes that the outstanding claim expense per quarter is $150 in 1995 dollars. This is not meant to be a true standard that will apply to any company nor should it be construed to be my company's standard. Future expenses are assumed to increase at 4% per year; one could use other assumptions. Note that the present value of the reserve could be calculated by using $150 consistently for as long as claims are expected to remain open.

One way of determining the outstanding cost per claim would be an automated work measurement study within the claim department. Such a study would determine *standards* rather than dollar amounts since many costs are inflation sensitive. For example, one may determine that a typical workers compensation claim requires fifteen hours to settle (which could be then translated into a cost using the most current hourly rates) rather than saying it costs $700.

Of course, the reserve calculated in Exhibit 4 covers only the expense in the first ten years the claims are open because the triangles used in the example end at ten years. Since there are claims remaining open after ten years, and there will likely be claims open for as many as forty years (or more), the reserve must be adjusted to account for the claims open after ten years.

The assumption to be used in calculating this "tail" reserve is that any workers compensation claim still open after ten years is a tabular claim for which benefits will be paid for the claimant's or the survivor's lifetime. Note that ten years is used in this example only and it is not meant to be a standard. For example, if one has data through fifteen or twenty years then one could make the same assumption.

One can obtain historical information as to the age of the claimant or survivor ten years after the claim is reported (for report year statistics) or ten years after the claim occurs (for accident year statistics). Additionally, an assumption must be made as to the average age at death to determine how many years the claims will remain open. Refinements to this methodology are obviously available, e.g., one can apply mortality tables to *each* claim open after ten years.

We will *assume* that claims open for ten years will remain open, on average, for an additional twenty-five years. Then the "tail reserve" would be the product of the number of claims open after ten years times twenty-five times the annual cost of handling the claim. Obviously, the tail reserve calculated in this manner is very sensitive to the number of years used in the calculation. The significant dollar amounts produced by this methodology (see Exhibit 5) begs the question "Will it really cost this much to handle tabular claims?"

Based on discussions with my claim department it has become clear that, while tabular claims incur expense, these claims are less expensive to handle than "newer" claims. Typically, the work involved in maintaining an open tabular claim is an annual or semi-annual review of the reserve and the mail delivery of a monthly or weekly check (which, typically, is an automated process). We have determined that tabular claims will incur roughly one-third of the expense of a newer claim. Obviously, this may differ from company to company.

The tail reserve for each report year is calculated as shown in Exhibit 6. In Exhibit 7, this tail reserve is shown for each report year after 120 months and the total reserve is calculated by summing the cost per quarter after a particular quarter.

Duration

We have, thus far, presented a methodology for calculating the *total reserve* which is the sum of the expenses in handling claims in the first ten years and the tail reserve for the tabular claims. Note that the reserve calculated in this manner results in a reserve for *all* claims, whether reported or not. For a company that does not wish to hold reserves for incurred but not reported (IBNR) claims or for claims which are not yet incurred, a variation of this methodology is necessary.

The concept of *duration* will be introduced to illustrate the calculation of a reserve per claim. Simply stated, the duration is the average life of a claim or the length of time, on average, that a claim remains open. *Please note that **duration** has a different and distinct meaning in the financial community from that offered here.* Since a claim incurs expense for as long as it remains open, the duration is obviously a key factor in calculating both the reserve and the cost of handling a particular claim.

One way of computing the duration of a claim involves counting the number of days between the date of report and the date of closure using "many" years. This method of computing the duration may understate a company's duration if the claims system began in (for example) 1970 or if the company has not been writing workers compensation claims since the early 1900s because it is not uncommon for workers compensation claims to remain open for fifty years or more. Even for a company writing business for many years, the duration may be mis-stated if the volume has changed significantly over time.

Another way of estimating duration is to use triangles. For each report year, one would take the weighted average over time of the incremental closed claims in each quarter as well as the weighted average over time of the incremental reported claims in each quarter. The difference of the closed weighted average and the created weighted average gives an estimate of the duration for each report year.

A company with only twenty years of workers compensation experience could compute the truncated duration of the first twenty years worth of claims and then make the assumption that claims still open after twenty years are tabular claims. Using annuity tables, one could then estimate the length of time the tabular claims will remain open or one could use a method similar to what was illustrated above for the tail reserve. The total duration could then be calculated using a simple weighted average.

As an example, assume the duration of report year 1977 claims as of December 31, 1996 is 12.6 months and that 99.5% of these claims are closed. The remaining 0.5% of claims are open and are expected to remain open for an *additional* 21 years. The total duration would be (0.995 x 12.6) + (0.005 x [21 + 19.5] x 12) = 15 months.

Obviously, the duration will differ by state because of the different laws in each state for workers compensation benefits. For example, the duration of the permanent total claims in the ten states in the NCCI Closed Claims Studies[1] ranged from 21.3 months (South Carolina) to 50.2 months (Wisconsin).

Industry data from the NCCI Closed Claims Studies[2] showed increasing durations for all of the ten states in the study. This study measured the duration in median number of days for permanent disability claims through closure year 1992. It seems likely that managed care will have some impact on decreasing the overall claim duration, but it is too soon to determine the validity of this hypothesis.

We will assume that the countrywide duration for a workers compensation lost time claim (WCLT) claim is 15 months, the cost *per month* of handling a claim is \$50, and there is no inflation. Then every reported claim will need to have a reserve of \$750 (= 15 x \$50) set aside. Therefore, the reserve as of any point in time would be {the number of created claims} *times* {\$750} *minus* {the money released from the reserve from open claims}. This concept is probably easier to illustrate than to explain.

Assume that one claim is reported at the beginning of each quarter and that the number of open claims at the end of each quarter is as shown below. Also assume for simplicity that claims close at the end of the quarter.

Quarter	Number of Reported Claims	Number of Open Claims*	Addition to Claim Reserve	Subtraction from Claim Reserve	Reserve at the end of the Quarter
1	1	1	$750	$150	$600
2	1	2	$750	$300	$1,050
3	1	3	$750	$450	$1,350
4	1	3	$750	$450	$1,650

***Note: This is the number of open claims at the *end* of *each month* of the quarter.**

In the example above, the reserve is increased by $750 whenever a claim is reported and the reserve is drawn down by $50 for every month a claim is open. So each quarter the reserve is computed as the reserve at the beginning of the quarter plus the addition to the reserve (from newly-reported claims) minus the claim expenses incurred during the quarter.

In the example above, the assumption is made that claim expense is incurred if the claim is open at the *end of the month.* Since, in the fourth quarter, one claim was closed before the end of the first month of the quarter, no money is released from the reserve for this claim. In this way, the money set aside for claims that close "early" (before 15 months) is there for the claims that remain open "late" (after 15 months).

Pricing Claims Service

The concept of duration was used to compute the reserve per claim, which can easily be modified to derive the price of handling a claim. For many customers today and for virtually all National Accounts customers, claims service is an unbundled, separately-negotiated piece of the risk-financing program.

The methodology described here is only for the *basic claim expenses*, i.e., the unallocated loss adjustment expenses. The *total cost* of adjusting claims would be the sum of the basic claim expense and the sundry allocated types of loss adjustment expenses such as legal expenses, managed care expenses, 1-800 telephone reporting systems, nurse case managers, etc.

In the examples presented thus far, we have assumed that claims incur uniform expenses each month for the first ten years. Discussions with my claim department would indicate that this is an overly simplistic assumption. Rather, a claim generally incurs the most expense during the first month in which it is open, during which time the file must be set up, various phone calls must be made, investigatory work is necessary, etc. Therefore, the expense incurred by a claim may better be modeled by assuming an **intake expense** and then several months of **outstanding expense** for as long as the claim is open.

A further refinement in modeling the claim expense would be to differentiate between the outstanding expenses. Again, the idea is that the first few months a claim is open are more labor-intensive than the later months. Thus, there may be discriminatory standards for outstanding expenses. The cost of handling a claim (excluding ALE) would then be:

Intake Expense + (OS1 * x months) + (OS2 * [duration - 1 - x] months),

where OS1 is the higher cost of handling claims in the first few months and OS2 is the lower cost of handling claims later. Note that we are assuming the cost of handling a claim in the first month is included in the intake expense, so that we only have to account for (duration - 1) months of outstanding expenses.

In setting the reserve using the reserve per claim concept, a reserve equal to **(OS1 * x months) + (OS2 * [duration - 1 - x] months)** would be set aside for each claim in the month in which the claim is reported. If the claim closes in the first month, then the full reserve would be banked for claims remaining open longer than the average life of claim. If the claim remains open at the end of the second (or third) month, then OS1 dollars would be released from the reserve. If the claim remains open at the end of the fourth and succeeding months, then OS2 dollars would be released from the reserve for each month the claim is open.

These additional claim standards will have to be determined based on some type of work measurement study. A few years ago, my company embarked upon an automated work measurement study in order to derive precise measures of these standards. Although these standards will conceivably differ by state, the real difference by state is due to the duration. One could take these differing durations into account in pricing claims service to avoid adverse selection in "problem" states.

The formula presented above is for *handle-to-conclusion* pricing, i.e., the fee is sufficient to cover the expenses of handling the claim for as long as the claim is open. Today many third party administrators (TPAs) also price claims on a *limited time handling* basis. Under this option, an additional fee would be levied to service claims remaining open after (for example) two years. Typically, this additional fee would be negotiated at the time of sale.

Today most large (self-)insureds separately negotiate the cost of claims service with an insurance company TPA or a stand-alone TPA. The stand-alone TPA will partner with an insurance company who is willing to unbundle its claims service. While an insurance company TPA would be willing to offer this limited time handling option, many insurance companies would not want the insured to take its claims elsewhere to be serviced since these claims are the insurance company's liability (or conceivably could be if serviced under a deductible policy).

Given a handle-to-conclusion fee, how could one determine the limited time handling fee? The statistics in Exhibit 2 show that 22.6% of claims remain open after two years. We could then estimate the limited time handling fee for two years as (1 - 0.226) x HTC, where HTC is the handle-to-conclusion fee. The claims remaining open after two years would begin to incur a monthly fee and would continue to do so for as long as the claim stayed open.

Note that those claims still open at 24 months would likely remain open for an *additional* 24 months. This is calculated as the reserve as of 24 months divided by the number of open claims at 24 months divided by the cost per outstanding (including inflation). Therefore, if a customer chose instead to pay a one-time fee to handle the claims remaining open after 24 months, the necessary fee assuming a monthly outstanding expense of $50 would be $1,200 = 24 x $50.

This one-time fee could also be calculated as the cost of handling *take-over claims*. A customer who has a limited time handling option who chooses to take its claims to another TPA would be subject to a take-over claim fee.

Monitoring the Duration

As mentioned earlier, there is some evidence that duration has increased during the 1990s. It also seems likely that managed care will play some part in decreasing the duration. Because it is generally true that the longer a claim remains open, the higher will be the expense of handling that claim, it is a good idea for claim departments to monitor progress or slippage in duration.

A process for monitoring the duration would be to use quarterly report quarter outstanding rates. The example presented below shows claims reported during a quarter and the number of claims open at 3, 6, 9, and 12 months.

	No. Claims Reported during Quarter	No. Claims Open after 3 months	No. Claims Open after 6 months	No. Claims Open after 9 months	No. Claims Open after 12 months
	(1)	(2)	(3)	(4)	(5)
1-st Quarter 93	3,481	2,536	2,012	1,647	1,287
2-nd Quarter 93	3,623	2,668	2,082	1,721	1,401
3-rd Quarter 93	4,220	3,098	2,461	2,013	1,648
4-th Quarter 93	4,002	3,034	2,315	1,921	1,613
1-st Quarter 94	3,991	3,100	2,320	1,920	1,647
2-nd Quarter 94	3,621	2,850	2,134	1,738	1,514
3-rd Quarter 94	3,398	2,649	2,014	1,651	1,429
4-th Quarter 94	2,910	2,287	1,741	1,426	1,248
1-st Quarter 95	3,830	3,041	2,297	1,896	
2-nd Quarter 95	3,863	3,079	2,326		
3-rd Quarter 95	3,284	2,642			

The table below shows the percentage of claims open at successive evaluations. Of course, in the absence of change in claims handling, one would expect the same percentages throughout a column.

	Percentage of Claims Open after 3 months	Percentage of Claims Open after 6 months	Percentage of Claims Open after 9 months	Percentage of Claims Open after 12 months
	(6)	(7)	(8)	(9)
1-st Quarter 93	72.9%	57.8%	47.3%	37.0%
2-nd Quarter 93	73.6%	57.5%	47.5%	38.7%
3-rd Quarter 93	73.4%	58.3%	47.7%	39.1%
4-th Quarter 93	75.8%	57.8%	48.0%	40.3%
1-st Quarter 94	77.7%	58.1%	48.1%	41.3%
2-nd Quarter 94	78.7%	58.9%	48.0%	41.8%
3-rd Quarter 94	78.0%	59.3%	48.6%	42.1%
4-th Quarter 94	78.6%	59.8%	49.0%	42.9%
1-st Quarter 95	79.4%	60.0%	49.5%	
2-nd Quarter 95	79.7%	60.2%		
3-rd Quarter 95	80.5%			

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This example has been purposefully contrived to show that claims are remaining open longer, at least through the first twelve months. It seems likely that the duration of claims reported in the most recent report quarter will be greater than that of the earlier report quarters.

By using *report quarter* instead of *accident quarter*, there is no issue with claim development. Also, by using report *quarter* rather than report *year*, the analyst can more quickly discern changes in outstanding rates (because of the frequency with which these reports will be produced) or any seasonality that may exist.

While this type of triangulation may be used to monitor duration, it may also be used by claim departments or third-party administrators in setting goals for the future. The goal could be to continue to close claims at the same rate or the goal could be to close claims more quickly. Certainly, the longer claims stay open the higher the total cost of handling the claim although this could be somewhat of a trade-off in that closing claims too quickly could lead to more reopened claims and/or higher settlement values.

A claim department or third party administrator who is interested in more sophisticated monitoring techniques could use the same types of report quarter comparisons at successive evaluations to monitor

- average incurred claim size,
- average paid claim size,

- average outstanding claim size,
- ratio of paid ALE to paid loss,
- average ALE per reported claim,
- average recovery per claim,
- recovery as a percentage of loss,
- ratio of closed claims to the number of claims handlers.

By monitoring the claim closing rate as well as the claim costs and other measures at like points in time, a claim department can monitor not just the closing of the claims but the full range of statistics bearing on a claim department's performance.

By using the techniques described here, a claim department or third party administrator can price claim service based on the total cost of handling the claim. This will also allow the company to set up and maintain an adequate reserve and to monitor the success in handling the claims.

References

1 Hartwig, Robert P.; Kahley, William J.; and Restrepo, Tanya E., "Workers Compensation Loss Ratios and the Business Cycle", *NCCI Journal,* December, 1994.

2 Op. cit.

DEFINITIONS

Allocated loss adjustment expense (ALAE). Expenses associated with settling a claim that are allocable to a specific claim, e.g., attorneys' fees, investigative fees, independent medical examinations, many managed care expenses, and court and other legal fees.

Created Claims. Claims reported to an insurance company or third party administrator. *Also known as **reported claims**.*

Duration. The amount of time that a claim remains open. *Also known as **the life of claim**.*

Handle-to-conclusion. A term used by third party administrators to denote claims service that will continue for as long as the claim remains open. The fee charged for handle-to-conclusion would, unless otherwise stated, also cover the handling of any reopened claims for as long as they remain (re)-opened.

Intake expense. The cost of setting up a newly-created claim into the system.

Limited-time handling. A term used by third party administrators to signify claims service for some specified time limit, after which time an additional fee will be charged for the continued handling of the claim.

Outstanding fee. The expense of handling a claim for as long as it remains open. This could be expressed in various ways, e.g., as a fee per month or a quarterly fee.

Reported claims. Claims for which the insurance company or third party administrator has been made aware. *Also known as **created claims**.*

Third party administrator (TPA). A company who is in the business of handling and servicing claims. Such a company may also provide other than claims services such as loss control, risk management information systems, actuarial services, etc. These companies may either be affiliated with an insurance carrier or as a stand-alone entity.

Unallocated loss adjustment expense (ULAE). Expenses associated with settling a claim that are not allocable to a specific claim, e.g., claim adjusters' salaries, heat, light, rent, etc.

5/1/96

Workers Compensation Lost Time Claims

Exhibit 1
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Created Claims

Report Year	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	23,983	48,467	73,985	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909
1987	24,634	49,335	72,704	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869
1988	24,555	49,550	75,570	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346
1989	25,500	52,425	80,455	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315
1990	25,768	55,292	82,434	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029	111,029
1991	23,898	50,323	77,679	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345	107,345
1992	25,318	52,893	81,827	113,367	113,367	113,367	113,367	113,367	113,367	113,367	113,367	113,367	113,367	113,367	113,367	113,367				
1993	25,478	52,901	79,780	107,084	107,084	107,084	107,084	107,084	107,084	107,084	107,084	107,084								
1994	24,765	50,509	77,522	107,687	107,687	107,687	107,687	107,687												
1995	24,383	49,863	76,524	104,446																

Workers Compensation Lost Time Claims

Exhibit 1
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Report Year	Created Claims 63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120	Ultimate
1986	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909	101,909
1987	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869	96,869					96,869
1988	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346	102,346									102,346
1989	107,315	107,315	107,315	107,315	107,315	107,315	107,315	107,315													107,315
1990	111,029	111,029	111,029	111,029																	111,029
1991																					107,345
1992																					113,367
1993																					107,084
1994																					107,687
1995																					104,446

Workers Compensation Lost Time Claims

Exhibit 2
Page 1

Open Claims

Report Year	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	17,957	28,671	36,937	46,680	40,317	32,933	28,228	24,271	21,023	17,780	15,844	13,903	12,671	11,252	10,246	9,203	8,460	7,501	6,589	5,960
1987	18,115	28,996	38,325	45,306	33,093	26,843	22,631	19,287	16,601	14,405	12,366	10,949	9,234	8,325	7,227	6,341	5,774	5,166	4,743	4,410
1988	16,570	30,035	38,877	46,745	35,385	29,480	25,050	21,720	18,300	15,755	13,765	12,115	11,125	10,020	9,200	8,265	7,515	6,820	6,415	5,900
1989	19,230	32,975	39,548	49,865	37,310	31,055	26,015	22,355	19,555	17,040	15,370	13,775	12,015	10,755	9,830	8,835	8,060	7,460	6,820	6,320
1990	19,767	36,284	40,645	51,152	39,629	33,327	28,725	25,355	22,480	19,240	17,701	15,678	14,102	12,974	11,986	10,780	9,937	9,116	8,492	7,810
1991	18,879	33,587	40,522	49,710	39,400	32,630	28,360	24,630	21,810	19,330	17,505	15,585	14,290	12,640	11,600	10,630	9,650	9,020	8,210	7,245
1992	20,205	36,239	42,877	52,935	43,960	37,360	32,185	28,340	25,025	22,215	19,855	18,070	15,810	14,405	12,885	11,225	8,888	8,106	7,426	6,768
1993	19,243	33,259	40,655	49,428	37,667	31,360	26,760	23,352	20,787	18,868	16,833	14,554	12,850	11,597	10,505	9,391	8,395	7,657	7,014	6,393
1994	19,125	33,887	40,188	50,002	37,896	35,123	30,547	26,668	20,968	16,328	16,368	14,505	12,922	11,663	10,564	9,444	6,443	7,700	7,054	6,429
1995	18,455	32,651	39,586	49,155	37,674	31,710	27,135	23,573	20,357	17,777	15,876	14,069	12,534	11,312	10,246	9,160	8,189	7,468	6,841	6,235

Ratio of Open to Ultimate Claims

				12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	0.1762	0.2813	0.3625	0.4581	0.3956	0.3232	0.2770	0.2382	0.2063	0.1745	0.1555	0.1364	0.1243	0.1104	0.1005	0.0903	0.0830	0.0736	0.0647	0.0585
1987	0.1870	0.2993	0.3750	0.4677	0.3416	0.2771	0.2336	0.1991	0.1714	0.1487	0.1277	0.1130	0.0953	0.0859	0.0746	0.0655	0.0596	0.0533	0.0490	0.0455
1988	0.1814	0.2935	0.3799	0.4567	0.3457	0.2880	0.2448	0.2122	0.1788	0.1539	0.1345	0.1184	0.1087	0.0979	0.0899	0.0808	0.0734	0.0666	0.0627	0.0576
1989	0.1792	0.3073	0.3685	0.4647	0.3477	0.2894	0.2424	0.2083	0.1822	0.1588	0.1432	0.1284	0.1120	0.1002	0.0916	0.0823	0.0751	0.0695	0.0638	0.0589
1990	0.1760	0.3268	0.3661	0.4607	0.3569	0.3002	0.2587	0.2264	0.2025	0.1733	0.1594	0.1412	0.1270	0.1169	0.1080	0.0971	0.0895	0.0821	0.0765	0.0703
1991	0.1759	0.3129	0.3775	0.4631	0.3670	0.3058	0.2642	0.2294	0.2032	0.1801	0.1631	0.1452	0.1331	0.1196	0.1081	0.0990	0.0899	0.0840	0.0765	0.0675
1992	0.1782	0.3197	0.3782	0.4669	0.3878	0.3295	0.2839	0.2500	0.2207	0.1960	0.1751	0.1594	0.1395	0.1271	0.1137	0.0990				
1993	0.1797	0.3106	0.3797	0.4616	0.3518	0.2929	0.2499	0.2181	0.1941	0.1762	0.1572	0.1359								
1994	0.1776	0.3147	0.3732	0.4643	0.3519	0.3262	0.2837	0.2476												
Average				0.4626	0.3607	0.3036	0.2598	0.2257	0.1949	0.1702	0.1520	0.1347	0.1200	0.1083	0.0981	0.0877	0.0784	0.0715	0.0655	0.0597
Selected				0.4626	0.3607	0.3036	0.2598	0.2257	0.1949	0.1702	0.1520	0.1347	0.1200	0.1083	0.0981	0.0877	0.0784	0.0715	0.0655	0.0597

Example: For RY 1995 at 24 months: 23,573 = 0.2257 x 104,446.

Workers Compensation Lost Time Claims

Exhibit 2
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Open Claims

Report Year	63	66	69	72	75	78	81	84	87	90
1986	5,452	5,071	4,700	4,479	4,230	3,901	3,793	3,525	3,323	3,064
1987	4,086	3,749	3,632	3,438	3,272	2,975	2,781	2,646	2,552	2,484
1988	5,520	5,140	4,750	4,445	4,115	3,620	3,495	3,255	2,905	2,765
1989	5,800	5,045	4,820	4,550	4,115	3,980	3,740	3,470	3,123	2,962
1990	7,129	6,739	6,250	5,647	4,275	3,930	3,742	3,497	3,231	3,064
1991	5,754	5,292	4,959	4,637	4,133	3,800	3,618	3,381	3,124	2,963
1992	6,076	5,589	5,238	4,897	4,365	4,013	3,820	3,571	3,299	3,129
1993	5,740	5,279	4,947	4,626	4,123	3,791	3,609	3,373	3,116	2,956
1994	5,772	5,309	4,975	4,652	4,146	3,812	3,629	3,392	3,134	2,972
1995	5,596	5,149	4,825	4,512	4,021	3,697	3,520	3,290	3,039	2,883

Report Year	93	96	99	102	105	108	111	114	117	120
1986	3,017	2,726	2,726	2,599	2,458	2,468	2,322	2,289	2,195	2,038
1987	2,331	2,219	2,052	1,971	1,841	1,742	2,209	2,180	2,083	1,937
1988	2,620	2,385	2,456	2,344	2,211	2,160	2,333	2,303	2,200	2,047
1989	2,833	2,608	2,576	2,458	2,318	2,264	2,447	2,415	2,307	2,146
1990	2,931	2,698	2,665	2,543	2,398	2,343	2,531	2,498	2,387	2,221
1991	2,834	2,608	2,576	2,458	2,319	2,265	2,447	2,415	2,308	2,147
1992	2,993	2,755	2,721	2,596	2,449	2,392	2,585	2,551	2,437	2,267
1993	2,827	2,602	2,570	2,452	2,313	2,259	2,442	2,409	2,302	2,142
1994	2,843	2,617	2,584	2,466	2,326	2,272	2,455	2,423	2,315	2,154
1995	2,757	2,538	2,507	2,392	2,256	2,204	2,381	2,350	2,246	2,089

	63	66	69	72	75	78	81	84	87	90
1986	0.0535	0.0498	0.0461	0.0440	0.0415	0.0383	0.0372	0.0346	0.0326	0.0301
1987	0.0422	0.0387	0.0375	0.0355	0.0338	0.0307	0.0287	0.0273	0.0263	0.0256
1988	0.0539	0.0502	0.0464	0.0434	0.0402	0.0354	0.0341	0.0318	0.0284	0.0270
1989	0.0540	0.0470	0.0449	0.0424	0.0383	0.0371	0.0349	0.0323		
1990	0.0642	0.0607	0.0563	0.0509						
1991										
1992										
1993										
1994										
Average	0.0536	0.0493	0.0462	0.0432	0.0385	0.0354	0.0337	0.0315	0.0291	0.0276
Selected	0.0536	0.0493	0.0462	0.0432	0.0385	0.0354	0.0337	0.0315	0.0291	0.0276

	93	96	99	102	105	108	111	114	117	120
1986	0.0296	0.0267	0.0267	0.0255	0.0241	0.0242	0.0228	0.0225	0.0215	0.0200
1987	0.0241	0.0229	0.0212	0.0203	0.0190	0.0180				
1988	0.0256	0.0233								
1989										
1990										
1991										
1992										
1993										
1994										
Average	0.0264	0.0243	0.0240	0.0229	0.0216	0.0211	0.0228	0.0225	0.0215	0.0200
Selected	0.0264	0.0243	0.0240	0.0229	0.0216	0.0211	0.0228	0.0225	0.0215	0.0200

Workers Compensation Lost Time Claims

Exhibit 3
Page 1

Average Open Claims*

Report Year	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	8,979	23,314	32,604	41,809	43,498	36,625	30,581	26,250	22,647	19,402	16,812	14,873	13,287	11,962	10,749	9,724	8,831	7,981	7,045	6,275
1987	9,057	23,555	32,661	40,815	39,200	29,968	24,737	20,959	17,944	15,503	13,385	11,657	10,091	8,780	7,776	6,784	6,057	5,470	4,955	4,577
1988	9,285	24,303	34,456	42,811	41,065	32,433	27,265	23,385	20,010	17,028	14,760	12,940	11,620	10,573	9,610	8,733	7,890	7,168	6,618	6,158
1989	9,615	26,103	36,262	44,707	43,588	34,183	28,535	24,185	20,955	18,298	16,205	14,573	12,895	11,385	10,293	9,333	8,448	7,760	7,140	6,570
1990	9,884	28,025	38,464	45,899	45,391	36,478	31,026	27,040	23,917	20,860	18,470	16,689	14,890	13,538	12,480	11,383	10,358	9,526	8,804	8,151
1991	9,439	26,233	37,054	45,116	44,555	36,115	30,595	26,495	23,220	20,570	18,418	16,545	14,938	13,565	12,220	11,115	10,140	9,335	8,615	7,728
1992	10,102	28,222	39,558	47,906	46,448	40,660	34,773	30,263	26,683	23,620	21,035	18,963	16,940	15,108	13,645	12,055	10,057	8,497	7,766	7,097
1993	9,622	26,251	36,957	45,041	43,547	34,514	29,060	25,056	22,069	19,827	17,850	15,693	13,702	12,224	11,051	9,948	8,893	8,026	7,336	6,704
1994	9,563	26,506	37,038	45,095	43,949	36,510	32,835	28,808	23,828	19,658	17,348	15,437	13,714	12,293	11,114	10,004	8,944	8,072	7,377	6,742
1995	9,228	25,553	36,119	44,371	43,415	34,692	29,423	25,354	21,965	19,067	16,827	14,973	13,302	11,923	10,779	9,703	8,875	7,829	7,155	6,536

* *Average Open Claims* = Average number of claims at the beginning and the end of the quarter.

Cost Per Open Claim**

Report Year	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	105	105	105	105	109	109	109	109	113	113	113	113	118	118	118	118	123	123	123	123
1987	109	109	109	109	113	113	113	113	118	118	118	118	123	123	123	123	128	128	128	128
1988	113	113	113	113	118	118	118	118	123	123	123	123	128	128	128	128	133	133	133	133
1989	118	118	118	118	123	123	123	123	128	128	128	128	133	133	133	133	138	138	138	138
1990	123	123	123	123	128	128	128	128	133	133	133	133	138	138	138	138	144	144	144	144
1991	128	128	128	128	133	133	133	133	138	138	138	138	144	144	144	144	150	150	150	150
1992	133	133	133	133	138	138	138	138	144	144	144	144	150	150	150	150	156	156	156	156
1993	138	138	138	138	144	144	144	144	150	150	150	150	156	156	156	156	162	162	162	162
1994	144	144	144	144	150	150	150	150	156	156	156	156	162	162	162	162	168	168	168	168
1995	150	150	150	150	156	156	156	156	162	162	162	162	168	168	168	168	175	175	175	175

** *Cost Per Open Claim* is assumed to be $150 per quarter in 1995 dollars. Prior and subsequent expenses are derived assuming 4% inflation

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Workers Compensation Lost Time Claims

Exhibit 3
Page 2

Average Open Claims*

Report Year	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120
1986	5,706	5,262	4,886	4,590	4,355	4,066	3,847	3,659	3,424	3,194	3,041	2,872	2,726	2,663	2,529	2,463	2,395	2,305	2,242	2,116
1987	4,248	3,917	3,690	3,535	3,355	3,123	2,878	2,714	2,599	2,518	2,408	2,275	2,135	2,012	1,906	1,791	1,975	2,195	2,132	2,010
1988	5,710	5,330	4,945	4,598	4,280	3,868	3,558	3,375	3,080	2,835	2,693	2,503	2,421	2,400	2,278	2,186	2,247	2,318	2,252	2,124
1989	6,060	5,423	4,933	4,685	4,333	4,048	3,880	3,605	3,297	3,043	2,898	2,721	2,592	2,517	2,388	2,291	2,356	2,431	2,361	2,227
1990	7,470	6,934	6,495	5,949	4,961	4,103	3,836	3,620	3,364	3,148	2,998	2,815	2,682	2,604	2,471	2,371	2,437	2,515	2,443	2,304
1991	6,500	5,523	5,126	4,798	4,385	3,967	3,709	3,500	3,253	3,044	2,899	2,721	2,592	2,517	2,389	2,292	2,358	2,431	2,362	2,228
1992	6,422	5,833	5,414	5,068	4,631	4,189	3,917	3,696	3,435	3,214	3,061	2,874	2,738	2,659	2,523	2,421	2,489	2,568	2,494	2,352
1993	6,067	5,510	5,113	4,787	4,375	3,957	3,700	3,491	3,245	3,036	2,892	2,715	2,586	2,511	2,383	2,286	2,351	2,426	2,356	2,222
1994	6,101	5,541	5,142	4,814	4,399	3,979	3,721	3,511	3,263	3,053	2,908	2,730	2,601	2,525	2,396	2,299	2,364	2,439	2,369	2,235
1995	5,917	5,374	4,987	4,669	4,267	3,859	3,609	3,405	3,165	2,961	2,820	2,648	2,523	2,450	2,324	2,230	2,293	2,366	2,298	2,168

* *Average Open Claims* = Average number of claims at the beginning and the end of the quarter.

Cost Per Open Claim**

Report Year	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120
1986	128	128	128	128	133	133	133	133	138	138	138	138	144	144	144	144	150	150	150	150
1987	133	133	133	133	138	138	138	138	144	144	144	144	150	150	150	150	156	156	156	156
1988	138	138	138	138	144	144	144	144	150	150	150	150	156	156	156	156	162	162	162	162
1989	144	144	144	144	150	150	150	150	156	156	156	156	162	162	162	162	168	168	168	168
1990	150	150	150	150	156	156	156	156	162	162	162	162	168	168	168	168	175	175	175	175
1991	156	156	156	156	162	162	162	162	168	168	168	168	175	175	175	175	182	182	182	182
1992	162	162	162	162	168	168	168	168	175	175	175	175	182	182	182	182	189	189	189	189
1993	168	168	168	168	175	175	175	175	182	182	182	182	189	189	189	189	197	197	197	197
1994	175	175	175	175	182	182	182	182	189	189	189	189	197	197	197	197	205	205	205	205
1995	182	182	182	182	189	189	189	189	197	197	197	197	205	205	205	205	213	213	213	213

** *Cost Per Open Claim* is assumed to be $150 per quarter in 1995 dollars. Prior and subsequent expenses are derived assuming 4% inflation.

Workers Compensation Lost Time Claims

Incremental Cost Per Quarter

Report Year	3	6	9	12	15	18	21	24	27	30
1986	942,795	2,447,970	3,444,420	4,389,945	4,741,282	3,992,125	3,333,329	2,861,250	2,559,111	2,192,426
1987	987,213	2,567,495	3,560,049	4,448,835	4,429,600	3,386,384	2,795,281	2,368,367	2,117,392	1,829,354
1988	1,049,205	2,746,239	3,893,528	4,837,643	4,845,670	3,827,094	3,217,270	2,759,430	2,461,230	2,094,444
1989	1,134,570	3,080,154	4,278,916	5,275,426	5,361,324	4,204,509	3,509,805	2,974,755	2,682,240	2,342,144
1990	1,215,732	3,447,075	4,731,072	5,645,577	5,810,048	4,689,184	3,971,328	3,461,120	3,180,961	2,774,380
1991	1,208,192	3,357,824	4,742,912	5,774,848	5,925,815	4,803,295	4,069,135	3,523,835	3,204,360	2,838,660
1992	1,343,566	3,753,526	5,261,214	6,371,498	6,685,824	5,611,080	4,798,674	4,176,294	3,842,352	3,401,280
1993	1,327,836	3,622,638	5,100,066	6,215,658	6,270,768	4,970,016	4,184,640	3,608,064	3,310,350	2,974,050
1994	1,377,072	3,816,864	5,333,472	6,493,680	6,592,350	5,476,500	4,925,250	4,291,200	3,717,168	3,066,848
1995	1,384,200	3,832,950	5,417,850	6,655,650	6,772,740	5,411,952	4,569,988	3,955,224	3,558,330	3,088,854

Report Year	33	36	39	42	45	48	51	54	57	60
1986	1,899,756	1,680,649	1,567,866	1,411,516	1,268,382	1,147,432	1,086,213	981,663	866,535	771,825
1987	1,579,430	1,375,526	1,241,193	1,079,940	956,448	834,432	775,296	700,160	634,240	585,856
1988	1,815,480	1,591,620	1,487,360	1,353,344	1,230,080	1,117,824	1,049,370	953,344	880,194	819,014
1989	2,074,240	1,865,344	1,715,035	1,514,205	1,368,969	1,241,289	1,165,824	1,070,880	985,320	906,660
1990	2,456,510	2,219,637	2,054,820	1,868,244	1,722,240	1,570,854	1,491,552	1,371,744	1,267,776	1,173,744
1991	2,541,684	2,263,210	2,151,072	1,953,360	1,759,680	1,600,560	1,521,000	1,400,250	1,292,250	1,159,200
1992	3,029,040	2,730,672	2,541,000	2,266,200	2,046,750	1,806,250	1,568,892	1,325,532	1,211,496	1,107,132
1993	2,677,500	2,353,950	2,137,512	1,906,944	1,723,956	1,551,888	1,440,666	1,300,212	1,188,432	1,086,048
1994	2,706,268	2,408,172	2,221,668	1,991,466	1,800,468	1,620,648	1,502,592	1,356,096	1,239,336	1,132,656
1995	2,725,974	2,425,626	2,234,736	2,003,064	1,810,872	1,630,104	1,518,125	1,370,075	1,252,125	1,144,150

Example: For RY 1995, expenses in the fourth quarter = $6,655,650 = 44,371 x 150.

Reserve as of Quarter*

Report Year	3	6	9	12	15	18	21	24	27	30
1986	51,961,660	49,513,690	46,069,270	41,679,325	36,938,043	32,945,918	29,612,589	26,751,339	24,192,228	21,999,802
1987	44,882,280	42,294,785	38,734,736	34,285,901	29,856,301	26,469,917	23,674,636	21,306,269	19,188,877	17,359,523
1988	52,555,848	49,809,609	45,916,081	41,078,438	36,232,768	32,405,674	29,188,404	26,428,974	23,967,744	21,873,300
1989	58,058,743	54,978,589	50,699,673	45,424,247	40,062,923	35,858,414	32,348,609	29,373,854	26,691,614	24,349,470
1990	66,887,665	63,440,590	58,709,518	53,063,941	47,253,893	42,584,709	38,613,381	35,152,261	31,971,300	29,196,920
1991	67,269,484	63,911,660	59,168,748	53,393,900	47,468,085	42,664,790	38,595,655	35,071,620	31,867,460	29,028,800
1992	75,936,773	72,183,247	66,922,033	60,550,535	53,864,711	48,253,631	43,454,957	39,278,663	35,436,311	32,035,031
1993	69,600,344	66,177,706	61,077,640	54,861,982	48,591,214	43,621,198	39,436,558	35,828,494	32,518,144	29,544,094
1994	74,435,670	70,618,806	65,285,334	58,791,654	52,199,304	46,722,804	41,797,554	37,506,354	33,789,186	30,722,538
1995	74,252,881	70,419,931	65,002,081	58,346,431	51,573,691	46,161,739	41,571,751	37,616,527	34,058,197	30,969,343

Report Year	33	36	39	42	45	48	51	54	57	60
1986	20,100,046	18,419,397	16,851,531	15,440,015	14,171,633	13,024,201	11,937,968	10,956,325	10,069,790	9,317,965
1987	15,780,093	14,404,567	13,163,374	12,083,434	11,126,986	10,292,554	9,517,258	8,817,098	8,182,858	7,597,002
1988	20,057,820	18,466,200	16,978,840	15,625,496	14,395,416	13,277,592	12,228,222	11,274,878	10,394,684	9,575,670
1989	22,275,230	20,409,886	18,694,851	17,180,646	15,811,677	14,570,388	13,404,564	12,333,684	11,348,364	10,441,704
1990	26,740,410	24,520,773	22,465,953	20,597,709	18,875,469	17,304,615	15,813,063	14,441,319	13,173,543	11,999,799
1991	26,487,116	24,203,906	22,052,834	20,099,474	18,339,794	16,739,234	15,218,234	13,817,984	12,525,734	11,366,534
1992	29,005,991	26,275,319	23,734,319	21,468,119	19,421,369	17,613,119	16,044,227	14,718,695	13,507,199	12,400,067
1993	26,866,594	24,512,644	22,375,132	20,468,188	18,744,232	17,192,344	15,751,678	14,451,466	13,263,034	12,176,986
1994	28,016,250	25,608,078	23,386,410	21,394,944	19,594,476	17,973,828	16,471,236	15,115,140	13,875,804	12,743,148
1995	28,243,369	25,817,743	23,583,007	21,579,943	19,769,071	18,138,967	16,620,842	15,250,767	13,998,842	12,854,492

Example: For RY 1995, the reserve as of 36 months = $25,817,743 = $2,234,736 + $2,003,064 + $1,810,872 + . . .

**Note: This reserve calculated in this example only covers claim expenses through the first ten years.*

Workers Compensation Lost Time Claims

Exhibit 4
Page 2

Cost Per Quarter

Report Year	63	66	69	72	75	78	81	84	87	90
1986	730,368	673,536	625,408	587,520	579,215	540,778	511,651	486,647	472,512	440,772
1987	564,964	520,961	490,770	470,155	462,990	430,974	397,164	374,532	374,256	362,592
1988	787,980	735,540	682,410	634,524	616,320	556,992	512,352	486,000	462,000	425,250
1989	872,640	780,912	710,352	674,640	649,950	607,200	579,000	540,750	514,332	474,708
1990	1,120,500	1,040,100	974,250	892,350	773,916	640,068	598,416	564,720	544,968	509,976
1991	1,014,000	861,586	799,656	746,486	710,370	642,654	600,856	567,000	546,504	511,392
1992	1,040,364	944,946	877,068	821,016	778,006	703,752	658,056	620,928	601,125	562,450
1993	1,019,256	925,680	858,964	804,216	765,625	692,475	647,500	610,925	590,590	552,552
1994	1,067,675	969,675	899,850	842,450	800,618	724,178	677,222	639,002	616,707	577,017
1995	1,076,894	978,066	907,634	849,758	806,463	729,351	682,101	643,545	623,505	583,317

Report Year	93	96	99	102	105	108	111	114	117	120
1986	419,658	398,336	392,544	383,472	364,176	354,672	359,250	345,750	338,300	317,400
1987	346,752	327,600	320,250	301,800	285,900	268,650	306,100	342,420	332,592	313,560
1988	403,950	375,450	377,676	374,400	355,368	341,016	364,014	375,516	364,824	344,088
1989	452,088	424,476	419,904	407,754	366,856	371,142	395,808	406,406	396,648	374,136
1990	485,676	456,030	450,576	437,472	415,128	396,328	426,475	440,125	427,525	403,200
1991	487,032	457,128	453,600	440,475	416,075	401,100	426,792	442,442	429,884	405,496
1992	535,675	502,950	496,316	483,938	459,186	440,622	470,421	485,352	471,366	444,528
1993	526,344	494,130	488,754	474,579	450,387	432,054	463,147	477,922	464,132	437,734
1994	549,612	515,970	512,397	497,425	472,012	452,903	484,620	499,995	485,645	458,175
1995	555,540	521,656	517,215	502,250	476,420	457,150	488,409	503,958	489,474	461,764

Reserve as of Quarter*

Report Year	63	66	69	72	75	78	81	84	87	90
1986	8,587,597	7,914,061	7,288,653	6,701,133	6,121,918	5,581,140	5,069,489	4,582,842	4,110,330	3,669,558
1987	7,032,016	6,511,057	6,020,287	5,550,132	5,087,142	4,656,168	4,259,004	3,884,472	3,510,216	3,147,624
1988	8,787,690	8,052,150	7,369,740	6,735,216	6,118,896	5,581,904	5,049,552	4,563,552	4,101,552	3,676,302
1989	9,569,084	8,788,152	8,077,800	7,403,160	6,753,210	6,146,010	5,567,010	5,026,260	4,511,928	4,037,220
1990	10,879,298	9,839,199	8,864,949	7,972,599	7,198,683	6,558,615	5,960,199	5,395,479	4,850,511	4,340,535
1991	10,352,534	9,490,846	8,691,290	7,942,802	7,232,432	6,589,778	5,988,920	5,421,920	4,875,416	4,364,024
1992	11,359,703	10,414,757	9,537,689	8,716,673	7,938,665	7,234,913	6,578,857	5,955,929	5,354,804	4,792,354
1993	11,157,730	10,232,050	9,373,066	8,568,850	7,803,225	7,110,750	6,463,250	5,852,325	5,261,735	4,709,183
1994	11,675,473	10,705,798	9,805,948	8,963,496	8,162,880	7,438,702	6,761,480	6,122,478	5,505,771	4,926,754
1995	11,777,596	10,799,530	9,891,896	9,042,138	8,235,675	7,506,324	6,824,223	6,180,678	5,557,173	4,973,856

Report Year	93	96	99	102	105	108	111	114	117	120
1986	3,249,900	2,853,564	2,461,020	2,077,548	1,713,372	1,358,700	999,450	653,700	317,400	0
1987	2,800,672	2,473,272	2,153,022	1,851,222	1,565,322	1,298,672	968,572	646,152	313,560	0
1988	3,272,352	2,896,902	2,519,226	2,144,826	1,789,458	1,448,442	1,084,428	708,912	344,088	0
1989	3,585,132	3,160,656	2,740,752	2,332,998	1,946,142	1,575,000	1,179,192	770,784	374,136	0
1990	3,854,859	3,398,829	2,948,253	2,510,781	2,095,653	1,697,325	1,270,850	830,725	403,200	0
1991	3,876,992	3,419,864	2,966,264	2,525,789	2,107,714	1,706,614	1,277,622	835,380	405,496	0
1992	4,256,679	3,753,729	3,255,413	2,771,475	2,312,289	1,871,667	1,401,246	915,894	444,528	0
1993	4,182,839	3,688,709	3,199,955	2,725,376	2,274,989	1,842,935	1,379,788	901,866	437,734	0
1994	4,379,142	3,863,172	3,350,775	2,853,350	2,381,338	1,928,435	1,443,815	943,820	458,175	0
1995	4,418,316	3,898,660	3,379,445	2,877,195	2,400,775	1,943,625	1,455,216	951,258	461,764	0

**Note:* This reserve calculated in this example only covers claim expenses through the first ten years.*

Calculation of "Tail" Reserve

The tail reserve would be calculated as the number of claims open after ten years times the outstanding expense per year times the number of years the claim is expected to remain open. In this example, we assume claims open after ten years will remain open, on average, for an additional 25 years. Note that the resulting tail reserve is very sensitive to the number of years used.

For example, for report year 1986:

$$\text{"Tail" Reserve}^{*} = 2{,}038 \times 4 \times \$150 \times \{1.04 + 1.04^2 + \ldots + 1.04^{25}\}$$

$$= \$52{,}961{,}547.$$

As discussed in the paper, the "tail" or tabular claims incur roughly one-third the expense of a newer claim. Then the "tail" reserve for report year 1986 would be $17,653,849. Similarly, the "tail" reserve for other report years may be calculated.

**It will be helpful to recall the formula for the sum of a geometric series:*

$$1 + q + q^2 + \ldots + q^n = (1 - q^{n+1}) / (1 - q).$$

Workers Compensation Lost Time Claims

Exhibit 6

Report Year	Estimated Quarterly Expense after 10 Years	Inflationary Factor for 25 Years	Projected Number of Claims Open after 10 Years	Estimated "Tail" Reserve*
	(1)	(2)	(3)	(4)
1986	50	43.3117	2,038	$17,653,849
1987	52	43.3117	1,937	17,450,111
1988	54	43.3117	2,047	19,150,355
1989	56	43.3117	2,146	20,820,107
1990	58	43.3117	2,221	22,445,567
1991	61	43.3117	2,147	22,565,627
1992	63	43.3117	2,267	24,743,281
1993	66	43.3117	2,142	24,368,548
1994	68	43.3117	2,154	25,500,196
1995	71	43.3117	2,089	25,695,792

Notes:

(1) The estimated claim expense per quarter is one-third of the expense of handling newer claims.

(2) 43.3117 = 1.04 + (1.04 ^ 2) + . . . + (1.04 ^ 25).

(3) From Exhibit 2, Page 2.

(4) (1) x (2) x (3) x 4.

Workers Compensation Lost Time Claims

Exhibit 7
Page 1

Incremental Cost Per Quarter

Report Year	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	942,795	2,447,970	3,444,420	4,389,945	4,741,282	3,992,125	3,333,329	2,861,250	2,559,111	2,192,426	1,899,756	1,680,649	1,587,868	1,411,516	1,268,382	1,147,432	1,086,213	981,663	868,535	771,825
1987	987,213	2,567,495	3,560,049	4,448,835	4,429,600	3,386,384	2,795,281	2,368,367	2,117,392	1,829,354	1,579,430	1,375,526	1,241,193	1,079,940	956,448	834,432	775,298	700,160	634,240	585,856
1988	1,049,205	2,746,239	3,893,528	4,837,643	4,845,870	3,827,094	3,217,270	2,759,430	2,461,230	2,094,444	1,815,460	1,591,620	1,487,360	1,353,344	1,230,080	1,117,824	1,049,370	953,344	880,194	819,014
1989	1,134,570	3,080,154	4,278,916	5,275,426	5,361,324	4,204,509	3,509,805	2,974,755	2,682,240	2,342,144	2,074,240	1,865,344	1,715,035	1,514,205	1,368,969	1,241,289	1,165,824	1,070,880	985,320	906,660
1990	1,215,732	3,447,075	4,731,072	5,645,577	5,810,048	4,669,184	3,971,328	3,461,120	3,180,961	2,774,380	2,456,510	2,219,637	2,054,820	1,868,244	1,722,240	1,570,854	1,491,552	1,371,744	1,267,776	1,173,744
1991	1,208,192	3,357,824	4,742,912	5,774,848	5,925,815	4,803,295	4,069,135	3,523,835	3,204,360	2,838,660	2,541,684	2,283,210	2,151,072	1,953,360	1,759,680	1,600,560	1,521,000	1,400,250	1,292,250	1,159,200
1992	1,343,566	3,753,526	5,261,214	6,371,498	6,685,824	5,611,080	4,798,674	4,176,294	3,842,352	3,401,280	3,029,040	2,730,672	2,541,000	2,266,200	2,046,750	1,808,250	1,568,892	1,325,532	1,211,496	1,107,132
1993	1,327,836	3,622,638	5,100,066	6,215,658	6,270,768	4,970,016	4,184,640	3,608,064	3,310,350	2,974,050	2,677,500	2,353,950	2,137,512	1,906,944	1,723,956	1,551,888	1,440,666	1,300,212	1,188,432	1,086,048
1994	1,377,072	3,816,864	5,333,472	6,493,680	6,592,350	5,476,500	4,925,250	4,291,200	3,717,168	3,066,648	2,706,288	2,408,172	2,221,668	1,991,466	1,800,468	1,620,648	1,502,592	1,356,096	1,239,336	1,132,656
1995	1,384,200	3,832,950	5,417,850	6,655,650	6,772,740	5,411,952	4,589,988	3,955,224	3,558,330	3,088,654	2,725,974	2,425,626	2,234,736	2,003,064	1,810,872	1,630,104	1,518,125	1,370,075	1,252,125	1,144,150

***Example:** For RY 1995, expenses in the fourth quarter = $6,655,650 = 44,371 x 150.*

Reserve as of Quarter

Report Year	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1986	69,615,509	67,167,539	63,723,119	59,333,174	54,591,892	50,599,767	47,266,438	44,405,188	41,846,077	39,653,651	37,753,895	36,073,246	34,505,380	33,093,864	31,625,482	30,678,050	29,591,837	28,610,174	27,743,639	26,971,814
1987	62,312,391	59,744,896	56,184,847	51,736,012	47,306,412	43,920,028	41,124,747	38,756,380	36,638,988	34,809,634	33,230,204	31,854,678	30,613,485	29,533,545	28,577,097	27,742,665	26,967,369	26,267,209	25,632,969	25,047,113
1988	71,706,203	68,959,964	65,066,436	60,228,793	55,383,123	51,558,029	48,338,759	45,579,329	43,118,099	41,023,655	39,208,175	37,616,555	36,129,195	34,775,851	33,545,771	32,427,947	31,378,577	30,425,233	29,545,039	28,726,025
1989	78,878,850	75,798,696	71,519,780	66,244,354	60,883,030	56,678,521	53,168,716	50,193,961	47,511,721	45,169,577	43,095,337	41,229,993	39,514,958	38,000,753	36,631,784	35,390,495	34,224,671	33,153,791	32,168,471	31,261,611
1990	89,333,232	85,886,157	81,155,065	75,509,508	69,699,460	65,030,276	61,058,948	57,597,828	54,416,867	51,642,487	49,185,977	46,966,340	44,911,520	43,043,276	41,321,036	39,750,182	38,258,630	36,886,886	35,619,110	34,445,366
1991	89,835,111	86,477,287	81,734,375	75,959,527	70,033,712	65,230,417	61,161,282	57,637,447	54,433,087	51,594,427	49,052,743	46,769,533	44,618,461	42,665,101	40,905,421	39,304,861	37,783,861	36,383,611	35,091,361	33,932,161
1992	100,680,054	96,926,528	91,665,314	85,293,816	78,607,992	72,996,912	68,186,238	64,021,944	60,179,592	56,778,312	53,749,272	51,018,600	48,477,600	46,211,400	44,164,650	42,356,400	40,787,508	39,461,976	38,250,480	37,143,348
1993	94,168,892	90,546,254	85,446,188	79,230,530	72,959,762	67,989,746	63,805,106	60,197,042	56,886,692	53,912,642	51,235,142	48,881,192	46,743,680	44,836,736	43,112,780	41,560,892	40,120,226	38,820,014	37,631,582	36,545,534
1994	99,935,866	96,119,002	90,785,530	84,291,850	77,699,500	72,223,000	67,297,750	63,006,550	59,289,382	56,222,734	53,516,446	51,108,274	48,886,606	46,895,140	45,094,672	43,474,024	41,971,432	40,615,336	39,376,000	38,243,344
1995	99,948,673	96,115,723	90,697,873	84,042,223	77,269,483	71,857,531	67,267,543	63,312,319	59,753,989	56,665,135	53,939,161	51,513,535	49,278,799	47,275,735	45,464,863	43,834,759	42,316,634	40,946,559	39,694,434	38,550,264

***Example:** For RY 1995, the reserve as of 36 months = $51,513,535 = $2,234,736 + $2,003,064 + $1,810,872 + . . .*

Workers Compensation Lost Time Claims

Exhibit 7
Page 2

Cost Per Quarter

Report Year	63	66	69	72	75	78	81	84	87	90
1986	730,368	673,536	625,408	587,520	579,215	540,778	511,651	486,647	472,512	440,772
1987	564,984	520,961	490,770	470,155	462,990	430,974	397,164	374,532	374,256	362,592
1988	787,960	735,540	682,410	634,524	616,320	556,992	512,352	486,000	462,000	425,250
1989	872,640	780,912	710,352	674,640	649,950	607,200	579,000	540,750	514,332	474,706
1990	1,120,500	1,040,100	974,250	892,350	773,916	640,068	598,416	564,720	544,968	509,976
1991	1,014,000	861,588	799,656	748,488	710,370	642,654	600,858	567,000	546,504	511,392
1992	1,040,364	944,946	877,068	821,016	778,008	703,752	658,056	620,928	601,125	562,450
1993	1,019,256	925,680	858,984	804,216	765,625	692,475	647,500	610,925	590,590	552,552
1994	1,067,675	969,675	899,850	842,450	800,618	724,178	677,222	639,002	616,707	577,017
1995	1,076,894	978,068	907,634	849,758	806,463	729,351	682,101	643,545	623,505	583,317

Report Year	93	96	99	102	105	108	111	114	117	120	"Tail" Reserve
1986	419,658	396,336	392,544	383,472	364,176	354,672	359,250	345,750	336,300	317,400	17,653,849
1987	346,752	327,600	320,250	301,800	285,900	268,650	306,100	342,420	332,592	313,560	17,450,111
1988	403,950	375,450	377,676	374,400	355,368	341,016	364,014	375,516	364,824	344,088	19,150,355
1989	452,066	424,476	419,904	407,754	386,856	371,142	395,806	406,406	396,648	374,136	20,820,107
1990	485,676	456,030	450,576	437,472	415,128	398,328	426,475	440,125	427,525	403,200	22,445,567
1991	487,032	457,128	453,600	440,475	418,075	401,100	428,792	442,442	429,884	405,496	22,565,627
1992	535,675	502,950	498,316	483,938	459,186	440,622	470,421	485,352	471,366	444,528	24,743,281
1993	526,344	494,130	488,754	474,579	450,387	432,054	463,147	477,922	464,132	437,734	24,368,548
1994	549,612	515,970	512,397	497,425	472,012	452,903	484,620	499,995	485,645	458,175	25,500,196
1995	555,540	521,656	517,215	502,250	476,420	457,150	488,409	503,958	489,474	461,784	25,895,792

Reserve as of Quarter

Report Year	63	66	69	72	75	78	81	84	87	90
1986	26,241,446	25,567,910	24,942,502	24,354,982	23,775,767	23,234,969	22,723,338	22,236,691	21,764,179	21,323,407
1987	24,482,129	23,961,168	23,470,398	23,000,243	22,537,253	22,106,279	21,709,115	21,334,583	20,960,327	20,597,735
1988	27,938,045	27,202,505	26,520,095	25,885,571	25,269,251	24,712,259	24,199,907	23,713,907	23,251,907	22,826,657
1989	30,389,171	29,608,259	28,897,907	28,223,267	27,573,317	26,966,117	26,387,117	25,846,367	25,332,035	24,857,327
1990	33,324,866	32,284,766	31,310,516	30,418,166	29,644,250	29,004,182	28,405,766	27,841,046	27,296,078	26,786,102
1991	32,918,161	32,056,573	31,256,917	30,508,429	29,798,059	29,155,405	28,554,547	27,987,547	27,441,043	26,929,651
1992	36,102,984	35,158,038	34,280,970	33,459,954	32,681,946	31,978,194	31,320,138	30,699,210	30,098,085	29,535,635
1993	35,526,278	34,600,598	33,741,614	32,937,398	32,171,773	31,479,298	30,831,798	30,220,873	29,630,283	29,077,731
1994	37,175,669	36,205,994	35,306,144	34,463,694	33,663,076	32,938,898	32,261,676	31,622,674	31,005,967	30,428,950
1995	37,473,390	36,495,322	35,587,688	34,737,930	33,931,467	33,202,116	32,520,015	31,876,470	31,252,965	30,669,648

Report Year	93	96	99	102	105	108	111	114	117	120
1986	20,903,749	20,507,413	20,114,869	19,731,397	19,367,221	19,012,549	18,653,299	18,307,549	17,971,249	17,653,849
1987	20,250,863	19,923,383	19,603,133	19,301,333	19,015,433	18,746,783	18,438,683	18,096,263	17,763,671	17,450,111
1988	22,422,707	22,047,257	21,669,581	21,295,181	20,939,813	20,598,797	20,234,783	19,859,267	19,494,443	19,150,355
1989	24,405,239	23,980,763	23,560,859	23,153,105	22,766,249	22,395,107	21,999,299	21,590,891	21,194,243	20,820,107
1990	26,300,426	25,844,396	25,393,820	24,956,348	24,541,220	24,142,892	23,716,417	23,276,292	22,848,767	22,445,567
1991	26,442,619	25,965,491	25,531,891	25,091,416	24,673,341	24,272,241	23,843,449	23,401,007	22,971,123	22,565,627
1992	28,999,960	28,497,010	27,998,694	27,514,756	27,055,570	26,614,948	26,144,527	25,659,175	25,187,809	24,743,281
1993	28,651,387	28,057,257	27,568,503	27,093,924	26,643,537	26,211,483	25,748,336	25,270,414	24,806,262	24,368,548
1994	29,879,338	29,363,368	28,850,971	28,353,546	27,881,534	27,428,631	26,944,011	26,444,016	25,956,371	25,500,196
1995	30,114,108	29,592,452	29,075,237	28,572,987	28,096,567	27,639,417	27,151,008	26,647,050	26,157,576	25,895,792

Workers Compensation Medical Reserving with Calendar Year Payments in a Cost Containment Environment

by Jeffery J. Scott, FCAS

WORKERS COMPENSATION MEDICAL RESERVING WITH CALENDAR YEAR PAYMENTS IN A COST CONTAINMENT ENVIRONMENT

JEFFERY J. SCOTT

Abstract

One of the new challenges facing the workers compensation reserving actuary is the incorporation of cost containment measures into the reserving process. The drastic reduction in medical payments due to these measures distorts historical development patterns and makes the prediction of future development patterns increasingly uncertain. Cost containment programs can affect all medical payments uniformly, or, more likely, affect different types of medical payments by varying degrees.

This paper uses actual medical payment data from the Ohio State Insurance Fund to illustrate the potential effects of cost containment measures on medical reserves. This paper explains three reserving methods based on medical payments, and examines the effects of medical inflation and cost containment initiatives on each method. The concept of the persistency of medical payments is explained and the stability of the historical persistency factors is used to illustrate the differences in the methods. Data by medical provider type is shown in the appendix as an example of the type of segregation possible in order to better reflect specific cost containment measures. The data groupings can also be used in reserving to capture specific development patterns inherent in the particular type of medical service.

Overview

One of the new challenges facing the workers compensation reserving actuary is the incorporation of cost containment measures into the reserving process. The drastic reduction in medical payments due to these measures distorts historical development patterns and makes the prediction of future development patterns increasingly uncertain. Cost containment programs can affect all medical payments uniformly, or, more likely, affect different types of medical payments by varying degrees.

This paper uses the experience of the Ohio State Insurance Fund (OSIF), a large monopolistic state insurance fund for workers' compensation. During 1993 and 1994, OSIF initiated substantial changes in the area of medical cost containment, such as use of fee schedules, utilization reviews, and independent medical exams. Consequently, the 1993 and 1994 calendar year payments were substantially lower than the recent history. The traditional accident year loss reserve projection method based on medical payment data produced highly volatile factors because the accident year development patterns were disrupted for the latest two "diagonals".

Additional issues can arise in projecting medical reserves because medical cost containment efforts can affect each type of health care provider differently. Inflation rates and utilization rates, which differ by provider type, can significantly affect the future value of payments. By separating medical payments by provider type, a reserve based on the unique characteristics of each provider type can be obtained. Because a significant amount of historical data separated by provider type may not be readily available, the use of the calendar year method can provide a reserving approach using only two or three years of available data. It is also possible to use just the latest 12 months of calendar year payments with this method.

The most common method for estimating reserves using payments is the cumulative paid loss development method. This method uses cumulative accident year payments to calculate link ratios which are subsequently used to project future payments using the cumulative accident year payments as a base. This paper presents an alternative reserving method using relationships (persistencies) of incremental payments.

Persistency of Medical Payments

In workers' compensation insurance, it is often useful to analyze medical payments as a function of the current open claims, or prior year medical payments. The worker receiving medical care, especially after several years, is likely to continue to receive these treatments until he or she is fully recovered or dies. Examples of treatments which can be the same from year to year are the administration of pharmaceutical drug products and chiropractic treatments. For example, a prescription drug may be taken daily or the injured worker may make 20 visits to a chiropractor each year. As workers recover and payments decrease, a persistency of remaining payments can be observed. For example, if medical payments made on behalf of workers injured in 1990 totaled $100,000 in 1993 and $75,000 in 1994, a persistency factor of 0.75 ($75,000/$100,000) could be calculated for 1993 to 1994. Persistency can be affected by factors such as medical recovery rates, inflation, mortality, alternative treatments and procedures, and utilization rates. While payments to hospitals and physicians may exhibit one level of persistency, payments for pharmaceutical drugs or chiropractic treatments may well exhibit another level.

In recent years cost containment procedures have resulted in changes to historical persistency patterns. For example, a current hospital room charge may be limited through use of fee schedules to a maximum daily rate, which may be 20% lower than the prior year's room rate. A reserving method that has measured historical accident year persistency now produces distinctly lower persistency factors along the latest calendar year of development. An adjustment to account for these types of changes must also be incorporated into the accident year methods of calculating persistency to produce more stable and reliable persistency factors. Alternatively, a calendar year measure of persistency can be used that will eliminate the need for historical cost containment adjustments.

Accident Year Persistency Methods

The accident year persistency method uses incremental payments, by accident year, to calculate persistency rates from one period to the next. To eliminate the effects of inflation, the payments can be indexed to the medical component of the Consumer Price Index (CPI) or another appropriate index. For example, the triangles of medical payments in Table 1 show actual incremental payments and incremental payments that have been indexed for inflation using the historical medical CPI. For accident year 1990, the incremental payments made in 1993 were $47,359 (000). The medical CPI index for calendar year 1993 is 1.231 (the 1990 year index has been set equal to 1.000), producing the indexed payments totaling $38,472 ($47,359/1.231).

Table 1

Paid Incremental Losses ($000's)

Accident	Development Years								
Year	1	2	3	4	5	6	7	8	9
1986	54,027	87,239	36,212	26,154	22,125	23,037	22,262	19,057	13,951
1987	62,096	96,999	42,273	29,222	28,732	27,572	23,598	15,530	
1988	70,513	111,540	50,937	40,426	36,160	29,571	19,545		
1989	71,089	120,905	65,178	49,746	37,333	24,490			
1990	57,089	139,120	80,727	47,359	28,940				
1991	77,548	144,437	68,247	35,728					
1992	97,834	149,762	54,759						
1993	100,450	122,436							
1994	83,387								

Medical CPI (1990=1.0)

Accident Year	Development Years 1	2	3	4	5	6	7	8	9
1986	0.749	0.799	0.851	0.917	1.000	1.087	1.168	1.231	1.296
1987	0.799	0.851	0.917	1.000	1.087	1.168	1.231	1.296	
1988	0.851	0.917	1.000	1.087	1.168	1.231	1.296		
1989	0.917	1.000	1.087	1.168	1.231	1.296			
1990	1.000	1.087	1.168	1.231	1.296				
1991	1.087	1.168	1.231	1.296					
1992	1.168	1.231	1.296						
1993	1.231	1.296							
1994	1.296								

Indexed Medical Payments *

Accident Year	Development Years 1	2	3	4	5	6	7	8	9
1986	72,132	109,185	42,552	28,521	22,125	21,193	19,060	15,481	10,765
1987	77,717	113,982	46,099	29,222	26,432	23,606	19,170	11,983	
1988	82,859	121,636	50,937	37,190	30,959	24,022	15,081		
1989	77,523	120,905	59,901	42,591	30,327	18,897			
1990	57,089	127,985	69,116	38,472	22,330				
1991	71,341	123,662	55,440	27,568					
1992	83,762	121,659	42,252						
1993	81,600	94,472							
1994	64,342								

* Indexed medical payments are calculated by dividing the payment triangle by the CPI index triangle.

The calendar year 1993 non-indexed payments for accident year 1990 of $47,359 can be compared to the non-indexed payments from calendar year 1992 for accident year 1990 of $80,727. The resulting persistency factor is the quotient of these two numbers, or 0.587 ($47,359/$80,727). Similarly, the calculation can be performed with indexed payments, producing a persistency factor of 0.557 ($38,472/$69,116). The non-indexed factor is higher, reflecting the inflation in the persistency factor. Table 2 contains the resulting persistency factors.

Table 2

Persistency Factors of Non-Indexed Payments

Accident Year	Age-to-Age Development Factors 1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
1986	1.615	0.415	0.722	0.846	1.041	0.966	0.856	0.732
1987	1.562	0.436	0.691	0.983	0.960	0.856	0.658	
1988	1.582	0.457	0.794	0.894	0.818	0.661		
1989	1.701	0.539	0.763	0.750	0.656			
1990	2.437	0.580	0.587	0.611				
1991	1.863	0.473	0.524					
1992	1.531	0.366						
1993	1.219							
1994								
3 Yr Avg	1.537	0.473	0.624	0.752	0.811	0.828	N/A	N/A
All Yr Avg	1.689	0.466	0.680	0.817	0.869	0.828	0.757	0.732

Persistency Factors of Indexed Payments

Accident Year	Age-to-Age Development Factors 1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
1986	1.514	0.390	0.670	0.776	0.958	0.899	0.812	0.695
1987	1.467	0.404	0.634	0.905	0.893	0.812	0.625	
1988	1.468	0.419	0.730	0.832	0.776	0.628		
1989	1.560	0.496	0.710	0.712	0.623			
1990	2.242	0.540	0.557	0.580				
1991	1.733	0.448	0.497					
1992	1.452	0.347						
1993	1.158							
1994								
3 Yr Avg	1.448	0.445	0.588	0.708	0.764	0.780	N/A	N/A
All Yr Avg	1.574	0.435	0.633	0.761	0.812	0.780	0.719	0.695

From these age to age persistency factors, averages can be calculated to predict future payments. For example, the 1995 expected payments for accident year 1990 could be calculated by multiplying the three year average non-indexed persistency factor for the period of development from 5 to 6 years (0.811) by the 1994 payments ($28,940) for accident year 1990. This produces expected payments of $23,470, as shown in Table 3.

Table 3

Projection of Future Payments - Accident Year Persistency Method - Non-Indexed Payments ($000s)

Accident Year	Development Years 1	2	3	4	5	6	7
1987							
1988							
1989							20,278
1990						23,470*	19,433**
1991					26,867	21,790	18,042
1992				34,170	25,696	20,839	17,255
1993			57,912	36,137	27,175	22,039	18,248
1994		128,166	60,622	37,828	28,447	23,070	19,102

* 23,470 = 0.811 x 28,940

With the indexed payment method, the non-indexed payments of $28,940 are multiplied by the indexed three year average persistency factor of 0.764 to calculate payments before inflation of $22,110. This must be adjusted to the 1995 cost level, requiring an assumption of medical cost inflation. If the medical inflation is expected to be 5% for 1995, the projected 1995 payments would be $23,216 (1.05 X $22,110).

Table 4

Projection of Future Payments - Accident Year Persistency Method - Indexed Payments ($000s)

Accident	Development Years						
Year	1	2	3	4	5	6	7
1987							
1988							
1989							20,057
1990						23,216*	19,014**
1991					26,560	21,307	17,450
1992				33,808	25,133	20,162	16,512
1993			57,208	35,320	26,257	21,063	17,251
1994		126,782	59,239	36,574	27,189	21,811	17,863

* 23,216 = 28,940 x 0.764 x 1.05

The two accident year methods described above are influenced considerably by the annual rate of medical inflation and changes in utilization. In the indexed method, the wide range of historical inflation is reflected by adjusting payments using the medical component of the CPI; however, changes in utilization are difficult to quantify. Because of the historical adjustment for inflation, a future projection of medical inflation is required. In the method without indexing, large annual changes in rates of inflation would impact the magnitude of the persistency development factors. The future impact of inflation is assumed to be consistent with the rate of inflation inherent in the historical average persistency factors.

Calendar Year Persistency Method

This method compares persistency of calendar year payments from different accident years. The level of payments from one accident year is compared to the level of payments from an accident year one year further developed, but during the same calendar year. Because this involves comparing payments from different accident years, an adjustment to bring each accident year to a common exposure basis is necessary so that a valid comparison between the accident years can be made. This example uses ultimate lost time claim counts as the basis for adjusting each accident year to a common base, reflecting the average medical payment per injured worker.

For the 1990 accident year, the projected number of ultimate lost time claims is 50,666, producing a payment per injured worker of $935 ($47,359/50,666 X 1,000) for calendar year 1993. The age of development for this accident year at the end of 1993 is four years. This payment can be compared to the average calendar year 1993 payment for the accident year at five years of development (accident year 1989) of $726. The payments are at the same cost level, just one year apart in development.

Table 5

Average Payment per Injured Worker

Accident Year	Development Years 1	2	3	4	5	6	7	8	9	10	Ultimate Lost Time Claim Counts
1985	1,254	1,750	768	578	489	456	476	467	405	298	43,826
1986	1,211	1,956	812	586	496	517	499	427	313		44,601
1987	1,314	2,053	895	618	608	584	499	329			47,251
1988	1,393	2,204	1,007	799	715	584	386				50,605
1989	1,385	2,553	1,268	968	726	477					51,393
1990	1,127	2,746	1,595	935	571						50,666
1991	1,646	3,065	1,448	758							47,119
1992	2,135	3,268	1,195								45,822
1993	2,185	2,663									45,969
1994	1,847										45,155

The relationship, or persistency, between the fourth and fifth years of development for calendar year 1993 is 0.776 ($726/$935). By calculating similar fourth to fifth year persistency factors, an average persistency factor for this development period can be used to project future payments. The calculated calendar year persistency factors are shown in Table 6.

Table 6

Calendar Year Persistency Factors

Accident Year	Age-to-Age Development Factors 1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
1986	1.445	0.393	0.712	0.833	0.879	0.925	0.936	0.949	0.952
1987	1.489	0.396	0.655	0.803	0.850	0.854	0.856	0.951	
1988	1.474	0.400	0.614	0.761	0.817	0.854	0.852		
1989	1.594	0.428	0.630	0.739	0.804	0.809			
1990	2.088	0.462	0.608	0.776	0.835				
1991	1.668	0.520	0.646	0.753					
1992	1.436	0.443	0.634						
1993	1.496	0.449							
1994	1.442								
3 Yr Avg	1.458	0.471	0.629	0.756	0.819	0.839	0.881	N/A	N/A

Along with the selected persistency factor, an assumption of future medical inflation is required because the historical calendar year persistencies are multiplied by a prior calendar year average payment. The calendar year relationship of the historical factors does not consider the relationship between the current calendar year and the projected future calendar year. If the inflation assumption for the upcoming year is 5%, the estimated payments for accident year 1990 in 1995 are the product of the average persistency factor (0.837), the 1994 average payment per injured worker ($571), the number of injured workers (50,666), and one plus the estimated inflation percentage (1.05) for 1995. This produces expected payments of $25,425 (000). An additional factor could be included to reflect the calendar year effect of future cost containment measures.

Table 7

Projection of Future Payments - Calendar Year Persistency Method ($000s) *

Accident Year	Development Years 1	2	3	4	5	6	7
1987							
1988							
1989							22,162
1990						25,425**	22,986
1991					29,177	25,642	23,181
1992				36,969	30,200	26,542	23,995
1993			56,170	37,923	30,980	27,226	24,614
1994		137,481	63,083	42,591	34,792	30,577	27,643

* Payments calculated using 5% annual medical inflation and all years average persistency factor.

Stability of Development Factors

When inflation is changing little from year to year, all three methods should produce reasonably stable development factors. Abrupt changes in cost levels, however, can have a significant impact on the development factors of the first two persistency methods. Because the third method computes factors using payments from the same calendar year at the same cost level, the variability due to inflation or other adjustments to cost levels is significantly reduced.

The OSIF data reflects recent cost containment initiatives such as the use of fee schedules, utilization reviews, and independent medical exams. When these measures are implemented across the board, medical payments for all accident years are reduced. This was particularly true for calendar years 1993 and 1994. A decidedly downward trend in the traditional accident year development persistency factors illustrates the improvements in payments. The drop is pronounced in the 1993 and 1994 diagonals.

The variability in the resulting persistency factors can be measured by the coefficient of variation (CV) of the historical persistency factors at each age of development. The CV is calculated as the standard deviation of the persistency factors divided by the mean of those factors. Exhibit 1 shows the resulting CVs of each method for each age to age development period. For the persistency factors calculated using all medical payments combined, the CVs are highest for the non-indexed accident year method, slightly lower for the indexed accident year method, and substantially lower for the calendar year persistency method. An improvement in the indexed accident year method may be obtained by changing the index for each year from the medical CPI to an index that better reflects the cost containment measures implemented for the last two years. Because of the limited amount of data available by provider type, the CVs for the accident year method are calculated using three observations and the CVs for the calendar year method shown in the appendix are calculated using both the last three and all four observations.

The reduction in variability with the calendar year persistency method disappears after approximately 15 years. As there are fewer active claimants, and differing types of injuries between accident years for these active claimants, the comparison of different accident year claimants results in persistency factors that are probably not as useful. This illustrates a potential problem with the calendar year persistency method.

Analysis by Medical Provider

Because cost containment issues can affect different types of medical services by varying magnitudes, there may be a benefit in analyzing the medical data by type of provider. In this analysis, the data is separated into six components by provider type. The separations are hospital, physician, pharmaceutical, chiropractor, rehabilitation, and all other. Examples of cost containment measures that would affect providers differently would be utilization reviews of the number of chiropractic treatments per injured worker and fee schedules that limit daily costs for hospital rooms, x-rays, specific procedures, etc.

In the provider type comparison, note that data for only four calendar years were available. However, the use of the calendar year persistency method allows immediate use of the data by provider type for reserve projections. The treatment of varying future inflation rates by provider type can also be incorporated into the analysis.

Conclusions

In this data sample, the effects of cost containment are observed as a reduction in medical payments during the 1993 and 1994 calendar years. The accident year persistency methods require judgmental decisions on the selection of persistency factors, as a downward trend is observed. With the calendar year persistency method, the factors remain more stable, so that judgment can be reduced.

The estimation of future inflation and cost containment measures are required in both the accident year indexed and calendar year persistency methods. This allows for the opportunity to establish reserves based on various scenarios of future inflation and cost containment initiatives.

One by-product of the calendar year method is the addition of an extra diagonal of persistency factors, as compared to accident year methods. It should also be noted that the reserve analysis could be completed using only one year of payments. During the early years of construction of the database (at a more detailed level by provider type), some benefit can be derived even from the first year of payment classification.

In addition to the inexact comparison of claimants from different accident years, another potential problem with the calendar year persistency method arises when changes in closing rates cause a distortion in the persistency factors. A speedup in the rate will cause an increase in the persistency factors, which will lead to an overstatement of reserves. One must balance these factors with the distortions due to cost containment procedures to determine the appropriate method for estimating reserves. In the data presented in this analysis, a slight adjustment was incorporated into the payment data to account for backlogs in the processing of medical payments.

Continued observation of medical payments by provider type should provide additional insight into persistency patterns and trend assumptions. As different areas of the medical system undergo reform and economic development, the ability to reflect these changes and incorporate them into the process should make reserving more accurate and responsive for medical payments.

Comparison of CV % of Persistency Factors

Age	Total Medical Payments CV% of Persistency Factors			Hospital Payments CV% of Persistency Factors			Physician Payments CV% of Persistency Factors			Pharmacy Payments CV% of Persistency Factors		
	Non-Index	Index	Cal. Yr.	Non-Index	Index	Cal. Yr.	Non-Index	Index	Cal. Yr.	Non-Index	Index	Cal. Yr.
1	26.7%	26.0%	23.0%	35.6%	34.5%	13.4%	8.8%	8.3%	5.5%	21.9%	20.7%	10.5%
2	14.4%	13.4%	12.4%	41.0%	39.8%	17.1%	10.8%	10.0%	7.0%	11.8%	10.6%	6.8%
3	10.7%	10.8%	5.3%	32.4%	31.2%	7.2%	14.3%	13.3%	3.5%	12.0%	10.9%	5.2%
4	11.1%	10.4%	4.6%	33.1%	32.1%	2.0%	16.6%	15.6%	5.1%	11.7%	10.5%	5.2%
5	10.6%	10.6%	4.2%	32.4%	31.4%	1.4%	12.0%	11.1%	2.3%	12.0%	10.8%	3.0%
6	11.7%	11.0%	5.9%	35.5%	34.6%	9.2%	13.1%	12.4%	3.3%	12.3%	11.3%	6.2%
7	12.2%	11.2%	6.3%	37.6%	36.8%	11.3%	13.2%	12.6%	5.7%	10.4%	9.3%	7.1%
8	10.4%	10.4%	6.3%	31.6%	30.5%	14.6%	19.6%	18.6%	3.7%	7.4%	6.4%	6.5%
9	11.7%	10.9%	5.4%	38.8%	37.7%	13.3%	13.3%	12.2%	2.5%	7.4%	6.3%	2.7%
10	11.3%	11.2%	4.1%	40.0%	39.2%	17.9%	16.7%	15.9%	5.9%	8.2%	7.1%	3.4%
11	11.4%	11.1%	8.7%	30.2%	29.1%	24.3%	10.6%	10.1%	6.5%	8.9%	7.8%	2.1%
12	13.7%	10.5%	7.3%	33.2%	32.4%	10.0%	14.9%	14.4%	4.8%	6.2%	5.1%	1.8%
13	9.9%	10.0%	8.2%	25.8%	25.0%	12.0%	9.1%	8.9%	5.9%	8.0%	6.9%	3.0%
14	12.7%	12.0%	9.2%	46.8%	45.8%	18.8%	15.9%	15.2%	5.1%	4.2%	3.2%	2.8%
15	11.6%	11.0%	10.0%	26.4%	25.2%	17.3%	6.2%	5.8%	5.1%	7.3%	6.2%	3.8%
16	11.4%	11.4%	14.0%	37.5%	36.8%	24.2%	15.6%	14.9%	10.0%	9.6%	8.5%	5.5%
17	10.0%	9.4%	15.5%	31.5%	31.6%	24.9%	5.7%	5.1%	4.9%	7.9%	6.8%	10.5%
18	11.2%	10.5%	14.7%	34.2%	34.2%	17.6%	8.2%	7.8%	9.6%	11.6%	10.6%	20.2%
19	14.0%	13.4%	17.1%	37.6%	36.7%	24.9%	16.7%	15.9%	6.8%	6.5%	5.7%	24.1%
20	12.3%	12.3%	15.1%	21.2%	21.3%	16.5%	13.3%	12.7%	8.8%	5.6%	4.4%	20.6%
21	12.7%	12.4%	16.0%	46.7%	46.6%	19.3%	17.9%	17.2%	8.0%	3.8%	2.7%	17.9%
22	13.3%	12.9%	12.9%	56.4%	55.4%	37.3%	17.4%	16.3%	13.9%	4.3%	3.3%	[illegible]
23	10.5%	9.7%	12.4%	25.7%	24.6%	29.5%	11.6%	10.5%	13.4%	6.4%	5.3%	[illegible]
24	17.1%	17.0%	19.1%	49.6%	48.6%	26.8%	23.1%	22.0%	9.0%	10.7%	9.6%	[illegible]
25	20.8%	20.3%	16.2%	49.6%	49.1%	28.2%	23.8%	22.7%	10.6%	9.1%	7.9%	[illegible]
26	20.5%	19.7%	21.6%	36.0%	35.2%	48.7%	13.2%	12.1%	23.0%	5.6%	4.7%	[illegible]
27	23.5%	22.3%	19.3%	70.0%	68.8%	42.6%	18.4%	17.2%	19.6%	4.8%	3.8%	[illegible]
28	13.5%	12.4%	18.6%	29.9%	28.7%	14.5%	7.5%	7.3%	9.2%	2.8%	2.3%	[illegible]
29	1.0%	0.9%	30.6%	20.8%	20.8%	32.7%	23.1%	23.1%	16.9%	1.2%	1.1%	14.6%

Age	Chiropracter Payments CV% of Persistency Factors			Rehabilitation Payments CV% of Persistency Factors			Other Health Payments CV% of Persistency Factors		
	Non-Index	Index	Cal. Yr.	Non-Index	Index	Cal. Yr.	Non-Index	Index	Cal. Yr.
1	12.0%	11.3%	5.3%	24.4%	23.4%	16.1%	16.6%	15.7%	15.1%
2	18.6%	17.8%	1.6%	25.8%	24.6%	10.9%	21.4%	20.3%	12.5%
3	16.4%	15.5%	2.8%	31.9%	30.7%	13.3%	28.7%	27.5%	9.4%
4	16.2%	15.6%	3.5%	22.5%	21.4%	14.7%	27.4%	26.3%	6.9%
5	15.7%	15.1%	2.2%	35.6%	34.4%	7.4%	22.6%	21.4%	14.1%
6	13.2%	12.8%	3.9%	25.8%	24.6%	6.8%	23.5%	22.3%	21.8%
7	14.6%	13.9%	8.3%	21.6%	20.7%	15.4%	25.3%	24.1%	35.2%
8	14.9%	14.3%	9.2%	34.6%	33.7%	27.4%	16.9%	15.8%	34.0%
9	14.1%	13.7%	8.1%	25.5%	24.2%	26.0%	14.1%	14.7%	63.5%
10	13.0%	12.4%	4.3%	5.4%	6.3%	24.7%	25.7%	24.5%	29.9%
11	13.4%	13.1%	2.3%	32.6%	31.4%	41.0%	20.2%	19.2%	31.1%
12	16.8%	16.1%	8.3%	18.5%	17.6%	35.1%	20.5%	19.6%	28.2%
13	10.6%	10.0%	12.2%	30.2%	30.3%	34.8%	12.4%	11.9%	31.3%
14	16.2%	15.5%	15.3%	26.6%	25.5%	67.8%	13.9%	13.1%	35.7%
15	13.9%	13.5%	12.2%	37.6%	38.2%	61.4%	12.5%	11.4%	30.0%
16	17.0%	16.2%	13.0%	19.2%	18.0%	43.8%	22.1%	20.9%	19.1%
17	18.6%	18.2%	12.6%	35.8%	36.4%	25.3%	17.2%	17.2%	17.9%
18	13.7%	13.0%	19.1%	13.7%	13.2%	34.1%	11.9%	11.9%	25.8%
19	10.0%	9.9%	13.5%	17.9%	17.8%	61.7%	3.3%	3.1%	31.7%
20	21.7%	20.7%	19.3%	29.4%	28.3%	47.6%	19.9%	18.7%	47.7%
21	21.7%	20.6%	15.5%	51.5%	50.9%	56.1%	34.9%	33.9%	35.6%
22	22.0%	21.4%	16.0%	60.9%	61.1%	46.6%	37.0%	36.1%	33.4%
23	2.8%	3.0%	24.3%	56.1%	56.7%	135.2%	22.0%	21.2%	17.8%
24	26.0%	24.9%	38.1%	57.9%	57.9%	92.9%	16.6%	15.4%	25.8%
25	21.1%	19.9%	20.6%	51.5%	50.2%	25.8%	10.2%	9.3%	5.7%
26	17.9%	17.0%	15.3%	111.4%	110.5%	38.5%	57.9%	56.7%	56.5%
27	27.9%	27.0%	13.5%	68.8%	68.0%	43.8%	16.2%	15.5%	68.8%
28	9.2%	8.4%	27.0%	83.0%	81.9%	38.4%	30.4%	29.4%	76.2%
29	8.4%	8.3%	14.7%	39.4%	39.3%	28.0%	70.3%	70.3%	65.5%

* Calendar year CV % are calculated using four observations.

Supplemental Data Used in Reserve Analysis

Calendar Year	Medical CPI*	Accident Year	Ultimate Lost Time Claim Counts **
1964	0.1378	1964	30,261
1965	0.1475	1965	31,415
1966	0.1578	1966	32,699
1967	0.1689	1967	31,412
1968	0.1812	1968	32,188
1969	0.1953	1969	34,485
1970	0.2088	1970	32,058
1971	0.2217	1971	30,846
1972	0.2291	1972	32,660
1973	0.2383	1973	38,477
1974	0.2604	1974	41,369
1975	0.2918	1975	36,717
1976	0.3194	1976	38,471
1977	0.3501	1977	40,003
1978	0.3796	1978	41,904
1979	0.4146	1979	43,875
1980	0.4601	1980	38,614
1981	0.5092	1981	36,551
1982	0.5682	1982	33,049
1983	0.6179	1983	33,605
1984	0.6560	1984	40,423
1985	0.6972	1985	43,826
1986	0.7494	1986	44,601
1987	0.7991	1987	47,251
1988	0.8514	1988	50,605
1989	0.9171	1989	51,393
1990	1.0000	1990	50,666
1991	1.0872	1991	47,119
1992	1.1677	1992	45,822
1993	1.2306	1993	45,969
1994	1.2961	1994	45,153

* Source for 1989-1994 Indices: U.S. Dept. of Labor: Bureau of Labor Statistics, "THE CPI DETAILED REPORT", 1994, Washington, D.C.
Source for 1970-1988 Indices: U.S. Bureau of the Census, Statistical Abstract of the United States 1990, (110th Edition), Washington, D.C. 1990.
** Ultimate Lost Time Claims are estimated

Appendix

The data contained in the appendix shows medical payment experience from 1964 to 1994. The data by provider type was available for years 1991 to 1994. The CVs for the calendar year persistency are shown using all four years of available data, as well as the latest three years. The accident year persistency factors shown in Exhibit 1 are for three years of persistency factors.

The persistency factors by provider type are calculated using all accident year lost time claim counts contained in Exhibit 2. This is a further limitation to a direct comparison of the CVs.

All Medical Payments

Paid Losses (in thousands) - Evaluation in Years

Accident Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1964																1,125
1965															1,131	1,234
1966														1,593	1,588	1,702
1967													1,851	1,745	2,067	2,447
1968												1,873	2,091	2,175	2,483	2,530
1969											2,044	1,988	2,606	2,848	3,18[illegible]	3,119
1970										2,089	2,133	2,234	2,681	2,658	2,741	2,649
1971									2,396	2,408	2,626	3,025	3,097	3,233	3,375	3,446
1972								2,884	2,897	3,333	3,810	4,009	3,753	4,123	4,034	4,082
1973							3,578	3,467	3,820	4,502	5,000	4,292	4,531	4,837	4,953	4,833
1974						4,621	4,575	5,222	5,795	6,060	6,382	6,231	6,245	6,246	6,082	5,921
1975					4,600	4,299	4,869	5,477	5,626	5,936	5,890	6,180	6,031	6,102	6,166	5,108
1976				6,431	5,672	5,747	6,221	6,594	6,788	6,749	6,551	6,941	6,606	6,316	5,142	5,978
1977			9,358	6,535	6,590	6,923	7,152	6,720	7,449	7,277	7,267	7,064	6,734	5,988	6,797	6,356
1978		33,364	11,267	8,866	8,618	8,249	8,125	8,399	8,617	8,459	8,548	7,698	7,698	7,733	[illegible]	6,516
1979	33,623	37,525	14,911	11,596	10,411	10,662	10,481	10,066	10,141	9,907	9,731	8,513	9,372	8,797	7,657	6,043
1980	34,365	36,761	15,654	11,860	11,110	10,787	10,709	10,258	10,309	9,897	8,704	9,373	9,374	8,147	5,797	
1981	38,363	41,358	16,441	12,603	11,266	10,727	11,097	10,271	9,795	8,515	9,807	9,577	8,464	6,354		
1982	43,325	41,182	17,256	13,784	11,792	11,730	10,983	10,205	8,920	9,978	10,244	8,482	6,110			
1983	42,915	50,717	20,066	15,551	13,473	12,552	11,739	10,610	11,220	11,402	10,164	7,526				
1984	52,592	63,371	26,607	19,601	17,253	15,575	13,815	14,710	15,709	13,232	9,384					
1985	54,954	76,705	33,675	25,320	21,420	19,108	20,930	20,466	17,767	13,056						
1986	54,027	87,239	36,212	26,154	22,125	23,037	22,262	19,057	13,951							
1987	62,096	96,999	42,273	29,222	28,732	27,572	23,598	15,530								
1988	70,513	111,540	50,937	40,426	36,160	29,571	19,545									
1989	73,489	130,905	55,178	49,746	37,333	24,490										
1990	57,069	139,120	80,727	47,359	28,940											
1991	77,548	144,437	68,247	35,728												
1992	97,654	149,762	54,759													
1993	106,450	122,436														
1994	83,367															

Paid Losses (in thousands) - Evaluation in Years

Accident Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964	1,227	1,346	1,525	1,907	1,621	1,792	1,635	1,579	1,604	1,554	1,247	1,224	1,243	1,059	858
1965	1,525	1,527	1,600	1,551	1,602	1,715	1,668	1,607	1,515	1,243	1,248	1,372	1,067	897	
1966	1,909	2,095	2,002	2,290	2,048	2,010	1,942	2,117	1,638	2,037	2,221	1,612	1,406		
1967	2,477	2,568	2,710	2,608	2,842	2,594	2,369	2,306	2,166	2,643	2,027	1,361			
1968	2,745	2,759	2,657	2,750	2,545	2,331	1,973	2,036	2,466	2,469	1,630				
1969	[illegible]	3,549	3,563	3,490	2,762	2,353	2,340	2,318	2,156	1,563					
1970	2,725	3,018	2,715	2,804	2,259	2,501	2,876	2,233	1,615						
1971	3,501	3,430	3,063	2,623	2,686	2,780	2,330	1,977							
1972	3,809	4,050	3,200	3,782	3,346	3,202	2,272								
1973	4,095	3,791	4,034	4,072	3,578	2,545									
1974	5,449	5,911	5,575	5,084	3,766										
1975	5,495	4,942	4,605	3,410											
1976	6,309	5,840	4,440												
1977	5,857	4,514													
1978	4,722														
1979															
1980															
1981															
1982															
1983															
1984															
1985															
1986															
1987															
1988															
1989															
1990															
1991															
1992															
1993															
1994															

All Medical Payments

Paid Losses per Ultimate Lost Time Claim Count - Evaluation in Years

Accident Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1964																
1965															36	
1966														49	49	
1967													59	55	66	
1968												58	65	68	77	
1969											59	58	76	83	92	
1970										65	67	70	84	83	86	
1971									78	78	85	98	100	105	109	1.
1972								88	89	102	117	123	115	126	124	12
1973							93	90	99	117	130	112	118	126	129	12(
1974						112	111	126	140	146	154	151	151	151	14[illegible]	143
1975					125	117	133	149	153	162	160	168	164	166	166	139
1976				167	147	149	162	171	176	175	170	180	172	164	154	155
1977			234	163	165	173	179	168	186	182	182	177	168	150	170	159
1978		796	269	212	206	197	194	200	206	202	204	184	169	185	191	155
1979	766	855	340	260	237	243	239	229	231	226	222	194	214	200	175	138
1980	888	1,004	405	307	288	279	277	265	267	256	225	243	243	211	150	
1981	1,050	1,132	450	345	308	293	304	281	268	233	268	262	232	174		
1982	1,311	1,246	522	417	357	355	332	309	270	302	310	257	185			
1983	1,277	1,509	597	463	401	374	349	316	334	339	302	224				
1984	1,301	1,568	658	485	427	385	342	364	389	327	232					
1985	1,254	1,750	768	578	489	436	478	467	405	298						
1986	1,211	1,956	812	586	496	517	499	427	313							
1987	1,314	2,053	895	618	608	584	499	329								
1988	1,393	2,204	1,007	799	715	584	386									
1989	1,383	2,353	1,268	968	726	477										
1990	1,127	2,746	1,593	935	571											
1991	1,646	3,065	1,448	758												
1992	2,135	3,268	1,195													
1993	2,185	2,663														
1994	1,847															

Paid Losses per Ultimate Lost Time Claim Count - Evaluation in Years

Accident Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964	41	44	50	63	54	59	54	52	53	51	41	40	41	35	28
1965	42	49	51	49	51	55	53	51	48	40	40	44	34	29	
1966	60	61	61	70	63	61	59	65	50	62	68	49	43		
1967	79	82	86	83	90	83	75	70	69	84	65	43			
1968	85	86	82	85	79	72	61	63	77	77	51				
1969	100	103	104	101	78	68	68	67	62	45					
1970	85	94	85	87	70	78	90	70	50						
1971	113	111	99	85	87	90	76	64							
1972	116	124	98	116	102	98	70								
1973	106	99	105	106	93	66									
1974	132	143	135	123	91										
1975	150	135	125	93											
1976	164	152	115												
1977	146	113													
1978	113														
1979															
1980															
1981															
1982															
1983															
1984															
1985															
1986															
1987															
1988															
1989															
1990															
1991															
1992															
1993															
1994															

All Medical Payments

Accident Year Persistency Non-Indexed Payments

Accident Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16
1964															
1965															1.0916
1966														0.9970	1.0715
1967													0.9415	1.1857	1.1838
1968												1.1164	1.0399	1.1417	1.0152
1969											0.9725	1.3109	1.0927	1.1166	0.9809
1970										1.0207	1.0474	1.2001	0.9916	1.0314	0.9664
1971									1.0050	1.0903	1.1519	1.0237	1.0440	1.0441	1.0209
1972								1.0046	1.1503	1.1433	1.0521	0.9362	1.0985	0.9784	1.0120
1973							0.9691	1.1018	1.1784	1.1107	0.8584	1.0557	1.0675	1.0240	0.9758
1974						0.9900	1.1416	1.1097	1.0457	1.0532	0.9764	1.0022	1.0002	0.9738	0.9734
1975					0.9346	1.1325	1.1250	1.0271	1.0550	0.9923	1.0493	0.9758	1.0119	1.0006	0.8365
1976				0.8820	1.0132	1.0824	1.0599	1.0295	0.9942	0.9706	1.0595	0.9518	0.9552	0.8149	1.1626
1977			0.6983	1.0085	1.0505	1.0330	0.9397	1.1084	0.9769	0.9987	0.9721	0.9533	0.8893	1.1350	0.9352
1978		0.3377	0.7887	0.9699	0.9571	0.9849	1.0337	1.0260	0.9816	1.0105	0.9006	0.9220	1.0896	1.0353	0.8138
1979	1.1161	0.3974	0.7643	0.9136	1.0242	0.9830	0.9604	1.0075	0.9769	0.9823	0.8748	1.1008	0.9386	0.8704	0.7892
1980	1.1299	0.4039	0.7576	0.9368	0.9709	0.9928	0.9560	1.0069	0.9601	0.8794	1.0769	1.0001	0.8691	0.7116	
1981	1.0781	0.3975	0.7666	0.8939	0.9522	1.0345	0.9255	0.9536	0.8691	1.1521	0.9765	0.8837	0.7507		
1982	0.9505	0.4190	0.7988	0.8555	0.9948	0.9363	0.9291	0.8741	1.1186	1.0267	0.8280	0.7204			
1983	1.1818	0.3957	0.7750	0.8664	0.9316	0.9353	0.9038	1.0575	1.0162	0.8914	0.7405				
1984	1.2050	0.4199	0.7367	0.8802	0.9027	0.8870	1.0648	1.0679	0.8423	0.7092					
1985	1.3958	0.4390	0.7519	0.8460	0.8920	1.0954	0.9779	0.8681	0.7348						
1986	1.6147	0.4151	0.7223	0.8459	1.0412	0.9663	0.8560	0.7321							
1987	1.5621	0.4358	0.6913	0.9832	0.9596	0.8559	0.6581								
1988	1.5818	0.4567	0.7936	0.8945	0.8178	0.6609									
1989	1.7007	0.5391	0.7632	0.7505	0.6560										
1990	2.4369	0.5803	0.5867	0.6111											
1991	1.8626	0.4725	0.5235												
1992	1.5308	0.3656													
1993	1.2189														

Avg All	1.438	0.432	0.728	0.876	0.940	0.971	0.967	0.998	0.994	1.002	0.969	1.010	0.985	[illegible]	0.989
Avg Last 3	1.537	0.473	0.624	0.752	0.811	0.828	0.831	0.869	0.864	0.876	0.848	0.868	0.853	[illegible]	0.846
C.V.(%)	28.7%	14.4%	10.7%	11.1%	10.6%	11.7%	12.2%	10.4%	11.7%	11.3%	11.4%	13.7%	9.9%	12.7%	[illegible]

Accident Year Persistency Non-Indexed Payments

Accident Year	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964	1.0902	1.0976	1.1330	1.2505	0.8497	1.1054	0.9113	0.9669	1.0157	0.9692	0.8022	0.9817	1.0160	0.8520	0.8099
1965	1.0736	1.1528	1.0478	0.9691	1.0328	1.0707	0.9728	0.9632	0.9429	0.8204	1.0038	1.0991	0.7782	0.8404	
1966	1.1571	1.0184	0.9986	1.1439	0.8940	0.9815	0.9662	1.0905	0.7736	1.2434	1.0903	0.7260	0.8720		
1967	1.0123	1.0449	1.0470	0.9625	1.0896	0.9130	0.9130	0.9311	0.9822	1.2200	0.7668	0.6714			
1968	1.0893	1.0048	0.9559	1.0427	0.9254	0.9161	0.8463	1.0323	1.2108	1.0013	0.6600				
1969	1.1091	1.0258	1.0096	0.9742	0.7740	0.8708	0.9948	0.9904	0.9276	0.7270					
1970	1.0285	1.1077	0.8995	1.0327	0.8055	1.1071	1.1499	0.7764	0.7232						
1971	1.0159	0.9799	0.8930	0.8561	1.0243	1.0348	0.8383	0.8483							
1972	0.9310	1.0657	0.7901	1.1821	0.8847	0.9569	0.7095								
1973	0.8472	0.9259	1.0640	1.0093	0.8787	0.7108									
1974	0.9204	1.0847	0.9433	0.9119	0.7407										
1975	1.0759	0.8993	0.9319	0.7404											
1976	1.0554	0.9257	0.7601												
1977	0.9215	0.7707													
1978	0.7247														
1979															
1980															
1981															
1982															
1983															
1984															
1985															
1986															
1987															
1988															
1989															
1990															
1991															
1992															
1993															

Avg All	1.003	1.007	0.960	1.006	0.900	0.967	0.922	0.950	0.939	0.997	0.865	0.870	0.889	0.846	0.810
Avg Last 3	0.901	0.865	0.878	0.887	0.835	0.901	0.899	0.872	0.954	0.983	0.880	0.870	0.889	0.846	0.810
C.V.(%)	11.4%	10.0%	11.2%	14.0%	12.3%	12.7%	13.3%	10.5%	17.1%	20.8%	20.5%	23.5%	13.5%	1.0%	N/A

All Medical Payments

Accident Year Persistency Indexed Payments

Accident Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16
1964															
1965															0.9837
1966														0.8984	0.9682
1967													0.8484	1.0713	1.0609
1968												1.0060	0.9396	1.0231	0.9335
1969											0.8764	1.1845	0.9792	1.0268	0.9239
1970										0.9197	0.9464	1.0755	0.9118	0.9715	0.9093
1971									0.9056	0.9852	1.0323	0.9414	0.9833	0.9824	0.9498
1972								0.9052	1.0394	1.0246	0.9675	0.8819	1.0335	0.9102	0.9491
1973							0.8733	0.9956	1.0560	1.0213	0.8086	0.9933	0.9932	0.9603	0.9159
1974						0.8921	1.0315	0.9944	0.9616	0.9920	0.9187	0.9323	0.9380	0.9140	0.9037
1975					0.8422	1.0233	1.0081	0.9445	0.9938	0.9337	0.9762	0.9151	0.9497	0.9289	0.7672
1976				0.7948	0.9155	0.9700	0.9747	0.9698	0.9355	0.9030	0.9936	0.8933	0.8868	0.7473	1.0694
1977			0.6292	0.9113	0.9414	0.9499	0.8851	1.0429	0.9088	0.9365	0.9124	0.8850	0.8155	1.0439	0.8708
1978		0.3043	0.7126	0.8692	0.8802	0.9277	0.9726	0.9546	0.9205	0.9484	0.8361	0.8456	1.0021	0.9639	0.7722
1979	1.0057	0.3590	0.6849	0.8401	0.9647	0.9249	0.8935	0.9448	0.9169	0.9119	0.8023	1.0125	0.8740	0.8260	0.7493
1980	1.0210	0.3619	0.6967	0.8824	0.9135	0.9236	0.8966	0.9451	0.8913	0.8065	0.9905	0.9311	0.8247	0.6756	
1981	0.9661	0.3655	0.7220	0.8411	0.8859	0.9702	0.8687	0.8853	0.7971	1.0597	0.9092	0.8386	0.7128		
1982	0.8743	0.3947	0.7516	0.7959	0.9329	0.8788	0.8625	0.8017	1.0289	0.9559	0.7856	0.6840			
1983	1.1131	0.3723	0.7210	0.8125	0.8744	0.8683	0.8289	0.9726	0.9462	0.8459	0.7031				
1984	1.1337	0.3906	0.6909	0.8261	0.8381	0.8134	0.9794	0.9943	0.7993	0.6734					
1985	1.2986	0.4117	0.7057	0.7854	0.8181	1.0075	0.9105	0.8238	0.6977						
1986	1.5145	0.3896	0.6705	0.7758	0.9577	0.8997	0.8123	0.6951							
1987	1.4001	0.4046	0.6340	0.9044	0.8935	0.8121	0.6249								
1988	1.4085	0.4188	0.7360	0.8328	0.7760	0.6276									
1989	1.5598	0.4958	0.7106	0.7121	0.6229										
1990	2.2414	0.5403	0.5567	0.5802											
1991	1.7342	0.4483	0.4971												
1992	1.4525	0.3472													
1993	1.1573														
Avg All	1.334	0.400	0.674	0.811	0.870	0.899	0.895	0.925	0.920	0.928	0.897	0.935	0.913	0.930	0.915
Avg Last 3	1.448	0.445	0.588	0.708	0.764	0.780	0.783	0.838	0.814	0.825	0.799	0.818	0.804	0.822	0.797
C.V.(%)	26.0%	13.4%	10.8%	10.4%	10.6%	11.0%	11.2%	10.4%	10.9%	11.2%	11.1%	10.5%	10.0%	12.0%	11.0%

Accident Year Persistency Indexed Payments

Accident Year	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964	0.9824	0.9918	1.0154	1.1499	0.8004	1.0401	0.8478	0.9068	0.9533	0.8998	0.7357	0.9030	0.9460	0.8084	0.7690
1965	0.9701	1.0331	0.9635	0.9128	0.9718	0.9961	0.9123	0.9040	0.8753	0.7524	0.9233	1.0234	0.7385	0.7979	
1966	1.0370	0.9305	0.9406	1.0763	0.8317	0.9204	0.9069	1.0123	0.7095	1.1437	1.0152	0.6889	0.8280		
1967	0.9309	0.9842	0.9851	0.8954	1.0218	0.8569	0.8476	0.8540	0.9034	1.1359	0.7276	0.6375			
1968	1.0261	0.9455	0.8893	0.9779	0.8685	0.8505	0.7761	0.9495	1.1273	0.9501	0.6267				
1969	1.0435	0.9544	0.9468	0.9143	0.7186	0.7986	0.9149	0.9222	0.8802	0.6903					
1970	0.9569	1.0388	0.8443	0.9587	0.7387	1.0183	1.0706	0.7368	0.6866						
1971	0.9527	0.9197	0.8290	0.7851	0.9421	0.9634	0.7955	0.8054							
1972	0.8738	0.9893	0.7246	1.0873	0.8237	0.9079	0.6736								
1973	0.7865	0.8492	0.9787	0.9398	0.8338	0.6749									
1974	0.8441	0.9970	0.8783	0.8653	0.7033										
1975	0.9890	0.8373	0.8843	0.7030											
1976	0.9820	0.8784	0.7217												
1977	0.8744	0.7318													
1978	0.6881														
1979															
1980															
1981															
1982															
1983															
1984															
1985															
1986															
1987															
1988															
1989															
1990															
1991															
1992															
1993															
Avg All	0.929	0.935	0.892	0.939	0.841	0.903	0.861	0.886	0.877	0.929	0.806	0.813	0.837	0.803	0.769
Avg Last 3	0.848	0.816	0.828	0.836	0.787	0.849	0.847	0.821	0.898	0.925	0.790	0.783	0.837	0.803	0.769
C.V.(%)	11.4%	9.4%	10.5%	13.4%	12.3%	12.4%	12.9%	9.7%	17.0%	20.3%	19.7%	22.3%	12.4%	0.9%	N.A.

All Medical Payments

ent ar	Calendar Year Persistency 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
64																0.0000
65															1.0331	1.0318
66														0.7388	0.8069	0.8105
967													0.8264	0.8752	0.7909	0.7731
968												1.0128	0.8542	0.9739	1.0098	1.0070
1969											0.9817	1.1268	0.8939	0.9540	0.8491	0.9430
1970										0.9096	0.8667	1.0848	0.9877	1.1122	1.0578	1.2138
1971									0.8389	0.8520	0.8184	0.8527	0.8260	0.8160	0.7553	0.7609
1972								0.8798	0.8801	0.8343	0.8406	0.8178	0.9119	0.8668	0.9046	0.9080
1973							0.9497	0.9845	1.0278	0.9972	0.9446	1.0302	1.0720	0.9824	0.9709	0.9263
1974						0.8324	0.8148	0.7865	0.8352	0.8871	0.7230	0.7818	0.8328	0.8525	0.8543	0.7436
1975					0.8915	0.9444	0.9520	0.9390	0.9560	0.9543	0.9390	0.8968	0.9193	0.8846	0.8666	0.9469
1976				0.7494	0.7941	0.8876	0.9226	0.8940	0.9161	0.9144	0.9885	0.9104	0.9679	1.0139	1.0406	0.9631
1977			0.7146	0.9026	0.9068	0.9343	0.9587	1.0504	0.9421	0.9361	0.9931	0.9724	0.9744	0.8929	0.9146	1.0321
1978		0.2938	0.6076	0.7769	0.8415	0.9082	0.8664	0.9291	0.8846	0.8999	0.8657	0.9163	0.8838	0.9206	0.8316	0.9417
1979	1.0390	0.3144	0.6240	0.7918	0.8296	0.7978	0.8390	0.8964	0.8733	0.9034	0.8283	0.8729	0.8640	0.9529	0.8910	0.8182
1980	0.9627	0.3386	0.6407	0.7725	0.8446	0.8551	0.8272	0.8718	0.8458	0.8653	0.8608	0.8800	0.8259	0.8272	0.9174	
1981	0.9564	0.3583	0.6829	0.8345	0.9063	0.9450	0.8733	0.9501	0.9565	0.9678	0.9047	0.9265	0.9111	0.8636		
1982	0.8631	0.3610	0.6604	0.7590	0.8225	0.8554	0.8455	0.8679	0.8629	0.8887	0.8453	0.9023	0.9403			
1983	0.9758	0.3460	0.6985	0.7710	0.8853	0.8898	0.8839	0.8549	0.9043	0.9136	0.8486	0.8256				
1984	1.1600	0.3809	0.7031	0.8268	0.8751	0.9066	0.9238	0.9174	0.8731	0.9239	0.9647					
1985	1.2503	0.3761	0.6311	0.7388	0.7883	0.7839	0.7620	0.8322	0.8074	0.7793						
1986	1.4449	0.3928	0.7116	0.8335	0.8789	0.9246	0.9356	0.9488	0.9524							
1987	1.4884	0.3955	0.6555	0.8021	0.8494	0.8554	0.8555	0.9517								
1988	1.4732	0.4059	0.6144	0.7612	0.8166	0.8546	0.8510									
1989	1.5935	0.4279	0.6299	0.7382	0.8044	0.8105										
1990	2.0879	0.4619	0.6075	0.7772	0.8343											
1991	1.6684	0.5198	0.6454	0.7533												
1992	1.4357	0.4432	0.6345													
1993	1.4957	0.4487														
1994	1.4422															
Avg All	1.3336	0.3915	0.6538	0.7856	0.8481	0.8741	0.8788	0.9096	0.8973	0.9017	0.8884	0.9256	0.9057	0.9067	0.9057	0.8129
Avg Last 3	1.4579	0.4705	0.6291	0.7562	0.8184	0.8402	0.8807	0.9109	0.8776	0.8723	0.8862	0.8848	0.8924	0.8812	0.8800	0.9307
C.V.(%)	23.0%	12.4%	5.3%	4.6%	4.2%	5.9%	6.3%	6.3%	5.4%	4.1%	8.7%	7.3%	8.2%	9.2%	10.0%	14.0%

Accident Year	Calendar Year Persistency 17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964															
1965	1.0549	1.0367	1.2373	1.0849	1.1612	0.9883	0.9824	1.0359	1.0648	1.0411	1.0182	0.9412	1.0304	0.9930	
1966	0.8075	0.8308	0.8062	0.7280	0.8719	0.8641	0.8614	0.7448	0.7899	0.6377	0.6429	0.6891	0.6641		
1967	0.7778	0.7433	0.8120	0.7542	0.6793	0.7190	0.8587	0.7134	0.9032	0.8072	0.7643	0.9926			
1968	0.9659	1.0065	1.0134	1.0590	1.0448	1.0412	1.3457	1.0901	1.0984	0.8412	0.8557				
1969	0.8543	0.7961	0.8222	0.7810	0.9244	0.8984	0.9323	1.1397	1.2302	1.1169					
1970	1.2107	1.1035	1.1951	0.8957	0.9683	0.8700	0.7493	0.8952	0.9000						
1971	0.8297	0.7616	0.8808	0.8287	0.8958	0.9954	0.9219	0.7860							
1972	0.9558	0.8009	0.8678	0.7519	0.8795	0.7706	0.9213								
1973	1.1652	0.9943	1.1047	0.9682	1.0543	1.0523									
1974	0.7480	0.7338	0.7852	0.7566	0.7261										
1975	0.9547	1.0014	0.9798	0.9802											
1976	0.8207	0.8262	0.8047												
1977	1.0368	1.0226													
1978	1.0014														
1979															
1980															
1981															
1982															
1983															
1984															
1985															
1986															
1987															
1988															
1989															
1990															
1991															
1992															
1993															
1994															
Avg All	0.9417	0.8967	0.9424	0.8717	0.9206	0.9110	0.9216	0.9150	0.9978	0.8888	0.8203	0.8743	0.8472	0.9930	N/A
Avg Last 3	0.9530	0.9500	0.8566	0.9017	0.8866	0.9394	0.8642	0.9403	1.0762	0.9218	0.7543	0.8743	0.8472	0.9930	N/A
C.V.(%)	15.5%	14.7%	17.1%	15.1%	16.0%	12.9%	12.4%	19.1%	16.2%	21.6%	19.3%	18.6%	30.6%	N/A	N/A

Hospitals

Paid Losses (in thousands) - Evaluation in Years

Accident Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1976																1,783
1977															2,138	1,908
1978														2,274	2,524	1,511
1979													2,988	2,723	2,010	1,131
1980												2,873	2,807	2,193	893	
1981											3,425	3,030	2,455	1,311		
1982										3,641	3,793	2,360	1,141			
1983									3,638	3,929	3,180	1,556				
1984								4,768	5,091	3,663	1,599					
1985							6,908	6,791	5,145	2,535						
1986						7,277	7,141	5,749	3,264							
1987					9,316	8,936	6,956	3,035								
1988				13,572	11,928	8,845	4,071									
1989			24,165	17,002	10,922	5,323										
1990		51,230	32,220	14,567	6,486											
1991	24,414	53,725	21,843	8,477												
1992	34,558	51,232	14,087													
1993	34,446	37,366														
1994	23,716															

Calendar Year Persistency

Accident Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
1976																0.968
1977															0.867	1.013
1978														0.985	0.792	1.215
1979													0.797	0.970	0.787	0.653
1980												0.915	0.854	0.807	1.115	
1981											0.794	0.877	0.845	0.645		
1982										0.850	0.722	0.941	1.039			
1983									1.018	0.982	0.755	0.746				
1984								0.918	0.928	1.044	1.171					
1985							0.748	0.813	0.772	0.684						
1986						0.966	0.968	0.911	0.790							
1987					0.828	0.847	0.876	1.139								
1988				0.735	0.802	0.842	0.798									
1989			0.570	0.712	0.822	0.777										
1990		0.465	0.520	0.739	0.809											
1991	1.952	0.558	0.620	0.712												
1992	1.512	0.415	0.585													
1993	1.492	0.378														
1994	1.548															
Avg All	1.626	0.454	0.574	0.725	0.815	0.858	0.848	0.945	0.877	0.890	0.860	0.870	0.883	0.852	0.890	0.770
Avg 92-94	1.517	0.450	0.575	0.721	0.811	0.822	0.881	0.954	0.830	0.903	0.882	0.855	0.913	0.807	0.898	0.960
C.V. All	13.4%	17.1%	7.2%	2.0%	1.4%	9.2%	11.3%	14.6%	13.3%	17.9%	21.3%	10.0%	12.0%	18.8%	17.3%	24.2%
C.V.92-94	1.9%	21.1%	8.8%	2.2%	1.3%	4.8%	9.6%	17.6%	10.3%	21.3%	28.3%	11.7%	12.0%	20.2%	20.9%	29.7%

Hospitals

Accident Year	Paid Losses (In thousands) - Evaluation In Years														
Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964												317	335	255	133
1965											288	369	228	129	
1966										706	553	271	186		
1967									716	1,066	699	253			
1968								513	729	942	341				
1969							712	668	642	304					
1970						776	1,123	645	307						
1971					777	681	564	383							
1972				1,366	844	879	383								
1973			1,218	1,339	998	361									
1974		1,706	1,432	1,234	598										
1975	1,647	1,258	1,244	610											
1976	1,859	1,794	856												
1977	1,753	874													
1978	705														

Accident Year	Calendar Year Persistency													
Year	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964														
1965											1.144	0.943	1.157	1.070
1966										0.424	0.695	0.877	0.722	
1967									0.948	0.498	0.373	0.706		
1968								1.429	1.499	0.760	0.760			
1969							0.773	1.168	1.572	1.202				
1970						0.852	0.553	0.925	0.921					
1971					0.961	1.588	1.101	0.771						
1972				0.602	0.854	0.679	1.059							
1973			1.322	0.743	1.038	1.250								
1974		0.768	1.005	0.869	0.649									
1975	0.919	1.010	0.881	0.870										
1976	0.709	0.727	0.747											
1977	1.064	1.018												
1978	1.299													
Avg All	0.998	0.881	0.989	0.771	0.875	1.092	0.871	1.074	1.235	0.721	0.743	0.842	0.939	1.070
Avg 92-94	1.024	0.918	0.878	0.827	0.847	1.172	0.904	0.955	1.331	0.820	0.609	0.842	0.939	1.070
C.V. All	24.9%	17.6%	24.9%	16.5%	19.3%	37.3%	29.5%	26.8%	28.2%	48.7%	42.6%	14.5%	32.7%	N/A
C.V.92-94	29.0%	18.1%	14.7%	8.9%	23.0%	39.2%	33.7%	20.9%	26.8%	43.3%	34.1%	14.5%	N/A	N/A

Physicians

Accident Year	Paid Losses (in thousands) - Evaluation in Years															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1976																1,514
1977															1,771	1,611
1978														2,009	1,958	1,793
1979													2,591	2,331	2,161	1,767
1980												2,545	2,421	2,262	1,617	
1981											2,559	2,512	2,374	1,858		
1982										2,565	2,593	2,513	1,818			
1983									2,985	2,994	2,797	2,255				
1984								3,820	4,217	3,679	2,663					
1985							5,212	5,098	4,690	3,608						
1986						6,022	5,863	5,511	4,090							
1987					7,362	6,951	6,534	4,950								
1988				9,347	8,848	7,774	5,887									
1989			14,594	11,627	9,625	7,155										
1990		30,222	18,434	12,514	8,463											
1991	14,199	30,366	17,189	10,311												
1992	14,628	31,523	15,480													
1993	16,051	29,484														
1994	16,257															

Accident Year	Calendar Year Persistency															
Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
1976																0.991
1977															0.889	1.015
1978														0.923	0.862	0.910
1979													0.812	0.879	0.869	0.809
1980												0.896	0.847	0.841	0.962	
1981											0.941	0.912	0.902	0.823		
1982										0.902	0.876	0.854	0.924			
1983									0.874	0.880	0.913	0.819				
1984								0.940	0.854	0.915	1.019					
1985							0.795	0.897	0.851	0.800						
1986						0.881	0.885	0.866	0.898							
1987					0.867	0.894	0.894	0.875								
1988				0.844	0.841	0.900	0.900									
1989			0.650	0.773	0.820	0.836										
1990		0.476	0.622	0.758	0.833											
1991	1.979	0.565	0.677	0.763												
1992	2.019	0.530	0.648													
1993	1.970	0.527														
1994	1.781															
Avg All	1.937	0.524	0.649	0.784	0.840	0.878	0.868	0.895	0.869	0.874	0.937	0.871	0.871	0.867	0.895	0.745
Avg 92-94	1.923	0.541	0.649	0.765	0.832	0.876	0.893	0.879	0.867	0.865	0.936	0.862	0.891	0.848	0.898	0.911
C.V. All	5.5%	7.0%	3.5%	5.1%	2.3%	3.3%	5.7%	3.7%	2.5%	5.9%	6.5%	4.8%	5.9%	5.1%	5.1%	10.0%
C.V.92-94	6.5%	3.9%	4.3%	1.0%	1.3%	4.1%	0.9%	1.8%	3.0%	6.8%	7.9%	5.4%	4.4%	3.4%	6.3%	11.3%

Physicians

Accident Year	Paid Losses (in thousands) - Evaluation in Years														
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964												290	268	290	221
1965											279	295	284	221	
1966										391	405	332	275		
1967									455	538	450	338			
1968								503	577	522	429				
1969							561	591	535	396					
1970						620	646	591	426						
1971					645	639	530	444							
1972				825	834	792	591								
1973			1,067	1,070	1,051	736									
1974		1,487	1,393	1,296	1,018										
1975	1,432	1,292	1,236	890											
1976	1,573	1,398	1,147												
1977	1,557	1,261													
1978	1,365														

Accident Year	Calendar Year Persistency													
	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964														
1965											1.077	0.941	1.063	1.036
1966										0.744	0.760	0.889	0.836	
1967									0.826	0.723	0.709	0.784		
1968								0.926	0.954	0.884	0.806			
1969							0.959	1.047	1.044	1.162				
1970						0.842	0.850	0.843	0.863					
1971					0.925	0.973	1.073	0.924						
1972				0.828	0.811	0.708	0.795							
1973			0.911	0.918	0.887	0.946								
1974		0.771	0.826	0.872	0.778									
1975	0.922	0.957	0.931	1.015										
1976	0.861	0.927	0.813											
1977	0.934	0.946												
1978	0.968													
Avg All	0.921	0.900	0.870	0.908	0.850	0.867	0.919	0.935	0.922	0.878	0.838	0.871	0.949	1.036
Avg 92-94	0.921	0.943	0.856	0.935	0.825	0.876	0.906	0.938	0.954	0.923	0.758	0.871	0.949	1.036
C.V. All	4.9%	9.6%	6.8%	8.8%	8.0%	13.9%	13.4%	9.0%	10.6%	23.0%	19.6%	9.2%	16.9%	N/A
C.V.92-94	6.0%	1.6%	7.5%	7.8%	6.8%	16.7%	16.3%	11.0%	9.5%	24.0%	6.4%	9.2%	N/A	N/A

Pharmacies

Accident Year	Paid Losses (in thousands) - Evaluation in Years															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1976																1,093
1977															1,176	1,269
1978														1,383	1,466	1,395
1979													1,495	1,684	1,644	1,568
1980												1,409	1,550	1,517	1,531	
1981											1,421	1,613	1,589	1,571		
1982										1,408	1,589	1,522	1,512			
1983									1,474	1,639	1,625	1,626				
1984								1,863	2,092	2,083	2.030					
1985							2,142	2,533	2,453	2,377						
1986						1,973	2,375	2,397	2,481							
1987					2,095	2,580	2,681	2,625								
1988				2,215	2,796	2,855	2,696									
1989			2,135	2,732	2,842	2,827										
1990		2,009	2,725	2,878	2,975											
1991	547	2,174	2,425	2,514												
1992	737	1,992	2,210													
1993	746	2,126														
1994	703															

Accident Year	Calendar Year Persistency															
Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
1976																0.977
1977															0.966	1.007
1978														0.891	0.907	0.896
1979													0.968	0.912	0.889	0.913
1980												0.933	0.956	0.954	0.901	
1981											0.939	0.910	0.904	0.923		
1982										0.913	0.918	0.944	0.939			
1983									0.971	0.986	0.953	0.946				
1984								0.952	0.943	0 938	0.963					
1985							0.943	0.895	0.920	0.926						
1986						1.104	1.086	1.042	0.975							
1987					0.998	0.975	0.947	1.001								
1988				1.013	0.988	1.006	1.043									
1989			1.054	1.040	1.020	0.969										
1990		1.048	0.988	0.974	0.937											
1991	3.416	1.166	1.103	1.101												
1992	2.869	1.184	1.106													
1993	2.677	1.043														
1994	2.970															
Avg All	2.983	1.110	1.063	1.032	0.986	1.013	1.005	0.972	0.952	0.941	0.943	0.933	0.942	0.920	0.916	0.758
Avg 92-94	2.838	1.131	1.066	1.038	0.982	0.983	1.025	0.979	0.946	0.950	0.944	0.933	0.933	0.929	0.899	0.939
C.V. All	10.5%	6.8%	5.2%	5.2%	3.6%	6.2%	7.1%	6.5%	2 7%	3.4%	2.1%	1.8%	3.0%	2.8%	3.8%	5.5%
C.V.92-94	5.3%	6.8%	6.3%	6.1%	4.3%	2.0%	6.9%	7.7%	2.9%	3.3%	2.5%	2.2%	2.9%	2.3%	1.0%	6.4%

Pharmacies

Accident Year	Paid Losses (in thousands) - Evaluation in Years 17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964												286	294	276	259
1965											310	317	309	285	
1966										374	397	386	393		
1967									449	487	493	457			
1968								502	551	519	492				
1969							551	573	511	471					
1970						595	600	567	542						
1971					661	683	632	584							
1972				768	800	775	739								
1973			858	871	832	805									
1974		1,289	1,456	1,299	1,222										
1975	1,019	1,114	999	973											
1976	1,229	1,168	1,163												
1977	1,193	1,148													
1978	1,368														

Accident Year	Calendar Year Persistency 17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964														
1965											0.957	0.964	0.927	0.945
1966										0.863	0.832	0.832	0.754	
1967									0.800	0.781	0.753	0.826		
1968								0.917	0.907	0.973	0.952			
1969							0.976	1.029	1.088	1.119				
1970						0.861	0.888	0.838	0.807					
1971					0.867	0.846	0.863	0.893						
1972				0.910	0.903	0.864	0.836							
1973			1.055	1.083	1.097	1.082								
1974		0.716	0.643	0.688	0.708									
1975	1.123	1.160	1.154	1.115										
1976	0.949	0.897	0.876											
1977	1.018	1.054												
1978	0.879													
Avg All	0.992	0.957	0.932	0.949	0.894	0.913	0.891	0.919	0.901	0.934	0.874	0.874	0.841	0.945
Avg 92-94	0.949	1.037	0.891	0.962	0.903	0.931	0.863	0.920	0.934	0.958	0.846	0.874	0.841	0.945
C.V. All	10.5%	20.2%	24.1%	20.6%	17.9%	12.4%	6.8%	8.8%	14.9%	15.6%	11.4%	8.9%	14.6%	N/A
C.V.92-94	7.3%	12.8%	28.7%	24.7%	21.6%	14.1%	3.0%	10.7%	15.2%	17.7%	11.9%	8.9%	N/A	N/A

Chiropractors

Accident Year	Paid Losses (in thousands) - Evaluation in Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1976																680
1977															775	830
1978														756	843	916
1979													1,085	1,109	1,190	997
1980												1,228	1,345	1,344	1,097	
1981											1,270	1,364	1,398	1,169		
1982										1,284	1,378	1,516	1,190			
1983									1,657	1,680	1,782	1,521				
1984								2,070	2,348	2,425	2,047					
1985							2,781	3,122	3,416	2,709						
1986						3,097	3,307	3,531	3,006							
1987					3,849	4,087	4,436	3,744								
1988				4,848	4,965	5,041	4,279									
1989			6,150	6,208	6,091	4,764										
1990		8,328	8,126	7,180	5,365											
1991	3,539	10,067	8,785	6,359												
1992	4,294	11,779	7,878													
1993	4,755	10,740														
1994	4,538															

Accident Year	Calendar Year Persistency 1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
1976																0.739
1977															0.911	0.914
1978														1.074	1.031	0.931
1979													0.730	0.796	0.806	0.733
1980												0.778	0.726	0.779	0.800	
1981											0.915	0.933	0.910	0.888		
1982										0.894	0.895	0.834	0.888			
1983									0.788	0.834	0.865	0.795				
1984								0.963	0.861	0.884	0.894					
1985							0.807	0.816	0.770	0.819						
1986						0.914	0.961	0.984	0.917							
1987					0.852	0.857	0.843	0.851								
1988				0.850	0.881	0.943	0.937									
1989			0.801	0.812	0.840	0.912										
1990		0.728	0.753	0.836	0.875											
1991	2.189	0.751	0.760	0.785												
1992	2.280	0.725	0.785													
1993	2.485	0.736														
1994	2.325															
Avg All	2.320	0.735	0.775	0.821	0.862	0.907	0.887	0.903	0.834	0.858	0.892	0.835	0.813	0.884	0.887	0.664
Avg 92-94	2.363	0.737	0.766	0.811	0.866	0.904	0.914	0.884	0.849	0.846	0.885	0.854	0.841	0.821	0.879	0.860
C.V. All	5.3%	1.6%	2.8%	3.5%	2.2%	3.9%	8.3%	9.2%	8.1%	4.3%	2.3%	8.3%	12.2%	15.3%	12.2%	13.0%
C.V.92-94	4.6%	1.7%	2.2%	3.2%	2.6%	4.8%	6.8%	10.1%	8.7%	4.0%	1.9%	8.3%	12.0%	7.1%	15.0%	12.8%

Chiropractors

Accident Year	Paid Losses (in thousands) - Evaluation in Years														
Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964												105	116	114	96
1965											114	146	135	117	
1966										130	151	164	170		
1967									124	177	174	125			
1968								162	215	218	176				
1969							186	173	169	169					
1970						170	188	179	142						
1971					203	265	289	260							
1972				265	344	341	248								
1973			378	357	381	328									
1974		523	548	554	464										
1975	480	542	535	444											
1976	730	829	663												
1977	814	654													
1978	698														

Accident Year	Calendar Year Persistency													
Year	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964														
1965											0.959	0.828	0.881	0.852
1966										0.910	1.006	0.856	0.716	
1967									1.007	0.822	0.902	1.308		
1968								0.785	0.844	0.820	0.729			
1969							0.932	1.331	1.377	1.119				
1970						1.019	0.854	0.879	1.101					
1971					0.807	0.684	0.597	0.527						
1972				0.810	0.814	0.896	1.109							
1973			0.826	1.138	1.055	0.891								
1974		0.777	0.700	0.739	0.760									
1975	0.967	0.898	0.918	0.928										
1976	0.778	0.677	0.701											
1977	1.058	1.054												
1978	0.981													
Avg All	0.946	0.851	0.786	0.904	0.859	0.873	0.873	0.881	1.083	0.918	0.899	0.997	0.799	0.852
Avg 92-94	0.939	0.876	0.773	0.935	0.876	0.824	0.853	0.913	1.108	0.920	0.879	0.997	0.799	0.852
C.V. All	12.6%	19.1%	13.5%	19.3%	15.5%	16.0%	24.3%	38.1%	20.6%	15.3%	13.5%	27.0%	14.7%	N/A
C.V.92-94	15.4%	21.6%	16.2%	21.3%	17.9%	14.7%	30.0%	44.2%	24.1%	18.7%	15.9%	27.0%	N/A	N/A

Rehabilitation

Accident Year	Paid Losses (In thousands) - Evaluation in Years															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1976																112
1977															136	85
1978														339	295	186
1979													294	170	106	121
1980												298	234	167	87	
1981											354	440	237	90		
1982										413	261	183	122			
1983									398	353	231	179				
1984								818	783	456	320					
1985							923	768	549	321						
1986						1,119	1,027	729	338							
1987					1,671	1,483	906	485								
1988				2,872	2,288	1,309	775									
1989			3,897	3,343	2,148	964										
1990		5,771	4,643	2,544	1,286											
1991	1,993	6,904	4,056	1,955												
1992	2,472	6,719	3,283													
1993	3,034	6,421														
1994	3,279															

Accident Year	Calendar Year Persistency															
Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
1976																1.088
1977															0.856	1.328
1978														0.421	0.301	0.355
1979													1.207	1.823	1.844	1.087
1980												0.867	0.638	0.558	1.220	
1981											0.799	0.503	0.665	0.921		
1982										0.774	1.528	1.172	0.665			
1983									1.054	0.752	0.804	0.695				
1984								0.586	0.542	0.610	0.671					
1985							0.962	1.104	0.901	1.082						
1986						0.839	0.761	0.766	0.966							
1987					0.710	0.734	0.852	0.738								
1988				0.623	0.694	0.741	0.670									
1989			0.748	0.695	0.619	0.817										
1990		0.666	0.710	0.832	0.739											
1991	2.693	0.625	0.583	0.612												
1992	2.716	0.587	0.579													
1993	2.222	0.513														
1994	1.924															
Avg All	2.388	0.598	0.655	0.691	0.690	0.783	0.811	0.799	0.866	0.805	0.951	0.809	0.793	0.931	1.055	0.771
Avg 92-94	2.287	0.575	0.624	0.713	0.684	0.764	0.761	0.870	0.803	0.815	1.001	0.790	0.656	1.101	1.122	0.923
C.V. All	16.1%	10.9%	13.3%	14.7%	7.4%	6.8%	15.4%	27.4%	26.0%	24.7%	41.0%	35.1%	34.8%	67.8%	61.4%	43.8%
C.V.92-94	17.5%	9.9%	11.9%	15.6%	8.9%	6.0%	12.0%	23.4%	28.4%	29.7%	46.1%	43.6%	2.3%	59.2%	69.2%	54.9%

Rehabilitation

Accident Year	Paid Losses (in thousands) - Evaluation in Years														
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964												17	15	20	8
1965											28	40	9	7	
1966										15	72	16	4		
1967									13	25	17	16			
1968								19	16	15	12				
1969							25	11	12	9					
1970						34	27	42	10						
1971					43	52	53	52							
1972				41	39	41	9								
1973			73	56	38	14									
1974		147	123	105	55										
1975	116	89	57	34											
1976	108	72	58												
1977	63	79													
1978	125														

Accident Year	Calendar Year Persistency													
	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964														
1965											0.629	0.399	2.422	1.317
1966										2.021	0.580	0.551	1.621	
1967									1.089	2.802	0.907	0.245		
1968								0.699	1.537	1.230	1.426			
1969							0.813	1.558	1.339	1.382				
1970						0.674	0.393	0.259	0.826					
1971					0.770	0.491	0.752	0.192						
1972				1.103	1.421	1.387	6.063							
1973			0.665	0.814	1.269	0.778								
1974		0.534	0.493	0.388	0.268									
1975	1.124	1.224	1.625	1.437										
1976	0.860	0.835	0.609											
1977	1.184	0.765												
1978	0.662													
Avg All	0.958	0.840	0.848	0.936	0.932	0.832	2.005	0.677	1.198	1.858	0.886	0.398	2.022	1.317
Avg 92-94	0.902	0.942	0.909	0.880	0.986	0.885	2.403	0.670	1.234	1.804	0.971	0.398	2.022	1.317
C.V. All	25.3%	34.1%	61.7%	47.6%	56.1%	46.6%	135.2%	92.9%	25.8%	38.5%	43.8%	38.4%	28.0%	N/A
C.V.92-94	29.2%	26.3%	68.5%	60.0%	63.5%	51.7%	132.1%	115.0%	29.7%	48.1%	43.9%	38.4%	N/A	N/A

Health - Other

Accident Year	Paid Losses (in thousands) - Evaluation in Years: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1976																846
1977															745	735
1978														983	921	715
1979													867	771	546	457
1980												981	949	667	573	
1981											734	643	410	355		
1982										613	666	389	322			
1983									1,026	818	544	388				
1984								1,155	1,140	915	717					
1985							2,026	2,000	1,478	1,496						
1986						1,745	1,531	1,005	755							
1987					1,744	1,608	921	597								
1988				2,893	2,275	1,389	870									
1989			3,227	3,420	1,565	1,044										
1990		3,628	3,163	2,066	1,198											
1991	1,046	3,136	2,243	1,516												
1992	1,043	2,703	1,528													
1993	1,028	2,201														
1994	962															
Accident Year	**Calendar Year Persistency: 1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**	**9-10**	**10-11**	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**	**16-17**
1976																0.968
1977															1.181	1.114
1978														0.794	0.836	0.698
1979													1.188	1.251	1.370	1.054
1980												0.778	0.714	0.720	0.702	
1981											1.265	1.398	1.542	1.526		
1982										1.082	0.872	0.951	0.998			
1983									0.608	0.829	0.727	0.844				
1984								1.069	0.862	0.715	0.651					
1985							0.618	0.618	0.671	0.520						
1986						1.182	1.330	1.497	2.015							
1987					1.060	1.008	1.156	1.341								
1988				0.646	0.757	0.710	0.735									
1989			0.910	0.675	0.902	0.846										
1990		0.877	1.066	0.747	0.860											
1991	3.225	0.938	0.857	0.735												
1992	2.923	0.807	0.965													
1993	2.637	0.697														
1994	2.247															
Avg All	2.758	0.830	0.949	0.701	0.895	0.936	0.960	1.131	1.039	0.786	0.879	0.993	1.111	1.073	1.022	0.767
Avg 92-94	2.603	0.814	0.962	0.719	0.840	0.855	1.074	1.152	1.183	0.688	0.750	1.064	1.085	1.166	0.969	0.955
C.V. All	15.1%	12.5%	9.4%	6.9%	14.1%	21.8%	35.2%	34.0%	63.5%	29.9%	31.1%	28.2%	31.3%	35.7%	30.0%	19.1%
C.V.92-94	13.0%	14.8%	10.9%	5.3%	8.9%	17.5%	28.5%	40.7%	61.5%	22.7%	15.0%	27.6%	38.8%	35.1%	36.4%	23.5%

Health - Other

Paid Losses (in thousands) - Evaluation in Years

Accident Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1964												208	228	104	141
1965											188	176	103	139	
1966										414	647	441	376		
1967									422	353	193	171			
1968								317	371	253	180				
1969							291	319	281	215					
1970						283	297	208	187						
1971					354	549	262	254							
1972				501	488	375	301								
1973			427	388	279	300									
1974		745	647	595	409										
1975	781	712	533	460											
1976	787	581	552												
1977	476	498													
1978	460														

Calendar Year Persistency

Accident Year	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31
1964														
1965											1.148	1.346	1.048	1.054
1966										0.473	0.283	0.242	0.385	
1967									0.943	1.763	2.196	2.110		
1968								1.365	0.974	0.781	0.973			
1969							1.167	1.246	0.964	0.897				
1970						0.955	0.997	1.254	1.069					
1971					0.770	0.521	0.763	0.708						
1972				0.747	1.189	0.741	0.893							
1973			1.383	1.482	1.583	1.184								
1974		0.616	0.645	0.503	0.789									
1975	0.846	0.806	0.992	0.789										
1976	0.948	0.960	0.873											
1977	1.268	1.152												
1978	1.134													
Avg All	1.049	0.884	0.974	0.880	1.083	0.850	0.955	1.143	0.988	0.978	1.150	1.233	0.716	1.054
Avg 92-94	1.117	0.973	0.837	0.925	1.187	0.816	0.885	1.069	1.002	1.147	1.151	1.233	0.716	1.054
C.V. All	17.9%	25.8%	31.7%	47.7%	35.6%	33.4%	17.8%	25.8%	5.7%	56.5%	68.8%	76.2%	65.5%	N/A
C.V.92-94	14.4%	17.8%	21.1%	54.4%	33.5%	41.4%	13.2%	29.3%	5.8%	46.8%	84.2%	76.2%	N/A	N/A

A Model for Reserving Workers Compensation High Deductibles

Jerome J. Siewert, FCAS

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Abstract

Several approaches for estimating liabilities under a high deductible program are described. Included is a proposal for a more sophisticated approach relying upon a loss distribution model. Additionally, the discussion addresses several related issues dealing with deductible size and mix, absence of long-term histories, as well as the determination of consistent loss development factors among deductible limits. Lastly, approaches are proposed for estimating aggregate loss limit charges, if any, and the asset value for associated servicing revenue.

Biography

Jerry Siewert is an Assistant Vice President and Actuary with Wausau Insurance Companies. He currently manages the reserving unit of the actuarial department. His previous experience includes managing several pricing units and serving on various industry ratemaking committees. Prior to joining Wausau, he taught mathematics for four years at the secondary level.

Jerry is a Member of the American Academy of Actuaries and became a Fellow of the Casualty Actuarial Society in 1985. He graduated from the University of Wisconsin - Stevens Point (1972) earning bachelor degrees in both mathematics and psychology.

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A Model for Reserving Workers Compensation High Deductibles

1. Abstract

Several approaches for estimating liabilities under a high deductible program are described. Included is a proposal for a more sophisticated approach relying upon a loss distribution model. Additionally, the discussion addresses several related issues dealing with deductible size and mix, absence of long-term histories, as well as the determination of consistent loss development factors among deductible limits. Lastly, approaches are proposed for estimating aggregate loss limit charges, if any, and the asset value for associated servicing revenue.

2. Introduction

With the advent of the high deductible program in the early '90s, actuarial efforts focused principally on pricing issues. Insurers initially developed this program to provide both themselves and insureds many advantages, including:

1. achieving price flexibility while passing additional risk to larger insureds in what was considered at that time an unprofitable line of business,
2. ameliorating onerous residual market charges and premium taxes in some states,
3. realizing cash flow advantages similar to those of the closely related product - the paid loss retro,
4. providing insureds with another vehicle to control losses while protecting them against random, large losses, and
5. allowing "self-insurance" without submitting insureds to sometimes demanding state requirements.

Now as the program matures, the focus shifts to the liability side. Questions are being asked as to what losses are actually emerging and, more importantly, what will they ultimately cost insurers. For the actuary, the question is how best to estimate these liabilities when losses are not expected to emerge above deductible limits for many years. Many issues need to be addressed:

1. In the absence of long-term development histories under a deductible program, how can the actuary construct reasonable development factors?
2. How can the actuary determine development patterns that reflect the diversity of both deductible size and mix?
3. How should the actuary determine consistent development factors between limited and excess values?
4. What is a reasonable approach for the indexing of deductible limits over time?
5. How can the actuary estimate the liability associated with aggregate loss limits, if any?

6. Is there a sound way to determine the proper asset value for associated service revenue?[1]

In the remainder of this paper I describe possible approaches dealing with those issues.

3. Development Approaches

Overview

The development approach presented relies heavily upon my company's extensive history of full coverage workers compensation claim experience. In effect, I create deductible/excess development patterns as needed. Of course, this approach poses problems if credible histories of full coverage losses are not readily available.

Once I establish the appropriate development factors, I apply them at the account level and determine the overall aggregate reserve by summarizing estimated ultimates for each account. I argue this is a reasonable approach, if you view each account as belonging to a cohort of policies with similar limit characteristics. Determining the overall reserve in such a fashion allows me to address the issue of deductible mix by reflecting each account's unique limits.

Later I describe the possible use of a loss distribution model to enforce consistent results between deductible/excess development factors. Once the parameters of the distribution are set, it is possible to determine development factors, as needed, for any deductible size. Perhaps, the use of such a model may even provide an alternative approach for determining tail factors through the projection of the distribution parameters.

Loss Ratio

In the absence of credible development histories, a common approach for determining liabilities is to apply loss ratios to premiums arising from the exposures. Historically, as that element was required to first price the product, loss ratios for the various accounts written should be readily available. For immature years, where data is sparse, applying loss ratios is probably the most practical approach to take. Given the long-tailed nature of this business, actual experience over deductible limits emerges slowly over time . Also the expected experience is readily converted to an accident year basis based upon a pro rata earnings of the policy year exposures.

The loss ratio approach requires a database of individual accounts and pricing elements. The database should include an estimate of the full coverage loss ratio. From a pricing standpoint, that number can come from a variety of sources. One approach would be to use company experience by state, reflecting the individual account's premium distribution. Possibly, that experience to the extent credible could be blended with industry experience. As with other

[1] Similar in usage to a loss conversion factor in retro rating, loss multipliers are applied to deductible losses to capture expenses that vary with loss.

pricing efforts, that experience ought to be developed to ultimate, brought on level, and trended to the appropriate exposure period.

Besides an estimate of the full coverage loss ratio, the database should include estimates of excess losses for both occurrence and aggregate limits. For the occurrence limit, several approaches are possible including estimating excess ratios based upon company experience. A potentially more credible approach uses excess loss pure premium ratios underlying industry-based excess loss factors used in retro rating. Besides their availability by multiple limits, excess loss factors can easily be adjusted to a loss basis and reflect hazard groups with differing severity potential. Utilizing account-based excess ratios reflecting unique state and hazard group characteristics should lead to reasonable estimates of per occurrence excess losses:

(3.1) $P \cdot E \cdot \chi$

where P = premium, E = expected loss ratio, and χ = per occurrence charge

Regarding the aggregate loss charge, if any, an approach I prefer uses a process similar to that for determining insurance charges in a retro rating program. Those charges would, in turn, rely on the National Council on Compensation Insurance's (NCCI) Table M. I refer the interested reader to the Retrospective Rating Plan [1] for further details. The process reflects the size of the account, deductible, state severity relativities, prospective rating period, and appropriate rating plan parameters:

(3.2) $P \cdot E \cdot (1-\chi) \cdot \phi$

where P = premium, E = expected loss ratio, χ = per occurrence charge, and ϕ = per aggregate charge

Applying this procedure to each account and aggregating leads to an estimate of ultimate accident year losses. I show in Table 1 a hypothetical case of how to apply those factors to determine the ultimate liabilities. Incurred But Not Reported (IBNR) amounts are easily determined by subtracting known losses from the ultimate estimate.

Again, this approach is particularly useful when no data is available or the data is so immature as to be virtually useless. Obviously, loss ratio estimates can be consistently tied to pricing programs, at least at the outset. This procedure also benefits from its reliance on a more credible pool of company and/or industry experience. On the negative side, a loss ratio approach ignores actual emerging experience, which in some circumstances may differ significantly from estimated ultimate losses. For this reason alone, the loss ratio approach is not particularly useful after several years of development. Another shortcoming of this method is that it may not properly reflect account characteristics, as development may emerge differently due to the exposures written.

Table 1
Countrywide Insurance Enterprise
Account: Widget, Inc.
Expected Deductible/Aggregate Loss Charges

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(2) x (3)		(4) x (5)		[(4) - (6)] x (7)
					Deductible	Aggre-	Aggregate
			Expected	Excess	Loss	gate	Loss
State	Premium	ELR	Loss	Ratio	Charge	Ratio	Charge
Arkansas	9,084	.567	5,151	.062	319	.02	97
Illinois	573,066	.532	304,871	.105	32,011	.02	5,457
Iowa	373,072	.588	219,366	.096	21,059	.02	3,966
Kansas	70,549	.644	45,434	.071	3,226	.02	844
Minnesota	1,012,622	.457	462,768	.143	66,176	.02	7,932
South Carolina	22,980	.522	11,996	.048	576	.02	228
South Dakota	94,401	.697	65,797	.211	13,883	.02	1,038
Total	2,155,774	.517	1,115,383	.123	137,250	.02	19,562

Implied Development

There are many ways to incorporate actual emergence in high deductible reserve estimates. Determining excess development implicitly is one possibility. By implied development, I mean an approach that works as follows:

1. Develop full coverage losses to ultimate.
2. Next, develop deductible losses to ultimate by applying development factors reflecting various inflation indexed limits.
3. Finally, determine ultimate excess losses by differencing the full coverage ultimate losses and the limited ultimate losses.

A variety of the usual development techniques could be applied to determine full coverage losses. Those methods include paid and incurred techniques designed consistently with the company's reserving procedures for full coverage workers compensation. However, care should be exercised in determining a full coverage tail factor consistent with the limited loss tail factors. In particular, the actuary should avoid developing limited losses beyond unlimited losses, or even losses for lower limits beyond those of higher limits.

When calculating development factors for the various deductibles, it is appropriate to index the limits for inflationary effects. Adjusting the deductible by indexing keeps the proportion of deductible/excess losses constant about the limit from year to year, at least, in theory. For example, if inflationary forces drive claim costs ten percent higher each year, the percentage of losses over a $100,000 deductible for one year equate to those of a $110,000 deductible in the next. Indexing of deductible limits allows for the possibility of combining differing experience years in the determination of development factors.

There is really no set method for determining the indexing value. One approach would be to determine that index by fitting a line to average severities over a long-term history. Another simpler approach might be to use an index that reflects the movement in annual severity changes. In any event, the actuary needs to be cognizant that a constant deductible over time usually implies increasing excess losses.

An advantage of the implied development approach is that it provides an estimate of excess losses at early maturities even when excess losses have not emerged. Also, the development factors for limited losses are more stable than those determined for losses above the deductible. This procedure also provides an important byproduct in the estimation of assets under the high deductible program. Specifically, estimating deductible losses helps determine the asset represented by revenue collected from the application of a loss multiplier to future losses. Despite these advantages, this approach does appear to have its focus misplaced, as one would like to explicitly recognize excess loss development.

Direct Development

This approach explicitly focuses on excess development, though it relies upon development factors implicit from the previous technique. That is, given development factors for limited as well as full coverage losses, excess loss development factors are fixed. It is important to recognize here that excess development is part of overall development, and the actuary should strive to determine excess factors in conjunction with limited development factors that balance back to full coverage development. That is not to say that reserve indications from implicit and explicit methods necessarily will be the same, but only that the underlying loss development factors should be.

Again, a variety of paid and incurred techniques are applicable here. I see several disadvantages to directly determining excess development factors and applying them to excess losses. Those factors tend to be quite leveraged and extremely volatile, making them difficult to select. Additionally, if excess losses have not actually emerged at any particular stage of development, it is not possible to get an estimate of the required liability.

Credibility Weighting Techniques/Bornhuetter-Ferguson

Given the significant drawbacks mentioned for the previous approaches to determining excess liabilities for the deductible product, the next approach described offers greater promise. It relies on credibility weighting indications based upon actual experience with expected values, preferably based on pricing estimates. This method requires that the actuary determine a suitable set of weights or credibilities. The Bornhuetter-Ferguson [2] technique offers one possible approach for determining credibilities that are specified as reciprocals of loss development factors.

(3.3) $L = O_t \cdot LDF_t \cdot Z + E \cdot (1 - Z)$ (Credibility viewpoint)

where L = ultimate loss estimate, O_t = observed loss at time t, LDF_t = age to ultimate development factor, Z = credibility, and E = expected ultimate loss

Letting $Z = \frac{1}{LDF_t}$ leads to:

(3.4) $L = O_t + E \cdot \left(\frac{LDF_t - 1}{LDF_t} \right)$ (Bornhuetter-Ferguson viewpoint)

Using the Bornhuetter-Ferguson approach allows the actuary to determine liabilities either directly or indirectly. This procedure affords the ability to tie into pricing estimates for recent years where excess losses have yet to emerge. Also, it provides more stable estimates over time, rather than the volatility arising from erratic emergence or leveraged development factors. Hopefully, a credibility weighting approach like this provides better estimators of ultimate liabilities as well. Of course, a disadvantage of this technique is that it ignores actual experience to the extent of the complement of credibility. That drawback suggests finding alternative weights or credibilities that may be more responsive to the actual experience as desired.

4. Development Model

This section deals more specifically with a number of the issues I described at the outset. How best can the actuary determine development factors in the absence of a long-term history under the deductible program? How can the actuary determine development patterns that reflect the diversity of both deductible size and mix? What is a reasonable approach for indexing deductible limits over time? How best should the process relate development for various limits consistently? Determining development factors for a high deductible program is really an exercise in partitioning development about the deductible limit. Is it possible to develop consistent tail factors among the limits the company is exposed to?

Some Possible Approaches

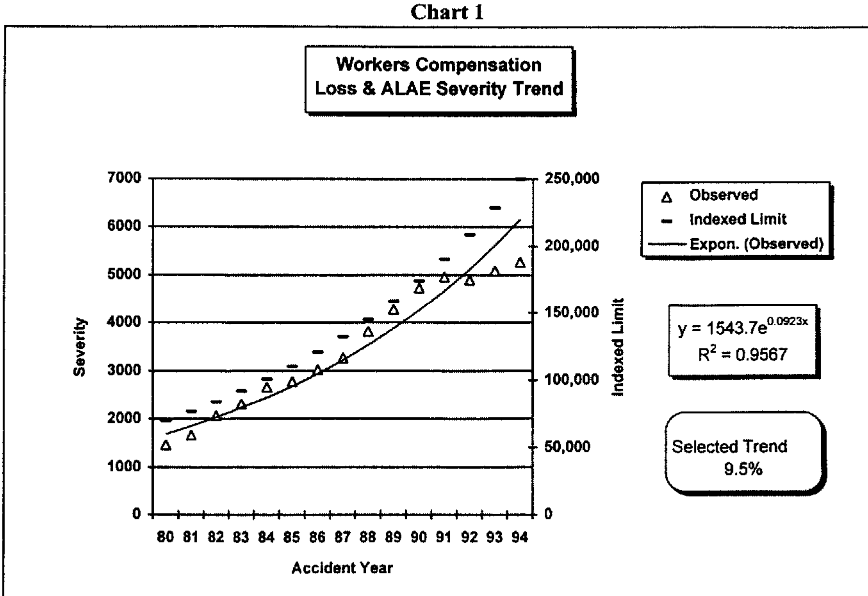
As I stated earlier, in the absence of long-term experience under the deductible program, I suggest making extensive use of a company's history of full coverage workers compensation claims, if available. It is also appropriate to apply an indexed limit to the claims in order to determine a series of accident year loss development histories by limit. In some of the analyses I performed, I looked at selected limits ranging from \$50,000 to \$1,000,000. I focused, however, on the more common deductible sizes in the neighborhood of \$250,000. I used case losses that included indemnity, medical, and any subject allocated claim expense. The histories I reviewed ran out for 25 years but were not further separated by account, injury, or state. That suggests eventually creating alternative development patterns that do reflect those types of break-out. I show in Table 2, age-to-age development factors by indexed limit resulting from my preliminary studies.

Table 2
Workers Compensation - High Deductibles
Limited Loss & ALAE Age-to-Age Development Factors
by Indexed Limit (Middle 6 of Last 8)

Limit	12:24 Months	24:36 Months	36:48 months	48:60 Months	60:72 Months
$50,000	1.5031	1.0418	1.0038	1.0025	1.0020
$100,000	1.6225	1.0727	1.0151	1.0063	1.0080
$250,000	1.6791	1.1300	1.0451	1.0207	1.0060
$500,000	1.6827	1.1393	1.0684	1.0322	1.0170
$750,000	1.6816	1.1408	1.0720	1.0359	1.0214
$1,000,000	1.6811	1.1411	1.0728	1.0371	1.0229
Unlimited	1.6876	1.1430	1.0749	1.0391	1.0196

In order to determine those development factors, I combined several years of experience based upon indexed limits. For example, for the most recent year, limits were used as stated. But for the first prior year, I adjusted limits downward by an indexing factor of 1.095. For the current year, I assumed a limit of $250,000 was the equivalent of a limit of $228,311 for the first prior year. Each limit was adjusted by the same index, back for as many years as needed, to generate the desired development factors.

Chart 1



I simply based the selected indexing factor of 1.095 upon a long-term severity history. As I alluded to earlier, other approaches may be better. Possibly varying the indexing factor by year or adjusting for the distorting effects of larger claims are but a couple of examples of improvements that could be explored. I show in Chart 1 the exponential trend line fit through known data points determining the long-term indexing factor of 1.095. Also depicted is the indexed $250,000 loss limit.

The approach I recommend requires separating claim count development from severity development. In my work to date I focused on the counts for full coverage losses rather than worrying about emergence of claims over a specific deductible limit. I feel it is much easier to recognize development in this fashion, as there is generally very little true claim count IBNR after about three years. This is true even for the larger claims, as they will be reported early on just like the other claims, but their true severity will not be known for some time.

Table 3
Workers Compensation
Age-to-Age Development Factors
Full Coverage Claim Count

Accident Year	12:24 Months	24:36 Months	36:48 months	48:60 Months
1988	-	-	-	0.9999
1989	-	-	0.9999	0.9994
1990	-	1.0026	0.9999	1.0001
1991	1.1111	1.0022	1.0002	-
1992	1.1305	1.0017	-	-
1993	1.1283	-	-	-
Last 3	1.1233	1.0022	1.0000	0.9998
Selected	1.1250	1.0025	1.0000	1.0000
Age to Ultimate	1.1278	1.0025	1.0000	1.0000

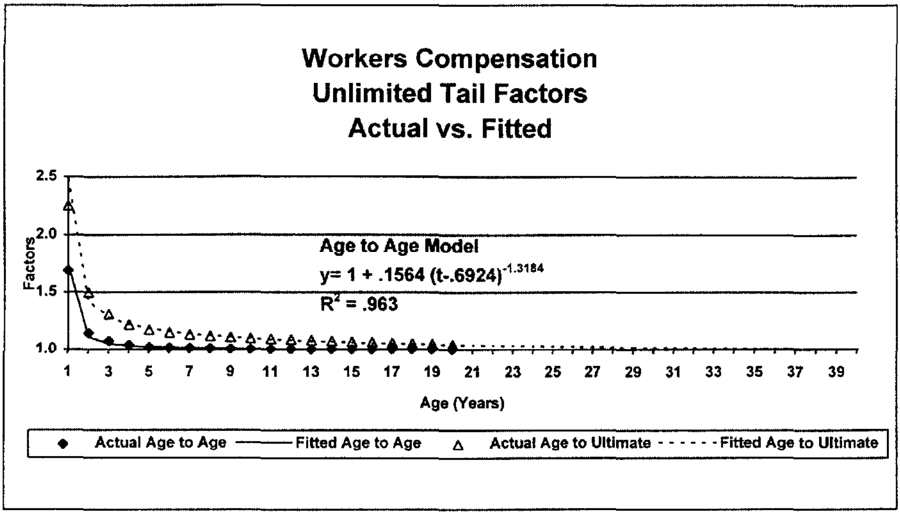
In order to handle the issue of how to develop limited losses to ultimate, I relied upon an inverse power curve recommended by Richard Sherman [3] to model the development arising in the tail. Specifically, I used a three parameter version of the curve depicted as follows:

(4.1) $y = 1 + a \cdot (t + c)^{-b}$

Again, my concern was to determine consistent tail factors by limit. Starting with the unlimited loss development and fitting an inverse power curve to known age-to-age factors allowed me to project ultimate unlimited losses. As the inverse power curve continues indefinitely, there is a need to select a time at which the projection should end. At this point I tied this approach to a similar method used for determining our full coverage tail factor that relies upon extended development triangles. That procedure suggested that I could get an equivalent result from the inverse power curve model by stopping its projected age-to-age development factors at 40 years. Compounding the age-to-age factors from the fitted curve leads to the desired completion or tail factors.

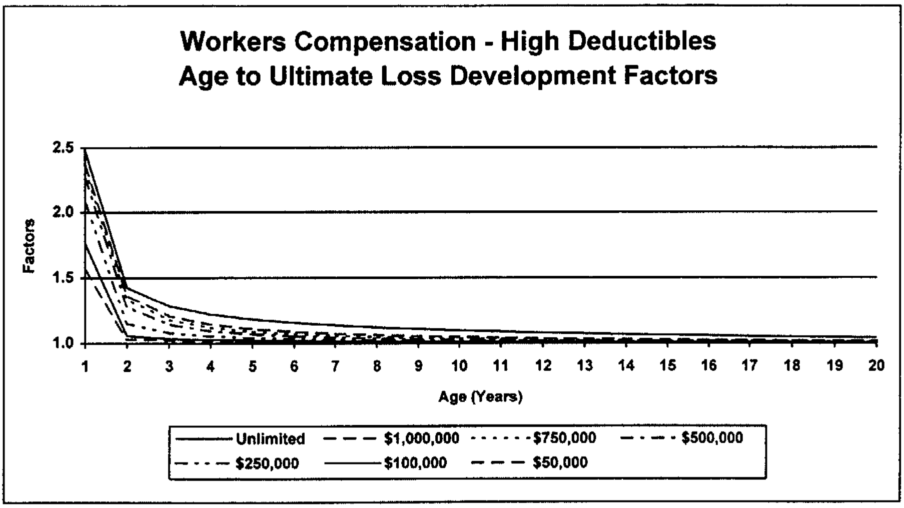
Once I set the ultimate age, I fit the inverse power curves to age-to-age factors for the various deductible limits under review and extended to that common maturity. Though this approach utilizes a consistent technique and generates uniformly decreasing tail factors, it is still an open issue whether the bias in extending all curves to a common maturity is significant or not. (At lower limits, development likely ceases well before forty years.) Chart 2 depicts the age-to-age model determined for the unlimited loss development.

Chart 2



In Chart 3 I show the pattern of age-to-ultimate limited loss development factors resulting from the inverse power curve model.

Chart 3



Another issue the actuary needs to be sensitive to is the relationship between loss development factors and limited severity relativities.[2] In some of my earlier efforts I attempted to uniquely develop losses by limit without regard to how they might relate to one another. This led to inconsistencies in development factors where completion factors for smaller deductibles, for example, sometimes exceeded factors for larger deductibles. Upon closer inspection, I found that any attempts to determine deductible development factors need to address the relationship between the full coverage loss development and severity relativities. The following formulas show the relationship between limited and excess development factors with the unlimited loss development and severity relativities.

(4.2) $$LDF^L = \frac{C}{C_t} \cdot \frac{S}{S_t} \cdot \frac{R^L}{R_t^L}$$

where L = Deductible Limit, C = Counts, S = Severity, R = Severity Relativity, and t = age

(4.3) $$XSLDF^L = \frac{C}{C_t} \cdot \frac{S}{S_t} \cdot \frac{\left(1-R^L\right)}{\left(1-R_t^L\right)}$$

where L = Deductible Limit, C = Counts, S = Severity, R = Severity Relativity, and t = age

[2] Limited severity relativities are defined simply as the ratio of the limited to unlimited severity.

Motivation for Relationship

(4.4) $LDF_t = R_t^L \cdot LDF^L + \left(1 - R_t^L\right) \cdot XSLDF^L$

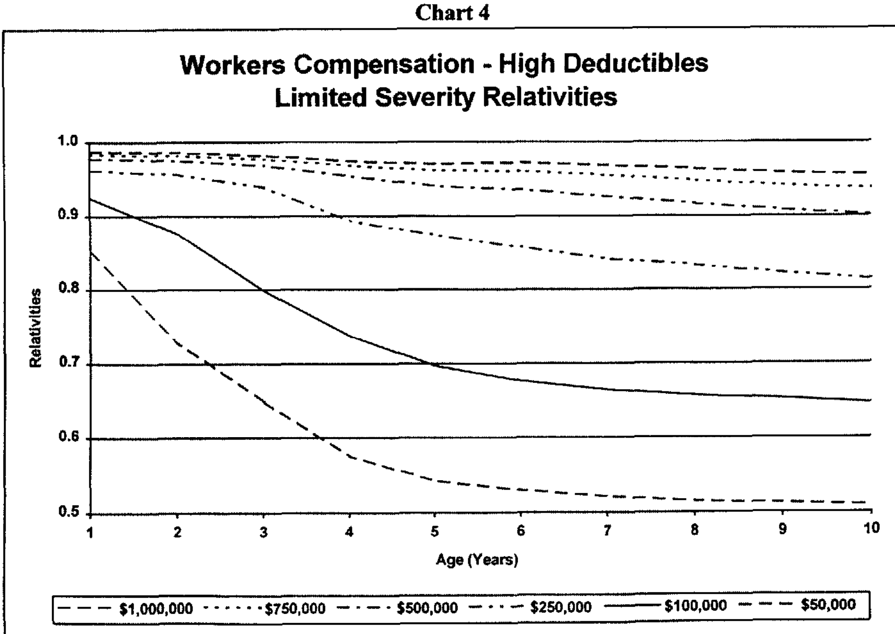
(4.5) $LDF_t = R_t^L \cdot \frac{C}{C_t} \cdot \frac{S}{S_t} \cdot \frac{R^L}{R_t^L} + (1 - R_t^L) \cdot \frac{C}{C_t} \cdot \frac{S}{S_t} \cdot \frac{\left(1 - R^L\right)}{\left(1 - R_t^L\right)}$

(4.6) $LDF_t = \frac{C}{C_t} \cdot \frac{S}{S_t} \cdot R^L + \frac{C}{C_t} \cdot \frac{S}{S_t} \cdot (1 - R^L)$

(4.7) $LDF_t = \frac{C}{C_t} \cdot \frac{S}{S_t}$

The motivation for these relationships results from the desire to partition total loss development in a consistent fashion between limited and excess development. I show in Chart 4 how the historical limited severity relativities ought to relate to one another and change over time.

Chart 4



In Table 4 I show age-to-age development about a $250,000 deductible limit.

Table 4
Workers Compensation
High Deductibles

Age-to-Age Loss & ALAE Development Factors
(Unlimited)

Accident Year	12:24	24:36	36:48	48:60	60:72
1989	1.7063	1.1756	1.0929	1.0359	1.0273
1990	1.8219	1.1574	1.0744	1.0387	-
1991	1.7724	1.1506	1.0737	-	-
1992	1.6912	1.1398	-	-	-
1993	1.6044	-	-	-	-
Average	1.7192	1.1559	1.0803	1.0373	1.0273

Age-to-Age Loss & ALAE Development Factors
($250,000 Deductible)

Accident Year	12:24	24:36	36:48	48:60	60:72
1989	1.7077	1.1598	1.0657	1.0221	1.0120
1990	1.7755	1.1509	1.0550	1.0247	-
1991	1.7734	1.1461	1.0643	-	-
1992	1.6750	1.1363	-	-	-
1993	1.6229	-	-	-	-
Average	1.7109	1.1483	1.0617	1.0234	1.0120

Age-to-Age Loss & ALAE Development Factors
(Excess of $250,000 Deductible)

Accident Year	12:24	24:36	36:48	48:60	60:72
1989	1.6646	1.6582	1.6742	1.1927	1.2011
1990	4.4890	1.3049	1.3151	1.2411	-
1991	1.7373	1.3115	1.3675	-	-
1992	2.2474	1.2291	-	-	-
1993	1.1684	-	-	-	-
Average	2.2613	1.3759	1.4523	1.2169	1.2011

In Table 5 I show relativities and their changes for the selected deductible limit.

Table 5
Workers Compensation
High Deductibles

Limited Severity Relativities
($250,000 Deductible)

Accident Year	12 Months	24 Months	36 Months	48 Months	60 Months	72 Months
1989	0.9675	0.9683	0.9553	0.9315	0.9191	0.9053
1990	0.9829	0.9578	0.9524	0.9353	0.9227	-
1991	0.9723	0.9728	0.9690	0.9605	-	-
1992	0.9717	0.9623	0.9594	-	-	-
1993	0.9593	0.9704	-	-	-	-
Average	0.9707	0.9663	0.9590	0.9424	0.9209	0.9053

Changes in Limited Severity Relativities
($250,000 Deductible)

Accident Year	12:24	24:36	36:48	48:60	60:72
1989	1.0008	0.9866	0.9751	0.9867	0.9850
1990	0.9745	0.9944	0.9820	0.9865	-
1991	1.0005	0.9961	0.9912	-	-
1992	0.9903	0.9970	-	-	-
1993	1.0116	-	-	-	-
Average	0.9955	0.9935	0.9828	0.9866	0.9850

Note how the change in limited loss development relates to the unlimited loss development. Also note how actual case loss development does not always conform to expectations, as the limited loss development factor sometimes exceeds the unlimited.

(4.8) $LDF^L = LDF \cdot \Delta R^L$

For example, for accident year 1993, moving from 12 to 24 months, a limited factor of 1.6229 is observed. That is equivalent to the unlimited loss development factor of 1.6044 compounded with the change in severity relativities for the same time period of 1.0116.

Note also the relationship of the excess development to the unlimited loss development for the same year.

$$(4.9)\quad XSLDF^{L} = LDF \cdot \Delta\left(1 - R^{L}\right)$$

There the accident year 1993 excess development factor of 1.1684 is equivalent to the unlimited development factor compounded with the ratio of the complements of the severity relativities moving from 12 to 24 months. (1.1684 = (1.6044) (1 - 0.9704) / (1 - 0.9593))

And, as desired, the weighted average of the limited and excess development factors using the relativity as the weight leads to the unlimited loss development factor.

$$(4.10)\quad LDF_t = R_t^{L} \cdot LDF_t^{L} + \left(1 - R_t^{L}\right) \cdot XSLDF_t^{L}$$

(Accident Year 1993: 1.6044 = (0.9704) (1.6229) + (1 - 0.9704) (1.1684))

Distributional Model - A More Promising Approach

Because of the concepts just described, this whole approach seems ideally suited for the application of some form of loss distribution model. That model helps to tie the relativities to the severities and consequently provides consistent loss development factors. Not only that, a distributional model easily allows for interpolation among limits and years, as needed.

The approach I propose models the development process by determining parameters of a distribution that vary over time. Once the distribution and its parameters are specified, it is possible to calculate the desired limited/excess severities. Comparing those severities over time leads to the needed development factors. Of course, care has to be exercised to recognize claim count development at earlier maturities.

For my work, I relied upon a Weibull distribution to specify the workers compensation claim loss distribution. That distribution has been commonly used for workers compensation claims and is familiar to actuaries working with distributional models. It is ideally suited for this type of work, as it gives a reasonable depiction of the loss distributions and is easy to work with.

Of course, the most difficult aspect of working with distributional models is estimating the parameters involved. There are various approaches that can be used, including Method of Moments as well as Maximum Likelihood. I tried an alternative approach that optimizes the fit between actual and theoretical severity relativities around the $250,000 deductible size. Specifically, I minimized the chi-square between actual and expected severity relativities to determine the needed parameters. I made use of a solver routine incorporated in Microsoft Excel's spreadsheet application, which allowed me to constrain the optimization routine in such a fashion that the parameters generated produced the actual unlimited severity at the specified maturity.

I show in Table 6 an example of results used to determine age-to-ultimate loss development factors by limit from 48 months to ultimate. I selected 48 months in order to focus attention on changes in severity rather than changes in total claim counts assuming no IBNR count development after 36 months. (Please see Appendix I for details.)

Table 6
Workers Compensation High Deductibles
Actual Versus Fitted Limited/Excess Development Factors (@ 48 Months)
(using a Weibull Loss Distribution)

Ultimate

Limit	Unlimited	$1,000,000	$750,000	$500,000	$250,000	$100,000	$50,000
			Observed				
Limited Severity	6,846.4	6,159.2	5,980.4	5,714.4	5,094.8	3,939.6	3,036.5
Relativity	1.0000	0.8996	0.8735	0.8347	0.7442	0.5754	0.4435
Excess Severity	0.0	687.2	866.0	1,132.0	1,751.6	2,906.8	3,809.9
			Fitted				
Limited Severity	6,846.4	6,295.2	6,106.5	5,778.7	5,064.4	3,926.7	3,043.8
Relativity	1.0000	0.9195	0.8919	0.8440	0.7397	0.5735	0.4446
Excess Severity	0.0	551.2	739.9	1,067.7	1,782.0	2,919.7	3,802.6
Weibull Parameters		Scale =	180.0	Shape = .2326			
		Mean =	6,846.4	Coefficient of Variation = 10.07			

48 Months

Limit	Unlimited	$1,000,000	$750,000	$500,000	$250,000	$100,000	$50,000
			Observed				
Limited Severity	5,530.2	5,346.6	5,288.5	5,182.3	4,824.0	3,807.5	2,937.1
Relativity	1.0000	0.9668	0.9563	0.9371	0.8723	0.6885	0.5311
Limited LDF	1.2380	1.1520	1.1308	1.1027	1.0561	1.0347	1.0338
Excess Severity	0.0	183.6	241.7	347.9	706.2	1,722.7	2,593.1
Excess LDF	-	3.7429	3.5830	3.2538	2.4803	1.6874	1.4692
			Fitted				
Limited Severity	5,530.2	5,380.5	5,301.4	5,142.5	4,722.4	3,894.0	3,144.1
Relativity	1.0000	0.9729	0.9586	0.9299	0.8539	0.7041	0.5685
Limited LDF	1.2380	1.1700	1.1519	1.1237	1.0724	1.0084	0.9681
Excess Severity	0.0	149.7	228.8	387.7	807.8	1,636.2	2,386.1
Excess LDF	-	3.6820	3.2338	2.7539	2.2060	1.7844	1.5936
Weibull Parameters		Scale =	305.7	Shape = .2625			
		Mean =	5,530.2	Coefficient of Variation = 7.35			

Lastly, the following formulation shows how expected development can be partitioned about the deductible limit.

$$(4.11)\quad \text{Expected Development} = 1 - \frac{1}{LDF_t}$$

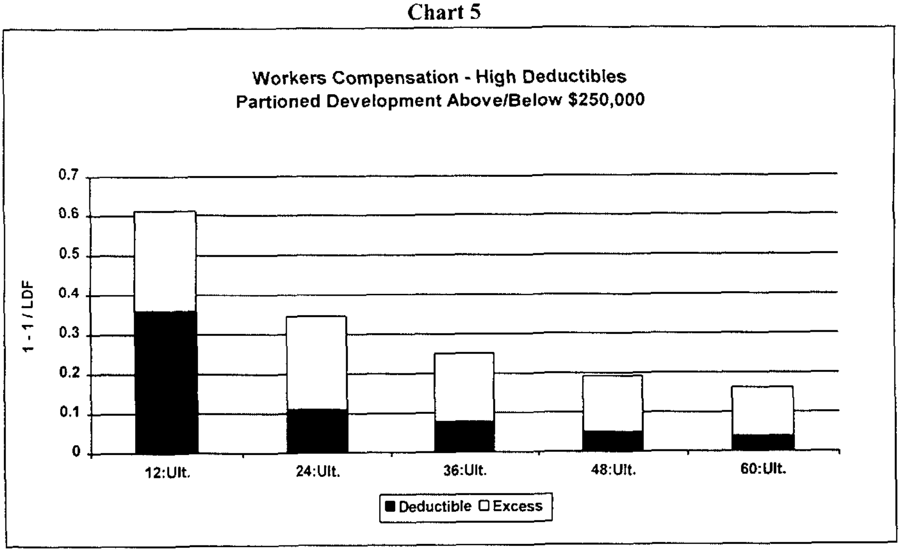
$$(4.12)\quad = \frac{LDF_t - 1}{LDF_t}$$

$$(4.13)\quad = \frac{R_t^L \cdot LDF_t^L + \left(1 - R_t^L\right) \cdot XSLDF_t^L - 1}{R_t^L \cdot LDF_t^L + \left(1 - R_t^L\right) \cdot XSLDF_t^L}$$

$$(4.14)\quad = \frac{R_t^L \cdot \left(LDF_t^L - 1\right) + \left(1 - R_t^L\right) \cdot \left(XSLDF_t^L - 1\right)}{R_t^L \cdot LDF_t^L + \left(1 - R_t^L\right) \cdot XSLDF_t^L}$$

I show graphically in Chart 5 partitioned development for a selected $250,000 deductible limit based upon the previously described Weibull loss distribution model. Note the changing proportions of development over time. Not unexpectedly, excess development represents the vast majority of development with increasing age.

Chart 5



5. Other Elements

Several other elements associated with high deductible plans call for further discussion: aggregate limits, service revenue and allocated claim expense. Determining sound estimates for those items involves a fair amount of complexity. In the following discussion I recommend using advanced collective risk modeling techniques to estimate losses excess of aggregate limits. I also suggest an alternative procedure using the NCCI Table M, if collective risk modeling is not considered practical. The asset for service revenue, though not as difficult to determine, however, depends upon prior estimates of losses for deductible/aggregate limits. Treating allocated claim expense in a similar fashion to loss simplifies the estimation process for that liability, but separating the two pieces is problematic.

Aggregate Limits

Some risks, besides choosing to limit their per occurrence losses, desire to limit all losses that they will pay under a high deductible program. Insurers satisfy that need by providing aggregate loss limits. Those limits are conceptually similar to maximum premium limitations used in retro rating plans.

Determining loss development factors for losses excess of aggregate limits is more complicated than for per occurrence limitations. However, the obligations arising from those aggregate limits are generally less significant than for per occurrence limits. Besides the additional complexity, the data needed to determine development factors for these limits is generally sparse and not likely to be very credible. Outside of actually attempting to gather data for development factors of this sort, I suggest making use of collective risk modeling techniques to determine the needed loss development factors. Such a model could utilize the loss distributions just described for the deductible limits in conjunction with selected claim frequency distributions.

I used a collective risk model described by Heckman and Meyers [4] to determine development factors for losses excess of aggregate limits. I show in Table 7 selected development factors using the same Weibull loss distribution I used previously to determine deductible development factors. I assumed a Poisson claim count distribution to model frequency. Though I did not incorporate any parameter risk in determining the development factors, the model does allow for that possibility. I refer the interested reader to a discussion by Meyers and Schenker [5] describing how to incorporate parameter risk into the collective risk model.

The sampling of development factors I calculated shows that development for losses excess of aggregate limits decreases more rapidly over time with smaller deductibles than larger ones. That is not unexpected as most of the later development occurs in the layers of loss above the deductible limits, which is not covered by the aggregate. Also, not unexpectedly, development is more leveraged for larger aggregate limits. There is one additional point the reader should note in reviewing Table 7. Though I show hypothetical results for risks of $1 million and $2.5 million in expected loss size, the limited expectations are considerably smaller.

Table 7
Workers Compensation High Deductibles
Development Factors for Losses Excess of Aggregate Limits
(Collective Risk Model Utilizing Weibull Loss Distribution)

Expected Unlimited Losses of $1,000,000

Aggregate Limit = 500,000

	12 Months		48 Months		Ultimate
Deductible	Excess Loss	LDF	Excess Loss	LDF	Excess Loss
$100,000	9,253.6	13.024	114,646.0	1.051	120,523.3
$250,000	22,882.5	12.007	228,070.7	1.205	274,761.6
$500,000	28,653.6	13.255	289,389.2	1.312	379,794.3

Aggregate Limit = 750,000

	12 Months		48 Months		Ultimate
Deductible	Excess Loss	LDF	Excess Loss	LDF	Excess Loss
$100,000	155.1	136.451	18,005.9	1.175	21,163.6
$250,000	1,844.9	63.845	84,475.1	1.394	117,788.5
$500,000	4,257.2	49.763	138,526.3	1.529	211,851.8

Aggregate Limit = 1,000,000

	12 Months		48 Months		Ultimate
Deductible	Excess Loss	LDF	Excess Loss	LDF	Excess Loss
$100,000	.8	2,242.750	1,274.7	1.408	1,794.2
$250,000	94.5	418.531	23,343.1	1.694	39,551.2
$500,000	494.5	213.275	57,471.2	1.835	105,464.6

Expected Unlimited Losses of $2,500,000

Aggregate Limit = 1,000,000

	12 Months		48 Months		Ultimate
Deductible	Excess Loss	LDF	Excess Loss	LDF	Excess Loss
$100,000	39,703.2	11.761	456,498.9	1.023	466,934.1
$250,000	81,084.7	10.876	759,354.4	1.161	881,844.0
$500,000	95,069.6	12.021	912,976.1	1.252	1,142,866.6

Aggregate Limit = 1,250,000

	12 Months		48 Months		Ultimate
Deductible	Excess Loss	LDF	Excess Loss	LDF	Excess Loss
$100,000	3,829.0	64.779	236,271.2	1.050	248,037.5
$250,000	17,740.7	36.191	522,364.3	1.229	642,046.5
$500,000	26,520.1	33.986	674,759.3	1.336	901,315.4

Aggregate Limit = 1,500,000

	12 Months		48 Months		Ultimate
Deductible	Excess Loss	LDF	Excess Loss	LDF	Excess Loss
$100,000	173.5	564.077	87,988.1	1.112	97,867.3
$250,000	2,693.1	158.522	318,464.5	1.341	426,916.3
$500,000	6,001.8	112.833	463,359.8	1.461	677,200.3

Given the volatility of losses excess of aggregate limits, I recommend using a Bornhuetter-Ferguson method to smooth out indications of ultimate liability. The example I show in Table 8 makes use of expected aggregate loss charges as well as expected development factors based upon the previously described collective risk modeling approach. The final indication adds together known losses excess of aggregate limits and IBNR based upon the modeled development patterns.

Table 8
Countrywide Insurance Enterprise
Workers Compensation High Deductibles
Estimated Ultimate Aggregate Excess of Loss
(Utilizing Bornhuetter-Ferguson Methodology)

	Known Loss (@ 48 Months)			Aggregate Excess of Loss		
Account	Deductible	Deductible	Excess of Aggregate	Expected	LDF	Indicated
Expected Unlimited Loss - 1,000,000; Aggregate Limit - 750,000						
A	100,000	581,252	-	21,164	1.175	3,152
B	250,000	703,027	-	117,789	1.394	33,292
C	500,000	764,493	14,493	211,852	1.529	87,789
Expected Unlimited Loss - 2,500,000; Aggregate Limit - 1,250,000						
X	100,000	1,453,169	203,169	248,038	1.050	214,980
Y	250,000	1,757,616	507,616	642,047	1.229	627,248
Z	500,000	1,911,285	661,285	901,315	1.336	887,963

An alternative approach for determining IBNR estimates for aggregate excess of loss coverage merits consideration. That procedure utilizes the NCCI methodology [1] for determining insurance charges in retrospective rating plans. I consider it a more practical approach than collective risk modeling, but its accuracy hinges upon determining the proper insurance charge table.

Essentially the IBNR is determined by subtracting insurance charges at different maturities. The process used to determine the ultimate insurance charge would be the same as that used for pricing purposes. The key to the NCCI procedure is the adjustment of expected losses reflecting loss limits. That adjustment increases expected losses used in determining the appropriate insurance charge table by use of the following formula:

$$(5.1)\quad \text{Adjustment Factor} = \frac{(1+0.8\cdot\chi)}{(1-\chi)}$$

where χ = per occurrence charge

The intent of increasing expected losses for the use of a per occurrence limit is to utilize a less dispersed loss ratio distribution and, consequently, a smaller insurance charge. Though this adjustment for a loss limit moves the selection of an insurance charge table in the right direction, the question remains whether it does so in an appropriate manner. Additionally, the procedure generates smaller insurance charges by the use of limited losses in the entry ratio calculation.

In order to calculate the insurance charge at earlier maturities I suggest determining the per occurrence charge used in the NCCI procedure by relating undeveloped, limited losses to ultimate, unlimited losses. For example, using the fitted results depicted in Table 6 for a 250,000 deductible leads to a per occurrence charge of 31 percent (1 - 4722.4 / 6846.4) at 48 months. Besides reflecting the impact of the limit, this approach also captures the effects of development. Again, the issue remains whether or not the adjustment for both the limit and development is appropriate.

I show in Table 9 a comparison of IBNR estimates determined using the NCCI Table M with estimates from the previously described collective risk modeling approach depicted in Table 8. I further detail IBNR estimates from the NCCI Table M in Appendix II.

Table 9
A Comparison of Aggregate Excess of Loss IBNR Estimates (@ 48 Months)
Collective Risk Model Versus NCCI Table M

Account	Deductible	Collective Risk Model	NCCI Table M
	Expected Unlimited Loss - 1,000,000; Aggregate Limit - 750,000		
A	100,000	3,152	1,809
B	250,000	33,292	38,500
C	500,000	73,296	68,811
	Expected Unlimited Loss - 2,500,000; Aggregate Limit - 1,250,000		
X	100,000	11,811	9,959
Y	250,000	119,633	103,000
Z	500,000	226,678	222,168

Service Revenue

A significant element that ought to be reflected on the asset side of the balance sheet is the revenue associated with servicing claims under a high deductible program. As I noted earlier, service revenue is generated in an analogous fashion to the use of a loss conversion factor in a retro rating plan. Generally, a factor is applied to deductible losses, limited by any applicable aggregate, to cover expenses that vary with those losses. In practice, however, other elements are captured by the loss multiplier, reflecting the desire of the individual accounts to fund the cost of the program as losses emerge. The service revenue is often collected as losses are paid, but it may also be gathered as a function of case incurred losses.

I propose determining the asset in the following fashion:

1. Determine ultimate deductible losses at the account level.
2. Subtract ultimate losses excess of aggregate limits from ultimate deductible losses.
3. Apply the selected loss multiplier to the difference determined in step 2 to determine ultimate recoverables.
4. Determine the total asset by subtracting any known recoveries from the estimated ultimate recoverables and aggregate results for all accounts.

Table 10 shows an example of how in practice the asset for the service revenue might be determined.

Table 10
Countrywide Insurance Enterprise
Workers Compensation - High Deductibles
Estimated Ultimate Service Revenue

Expected Unlimited Loss - 2,500,000; Aggregate Limit - 1,250,000; Loss Multiplier - 10%

	Ultimate Loss					
		Excess of	Net of	Multiplier	Known	
Account	Deductible	Aggregate	Aggregate	Revenue	Recoveries	Asset
X	1,465,376	214,980	1,250,396	125,040	96,960	28,080
Y	1,884,867	627,248	1,257,619	125,762	102,712	23,050
Z	2,147,711	887,963	1,259,748	125,975	106,912	19,063
Total	5,497,954	1,730,191	3,767,763	376,777	306,584	70,193

Allocated Claim Expense

There are two principal means of handling allocated claim expense under a high deductible program. Either the account manages this expense itself or it is treated as loss and subjected to applicable limits. In the first instance development patterns reflecting loss only would be appropriate for determining liabilities, while a combination of loss and expense is appropriate for the second case. For this discussion I determined development factors combining loss and expense components assuming expenses were equivalent to additional loss dollars. Though different development patterns are likely for loss and expense versus loss only, the gain in precision is likely not worth the effort.

A remaining issue is how best to split loss and allocated claim expense for financial reporting purposes. Though splitting them proportionately based upon their full coverage counterparts is expeditious, other more actuarially sound approaches, even if available, may not be cost justifiable.

6. Conclusion

I intended with this discussion to suggest some possible approaches for estimating liabilities under a high deductible program. As with many actuarial procedures, much work and improvement are still needed. I hope my suggestions provoke further discussion as to how to better estimate these liabilities.

Although the reader probably has many ideas to improve upon the suggestions I have made, I feel several stand out including:

- Obtain longer histories of experience under the program better reflecting risk characteristics.
- Derive (Select) parameters (distributions) that provide better fits to the actual data.
- Determine better tail factors and/or parameters of the utilized loss distribution.
- Develop more advanced approaches to index loss limits.

None of these are really unknown issues for actuaries, who have long been confronted with developing either limited or excess losses. The availability of more comprehensive data in a workers compensation program allows for the application of more sophisticated loss distributional approaches that affords greater consistency to all of the pieces involved. To that end I hope this paper provides a few steps toward developing sounder actuarial techniques for analyzing workers compensation high deductible loss development.

REFERENCES

[1] National Council on Compensation Insurance, *Retrospective Rating Plan Manual for Workers' Compensation and Employers Liability Insurance - Appendix*

[2] Bornhuetter, Ronald L., and Ferguson, Ronald E., "The Actuary and IBNR," *PCAS* LIX, 1972, p. 181

[3] Sherman, Richard E., "Extrapolating, Smoothing, and Interpolating Development Factors," *PCAS* LXXI, 1984, p. 122

[4] Heckman, Philip E., and Meyers, Glenn G., "The Calculation of Aggregate Loss Distributions from Claim Severity and Claim Count Distributions," *PCAS* LXX, 1983, p. 22

[5] Meyers, Glenn G., and Schenker, Nathaniel, "Parameter Uncertainty in the Collective Risk Model," *PCAS* LXX, 1983, p. 111

Appendix I

Weibull Distribution

1. Cumulative Distribution Function $F(x) = 1 - e^{-\left(\frac{x}{\beta}\right)^{\alpha}}$; where $x > 0, \beta > 0, \alpha > 0$

2. Probability Density Function $f(x) = \frac{\alpha \cdot x^{\alpha - 1}}{\beta^{\alpha}} \cdot e^{-\left(\frac{x}{\beta}\right)^{\alpha}}$

3. $E(x) = \beta \cdot \Gamma\left(\frac{1}{\alpha} + 1\right)$; where $\Gamma(\alpha) = \int_0^{\infty} x^{\alpha - 1} e^{-x} dx$

4. $LEV(x) = \beta \cdot \Gamma\left(\frac{1}{\alpha} + 1\right) \cdot \Gamma\left(\frac{1}{\alpha} + 1; \left(\frac{x}{\beta}\right)^{\alpha}\right) + x \cdot e^{-\left(\frac{x}{\beta}\right)^{\alpha}}$

LDF calculations about $250,000 deductible limit

Severities at ultimate
$\beta = 180.0; \alpha = .2326$

$$E(x) = 180.0 \cdot \Gamma\left(\frac{1}{.2326} + 1\right) = 6846$$

$$LEV(x) = 6846 \cdot \Gamma\left[\frac{1}{.2326} + 1; \left(\frac{250000}{180}\right)^{.2326}\right] + 250000 \cdot \left(e^{-\left(\frac{250000}{180}\right)^{.2326}}\right) = 5064$$

$$E(x) - LEV(x) = 6846 - 5064 = 1782$$

Severities at 48 Months
$\beta = 305.7; \alpha = .2625$

$$E(x) = 305.7 \cdot \Gamma\left(\frac{1}{.2625} + 1\right) = 5530$$

$$LEV(x) = 5530 \cdot \Gamma\left[\frac{1}{.2625} + 1; \left(\frac{250000}{305.7}\right)^{.2625}\right] + 250000 \cdot \left(e^{-\left(\frac{250000}{305.7}\right)^{.2625}}\right) = 4722$$

$$E(x) - LEV(x) = 5530 - 4722 = 808$$

$$LDF_{48} = \frac{6846}{5530} = 1.238$$

$$LDF_{48}^{250000} = \frac{5064}{4722} = 1.072$$

$$XSLDF_{48}^{250000} = \frac{1782}{808} = 2.205$$

Appendix II

Determination of IBNR for an Aggregate Excess of 1,250,000
Risk Characteristics: Expected Unlimited Loss - 2,500,000;
Severity - 6846.4; Frequency - 365.2

	48 Months	Ultimate
a. Severity: Deductible = 250,000	4722.4	5064.4
b. Frequency	365.2	365.2
c. Limited Loss: a • b	1,724,620.5	1,849,518.9
d. Entry Ratio: Aggregate / c	0.72	0.68
e. Loss Excess of Deductible: 1 - LEV(x) / E(x)	0.310	0.260
f. Adjustment for Limit: (1 + .8 • e) / (1 - e)	1.810	1.633
g. Adjusted Limited Loss: Expected Unlimited Loss • f	4,525,000	4,082,500
h. 1994 Expected Loss Group	19	20
i. Insurance Charge Ratio	.336	.369
j. Insurance Charge Amount: c • i	579,472	682,472
k. IBNR	682,472 - 579,472 = 103,000	

Actuarial Note on Workmen's Compensation Loss Reserves—25 Years Later

by Lee R. Steeneck, FCAS

Actuarial Note on Workmen's Compensation Loss Reserves - 25 Years Later

by LEE STEENECK

Abstract

In 1971 Ron Ferguson documented the annuity mathematics necessary to establish reserves for lifetime workmen's (now workers) compensation cases. This paper provides a quarter century update, complete with personal computer spreadsheet application to illustrate various features of a tabular reserving system. Since 1971 statutory aggregate amount and duration limitations have disappeared. Understanding the impact of inflation on catastrophic medical permanent and total disability cases is crucial from a reserving perspective.

Use of non-proportional reinsurance as a risk management tool is revisited. Layering of catastrophic claims is demonstrated, demystifying some oftentimes falsely held notions. Several illustrations provide some sensitivity analysis concerning the interaction of mortality and claim cost structure. Both indemnity and medical expenses are modeled by annuities.

An argument is made for the inclusion of escalation of indemnity (where applicable) and medical inflation within the annuity mathematics to provide a proper forecast of the individual gross loss and to layer that loss properly. This moves the "loss development" provision away from IBNR reserves and into case reserves, providing greater accuracy and clarity to experience. This applies to gross, retrocessional, and net claim reserves.

Since the reserve is a sum of future periodic payments (amount of future payment times probability of surviving to collect the benefit), an accurate discounting of the estimated payments is readily available.

Comparisons of company results with Reinsurance Association of America development statistics are shown, since traditional link ratio analysis has shortcomings. Traditional IBNR methods forecast insufficient future values on past loss events.

Actuarial Note on Workmen's Compensation Loss Reserves - 25 Years Later

Introduction

In 1971, Ron Ferguson[1] wrote an actuarial paper on the subject of establishing workers compensation periodic payment for life claims' reserving as a function of life insurance mathematical annuities. Annuitants receive specified payments for a period certain or contingent on their being alive. Survivor's benefits (in work related death cases) and Permanent Total Disability benefits are normally, statutorily provided for life, according to the laws of the various USA jurisdictions.

In the last two and one half decades workers compensation has undergone revolutionary change for at least the following reasons:

- increased weekly indemnity and medical expenses unrestricted in duration and amount,
- rapid inflation in wages and medical costs impacting all catastrophic claims,
- increasing use of expensive technology to sustain and enhance life,
- wider acceptance of the terms "reasonable and customary" in describing eligible treatments,
- attorney involvement,
- increased life expectancies (especially for catastrophically injured claimants), and

For these reasons, lifetime catastrophic medical cases in particular have a tremendous marginal financial effect on an insurer. These claims are infrequent and catastrophic, but can be effectively controlled through proper risk management and spread loss concepts associated with purchasing reinsurance (and retrocessions).

It is important to understand, properly analyze, and reserve catastrophic medical claims, otherwise there can be serious strategic real and opportunity costs associated with adverse development on the balance sheet, income statement, and inappropriate line operating policy. With escalation of indemnity in certain states and inflation on medical costs in all states, the workers compensation development "tail" can be "material" for well over 60 years if escalation/inflation on annual benefits and costs aren't annuitized into a claims forecasting model.

These impacts are to be modeled in this paper. By examining forecasted development, the insurer will be less reliant on IBNR reserves, can demonstrate client experience including claim specific anticipated development, and can properly value excess of loss layers as part of an effective risk management program through risk transfer to a reinsurer or retrocessionaire.

The reader is directed to Appendix 1 for a short, simple discourse on life tables and tabular reserving. Appendix 2 advances the treatment of tabular reserving to include increasing lifetime

[1] "Actuarial Note on Workmen's Compensation Loss Reserves", Ronald E. Ferguson, Proceedings of the Casualty Actuarial Society, LVIII, New York, 1971.

annuities and layering of claims, through both text and the application of a computer based reserving model. This Excel based model is available upon request. Snader[2] has also illustrated tabular claim phenomena.

Frequency of Catastrophic Medical Claim

To appreciate the infrequent but severe nature of these claims requires an understanding of the distribution of total indemnity and medical claims by type of injury. The NCCI has published[3] elements of the following chart of national average annual frequencies* and severities.

Chart 1

Type of Claim	frequency of Claim*	% Dist'n	Indemnity Average	Medical Average		Total Average	Total Cost	% Dist'n
Fatal	5	0.05	115,000	3,000		118,000	590,000	1.3
Perm total	20	0.20	186,000	135,350		321,350	6,427,000	13.7
Perm partial	750	8.00	24,000	4,071		28,071	21,053,000	45.0
Temp total	1,480	15.81	2,000	1,161		3,161	4,679,000	10.0
Medical only	7,102	75.90	0	1,976		1,976	14,036,000	30.0
Total	9,357	100.0	2,700	2,300		5,000	46,785,000	100.0

*per 100,000 workers. Some data derived.

The figure for permanent total disability (PTD) has been tripled to 20 to reflect subsequent (to NCCI accumulations) reclassification of claims from temporary to permanent total disability (PTD) status. *These incurred values incorporate the time value of money, lowering the cost* associated with fatal and catastrophic medical PTD cases.

A disproportional cost, 13.2% is associated with PTD claims (0.2%). Internal studies suggest that claims classified as PTD can be more finely divided into:

1) Largely indemnity oriented 15
2) Mix of indemnity/medical 3
3) Catastrophic medical cases 2 - i.e. - brain damage, spinal cord injury, serious burn cases

Consider a *"type 2)"* claim with a mixture of indemnity and a moderate amount of ongoing annual medical.

[2] "Reserving Long Term Medical Claims", Richard H. Snader, Proceedings of the Casualty Actuarial Society, LXXIV, New York, 1987.
[3] Statistical Abstract, National Council on Compensation Insurance, Boca Raton, Florida, 1995 edition.

The annuity model - sensitivities

The following illustrate several analyses of the impact inflating annuities have on claim reserves. Chart 2 displays a reserve comparison for a 30 year old male claimant, where the insurer has annuitized $10,000 of fixed indemnity per annum, but has not annuitized medical expenses of $5,000 per year for life subject to 5.5% inflation (choosing instead to post a $100,000 reserve). Annuitizing and inflation drive the claim beyond the claim adjuster's point estimate.

Chart 2

Age 30 claimant	Uninflated, Indemnity only Annuitized		Annuitizing both, inflation on medical	
Indemnity/Medical	I= 484,002	M=100,000	I=484,002	M=1,254,248
Case incurred	sum=584,002		sum=1,738,250	

Inflation driven reserves will "develop" upward over the lifetime of the medical claim unless an inflation forecasted annuity reserve replaces the uninflated reserve on the insurer's records.

Chart 3 displays this same claim, except that the insurer has annuitized the medical, but not subjected it to inflation of 5.5% per annum. While the annuity reserve is better than the previous point estimate, consideration of inflation in a quantitative way is crucial for an accurate forecast.

Chart 3

Age 30 claimant	Uninflated Annuitized Claim		Annuitizing both, inflation on medical	
Indemnity/Medical	I=484,002	M=242,001	I=484,002	M=1,254,248
Case incurred	sum=726,003		sum=1,738,250	

There are **4 factors** which drive catastrophic average claim values: Life expectancy trends, annual costs of acute and maintenance care, economic inflation, and technological/societal changes. Not only can fixed periodic indemnity be viewed as an annuity, but so can predicted annual inflating medical expenses, as the above example illustrates.

➊ Mortality

Life expectancies have been improving in each decade this century according to USA census statistics[4]. In 1900 the expectation of life was 49 years; in 1960 it was 70 years; in 1970 it was 71 years; in 1980 it was 74 years. And for persons born in 1990, the life expectancy is 75+ years. Improvements are comparable between male and female and by race. Health care, technology, and nutrition have continually improved. PTD workers compensation claimants have presumably benefited as much as the general population.

The distribution of PTD claimants is within a spectrum of whole-life to impaired-life categories. Most PTD claimants have little, if any maintenance medical costs or a medical condition affecting life expectancy. Comatose or ventilator dependent brain damage (BD) or spinal cord injury (SCI)

[4] Vital Statistics of the United States, National Center for Health Statistics, Public Health Service, Washington, D.C., 1994 edition.

claimants have significant medical and rehabilitation acute and maintenance costs with adverse medical conditions affecting life expectancy.

SCI claimant life expectancy depends on: sex, the level of lesion of the spine, age at date of onset and years since onset (a select period, perhaps 1 year, before ultimate mortality rates again apply). There has been a dramatic improvement in all such life expectancies since the 1940's (initially studying soldiers and civilians).

The following chart displays the results of 2 studies conducted on SCI patients, at US Veterans Hospitals[5] and at Lyndhurst Lodge Hospital, Toronto[6]. Patients were classified as either Complete or Incomplete, relating to the degree of lesion, and Paraplegic or Quadriplegic (Tetraplegic), relating to the degree of mobility and vertebrae affected. Quadriplegics have injuries to the upper cord/vertebrae C(ervical)1 - C8. Many are on ventilators and exhibit complete quadriplegia with *significantly* reduced life expectancy. As an aside, actor Christopher Reeve is a C-1,2 quadriplegic. Paraplegics have injury to T(horacic)1 - T12. Paraplegics have some use of arms and upper chest.

The Veterans study encompassed 5,743 patients admitted between 1946-55. The 3 Lyndhurst Lodge studies followed 1,510 patients between December 1973 - 1980, representing application of newer medical technologies.

The figures are multipliers, percent increase in annual mortality. Owing to improvements in technology, it would be prudent to provide for further improvements, perhaps averaging **160%** for paraplegics and quadriplegics and **600%** for Complete ventilator quadriplegics. We apply *these figures to population mortality as a proxy for higher figures applying to select employed or* insured mortality.

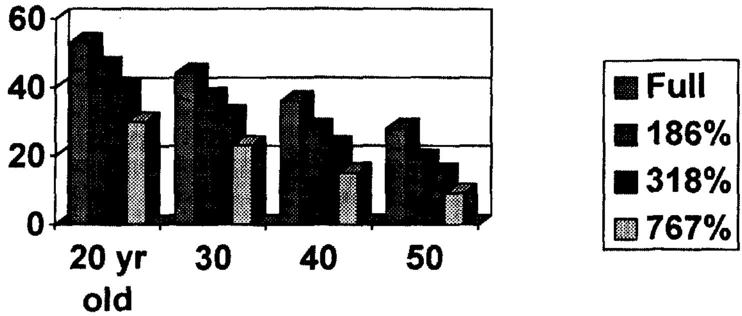
Studies also suggest that that mortality varies most during the 1-3 years after initial onset, then continues at much improved levels for the remainder of life, with mixed results at older ages. The leading causes of death are: heart disease, pulmonary embolism, suicide, and renal disorders.

Chart 4		Complete			Incomplete	
Study, % of annual mortality		Para	Quad		Para	Quad
US Veterans Hospitals		600-900	1400-2900		250-520	620-840
Lyndhurst Hospital		318	767		186	209

Translating the Lyndhurst Hospital study into life expectancies for various aged persons at onset (after an initial acute period of 1-2 months) shows declining life expectancies of:

[5] Burke, Hicks, Robins, Kessler, "Survival of Patients with Injuries of the Spinal Cord", Journal of the American Medical Association, 1960.
[6] Geisler, Jousse, Wynne-Jones, Breithaupt, "Survival in Traumatic Spinal Cord Injury", Paraplegia, International Medical Society of Paraplegia, 1983. Also Canadian Medical Association Journal, 1961, 1968.

Graph 1 - LIFE EXPECTANCIES by impairment



● Medical Cost Structure

It is "best practice" to consider the periodic, fixed, lifetime payment of wage replacement or more commonly, indemnity, as an annuity and to establish a case basis reserve using actuarial life-tabular techniques (described in Appendices 1, 2). Periodic, albeit unfixed in amount ongoing medical expenses can be viewed similarly, but as an increasing lifetime annuity.

Consider the paraplegic's needs and benefits provided. Acute hospital care and rehabilitation in the first 2 months currently cost approximately $US 90,000. Add maintenance costs of $10,000 for the remainder of the year, remodel the patient's home, suitably equip a car for a disabled driver, and buy pertinent equipment and this adds another $25,000. During the first 365 days after onset, this amounts to $125,000 in 1996 US dollars.

In year two, evaluations, upgrading, and maintenance add $60,000 of costs. Thereafter, costs of maintenance, depending on whether the injury is incomplete or complete, add $7,000 and 27,000 respectively, again in 1996 dollars. These will be subject to inflationary pressures as well as cost containment measures.

The following chart displays the medical cost structure for a well managed case. Without case management techniques costs increase.

Chart 5

$US 000	Para-	Quadriplegic or Tetraplegic			Brain Damage		Serious 3rd degree Burns	
	plegia T1-12	C5-8	C4	Venti-lator	Comatose Vegetative	Other	Up to 1/3 of body	Up to 2/3 of body
First year	125	260	270	500	250	300	450	1,000
Second year	60	100	150	240	210	130	90	150
Next years	7 or 27	100	125	240	210	50	2	2

● **Indemnity and Medical Inflation**

One year after the Ferguson paper was printed in the PCAS, a Presidential Commission made essential recommendations (1972) to improve and upgrade WC laws. Perhaps the two most expensive recommendations were to: (1) remove time and aggregate amount limitations on both medical and indemnity benefits in lifetime cases, and (2) account for the loss of purchasing power by increasing indemnity benefits to prior claimants per year, based on statewide inflation in wages. This meant providing an increasing annuity on both indemnity (termed escalation of indemnity, on PTD and fatality cases) and unlimited medical expenses. Both incorporate decades of inflation on wages and on services purchased for permanently disabled claimants.

Appendix 3 charts the current status of state laws as respects escalation of indemnity and who will provide and fund the benefit.

Our recent studies of macroeconomic trends in the United States suggest that **future** indemnity escalation, tied to wage inflation, could average 4.0% per annum indefinitely. While annual medical inflation has exhibited wide swings in recent decades, we estimate that the long-term rate could average 5.5% per annum. This includes expected inflation rates in professional service fees, drugs, equipment, and hospital/custodial care, provided during the maintenance period of a catastrophically injured claimant's life. Other individuals have come to similar conclusions.

An article in Best's Review[7] updated the Masterson composite inflation time series and found the 10 year ending workers compensation claims cost trend per annum to average 5.6% (while the series of CPI All Items increased 3.6% per annum). A similar figure was cited by the NCCI at its Annual Meeting in April, 1995 for medical inflation during 1991-1993. Gary Venter conducted a study[8] of WCRB mostly catastrophic claims and stated, "Medical payments were inflated 4% each year in all states, which probably is too conservative".

As an aside, the price of the average Ford motor vehicle has risen from $3,579 in 1970 to $14,046 in 1995. This is a compound average growth rate of 5.6% per annum. During this same time period, average income increased 5.5% p.a. from $9,867 to $37,526, while the price of a first class US postal stamp increased 7% p.a. from 6 to 32 cents.

● **Technology**

Technological inflation also affects this catastrophic claimant population. Clearly, the replacement of a worn, old technology manual wheelchair with a new electric one has costs outstripping economic inflation. Similarly, using computerized medication pumps versus oral ingestion is more expensive, if not more assured a method of treatment. Conversely, previously accepted treatments of electrical stimulation of muscles have not proven to be therapeutic, so these services are not being continued. It is probable that one of the differences why medical inflation is approximately 200 basis points in excess of *All Item* averages lies in specialization and technology.

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[7] Van Ark, William, "Gap in Claims Cost Trends Continues to Narrow", Best's Review, March, 1996.
[8] Venter, Gary G., "An Excessive Claim Tail", Best's Review, November, 1992.

Use of discount

The time value of money, investment income on funds withheld between premium collection and the stream of catastrophic loss payments, also must be considered in a competitive environment. A reasonable and accepted statutory rate in use today for reserving purposes is 4.5%. The actuarial reserve can be a discounted loss cash flow to present value in establishing the balance sheet liability. While discounting of tabular indemnity is expressly allowed by the NAIC, the statutory insurance regulatory body, one must receive domiciliary state approval to discount tabular medical reserves. Cash flows on medical expenses are less certain. Risk based capital calculations charge surplus immediately for medical discount to be recaptured into reserves.

While it is tempting to inflate $1 of indemnity owed next year to $1.04 and add it to $1 of medical owed next year, inflated to $1.055 = $2.095 and present value at 4.5% to $2; there is considerable value in isolating each component, rather than netting them to the negligible impact shown. Forecasting nominal losses by layer and then discounting provides the actuarially correct practice.

The annuity model - additional sensitivities

The following illustrate how age and impairment status affect gross claim values. Chart 6 displays six 1996 impaired-life male claim comparisons where the insurer has annuitized $10,000 of fixed indemnity per annum and average annual medical payments of:

Paraplegic $125,000 in year 1 following injury, $30,000 per annum thereafter,
Quadriplegic $500,000 in year 1 following injury, $240,000 thereafter.

Medical payments are subject to 5.5% inflation in the comparison. The age and injury effect on valuation is considerable.

Chart 6

	Impair	Uninflated Indemnity/Medical		Indemnity + Inflated Medical	
Age	Pctg.	Paraplegic	Quadriplegic	Paraplegic	Quadriplegic
20					
	160	2,150,647		11,474,453	
	600		8,509,994		32,413,203
40					
	160	1,514,210		4,197,103	
	600		5,913,128		12,953,894
60					
	160	852,209		1,381,689	
	600		2,800,094		3,810,864

Chart 7 displays the single highlighted claim above, except that the annuitized medical payments have been examined under differing medical inflation rates.

Chart 7

Age	Impair Pctg.	Uninflated Paraplegic	Indemnity + Inflated Medical 4%	5%	6%	7%
40						
	160	1,514,210	2,997,735	3,733,921	4,739,455	6,123,483
	600					

In some sense, future values are intimidating, if not misleading. The economic consequence or statutory rated, discounted valuation figure is useful.

Chart 8

Discounted Value*	807,242	1,246,927	1,440,247	1,690,585	2,017,776

*$125,000 first year medical+10,000 indemnity + present value of reserve

Let us also examine the outcome of this case should the state law mandate escalation of indemnity. Chart 9 illustrates the incremental impact that 4% escalation of indemnity has. Discounted values at 4.5% are also given.

Chart 9

	Uninflated Indemnity/Medical		4% Inflated Indemnity + 5.5% Inflated Medical	
Paraplegic	Indemnity	Medical	Indemnity	Medical
40 year old				
160%, Nominal	352,566	1,161,644	877,515	3,814,097
Discounted Value*	169,506	637,736	321,054	1,382,705

*$125,000 first year medical+10,000 indemnity + present value of reserve

The impact of the infrequent catastrophic medical PTD case can be managed through the purchase of excess of loss, also called non-proportional (hereinafter called N-P) reinsurance.

Reinsurance theory - diversification of risk and layering

Reinsurance (and retrocessions for reinsurers) is basically a method for diversifying risk. The reinsured companies pool ceded premiums and losses in a reinsurance company with the objective of smoothing their year to year profitability, making their net exposures more homogeneous and losses less volatile. In a "fair" transaction, the ceding company pays its own losses, its share of the overhead incurred by the reinsurer, and a small margin which allows the reinsurer to attract the capital it needs.

Generally, reinsurance rates can be responsive to a company's loss experience only to the extent that experience is predictive of future outcomes. This is most often true for working layers (layers which experience high claim frequency). This allows the reinsurer to use recent experience to forecast future outcomes within a tolerable level of accuracy. By incorporating anticipated inflation of annual costs into the claims reserving process, frequencies are enhanced as claims are forecasted into upper layers soon enough to be featured explicitly in client ratemaking.

Many reinsurance professionals believe that WC losses under $1,000,000 comprise the frequency driven area. Recall the distribution of losses by injury type and cost from Chart 1. N-P reinsurance purchased in layers (mostly above $100,000) up to $1,000,000 are said to be "working layers" of meaningful frequency. These N-P claims are certainly to involve fatality cases with lifetime survivor's benefits and claims for lifetime PTD benefits and medical expenses. But *with medical inflation and escalation of indemnity, working layers extend to $2,000,000 for* moderately sized companies. Catastrophic or "non-working" layers are expected to respond rarely, as in the case of the catastrophic medical case or the multiple person occurrence over high retentions.

A typical reinsurance program for a mid-size insurer could be layer rated as follows:
I. 5-year Adjustable Premium featured reinsurance in the amount of $800,000 xs 200,000
II. Guaranteed cost excess reinsurance in the amount of $1,000,000 xs 1,000,000
III. Guaranteed cost excess reinsurance in the amount of $8,000,000 xs 2,000,000

The first layer could have an expectation of 10 losses of $4,000,000 annually, or 50 losses over a 5 year period. The **net premium to limits** relationship or "**balance**" is 5:1. (Balance is a proxy for frequency and varies directly with the credibility assigned to the expected experience.) The cedant would be diversifying its losses chronologically over time and (1) the premium retained by the reinsurer would incorporate little profit and risk charge, (2) the cedant would be paying for his own losses, (3) the probability that losses were significantly above 50 would be low. There would be little overall process risk and a moderate amount of parameter risk reinsured.

Think of process risk by way of rolling a pair of fair dice. On one roll the range is 2-12 and it would be expensive to reinsure "excess 8" a 10/36 chance. After 50 rolls, the sum is very likely to be near 50 x 7 = 350. It is much less likely than 10/36 to roll a sum over 400 = 50 x 8. The process tends toward the mean with repetition. Financial theory suggests that process risk which can be diversified deserves no risk charge. In reinsurance we also consider parameter risk, since we can only guess that the dice are fair. If we mis-parameterize our pricing and reserving models we risk the "winner's curse". We would then only win business where we estimated expected losses below our competitors, most likely below the cost of providing the reinsurance. In WC reinsurance, we are making 60+ year estimates on the application of state law, medical inflation and technology, and the earning ability of assets on the balance sheet. WC reinsurance has perhaps the longest term risk on its *promise to pay* of all property and casualty lines of business.

A small insurer may have a similar program but with guaranteed cost premium for this first layer since the expected 5 year frequency may be too small to be self rated. The annual loss expectation might be 1 @ $480,000 and the balance would be low at 0.6:1. In this case, because of expected volatility, the insurer is seeking to diversify its risk against the portfolio of his reinsurer. A class and state sensitive guaranteed cost book rate is charged which reflects the cedant's specific risk profile. The occurrence of a loss to a specific reinsured does not give cause to reexamine the rate for the reinsured, but is incorporated into the portfolio rate analysis for the reinsurer's book of business.

Generally, if the balance is >5:1 the layer rating implies diversification over time. If the balance is <3:1 the results should be diversified across the portfolio of clients. Balances between 3 and 5:1 leave room for judgment. Stated another way, balance is a metric for predictability.

The second layer is likely sold as a diversification against the reinsurer's portfolio of similar risks presented by all its cedants. The reinsurer may price this layer to produce process and parameter risk adjusted profits per annum or over a multi-year horizon in an underwriting cycle.

The third layer is likely also sold as a diversification against a reinsurer's portfolio of risks presented by all its cedants. The reinsurer may price this catastrophe layer to produce greater process and parameter risk adjusted profits over an underwriting cycle of 3-10 years. A large reinsurer may be able to lower the process risk charge by passing through its favorable "retro" terms.

Let us examine several claims within the noted layering structure.

Chart 10 - ANNUITY VALUES of claims

	Widow receiving $10,000 p.a.				Widow receiving $25,000 p.a.		
Age	**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**		**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**
20	434,385	0	0		782,432	596,780	4,240
30	337,948	0	0		760,908	379,916	0
40	243,753	0	0		709,710	192,239	0
50	155,253	0	0		603,883	61,482	0
60	80,950	0	0		444,356	4,526	0

With our mortality tables going up to age 103, a widow age 20, receiving $10,000 per annum has no opportunity to survive long enough to receive an aggregate amount extending beyond the frequency layer. However, at an annual $25,000, there is significant probability that she will live 1,000,000/25,000 = 40 years, so that $1 M xs $1 M is a working layer for higher indemnified widows. There is a small probability that she will survive 80 years and attach to the third layer.

The 4.5% present value of that series of probabilistic payments at ages 101, 102, and 103 which total $4,240 is merely $120. Similarly, the 4.5% present value of the 1 M xs 1 M claim to the 20 year old of $596,780 is $57,704.

Let us now reexamine the 40 year old paraplegic in this layering structure (previously noted in Chart 6 as a gross loss). As expected, inflation drives the developing claim higher into the layers, to the point that the ceding company may actually completely exhaust the reinsurance, should the claimant survive toward the terminal age of 103. The distant payments, however, have the deepest discount to present value.

Chart 11

Age	Indemnity = 10,000 Medical = 125,000; then 30,000				Same figures, but including 5.5% medical inflation			
40	**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**		**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**	**xs10,000**
Nominal	746,432	545,040	23,083		761,709	856,132	2,329,306	50,297
Discounted Value	464,892	142,669	2,549		517,727	348,096	489,936	4,269

Reinsurance (and some retrocessional) treaties have claim reporting triggers that depend both on (a) amount of claim payments + company valued reserve and/or (b) injury type. Brain damage, serious burn, and SCI cases may be reportable under the injury criterion, even if uninflated claims reserves would not appear to breech the amount being >1/2 of retention criterion.

In the case cited above, the gross uninflated loss to the **reinsurer** writing 9800 xs 200 as highlighted sums to $1,314,555. This would trigger the amount criterion if the **retrocession** were attaching excess 1,800,000 (8 xs 2 M retroceded) but would not it the reinsurer were retaining more than $2,629,110. The reinsurer would likely place the retrocessionaire on notice that a potentially attaching claim had been made, but might not advise of loss amount - instead relying on an *incurred but not reported* loss provision when compiling ceded experience. By including inflation and by layering the loss, this reserving (IBNR) issue can be better framed.

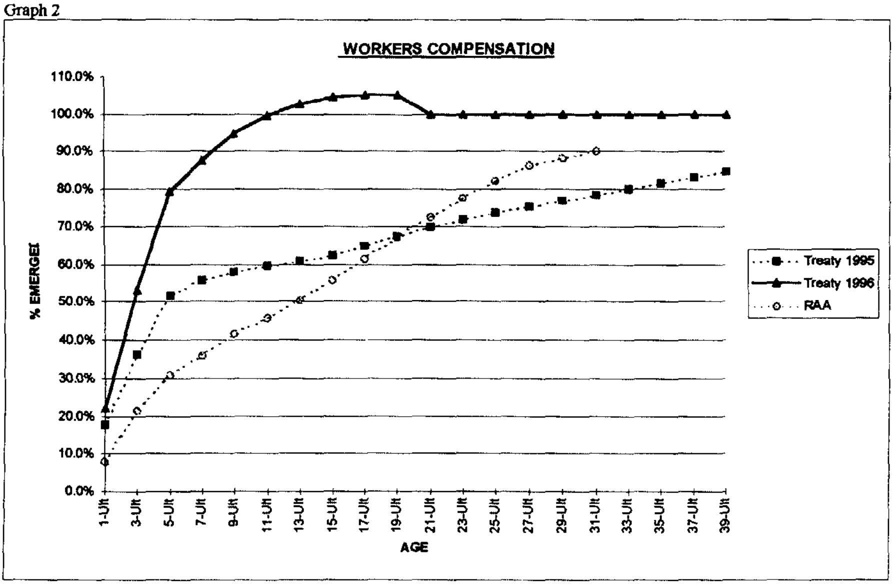
N-P (Xs) Reinsurance Claims Emergence

While the examination of individual claims provides a microcosm for understanding the various features of a workers compensation annuity based reserving system, it is also useful to view the macrocosm of the mixture of cedant layers, types and amounts of claims, over inflationary decades of maturing accidént years. We will compare (a) the annuity case driven model (which isolates strictly IBNR claims) with (b) current non-inflationary practice applied to our company figures and (c) the mixture of reserving practices employed by members of the RAA and examined in Reinsurance Association of America Historic Loss Development Study[9].

Traditional chain ladder techniques, employing link ratios, typically neither capture 60+ years of empirical evidence in the "triangles" actuaries use, nor will they forecast lifetime inflating payments due to prior statutes' limitations on benefits.

[9] Reinsurance Association of America: Historic Loss Development Study, Washington, D.C., 1995 edition.

Graph 2



This graph compares RAA accident year claims amount emergence by development age to our company's net claims emergence, both on a pre-inflation 1995 driven annuity case reserve structure and 1996 post-inflation driven reserve basis. The RAA emergence is neither as quickly reporting in the initial 20 years nor as tail data driven in the emergence from 29-ultimate.

The 1996 emergence exceeds ultimate during a period where settlement savings exceed strict IBNR emerging into known claims reserves. It is expected that at year 20 of an accident year's development, all claims are reported and reserved with inflation at unbiased amounts. Any residual development, up or down, is expected to be immaterial.

Values underlying Graph 2 can be found in Appendix 4. The RAA values for ages 1-29 as well as the stated "tail" come from the RAA graph and data.

Findings

- The average gross loss does not capture the distribution of possible outcomes. This distorts thinking about risk management and the role non-proportional reinsurance can play.
- Since carried reserves are oftentimes discounted for the time value of money, the size of loss is further distorted.
- Tabular mathematics impacts layering in oftentimes non-intuitive ways, especially that lower layers need not fill up fully before a higher layer becomes liable.
- Inflation is a driver of catastrophic medical PTD claims; that due to decades of compounding inflation, an annual rate of inflation is magnified into a compound rate on the claim.
- Escalation of indemnity, where applicable, also drives claim values, and that when medical and escalating indemnity are present, claims values are further compounded.
- Inflation captured in an IBNR reserve is not best practice, since individual claims are not properly forecast and chargeable to the (re)insured and don't layer properly.
- Historical inflation in loss triangles (and probably in IBNR forecasts) may not replicate future inflation rates, biasing the forecast, unless adjustments are made.
- Loss development in tabular cases can be forecast, although medical expenditures in the last years of life are highly volatile.
- Utilization of medical services can be cost controlled, somewhat offsetting medical inflation, but in some PTD claims, once relatives of a catastrophically injured claimant are unable or unwilling to care for the claimant, custodial costs act to increase case development considerably.
- Claims emergence to non-proportional reinsurers can be accelerated, with considerable informational and medical management value.

Appendix 1 **Tabular Reserving, a Primer**

Actuaries compile mortality tables by analyzing annual probabilities of surviving to one's next birthday. These are conveniently and **simply** portrayed in tabular form, such as the simplistic illustration given in Chart 12. Column 2 illustrates mortality detail from ages 90-100 expected from 100,000 births.

Chart 12

Age (x)	**Living population (lx)**	**# payments at $1 per annum**	**Cumulative Payments/EOY**	**Remaining Payments/BOY**
0	100,000 births			
and so on to	....			
90	10	1,1,1,1,1,1,1,1,1,1*	10	55
91	9	1,1,1,1,1,1,1,1,1	19	45
92	8	1,1,1,1,1,1,1,1	27	36
93	7	1,1,1,1,1,1,1	34	28
94	6	1,1,1,1,1,1	40	21
95	5	1,1,1,1,1	45	15
96	4	1,1,1,1	49	10
97	3	1,1,1	52	6
98	2	1,1	54	3
99	1	1**	55	1
100	0			

If we equate a year of life from age 90 to $1.00, then Columns 3, 4, and 5 illustrate the individual (End Of Year) and aggregation of (Beginning Of Year) $1 payments-to-go, contingent on reaching a particular birthday. At the margins:

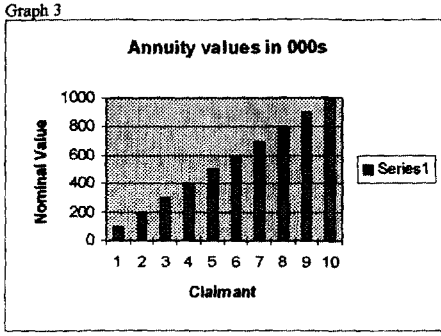
- *One person dies between his 90th and 91st birthday, receiving $1 in benefits only,
- **One person dies between his 99th and 100th birthday, receiving $10 in benefits (vertical highlighted column).

While no 90 year old can know in advance his particular life span, on average, this illustration portrays it as 5.5 years. The sum of lives (l_x) for "x" from 90 to 100 divided by (l_{90}) is the life expectancy of a ninety year old. The life expectation for payment is $5.50 per person.

Suppose each 90 year old begins getting a $100,000 pension on his 90th birthday and each surviving birthday thereafter. Again, no one can know his/her actual life span, so the following Graph 3 illustrates the amounts the annuity provider will pay to the 10 annuitants. The provider will establish a reserve based on Series 1 with: $100,000 x (55/10) = $550,000 for each claimant, or $5,500,000 in the aggregate.

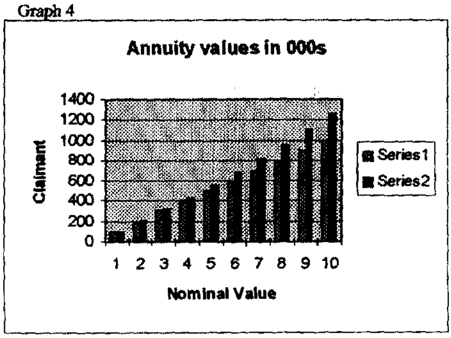
It is worthwhile to note that the variability around the $550,000 mean value will become very important when pensions are stratified, for example, into the $200,000 wide bands as illustrated.

Graph 3



Were this to be a 5% per annum increasing annuity, a Series 2 of actual annuity values would be paid. This illustrates, Graph 4, the compounding effect annual inflation has on a series of inflating payments. Appendix 2 will describe the higher level annuity mathematics necessary to perform various computations.

Graph 4



If Series 1 were to be "layered" for reinsurance and retrocession, the annuity mathematics is not intuitive. To illustrate:

Annuity company (call it a WC carrier) Retention:	200,000
Excess of Loss Reinsurance protection purchased:	800,000
Reinsurer Retention on its own account:	500,000
Retrocession (on gross loss ⇒ 300 xs [500 xs 200])	300,000

From Series 1, the initializing gross loss to the WC primary carrier is $5,500,000 from 10 claimants at $550,000 each. On a net basis, their retention is exhausted after 2 years and is termed a **temporary** (in duration) annuity. They will pay the equivalent of $100,000 x (55-36)/10 = $190,000 per claimant or $1,900,000 for all 10. This is clearly not the same as 2 years of

$100,000 for 10 claimants = $2,000,000 because 1 in 10 died "within retention" and was not paid a second $100,000.

This is oftentimes misunderstood. If the average gross loss is $550,000, and the retention is $200,000, why isn't the average net reserve $200,000? And the average ceded reserve $350,000? The answer lies in the dispersion around the average reserve, as explained above.

The reinsurer has losses associated with claimants living beyond 2 years, a **deferred** annuity. The reserves are 10 times the per person reserve of $100,000 x 36/10 = $360,000 or $3,600,000.

The sum of the WC company's net loss and the reinsurer's gross loss is the full gross loss.

What of the retrocessionaire's loss? It is tempting to say that with an $700,000 attachment and a $550,000 average life expectancy claim, that the retrocessionaire is removed from all loss. Again the deferred annuity calculation illustrates otherwise. The retrocessionaire will attach after 7 years of payment. So the individual reserve is $100,000 x 6/10 = $60,000 and the total 10 person reserve is $600,000 (as can easily be seen in column 2, the bottom 3 rows).

The reinsurer's gross reserve of $360,000 is reduced by $60,000 to a net value of $300,000. This can be directly calculated as a **temporary, deferred annuity**: $100,000 x (36-6)/10 = $300,000.

The reinsurer's reserve is certainly not $550,000 - $200,000 (retention) either gross or net.

Appendix 2 **Advanced Tabular Reserving**

The chart associated with Series 2 from Appendix 1 is as follows. It represents $1 payments with 5% inflation.

Chart 13

Age (x)	Living population (lx)	payments at $1 per annum (D.)	Cumulative Payments	Remaining Payments (N.)
0	100,000 births	with 5% inflation		
and so on to	....			
90	10	10.00	10.00	64.12
91	9 x 1.05 =	9.45	19.45	54.12
92	8 etc.	8.82	28.27	44.67
93	7	8.10	36.37	35.85
94	6	7.29	43.66	27.75
95	5	6.38	50.04	20.46
96	4	5.36	55.40	14.08
97	3	4.22	59.62	8.72
98	2	2.95	62.57	4.50
99	$1 \times (1.05)^9 =$	1.55	64.12	1.55
100	0			0

For actuarial convenience, we now introduce "commutation functions" or symbols used to shorten notation. The value of annuities are oftentimes increased by an annual *inflator*, i%, our example being 5%. For an age x: $D_{x+n} = l_x$ times $(1 + i)^n$. **(See * below.)** Similarly, the present value can be associated with a time value of money for *discounting* purposes, d%. So that similarly, for age x (n=0): $D_x = l_x$ times $[(1 + i)/(1+d)]^0$ and similarly $D_{x+n} = l_x$ times $[(1+i)/(1+d)]^n$

Uninflated payments made to the 90 year olds = $D_{90} = l_{90}$ since n=0 and any number raised to the zero power = 1. With 5% inflation $D_{91} = l_{91} \times (1.05)^1$.

We also provide for $N_x = \Sigma D_{x+n}$, for all integers, n = 0 up through a terminal value. The fifth column displays these figures.

These commutation functions can be attuned for payments made monthly, rather than annually at the start, with additional complication not introduced here. WC weekly indemnity and medical payment reimbursements are likely to be paid periodically during the year, perhaps monthly.

Let us repeat the exercise in Appendix 1, where each 90 year old begins getting a $100,000 pension on his 90th birthday and each surviving birthday thereafter. While no one can know their actual life span, the annuity provider will pay (from Series 1): $100,000 x (55/10) = $550,000 for each claimant, or $5,500,000 in the aggregate. From Series 2, using 5% inflation, and commutation symbols: $100,000 N_{90} /D_{90} = $641,200. And the aggregate reserve for the 10 claimants would be $6,412,000. So that 5% inflation has a 16.5% effect on the total payments.

We can carry the layering exercise of Series 2 as well with the following results.

Chart 14

Loss Layering, Gross Loss	**Uninflated $550,000**	**Inflated $641,200**	$100,000 times (N-N)/D
Net 200,000	190,000	190,000	$(N_{90} - N_{92})/D_{90}$ less 4.5K*
Next 500,000	300,000	326,000	$(N_{92} - N_{97})/D_{90}$ +4.5K -38K**
Next 300,000	60,000	120,300	$(N_{97} - N_{100})/D_{90}$ +38K -4.9K***
Xs 1,000,000	0	4,900	N_{100} / D_{90} +4.9K

* $(N_{90} - N_{92})/D_{90}$ = 19.45, but the net payments are now $100,000 and specifically 105,000 in year 2, so that $5000 will not be paid to the 9 of 10 claimants surviving. $194,500 - 4,500.
** $(N_{92} - N_{97})/D_{90}$ = 35.95, but the net payments are 100K, 105K,110K,116K,122K,128K,134K so we add 9/10 of 5K and we subtract 4/10 of 95K (portion of 7th payment xs 500).
***$(N_{97} - N_{100})/D_{90}$ = 8.72, and again add in from below 38K and subtract out the top 1/10 of the maximum loss, 1,049K capped at 1,000K.

We notice that the leveraged effect of inflation is felt particularly on the higher layers. Furthermore, since the annuity provider only purchased 800 xs 200K in reinsurance, there is a 1 in 10 claim for $49,000 (or an average uncovered loss of $4,900 per original claimant) that goes beyond limits.

It is also clear that the retrocessionaire providing the 300,000 layer in excess of 700,000 is now very exposed to the loss, originally cited as a gross loss of $550,000. Without inflation, the tabular mathematical loss per claimant is $60,000 and with inflation it is $120,300.

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* The shorthand above must be corrected, in a technical sense, to expose certain values which become invisible when summarized as we have on the previous page. The actuarial definition of $D_{x+n} = [(1+i)/(1+d)]^{x+n}$ times l_{x+n} . When we calculate the annuity $N_x / D_x = [D_x + D_{x+1} + D_{x+2} + \ldots D_{100}] / D_x$, we essentially simplify into invisibility the value $[(1+i)/(1+d)]^x$. If we call this adjustment coefficient $[A]^x$ then the simplified expression for a whole life annuity to a 90 year old is given by $[l_{90} + Al_{91} + A^2 l_{92} + \ldots] / l_{90}$ which is equivalent to $1 + A(l_{91}/l_{90}) + A^2 (l_{92}/l_{90}) + \ldots$ which we will recognize as the probability of surviving to get the Adjusted benefit.

Appendix 3 ***Summary of Workers Compensation Indemnity Escalation***

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Colorado -					
Fatal	7/1/91	6/30/94	Benefits end at age 65 during years		Benefits are reduced by 50% of initial
Permanent Total (PT)	7/1/91	6/30/94	when escalation is applicable.	Annual COLA equal to 2%.	Social Security disability benefits up to
Temporary Total (TT)	7/1/91	6/30/94			age 65.
Connecticut -					
Fatal	10/1/77	6/30/93	Fatal - death or remarriage of surviving	Annual increase equal to percentage	
Permanent Total (PT)	10/1/69	6/30/93	spouse.	change in maximum weekly benefit.	
Temporary Total (TT)	10/1/69	6/30/93	PT/TT - period of disability		
District of Columbia-					
Fatal	10/1/72		Fatal - death or remarriage of surviving	Annual increase equal to % change in	WC plus SS disability benefits may not
Permanent Total (PT)	10/1/72		spouse.	maximum weekly benefit capped at 5%.	exceed 80% of the injured workers
Temporary Total (TT)	10/1/72		PT/TT - period of disability	Prior to 7/26/82, the USL&HW provision applied.	gross wage.
Florida -					
Permanent Total (PT)	7/1/84		Period of disability	Supplemental benefit equals 5% of injured workers initial weekly benefit times the number of calendar years since the date of injury limited to the current maximum benefit.	SS disability plus WC benefit are capped at 80% of pre-disability wage. For accidents occurring on or after 7/1/90, the supplemental benefit ends at age 62 if the worker is eligible for SS retirement benefits, and benefits return to pre-supplement amount.
Idaho -					
Fatal	7/1/91		Fatal - 500 weeks or remarriage or	Annual escalation is equal to the dollar	
Permanent Total (PT)	1/1/72		death of surviving spouse.	change in the SAWW capped at 6%	
Major Permanent Partial (PP)	1/1/72		PT/TT - period of disability	change.	
Minor Permanent Partial (PP)	1/1/72		PP - as per schedule		
Temporary Total (TT)	1/1/72				

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Maine -					
Fatal	1/1/72	12/31/92	Fatal - 500 weeks or remarriage or death of surviving spouse. PT/TT - period of disability PP - 260 weeks for impairment ratings < 15%. No maximum otherwise.	As of 7/1/85, annual escalation is equal to the % change in the SAWW capped at 5%. As of 11/20/87 escalation of PT and TT benefits begins on 3rd anniversary of the injury (with the same annual change as above). Injured workers who's benefits are at the maximum rate do not have to wait 3 years for escalation.	SS retirement offset beginning at age 65, on all benefits except for fatal.
Permanent Total (PT)	1/1/72	12/31/92			
Major Permanent Partial (PP)	1/1/72	11/19/87			
Minor Permanent Partial (PP)	1/1/72	11/19/87			
Temporary Total (TT)	1/1/72	12/31/92			
Maryland -					
Permanent Total (PT)	1/1/88		Period of disability	Annual escalation is equal to the % change in the CPI capped at 5%	WC plus SS disability benefits capped at 80% of gross pre-injury wage.
Massachusetts -					
Fatal	10/1/86		Fatal - benefits are limited to a maximum aggregate of 250 times the SAWW, if self-sufficient. PT - period of disability PP - 260 weeks or 520 weeks for special serious cases.	As of 12/24/91, annual COLA at 10/1 (beginning two years after injury date) equal to the lesser of a) 5%, b) the North East region urban area CPI or c) the percentage change in the SAWW.	There is a SS disability offset applicable to PT escalation benefits that has the potential of capping escalation but only to age 65.
Permanent Total (PT)	10/1/86				
Major Permanent Partial (PP)	10/1/86	12/23/91			
Minor Permanent Partial (PP)	10/1/86	12/23/91			
Minnesota -					
Fatal	10/1/75		Fatal - 10 years or death of surviving spouse. PT/TT - Period of disability	Annual change equal to the change in the SAWW capped at 4% beginning after 2nd anniversary date of injury.	See note below.
Permanent Total (PT)	10/1/75				
Temporary Total (TT)	10/1/75				
Montana -					
Permanent Total (PT)	7/1/87		To age 65	Annual increase of 3% begins after 2 years and lasts no longer than 10 years.	WC benefits are reduced by 50% of SS disability benefits.

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Ohio -					
Permanent Total (PT)	1953		Period of disability	Annual increase equal to the Sept. change in CPI and paid by the Disabled Workers Relief Fund. See note below.	WC benefits are offset by SS disability benefits.
Oregon -					
Fatal	7/1/73		Fatal - Death or remarriage of surviving spouse.		
Permanent Total (PT)	7/1/73			Annual July 1 increases.	
Major Permanent Partial (PP)	7/1/73		Period of disability on remaining injury types.	See Note Below	
Minor Permanent Partial (PP)	7/1/73				
Temporary Total (TT)	7/1/73				
Rhode Island -					
Fatal	9/1/86		Fatal - Death or remarriage of surviving spouse.	Annual increase equal to 4% on fatal benefits. Annual increase on PT's and PP's is equal to the percentage change in the CPI applied every May 10th after the 1st year for PT's and after the 6th year for PP's.	Retirement offset applicable for workers past age 55 or within 5 years of retirement.
Permanent Total (PT)	see note		PT - Period of disability		
Major Permanent Partial (PP)	see note		PP - 312 weeks		
Minor Permanent Partial (PP)	see note				
South Dakota -					
Permanent Total (PT)	7/1/88		Period of disability	Annual increase equal to the change in the CPI capped at 3%.	After 7/1/93, workers who reach age 65 are subject to SS offset equal to 150% of the WC benefit minus the SS disability benefit.
Texas -					
Permanent Total (PT)	9/1/91		Period of disability	Annual increase equal to 3% on lifetime cases	

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets

Vermont -

Fatal Permanent Total (PT) Major Permanent Partial (PP) Minor Permanent Partial (PP) Temporary Total (TT)	7/1/83 7/1/83 7/1/83 7/1/83 7/1/83		Fatal - Surviving spouse benefit is limited by age 62, death or remarriage. PT/TT - Period of disability. PP - limited to a schedule or 330 weeks if not a scheduled injury.	Annual increase equal to change in SAWW	

Virginia -

Fatal Permanent Total (PT) Temporary Total (TT)	7/1/75 7/1/75 7/1/75		Fatal and TT benefits are limited in duration to 500 weeks (or death or remarriage of surviving spouse). PT - Period of disability	Annual increase equal to the change in the CPI. The total benefit, including escalation is capped at the current maximum benefit.	Escalation available only if WC and SS (disability and survivorship) benefits are less than 80% of the employees average pre-injury monthly wage.

USL&HW -

Fatal Permanent Total (PT)	10/1/72 10/1/72		Fatal - Death or remarriage of surviving spouse. PT - Period of disability.	Annual increase equal to change in the National AWW limited to 5%. Prior to 1984 there was no limitation.	

Fed. Black Lung Act, Title IV Fed Coal Mine Safety Act '69

Fatal Permanent Total (PT) Temporary Total (TT)	12/30/69 12/30/69 12/30/69		Fatal - Death of surviving spouse PT/TT - Period of disability	Increase dependent upon increases in federal workers wage or an act of congress.	SS disability offset.

Notes

COLA = Cost of living adjustment, SAWW = State Average Weekly Wage, SS = Social Security, CPI = Consumer Price Index

Connecticut: Escalation on outstanding fatal losses prior to 10/1/77 or total losses prior to 10/1/69 is picked up by the Second Injury and Compensation Assurance Fund.

Florida: Supplemental benefits payable on claims prior to 7/1/84 are paid by the Workers Compensation Administration Trust Fund.

Idaho: Injured workers receiving benefits of less than 45% (minimum) of the Average State Wage (ASW) will receive an increase on Jan 1 and on the first anniversary of the injury and annual increases thereafter.
Injured workers receiving benefits greater than 90% (maximum) of the ASW are eligible for an increase at Jan 1 unless benefits are greater than 90% of the injured workers AWW.
After 52 weeks, benefits are limited to the lesser of 67% of the current ASW for injuries occurring after 7/1/91 (60% injuries occurring before 7/1/91) or 90% of the injured workers original AWW.

Massachusetts: Benefits after application of the COLA are limited to a maximum of "three times the original benefit". COLA benefits payable on claims from *occurrences prior to 10/1/86 and escalation above 5% on accidents on or after 10/1/86 are paid by the Workers Compensation Trust Fund.*
Prior to 12/24/91, the annual COLA was equal to the change in the SAWW capped at 10% (with no wait period) except for PP's which were capped annually at 5%. Permanent Partial benefits during the period when escalation applied, were limited in duration to 600 weeks.

Minnesota: If dependents are receiving Social Security benefits, then the fatal workers compensation benefit, before escalation, is limited to the deceased workers average weekly wage less the Social Security benefit. For total loss injury types judged to be permanent total, the workers compensation benefit is reduced by Social Security disability or retirement benefits after the first $25,000 of benefit is paid.

Montana: Conversion to PP is no longer allowed at age 65.

Ohio: All escalation benefits are paid by the Disabled Workers Relief Fund (DWRF). Self-insureds are billed for the amount paid to their eligible employees. *DX insurer will reimburse self-insureds for DWRF assessments on claims with dates of accident occurring after 8/86. Ohio has a monopolistic state fund.*

Oregon: Escalation on TT benefits is based on percentage change in SAWW. Escalation on Fatal, PT and PP's is computed and paid for by the Retroactive Reserve This is the only state where escalation on benefits is not the responsibility of the employer/insurer. Effective 6/7/95 (with SB 369), escalation on PP award granted on or after 6/7/95 for dates of injury prior to 7/1/71 are not eligible for reimbursement by the Retroactive Reserve.

Rhode Island: The COLA benefit on non-fatal claims with injury dates between 9/1/74 - 12/31/93 are reimbursed by the WC Administrative Fund. COLA benefits on cla occurring subsequent to 12/31/93 are not reimbursed by the fund. Claims occurring prior to 9/1/74 are subject to a maximum limitation.

USL&HW: Escalation payable on claims occurring prior to 10/1/72 are paid for by the USL&HW Special Fund.

Federal Black Lung: Claims filed under this act between 12/30/69 and 12/31/73 are paid for by the Federal Government. Employers are responsible for claims occurring after 12/31/73. If the Black Lung Benefits are greater than 37.5% of the lowest rate of pay for GS-2 federal employees, they will not increase with increases in the federal wage until the federal wage has caught up.

Appendix 4 **Link Ratio Comparison**

Treaty Workers Compensation
Emergence Comparison

	Without Inflation 12/95			With Inflation 1996			RAA		
	Age-to Age	Age-to Ult	IBNR Factor	Age-to Age	Age-to Ult	IBNR Factor	Age-to Age	Age-to Ult	IBNR Factor
1-2	1.800	5.695	0.824	2.000	4.510	0.778	2.050	12.676	0.921
2-3	1.150	3.164	0.684	1.200	2.255	0.557	1.325	6.183	0.838
3-4	1.270	2.751	0.637	1.300	1.879	0.468	1.250	4.667	0.786
4-5	1.120	2.166	0.538	1.150	1.446	0.308	1.150	3.733	0.732
5-6	1.050	1.934	0.483	1.050	1.257	0.204	1.080	3.246	0.692
6-7	1.030	1.842	0.457	1.050	1.197	0.165	1.080	3.006	0.667
7-8	1.020	1.788	0.441	1.040	1.140	0.123	1.080	2.783	0.641
8-9	1.015	1.753	0.430	1.040	1.096	0.088	1.070	2.577	0.612
9-10	1.015	1.727	0.421	1.030	1.054	0.051	1.050	2.408	0.585
10-11	1.015	1.702	0.412	1.020	1.023	0.023	1.050	2.294	0.564
11-12	1.010	1.677	0.404	1.020	1.003	0.003	1.050	2.185	0.542
12-13	1.010	1.660	0.398	1.010	0.984	-0.017	1.050	2.081	0.519
13-14	1.010	1.644	0.392	1.010	0.974	-0.027	1.050	1.981	0.495
14-15	1.015	1.627	0.386	1.010	0.964	-0.037	1.050	1.887	0.470
15-16	1.020	1.603	0.376	1.005	0.955	-0.047	1.050	1.797	0.444
16-17	1.020	1.572	0.364	1.000	0.950	-0.053	1.050	1.712	0.416
17-18	1.020	1.541	0.351	1.000	0.950	-0.053	1.050	1.630	0.387
18-19	1.020	1.511	0.338	1.000	0.950	-0.053	1.040	1.553	0.356
19-20	1.020	1.481	0.325	1.000	0.950	-0.053	1.040	1.493	0.330
20-21	1.015	1.452	0.311	0.950	0.950	-0.053	1.040	1.435	0.303
21-22	1.015	1.431	0.301	1.000	1.000	0.000	1.040	1.380	0.275
22-23	1.015	1.410	0.291	1.000	1.000	0.000	1.030	1.327	0.246
23-24	1.015	1.389	0.280	1.000	1.000	0.000	1.030	1.288	0.224
24-25	1.010	1.368	0.269	1.000	1.000	0.000	1.030	1.251	0.201
25-26	1.010	1.355	0.262	1.000	1.000	0.000	1.030	1.214	0.176
26-27	1.010	1.341	0.254	1.000	1.000	0.000	1.020	1.179	0.152
27-28	1.010	1.328	0.247	1.000	1.000	0.000	1.020	1.156	0.135
28-29	1.010	1.315	0.239	1.000	1.000	0.000	1.020	1.133	0.117
29	1.010	1.302	0.232	1.000	1.000	0.000	1.111	1.111	**0.100**
	1.010	1.289	0.224	1.000	1.000	0.000	-	-	RAA p18
	1.010	1.276	0.216	1.000	1.000	0.000	-	-	-
	1.010	1.264	0.209	1.000	1.000	0.000	-	-	-
	1.010	1.251	0.201	1.000	1.000	0.000	-	-	-
	1.010	1.239	0.193	1.000	1.000	0.000	-	-	-
	1.010	1.226	0.185	1.000	1.000	0.000	-	-	-
	1.010	1.214	0.176	1.000	1.000	0.000	-	-	-
	1.010	1.202	0.168	1.000	1.000	0.000	-	-	-
	1.010	1.190	0.160	1.000	1.000	0.000	-	-	-
	1.010	1.179	0.152	1.000	1.000	0.000	-	-	-
40 to Ultimate	**1.167**	1.167	0.143	1.000	1.000	0.000	-	-	-

factors represent a 60 or more year development pattern. 1995 values in the tail were selected in light of 1996 indications.

Appendix 5 **Navigating the Claim Spreadsheet**

Excel 5.0 spreadsheet **WCCASE**.XLS

A1 A2 A3 A4 A5 A7 A8 A10 A11 A12 A14 A16-18 A20-22 A24-26 A30-33 A35-38 A40-43 A45-48 A50-53 A55-58	Sex of claimant Date of birth Current date Age Mortality assumption Annual Meds Annual Indemnity Med Infl. rate Indy. Infl rate Discounting rate Ground up paid losses to date Layers 1, 2, 3 Attach ment, width, and participation Reins paid to date Nominal reserves Reins Incurred Discount Reserves net of Disc Max Life Payments	B1-B26 Values input for the Claimant Values calculated

A 115 A219	Up to 103 years of claimant activity	B age at payment date	Columns C through K Indemnity and Medical Payments by year	Columns M through P, Summary of paid loss, discount and mortality	R-U, W-Z, AB-AE, AG-AI itemize Layer claim values 221 = calculated reserves/incurred

Reserving Issues for Workers Compensation Managed Care

by Susan E. Witcraft, FCAS

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Abstract

Managed care is becoming an integral part of workers compensation claims management. Some techniques are being implemented internally by insurers, whereas other services are being provided by outside vendors. As part of the introduction of managed care, insurers are beginning to use compensation arrangements with medical providers and managed care networks other than the traditional fee-for-service basis of reimbursement. One such alternative is capitation under which the insurer pays a fixed fee to a provider or provider network in exchange for defined medical services. Under some agreements, only selected types of medical services are covered; under other arrangements, medical services provided in specified time periods are covered. In essence, the insurer is "reinsuring" the covered medical services with the provider group.

The widespread use of managed care techniques is expected to affect claim costs and payment patterns. In addition, because many managed care contracts are financed by a single up-front payment and the insurer may not receive detailed medical payment data, traditional actuarial methods of projecting ultimate medical losses must be adapted. In this paper, the reserving issues that result from managed care and from the various financial arrangements will be identified and approaches for addressing them will be presented.

Biography

Susan is a Consulting Actuary with the Minneapolis office of Milliman & Robertson, Inc. She has managed a property and casualty practice in the Minneapolis office since 1988 after several years in each of M&R's San Francisco and Los Angeles offices. Susan is a Fellow of the Casualty Actuarial Society and a Member of the American Academy of Actuaries.

Susan has advised insurance companies, self-insurance programs, managed care organizations, and regulatory and governmental agencies on a wide range of property-casualty issues, including reserving, ratemaking and product design. In the past several years, she has consulted extensively on the development, implementation and evaluation of workers' compensation managed care programs. She has also worked with clients in the design and pricing of workers' compensation managed care and 24-hour products.

Reserving Issues for Workers Compensation Managed Care

Introduction

Managed care has been an integral component of group health insurance since the 1970s, but it was only in the early 1990s that these techniques were formally introduced to workers compensation insurance. Today, managed care for workers compensation commonly includes some or all of the following features:

- Case management, including both control of medical costs and early return to work.
- Access to an existing provider network.
- Review of bills for reasonableness of charges and appropriateness of procedures.
- Pre-certification of certain treatments, such as surgery, hospitalization, and physical therapy.

Many of these managed care services are provided by outside vendors, though workers compensation insurers are beginning to perform many of these functions internally. It should be noted that, while insurers may be able to develop the expertise to perform the case management and review functions, there are few circumstances in which an insurer will be as effective as group health networks in the network-related functions. That is, because group health networks control a much larger volume of medical services, they have more leverage with providers with regard to negotiation of fee discounts, compliance with treatment guidelines and selection of providers for inclusion in the network. Thus, even many large workers' compensation insurers may continue to purchase at least some of these services externally while small insurers will likely contract out most of these services, at least in the near term.

Compensation of managed care vendors runs a full gamut from essentially risk-free (payment by the insurer for administrative fees for each service plus all medical costs) to highly risky, as in the case of multi-year capitation of all medical. For the purposes of this paper, workers' compensation managed care compensation plans are divided into fee-for-service and capitation.

- Fee for service agreements generally include the aforementioned services with fees charged per unit of service, per claim, as a percent of premium (or other exposure base) and/or per employee per month. Under contingent fee for service arrangements, the vendor also receives or pays contingent compensation based on estimated savings and/or selected performance measures.

- With limited capitation of medical services, a defined set of medical services are provided by the managed care vendor on a fixed fee basis. The covered medical services could be limited based on time (e.g., treatment date within so many years of injury date), the cost per injury or the covered services (e.g., pharmacy, physical therapy or primary care physician). Under full capitation of medical services, the workers compensation insurer transfers the full medical risk to the managed care vendor. Contingent compensation based on indemnity savings or other measures of medical performance can also contribute to the total fees paid to the managed care vendor.

Managed care itself, as well as the different types of compensation arrangements, raise many actuarial issues for workers compensation insurers. This paper will focus on loss reserving considerations. Of course, any issues presented by managed care related to the loss reserving process will similarly affect rate level analyses, as loss reserving forms the foundation of the actuarial ratemaking process. These considerations will be identified and insights regarding possible approaches for their resolution will be provided.

Managed Care and Loss Reserving

The goal of managed care is to reduce claim costs through more focused use of medical services and earlier return to work. It has been hypothesized that certain changes will occur in the average cost and timing of medical and indemnity payments as the result of managed care. Some of these hypotheses are contradictory and will only be resolved when managed care has been applied to a sufficient volume of workers compensation losses for a long enough period of time to allow comparison of results with non-managed care experience. These hypotheses include:

- Changes in the average medical cost per claim. A reduction is expected if medical services are provided more efficiently. An increase in the medical average cost per claim could result if the cost of increased medical intervention is expected to be more than offset by savings in indemnity benefits.

- A change in the medical payment pattern. Medical payments could accelerate as case managers focus on decreasing the time between treatments to reduce disability duration and, possibly, as increased medical intervention is used to accelerate recovery and return-to-work. Medical and possibly indemnity payments could be extended, particularly under capitation arrangements under which vendors have incentives to minimize and therefore delay medical treatments. Studies performed at successive evaluation dates have generally shown that estimates of medical savings are relatively stable across evaluation dates. From these findings, it can be inferred that medical payment patterns (at least at early maturities) have not changed in the presence of managed care.

- A change in the average indemnity cost per claim. If the percentage of claimants receiving indemnity benefits is reduced, the average cost of indemnity per claim with indemnity could decrease or increase. That is, if small indemnity claims become medical-only claims, the average cost of the remaining larger claims may be greater than the pre-managed care average cost. The average indemnity cost over all claims is expected to decrease.

- Shortening of the payment rate on indemnity claims with temporary benefits. The change in the payment rate for all indemnity benefits will depend on whether the amount of permanent partial and permanent total benefits decreases by more or less than the decrease in benefits paid on temporary disability claims.

As a result of these anticipated changes, the introduction of managed care may lead to distortions in most of the common actuarial methods, specifically any methods that rely on development or average claim cost projections either directly or implicitly.

Average Claim Cost Projections

When applying methods that rely on average claim costs, actuaries will need to make explicit assumptions regarding the impact of managed care on claims cost trends. For example, when projecting the average claim cost for a book of business for which all claims are newly treated with managed care techniques, the actuary will need to make assumptions regarding the percentage reductions in both medical and indemnity costs as well as whether managed care will affect the rate of increase in medical costs (i.e., the trend rate) over time. If only a portion of the claims are treated with managed care techniques, the actuary will need to reflect the penetration of managed care by either analyzing the experience of in-program and out-of-program claims separately or adjusting the average claim cost assumption for both the expected reduction in claim costs and the percentage of claims subject to managed care.

Preliminary analyses of managed care show reductions in both medical and indemnity claim costs in the range of 10% to 30%, with the findings of many studies at the lower end of the range. One study which reviewed claims from two successive policy years shows a very preliminary indication that managed care has not slowed the rate of trend in workers compensation benefits. That is, the study showed approximately the same percentage savings in claim costs in the second year of the program as in the first year of the program at the same maturity using pre-managed care claim cost trends to set the benchmarks.

To illustrate these concepts, assume the following ultimate average claim costs have been projected for losses before managed care was introduced:

Accident Year	Projected Ultimate Average Cost
1989	$ 7,000
1990	7,800
1991	8,300
1992	9,200
1993	10,000

From this experience, we might conclude that average claim costs are increasing at 9% per annum. Further assume that 25% of Accident Year 1994 claims, 50% of Accident Year 1995 and 100% of

Accident Year 1996 claims are in managed care. It would then be inappropriate to assume that the average claim costs for Accident Years 1994 through 1996 would exhibit a continuation of the 9% claim cost trend. If we assume that managed care only affects the level of claim costs and not claim cost inflation and that the impact is a 15% reduction in combined medical and indemnity costs, the following approach would provide better estimates of average claim costs than simply applying the 9% per annum trend, or even a judgmentally lowered trend factor.

Accident Year	(1) Claim Cost on Accident Year 1994 Level	(2) Claim Cost Trend in Absence of Managed Care	(3) Percent of Claims in Managed Care	(4) Projected Average Claim Cost (1)x(2)x [1-0.15x(3)]
1994	$10,900	1.00	25%	$10,491
1995	10,900	1.09	50%	10,990
1996	10,900	1.19	100%	11,025

If average claim costs had exhibited this pattern and the actuary had been unaware that managed care had been phased in over the three-year time period, the actuary would have made erroneous assumptions regarding future trend rates. In addition, ultimate losses would have been overstated for these accident years before sufficient information had emerged regarding average claim costs to identify that losses were less than might be expected based on historical trend rates and average claim costs.

Paid Development Methods

Paid loss development methods are reliant on the assumption that the underlying payment pattern is relatively consistent over time. Under the hypotheses identified in the introduction, this assumption becomes suspect. For medical, the actuary will need to review data to evaluate whether a shift in the timing of medical treatments has occurred. Such shifts could occur from one or a combination of the following sources:

- Accelerated medical treatment in an effort to enhance faster return to work.

- Slower medical treatment as part of medical cost containment efforts.

- A reduction or increase in active medical treatment early in the life of claims followed by medical maintenance costs that are similar to historical levels. If active medical treatment is reduced, the paid loss development factors will increase; if early medical costs increase, the paid development factors will decline.

To test the impact of the timing of managed care on medical treatments, the actuary can review statistics regarding the time lag between medical visits. Comparisons of the dollar amount of medical payments per claim for in and out of managed care claimants within the first two to three years after date of injury will also assist in evaluating whether and what adjustments are needed to paid loss development factors because of a possible mix in medical payments between active medical treatment and maintenance costs.

For indemnity, reduced temporary total durations are likely to be the primary source of expected savings. If temporary benefits are reduced with no change in permanent total and permanent partial payment patterns or benefits, the combined payment pattern will likely lengthen, though the result is also dependent on the extent to which temporary total benefits are reduced. The following example illustrates this result. Assume the following:

- Temporary total indemnity benefits are paid on the same percentage of claims as before managed care, but for a 20% shorter duration on average. The impact on the temporary total payment pattern is to reduce payments in the first year by 10%, the second year by 20%, the third year by 30% and the fourth year by 40%.

- Fatal, permanent partial and permanent total indemnity benefits are unaffected by managed care.

- Temporary total benefits make up 30% of indemnity benefits.

- The historical payment patterns for temporary total and other indemnity benefits are as shown in the table below.

Year of Payment	Temporary Total	Other Indemnity	Combined
Accident Year	40%	5%	15.4%
Accident Year + 1	70%	27%	40.0%
Accident Year + 2	90%	43%	57.1%
Accident Year + 3	100%	54%	67.6%
Accident Year + 4	100%	63%	74.1%

Under these assumptions, temporary total benefits would become 25.5% (= 30% x 0.8 / [30% x 0.8 + 70%]) of total indemnity, with other benefits increasing as a percentage of total indemnity benefits to 74.5%. The adjusted temporary total and total indemnity benefit payment patterns are shown below.

Year of Payment	Temporary Total	All Indemnity
Accident Year	45%	15.1%
Accident Year +1	75%	39.3%
Accident Year + 2	93%	55.8%
Accident Year + 3	100%	65.5%
Accident Year + 4	100%	72.4%

Having derived these adjusted payment patterns, we can adjust the paid loss development factors that we would otherwise use in the paid loss development and paid Bornhuetter-Ferguson methods. The table below shows the paid loss development factors from the above example before and after adjustment.

Maturity	Before Managed Care	After Managed Care
12 Months	6.49	6.62
24 Months	2.50	2.54
36 Months	1.75	1.79

Maturity	Before Managed Care	After Managed Care
48 Months	1.48	1.53
60 Months	1.35	1.38

As can be seen, the indemnity development factors before managed care understate development by 2% to 3%. The faster rate of temporary total payments is more than offset by the reduction in temporary total as a proportion of total indemnity, thereby lengthening the combined payment pattern. Of course, the adjustments made to the development factors are highly dependent on the assumptions made regarding the amount and timing of the impact of managed care on benefits.

Fee-For-Service Arrangements and Loss Reserving

Fee-for-service arrangements are expected to affect the loss reserving process in the same manner as managed care programs in general, as described in the previous section. Fee-for-service arrangements will also require the actuary to estimate a reserve for unpaid loss adjustment expenses relating to managed care services that have yet to be provided. Under the 1994 NAIC accounting changes, a reserve must be established for the estimated cost of these services, regardless of whether or not they have been prepaid.

The services that are likely to extend past the end of each accident year, and therefore require that a reserve be established, are medical case management, bill review and network access. Medical case management could be provided on claims until the injured worker has returned to work or has been declared permanent total, but will generally be weighted heavily to the first nine to twelve months after injury date. Using information about the likely duration of medical case management that can be obtained from the managed care vendor or insurer and the reporting pattern of claims, the actuary can develop a model to estimate the proportion of medical case management yet to be provided at the evaluation date of the reserve analysis. A reserve could be established either using an estimate of the number of hours remaining and an average hourly cost or by allocating the total fees among services and multiplying the estimated fees for medical case management by the percentage of services yet to be provided.

The timing of bill review services and network access and therefore payment of the corresponding fees are likely to be similar to medical payments. In the case of bill review, this hypothesis assumes that the charges per bill do not vary significantly over the life of a claim as most of these services are provided on a fee-per-bill basis. The actuary will need to understand the time period over which bill review and network access are expected to be provided and whether all bills will be reviewed and all services provided through the network. For example, some bill review excludes hospitalization. Other vendors may include only provider bills and therefore not cover many of the services provided for so-called medical maintenance costs. These considerations will affect the model that the actuary uses to estimate a reserve for bill review and network access fees.

To illustrate a possible reserving approach, consider the following assumptions:

- Bill review is estimated to cost 0.5% of premium and is performed on all bills for three years after injury date.

- Network access is estimated to save 10% of medical and the cost is 20% of savings.

- Medical case management is estimated to cost $75 per hour, and is expected to be provided on 10% of claims for an average of 10 hours each.

- 75% of medical case management is estimated to occur within 12 months of injury date, 20% in the next 12 months and 5% in the subsequent 12 months.

The medical case management pattern must first be converted to an accident year basis. Assuming that managed care claims occurred uniformly throughout the accident year, 37.5% of medical case management is provided in the accident year, 47.5% in the next year, 12.5% in the third year and 2.5% in the fourth year. Assume that the medical payment pattern is as shown in the table below.

Year of Payment	Percent Paid
Accident Year	30%
Accident Year + 1	27%
Accident Year + 2	10%
Accident Year + 3	4%
Accident Year + 4+	29%

The unallocated loss adjustment expense reserves at 24 months could be calculated as follows:

- Bill review: 0.5% of premium times 17.3% equals 0.09% of premium, where 17.3% is derived as the sum of the 10% of medical payments made in Accident Year + 2 and half of the 4% of medical payments made in Accident Year + 3 divided by the approximately 69% of medical payments made within three years after injury date (the average of payments through Accident Year + 2 and Accident Year + 3).

- Network savings: the fee of 10% of savings times savings of 20% of medical times unpaid medical at 24 months of 43% equals 0.86% of estimated ultimate medical.

- Medical case management: 10% of claims times 10 hours per claim times $75 per hour times 15% unpaid or $11.25 per ultimate reported claim.

Thus, the unallocated loss adjustment expense reserve for managed care fees would be 0.09% of premium plus 0.86% of estimated ultimate medical plus $11.25 per ultimate reported claim.

Reserving in the Presence of Capitation

There are two situations that the actuary may face in the presence of a medical capitation:

1. In the first situation, the managed care vendor will report medical payments (either the dollar amount paid by the vendor, the amount paid at the workers compensation fee schedule or a summary of the number of treatments by type) to the insurance company.

2. In the second situation, the insurance company will not know the types or dollar amount of medical treatment under the capitation.

The first situation is, not surprisingly, easier to address from a reserving perspective. If medical costs are fully capitated, the actuary will be concerned with reserves only on a gross basis. If the capitation is limited, however, the actuary will need to develop reserve estimates net of the capitation.

Medical Payments Known or Estimable

In the situation in which the actuary knows or can estimate the cost of medical treatments under the capitation arrangement based on information regarding specific treatments provided, the reserve analysis can begin in a fairly traditional manner. If the quantity of services is provided, the actuary can estimate the cost using the medical fee schedule or usual and customary fees which are available from a number of sources. If the medical payments provided are those paid by the managed care vendor, the actuary will want to adjust these payments for any differences between the fee schedule used by the managed care vendor and the fees normally paid by the insurer. This adjustment will eliminate any biases in the estimate of ultimate costs if the managed care vendor pays consistently higher or lower fees than the insurer. That is, because the insurer will pay medical after the capitation based on its own fee schedule, it is necessary to restate the medical payments under the capitation to reflect the same fee schedule.

To illustrate, assume that of $1,000,000 reported as paid medical as of 12 months, $250,000 of which was reported by the managed care vendor that is capitating medical for three years after injury date. Also assume that the managed care vendor is reporting medical at its cost and that the insurer generally compensates providers at the statutory fee schedule. By comparing reimbursement rates for a sample of CPT-4 codes, it has been determined that the managed care vendor's cost is about 15% lower than the fee schedule. It would then be appropriate to divide the $250,000 reported by the managed care vendor by 0.85 and add it to the $750,000 paid by the insurer before applying any actuarial methods to paid or incurred losses. Thus, paid medical at 12 months would be adjusted to $1,044,118 from $1,000,000.

The actuary will then need to estimate the proportion or amount of medical losses that are covered by the capitation. For illustration, assume that the data available to the actuary are accident year data developed annually, the capitation covers medical costs for three years after injury date, and it is reasonable to assume uniform injury dates throughout the accident year. In this situation, the actuary can estimate the percentage of medical losses covered by the capitation by assuming that all medical losses paid by 42 months are covered by the capitation. (On claims reported on the first day of the accident year, payments through 36 months are covered, whereas payments through 48 months are covered on claims reported on the last day of the accident year.)

Assume that, from historical medical paid loss development, the selected paid medical development factors in the absence of managed care are those shown in the following table.

Maturity	12	24	36	48	60	72
Paid Development Factor	2.86	1.64	1.43	1.35	1.30	1.25
Percent Paid	35%	61%	70%	74%	77%	80%

From this table, it would be reasonable to estimate that 72% of losses will be paid by the managed care vendor. Using the $1,044,118 of adjusted medical payments at 12 months and the pre-managed care development factor from 12 months to ultimate of 2.86, the paid loss development method would project ultimate medical losses of $2,986,175. Assuming that the other methods used provided similar indications, a selection of $3,000,000 might be made. To eliminate the losses covered by the capitation, the $3,000,000 of ultimate medical would be multiplied by the percent of losses projected to be paid more than three years after injury date of 28% (=100% - 72%) to arrive at an estimate of retained losses of $840,000. The actuary will, of course, need to consider all of the issues raised in the discussion of the impact of managed care on reserving in general.

The use of methods based on case reserves, such as incurred loss development and incurred Bornhuetter-Ferguson, will depend on whether case reserves are established and what liability is recognized in the case reserves. In the above example in which medical payments in the first three years after injury are capitated, several approaches could be used to set case reserves:

1. No case reserves are set until three years after injury date. This situation could occur if the claim administrator does not have complete information regarding the claimant's medical condition during the capitation period.

2. Case reserves are set in the traditional manner in which the reserve reflects the estimated future cost of medical services.

3. Two case reserves are set, one for the portion of costs expected to be paid under the capitation and one for medical treatments estimated to be made more than three years after injury date.

In the first situation, projection of incurred medical losses will be similar to projecting paid losses in the absence of payment data and is addressed in the next section. Under the latter two approaches, traditional actuarial methods can be used to project ultimate incurred losses. If only a single case reserve is set, assumptions need to be made for financial reporting regarding the amount of case reserves that are the liability of the insurer and the amount that will be covered under the capitation.

Under the third approach, the case reserve information can ease financial reporting and allocation of projected costs between parties.

Medical Treatments Unknown

If the actuary does not have any information regarding the medical payments that are being made, an estimate of the medical payments after the end of the capitation must be made directly without reliance on emerged payment experience. Two approaches for estimating those payments will be discussed: one that can be applied while no payment data are available (during the capitation period) and one after the capitation period has ended.

During the capitation period, to estimate the medical payments that will be made after the end of the capitation, the actuary could use the Bornhuetter-Ferguson method with the paid loss development factor adjusted to include only payments after the capitation. That is, the actuary could estimate ultimate medical payments in the absence of managed care using an expected percentage of premium or an ultimate average cost per claim. These assumptions could be extrapolated from pre-managed care experience. The percentage of total medical after the capitation could be estimated from a historically based medical payment pattern. The actuary would want to consider what effects the managed care would have on ultimate average claim costs and on payment patterns. In the presence of a capitation, the hypothesis that medical treatments may be provided slower to reduce total medical expenditures becomes more likely.

To illustrate, assume the following:

- Based on historical experience, medical losses are projected to be 40% of premium in the absence of managed care.
- Managed care is projected to reduce medical losses by 15%, but is assumed not to affect payment patterns (in the absence of information to the contrary).
- The historical medical payment pattern is that used in previous illustrations.

In this situation, with $9 million of earned premium, the Bornhuetter-Ferguson method would project retained medical payments, capitation as follows:

(1)	Earned Premium	$9,000,000
(2)	Medical Loss Ratio	40%
(3)	Expected Medical Losses without Managed Care (1)x(2)	$3,600,000
(4)	Estimated Medical Savings	15%
(5)	Expected Medical Losses with Managed Care (3)x[1-(4)]	$3,060,000
(6)	Estimated Percentage Unpaid 3 Years after Injury	28%
(7)	Estimated Retained Medical Costs (5)x(6)	$856,800

The same calculations would be performed at all evaluation dates up to 36 months. That is, the percentage of losses unpaid would be the best estimate for 42 months of maturity, regardless of whether the actual maturity of the accident year were 12 months or 36 months.

Once medical payment data have become available (and presumably the management of medical has been turned over to the insurer who then sets case reserves), the actuary could apply paid and incurred loss development methods. In these applications, the paid and incurred loss development factors would need to be adjusted to exclude payments prior to the capitation.

Continuing the earlier example, we estimated that roughly 72% of medical payments would be eliminated by the capitation. If payments after the capitation up to 60 months are $200,000, then we can estimate ultimate medical payments after the capitation as

$$\frac{\$200,000}{0.77 - 0.72} x (1 - 0.72) = \$1,120,000,$$

where 77% is the percent of medical losses estimated to be paid at 60 months from the earlier illustration.

Similarly, the same technique can be used for incurred losses. Assume the following regarding development of incurred medical losses:

Maturity	12	24	36	48	60	72
Incurred Development Factor	1.65	1.325	1.25	1.225	1.20	1.19
Percent Incurred	60%	75%	80%	82%	83%	84%

Using the same assumptions regarding the medical payment pattern and incurred losses of $300,000 as of 60 months, ultimate medical losses after the capitation would be estimated as

$$\frac{\$300{,}000}{0.83 - 0.72} \times (1 - 0.72) = \$763{,}636.$$

The denominator of this formula was derived as follows:

Incurred @ 60 months (with capitation)
= Paid between 42 and 60 months + Case @ 60 months
= Paid between 0 and 60 months + Case @ 60 months - Paid @ 42 months
= Incurred @ 60 months (without capitation) - Paid @ 42 months
= 0.83 - 0.72

Once the capitation period has elapsed, the actuary can also apply the Bornhuetter-Ferguson method in its traditional manner to both paid and incurred losses.

Conclusion

Managed care presents many issues for actuaries. Hypotheses regarding its impact must be selected, emerging experience must be monitored to test these hypotheses and projection methods must be adapted to the changing environment. Until definitive results are available, the presence of managed care will increase the uncertainty surrounding projections of workers' compensation liabilities.

From Disability Income to Mega-Risks: Policy-Event Based Loss Estimation

by Amy S. Bouska, FCAS

From Disability Income to Mega-Risks:
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Amy S. Bouska

ABSTRACT

As new types of losses appear for which traditional "triangular" analysis in inadequate, different approaches must be used. This paper defines policy-event based loss estimation (PEBLE), which is being used primarily in developing natural disaster and toxic tort rates and loss estimates. Although PEBLE appears to be new, its history goes back to life and disability reserving. The paper provides a non-mathematical discussion of the components of PEBLE, its advantages and disadvantages, and some of the issues associated with its use. The paper also examines the compatibility of PEBLE with CAS practices and principles.

BIOGRAPHY

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From Disability Income to Mega-Risks:
Policy-Event Based Loss Estimation

Black box. Obvious. Tricky. Inevitable. Old hat. Many adjectives can be used to describe the models that are emerging as the primary tools for estimating losses arising from natural disasters and toxic torts, but "non-actuarial" is not one of them. The intent of this paper is to provide an expository (i.e., non-mathematical) discussion of policy-event based loss estimation in general, including some of the advantages, disadvantages, and issues in its application, and to try to place it in the context of actuarial principles and practices.

Definition

By "policy-event based loss estimation" (PEBLE) technique, we mean any technique, whether for purposes of ratemaking or reserving, that estimates losses by comparing event outcomes directly to the applicable individual policy terms in order to estimate the potential loss to the policy. Some further calculation with these estimates (e.g., addition of general expenses or IBNR) may be required before arriving at a final result. These techniques may be either deterministic or stochastic and frequently rely on external, non-insurance data. They offer an alternative to traditional actuarial analysis for types of losses that are not "triangularizable" and coverages that do not lend themselves to loss ratio ratemaking.

At its most basic level, PEBLE consists of two elements: (1) a loss event that might give rise to an insurance claim, and (2) the application of the terms of an individual policy to that loss event in order to determine the insured loss. This is done for all of the policies exposed to the loss event in order to estimate the total insured loss. In addition, different

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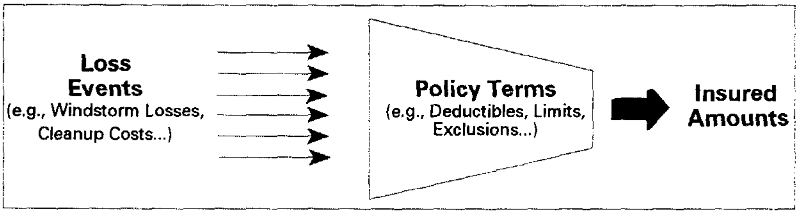
potential loss events might be used in order to better understand the variation in the total loss.



The PEBLEs with the highest property/casualty profiles at this time are the natural disaster models (e.g., windstorm or earthquake) and the toxic tort models (e.g., asbestos or pollution). However, they are also particularly useful for the analysis of auto warranty experience (see later).

PEBLEs are a form of collective risk model. As described by Roger Hayne in his 1989 paper,

> [t]he basic collective risk model approaches the question of the distribution of total reserves by modelling the claim process faced by an insurer. It considers the interaction between the distribution of the number of claims and the distribution(s) of the individual claims by calculating loss (or reserve) T as the sum
>
> $$T = X_1 + X_2 + \ldots + X_N,$$
>
> where the number of claims N is randomly selected, and each of the claims X_1, X_2, ..., X_N is randomly selected from claim size distribution(s). [1]

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[1] Roger M. Hayne, "Application of Collective Risk Theory to Estimate Variability in Loss Reserves," *PCAS* 1989, p. 78.

In a PEBLE, the claim size distribution of the collective risk model is replaced by the result of an explicit interaction of policy terms and exposures with external loss events.

In ratemaking, PEBLE is a pure premium approach rather than a loss ratio method. Assuming that sufficient care is taken in constructing the simulation sample (where simulation is involved) to adequately represent the tail of all of the relevant distributions, there is no need for credibility weighting against a broader average loss. The result is fully credible in the technical sense of the word.[2]

When Triangles Fail

Insurance policies are the proximate cause of insurance losses (without policies, would there be any losses?). Thus, it is reasonable to consider policies directly in the course of loss estimation. However, it is not always necessary, as the widespread and successful use of triangular methods clearly shows.

Strong implicit assumptions regarding both policy terms and loss events underlie triangular analysis methods, but they are rarely made explicit.[3] In particular, unless corrections or adjustments are made to the data, these methods assume a wide-ranging stability in both policies and losses. For example, if deductibles and/or limits change over time, historical report-to-report factors can mis-represent future development. Similarly, if the attributes of loss events or the handling of the resulting claims changes, analyses may be led astray.

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2 Michael A. Walters and François Morin, "Catastrophe Ratemaking Revisited (Use of Computer Models to Estimate Loss Costs)," Casualty Actuarial Society Forum Winter 1996, pp. 354-355.

3 "The basic objection to the simple methods is that they pay no regard to the theoretical foundations. Close examination will show that even apparently intuitive projections have some underlying model on which they are founded. .... (The chain ladder [triangular] method, for example, has been particularly subjected to such criticism.)" from the Claim Reserving Manual (2/89) of the UK Institute of Actuaries, p. D2.1.

We all know the various techniques that have been developed to deal with many of these aberrations in the data. However, there are other problems that are not resolvable within a triangular format.

Triangular analysis relies on a continuing flow of large numbers of relatively small loss events, the emergence and payment patterns of which do not change materially (or change predictably) over time. The first and most obvious case when the method fails is when there have been few, if any, similar losses in the past and a new type of loss emerges out of nowhere, or, more commonly, out of a report on a television news show. An example of this might be a surge in suits after an exposé on possible side effects of vaccines. The recent significant increase in silicone breast implant claims following a few successful lawsuits and increased publicity is another example.

The emergence of these losses tends to be on a calendar-year basis, reflecting the elapsed time since the initiating event rather than the underlying occurrence. For example, after a TV program on vaccines (the initiating event), claims might be equally likely from a family with a child who was recently vaccinated as from one with a child who was vaccinated five years ago. If the "occurrence" for purposes of triggering the policy is the onset of disability following the vaccination, then the accident-year age of the policy is irrelevant, and only the time since the initiating event is important. In this case, history provides no guidance, since the same forces are acting on all accident years simultaneously. (See Appendix A.)

Even if the claims emerge relatively slowly over time, triangular analysis may still fail. This is frequently due to a lack of correlation between a discrete occurrence and the accounting for the loss. Asbestos-related bodily injury is an example of this type of loss. Asbestos claims did not emerge full-blown after a single initiating event; instead, claim activity increased gradually from the first claims in the early 1970s. In the case of mesothelioma, it could be argued that, if the accident date were defined as the date of first exposure to asbestos, then some triangularization might be possible after adjustment for changing levels of exposure. This is due to mesothelioma's relatively well-understood latency period and the fact that it is less subject to reporting manipulation than the other asbestos-related diseases (since it is a signature disease of asbestos exposure).

However, the courts have not been that kind to actuaries. Instead, they have generally allowed all policies from the date of first exposure to the manifestation of the disease to be triggered. In this case, the cost of a claim might be recorded in any year -- or spread across all of these years -- making report-to-report analysis meaningless. (See Appendix B for an example.)

Triangular analysis shines where the losses can be described as "high frequency and low severity." It becomes more difficult when the losses are "low frequency and high severity" (as might be the case for excess medical malpractice or other excess liability coverages). It fails completely when the losses are either very rare or have never occurred before. Most natural disaster modelling falls in this category, as the timespan of recorded claim activity may not be long enough to capture the full impact of the tail of the severity distribution.

Although the CAS Ratemaking Principles require that "consideration ... be given to ... prospective changes in claim costs, claim frequencies, exposures, expenses, and premiums,"[4] traditional methods may fail in the face of those prospective changes. This occurred in the analysis of potential claims from leaking underground storage tanks (LUST). In 1988, the US Environmental Protection Agency (EPA) published regulations with future effective dates regarding financial responsibility, release detection, and

[4] "Statement of Principles Regarding Property and Casualty Insurance Ratemaking (As Adopted May 1988)", CAS 1996 Yearbook, p. 239.

corrosion protection. The official effective dates varied with the tank owner's business, volume of throughput, and age of the tank; due to differences in enforcement at the state level, actual effective dates varied even more. All of these had the potential to affect claims activity to greater or lesser extents. For example, the installation of release detection devices could reasonably be assumed to create a surge in claim reporting activity as old leaks were discovered. In addition, once detection devices were in place and existing leaks had been dealt with, claim severity was expected to decrease, since more leaks would be detected before they spread widely. As a result of the many future changes, LUST ratemaking for most tank populations requires unusually intricate simulations in the PEBLE.

The Emergence of PEBLE Techniques

With the exception of the very infrequent loss situation, all of the above examples are of relatively recent origin. It might be argued that a visceral understanding of the potential for very infrequent natural disaster losses to occur is also a relatively recent phenomenon resulting largely from Hurricane Andrew.[5] Thus, it is hardly surprising that, if a new class of insured losses appears, techniques will be developed in order to deal with them appropriately.

The increasing popularity of PEBLEs also corresponds with the emergence of cheap computing power.[6] PEBLES are frequently (although not always) very machine intensive, requiring megabytes of RAM and gigabytes of storage to be practical. In earlier days,

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5 "[Andrew] awakened some larger companies to the fact that their reinsurance protection against catastrophes was far from adequate. (It's only when the tide goes out that you learn who's been swimming naked.)" (Warren E. Buffett, Berkshire Hathaway, Inc. 1992 Annual Report, p. 10.)

6 Stephen W. Philbrick, "Catastrophe Modelling – Taking the Country by Storm," TopCat News (March 1996), p.4.

computing power of this magnitude was limited to mainframes, and access to mainframes tended to be relatively limited and relatively expensive.[7] Future PEBLE expansion will no doubt evolve in step with the available desktop machine power.

PEBLEs and Principles

PEBLEs are compatible with the CAS loss reserving and ratemaking principles even though these principles were articulated in the context of US actuarial practice, which tends to rely on the historical development of insurance data.

The CAS Loss Reserving Principles state that:

> An actuarially sound loss reserve for a defined group of claims as of a given valuation date is a provision, based on estimates derived from reasonable assumptions and appropriate actuarial methods, for the unpaid amount required to settle all claims, whether reported or not, for which liability exists on a particular accounting date. .... *Selection of the most appropriate method of reserve estimation is the responsibility of the actuary.* [Emphasis added.][8]

The CAS Ratemaking Principles are even more explicit:

> A number of ratemaking methodologies have been established by precedents or common usage within the actuarial profession. *Since it is desirable to encourage experimentation and innovation in ratemaking, the actuary need not be completely bound by these precedents.* [Emphasis added.] .... Historical premium, exposure,

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7 Of course, PEBLEs were done on mainframes. However, the wide availability of powerful and relatively inexpensive PCs widens the potential pool of model developers and users.

8 "Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves (As Adopted May 1988)," CAS 1996 Yearbook, pp. 231 and 236.

> loss and expense experience is usually the starting point of ratemaking. This experience is relevant if it provides a basis for developing a reasonable indication of the future. Other relevant data may supplement historical experience. *These other data may be external to the company or to the insurance industry and may indicate the general direction of trends in insurance claim costs, claim frequencies, expenses and premiums.* [Emphasis added.][9]

The importance of the underlying policy terms is clearly recognized by the Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves. One of its important "Considerations" is: "A knowledge of the general characteristics of the insurance portfolio for which reserves are to be established also is important. Such knowledge would include familiarity with policy provisions that may have a bearing on reserving, as well as deductibles, salvage and subrogation, policy limits and reinsurance."[10] (The Ratemaking Principles include a similar consideration on p. 239.)

Generic Description

In its most basic form, PEBLE consists of comparing an event outcome to the applicable policy terms in order to produce an estimate of the insured loss.

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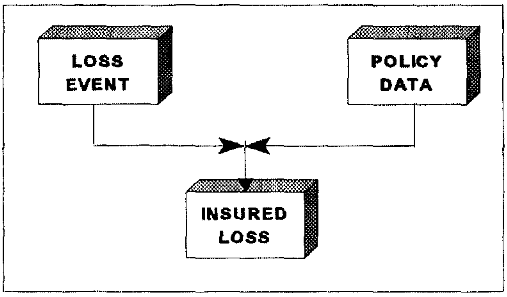
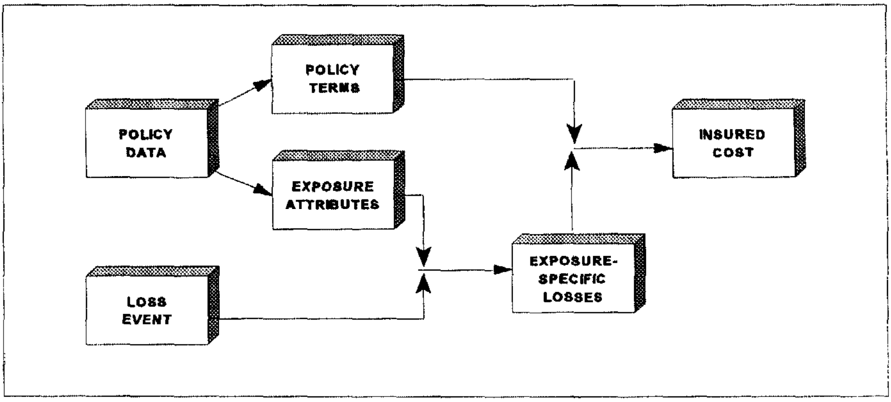
9 "Ratemaking Principles," p. 238.

10 "Loss Reserve Principles," p. 232.



However, in addition to the policy terms, the policy database usually supplies information on the attributes of the exposure (e.g., location, name of insured) that interact with the characteristics of the loss event to generate an exposure-specific loss amount. (In catastrophe models, this is called the damage module.) It is the comparison of this amount to the policy terms that determines the insured cost.



The relative size and complexity of the various modules depend on the loss peril being modelled. In natural disaster models, the event and loss amount modules are much more complex than the insured cost module; in pollution models, the opposite is true. The relationship reflects both the level of understanding of the loss event and the issues in policy allocation. In hurricane modelling, a great deal of meteorological information regarding past storms and storm behavior is available, along with engineering data on damageability, while the allocation of losses to policy is relatively simple due to the discrete nature of the loss. On the other hand, information regarding the underlying cost of pollution cleanups and its distribution among insureds is still developing and comparatively limited. The relative simplicity of the pollution loss event module is more than offset by the intricacy of the allocation module, which must be constructed to deal with multiple potential allocations across multiple years.

Because most are, PEBLEs are often assumed to be stochastic, but this is not necessarily true, as can be seen from their use in disability income reserving (see later). A stochastic PEBLE allows explicit consideration of process variance. This is especially important when the policies under consideration have high attachment points. In this case, the use of a deterministic average loss may seriously understate the potential average exposure to the higher layers. Implementation of the win factor in a pollution analysis as a deterministic multiplier rather than a stochastic culling of losses retains the correct average loss but understates the variability.[11]

[11] A pollution win factor decides whether the insured wins its coverage case against its insurer or not. It can be implemented as a multiplier of the pre-win factor loss (after allocation to layer) or as a random selector of losses to be completely removed (culled) from the results because coverage was denied. While the latter is more realistic, the former decreases the number of trials needed to reach a stable average for high layer coverages without changing the expected mean.

The distinction between deterministic and stochastic can be somewhat arbitrary: Although technically deterministic, the output of an asbestos model that is run for all possible values of underlying limits is indistinguishable from a model that is stochastic over that variable.

Stochastic PEBLEs need to address the intertwined issues of tails and number of trials. Especially when continuous (as opposed to empirical) distributions are used for some variables, care must be taken to run enough trials that the tails of the distributions are adequately sampled. Depending on the shapes of the distributions, a stable mean result may appear before the tail results are fully explored. Stratified sampling may be warranted, especially if the potential variability of the results is as important as the average result.

Loss Events

As noted above, modelling of loss events may be relatively straightforward (e.g., sampling from a single cost distribution) or very complicated (e.g., simulation of the attributes of a hurricane). In most cases, this module relies on work done outside of the insurance industry, for example, by meteorology researchers, by EPA contractors, or by the medical community (in the case of silicone breast implants).

Where multiple loss events are involved, one must consider correlations among the events. For example, hurricane paths within a single year may exhibit a clustering effect, having a greater tendency in that year towards moving up the US east coast versus moving into the Gulf of Mexico. Liability-based losses frequently occur in a "feeding frenzy" pattern, with a series of successful suits each increasing the likelihood that more suits will be filed.

Another important characteristic of the liability-based loss events is the "propensity to sue" adjustment. People whose homes have been blown away rarely neglect to file a claim, but even in cases of mesothelioma, where a significant award is virtually certain, not everyone will file a suit. Factors affecting the propensity to sue are not well understood, so it is usually incorporated as a simple multiplier, perhaps differing across broad types of exposure.

Underlying Losses

The underlying losses (i.e., exposure-specific losses before application of policy limits, deductibles, and other terms) are created by the interaction of the attributes of the loss event and the attributes of the exposure. This interaction may affect either frequency, severity, or both. For example, a hurricane will create different underlying losses depending on a dwelling's building materials. Likewise, the same hurricane will affect similarly constructed buildings differently depending on their locations, since one may be further from the coast and the average windspeed may have decreased by the time the storm reaches the inland structure.

Although it is sometimes said that trailer parks attract tornados, it is rarely argued that high-priced dwellings selectively attract hurricanes. On the other hand, it is reasonable to assume (but difficult to quantify) that larger petrochemical corporations will be exposed to more dumpsites than smaller ones. Similarly, certain types of manufacturing (e.g., petrochemicals) can be reasonably assumed to have exposure to more waste sites on average than, say, clothing manufacturers. Clearly, the larger manufacturers of asbestos-containing products are attracting more bodily injury claims than the smaller companies. Thus, frequency, as well as severity, can be a function of the exposure.

Like the loss event module, the underlying loss module frequently incorporates non-insurance expertise and/or data concerning, such as structural damageability, the differential effects of various types of asbestos, or EPA information regarding the PRP status of various corporations.

Insured Losses

The insurance module applies the terms of the applicable policy or policies in order to determine the insured loss. Since most actuaries are familiar with the operation of policy limits and deductibles (attachment points), this would seem to be relatively straightforward. Even in the case of natural disaster models, this view neglects the fact that usable individual policy data (or even exposure profiles) has only recently become widely available. Reinsurers and rating agencies have been instrumental in forcing insurers to develop the required exposure databases.

The problem of policy data availability is even worse in the case of latent toxic torts, where the policies in question may have been written before company operations were computerized. In addition, like all other records, policy data is routinely purged. Where available, policy data on old policies is likely to be incomplete or poorly recorded (e.g., as text fields). In these cases, some policy limits and/or attachment points will have to be simulated. It is important to note that the estimated losses may be very sensitive to both the average and the distribution of these policy terms. Before extensive simulation is used for policy terms, the possibility of completing the data should be explored.

In the case of liability-based exposures, estimation of insured losses from exposure-specific losses is difficult even if perfect policy data has been supplied. The estimation must take into account the possibility of different allocations across multiple years with widely variant policy terms, as well as the possibility that coverage will be denied. The latter is particularly important in estimating pollution losses. Even where an allocation to year has been selected, interaction of occurrence and aggregate limits and deductibles, differing expense treatments, drop-down clauses, and other common policy terms can require complicated programming.

Simplified Cases

The most basic PEBLE of reported claims is the total of the claim department's case reserves. On the other hand, the definition does not require that a policy-based loss estimate developed from another source be a case reserve. For example, a PEBLE might rely on completely simulated loss events (e.g., hurricane modelling) or simulated attributes for known loss events (e.g., pollution reserving). In these cases, the resulting loss estimates would not be appropriate for use as case reserves even though they are on a policy-by-policy basis and appear to be the functional equivalent of case reserves. PEBLEs as discussed in this paper are not expert systems for the claim department and are not intended to replace claims adjusters.

Going beyond the hands-on area of case reserves to the actuarial domain, it may appear that PEBLE is something new. However, PEBLE is actually very old, as it was and is the primary method for setting disability income reserves. In this case, the event module is reduced to the known duration-to-date of a disability-inducing event that has already occurred. The attributes from the policy database that combine with this to estimate the underlying loss cost (referred to as the probability of recovery) are age at disability, type of contract, and elimination period (deductible). This is then combined with the net present value of the policy benefits and multiplied by the probability of claim denial to calculate the reserve. In the case of life insurance reserves, the event module is reduced to a certainty.

Not surprisingly, tabular reserving for workers' compensation can be described in essentially the same way.

The derivation of increased limit factors (ILFs) and much of reinsurance analysis can also be considered to be somewhat simplified PEBLEs. Here, the loss module is simplified to the empirical or fitted distribution of underlying losses for the line of business under consideration. The attachment point and limit of the coverage are part of the ILF analysis, although these techniques do not generally reference individual policies. This is in contrast to the "new" PEBLEs, which are distinguished by the use of individual policy terms from an entire book of exposures, as opposed to the use of a generic attachment point or limit (e.g., "all losses greater than $25,000 and less than $1,000,000").

These PEBLE applications have very simplified loss event modules and few steps between the event and the result. The fact that they are entirely uncontroversial highlights two of the primary sources of unease about the "new" PEBLEs: their use of intricate, non-insurance based loss event modules; and their implementation through "black box" computer programs.

Issues in Using PEBLEs

There are several issues that are inherent in the use of PEBLEs and may lead to some reluctance to accept the result of the modelling. These include:

External Processes and Data

Much of the discomfort with respect to PEBLEs is concentrated in the loss event module. There are two reasons for this. First, loss event modules are frequently based on data developed outside of the insurance industry. Second, PEBLEs tend to deal with types of losses about which there is relatively little information, regardless of the source.

The actuarial literature does not deal with firewall movement in off-center automobile crashes, the relationship of central pressure to windspeed in Atlantic hurricanes, the demographics of drywall installers, or the migration of contaminant plumes in groundwater. We are not disadvantaged by the first of these omissions due to the abundance of private passenger claim data, but the others are emerging as more important. This creates two problems: (1) We have to rely on experts in other technical fields in developing our estimates. If we rely on incompetent "expert" advice, our estimates may be biased or completely wrong even if the insurance section of the model is completely correct. If it is very technical, the flaw may be invisible. (2) Because of the amount of (the frequently quite technical) outside material that must be studied, understanding of the relevant issues tends to be concentrated within the actuarial profession. This limits the number of actuaries who can deal knowledgably with a given issue; more importantly, it restricts the number who can usefully critique the work of the practitioners and contribute to the expansion of knowledge of the problem.

The expertise issue is a problem especially if there is relatively little hard data or experts disagree widely. This is the case, for example, with the estimation of future LUST discovery patterns. By definition, the 1998 regulations have never been implemented before. Anecdotal information can be gathered regarding the likely number of recalcitrant tank owners who are still not in compliance with earlier technical regulations but will bring their tanks into compliance in 1998 (and therefore discover leaks then). However, this sort of "soft" data is often a function of the source and should be viewed in the context of other related data.

In addition to non-actuarial expertise, significant amounts of external data may be required, the collection and maintenance of which can be both time-consuming and expensive. The data may not be practically arranged and, even where the original data source is considered to be reliable, the required "massaging" may introduce errors. To the extent that the data was not originally developed for modelling purposes, it may be inappropriate, biased, or incomplete. If claims have been reported, claims specialists can be a valuable and familiar source of information. However, the claims reported to date may be an inadequate sample from the universe of possible events. In the case of future changes in the external environment, reported claims may be unrepresentative of the future population.

"Black Box"

As Greg Taylor noted with respect to regression models, PEBLEs do not "... have the 'hands on' nature characteristic of methods based on age-to-age factors, for example, with which actuaries tend to feel at ease. There is a feeling of abstractness and loss of control .... "[12] Because of the "black box" nature of most PEBLEs, this reaction is well founded.

Actuarial standards of practice require that an actuarial report provide sufficient documentation that another actuary can replicate the work and confirm the conclusions. This is a problem when several hundred lines of computer code and multiple random number generators separate the input and output. The problem is exacerbated when the details of the model, the external data, and even some of the parameter selections are considered by the modeler to be proprietary.

While no standards for this situation are in place, pragmatic responses have emerged. Second opinions and methodology reviews are common. Assuming that the computer

[12] Greg C. Taylor, "Regression Models in Claims Analysis I: Theory," *PCAS* 1987, p. 354.

programs are correct (see later), the descriptions of them are accurate and sufficiently complete, and broad ranges for the parameters are supplied, experienced practitioners can generally reach an opinion regarding the likely overall appropriateness of the result. This is particularly true if a "benchmark" output or other information (e.g., survival ratios) is available. However, this is clearly an area that will require further attention as the use of PEBLEs and other intricate computer models such as dynamic financial analysis (DFA) become more widespread.

Validation and Usability

The use of any model, including PEBLEs, raises issues of validation and usability, where "validation" is only possible if losses of the type modelled have occurred, as is the case for natural disaster models.

Components of the model can and should be tested separately against individual events and for reasonableness overall. Validation should include consideration of the credentials of the outside sources used.[13] After the component parts of a model have been tested, it can be set to estimate the losses from a single storm with parameters matching a recent storm (to avoid significant changes in exposure) and the results compared to the actual losses. Because every event is unique, it is important to avoid over-calibration of the model.[14]

It is possible that the current review of catastrophe models by state regulators may provide additional guidelines for model validation.

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13 Walters and Morin provide a validation checklist in their Appendix C.

14 Karen M. Clark, "A Formal Approach to Catastrophe Risk Assessment and Management," *PCAS* 1986, p.87.

When PEBLEs are used for classes of losses that have not yet occurred or are likely to change significantly in the future, validation is not possible, and usability is the best that the actuary can achieve. In this case, the credentials of outside sources can be reviewed and their input independently confirmed, if possible. The overall structure of the model can be reviewed by others knowledgable in the field. Claims or legal specialists in the modelled type of loss are helpful for this step. While they frequently are unable to supply full distributions for the various parameters, they can provide insights on the distributions developed by the actuary.

Estimates are often needed where information is very sparse, but data-free analyses make actuaries nervous. The issues are whether the ranges of the parameters are sufficiently narrow to allow some analysis to proceed, and whether the true uncertainty in the resulting estimate can be conveyed to the end user. If the uncertainty is clearly disclosed, even in the absence of technical confidence intervals, sophisticated end users frequently find meaningful ways to incorporate the information. For example, acquisitions of property/ casualty insurers generally proceed even in the face of wide ranges of estimates of potential toxic tort exposures.

In the end, the decision regarding the usability of a given model is subjective and rests ultimately with the decision maker. The question of when the input and output ranges become sufficiently refined to be "usable" is a function of the intended use. For example, the range of results may be so wide that, in the user's opinion, the loss is not "estimable" in the sense of FAS 5, even though the model provides important information in scenario comparisons. Alternatively, the results may be partly usable. This was the case in 1992-93, when the SEC began to indicate to insurers that, even if the upper end of the potential pollution losses could not be estimated, it was the SEC's opinion that reasonable low estimates could be formed (and it was the SEC's *a priori* expectation that, for exposed companies, zero was not a reasonable low estimate).

In evaluating usability, it is important to remember that PEBLEs do not need to reproduce individual case reserves exactly (or, in some cases, even remotely) in order to be either usable or valid. Storms and courts of law are both fickle, and PEBLEs are intended to provide reasonable aggregate loss estimates, not replicate micro-scale behavior.[15]

Quality Assurance

There are well-developed quality-assurance and de-bugging techniques for computer programs, in which most actuaries are completely untrained. This introduces yet another reliance on outside expertise and a significant interface problem. The model may do exactly what the programmer wants, but is that what the actuary wanted? This is not a new problem, although the intricacy of the models increases the risk.

Specific applications may require adjustments to the model. However, this tinkering tends to introduce errors into the code. One way to reduce this is to hardcode as little as possible, parameterize everything, and make the parameter files the responsibility of the user. To the extent that changes "on the fly" are required, Murphy's Law is always in force, and only continuing reasonableness checks can provide the necessary control.

Parameterization

It is possible to over-parameterize a PEBLE model. This stems from trying to closely replicate either actual losses or the details of the loss process as it becomes better understood. In both cases, the resulting model can become too sensitive and too intricate. Clearly, all major components of the ultimate loss should be included and refined over time. However, the fine line at which "better" becomes "too much" is not always clear.

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15 Walters and Morin, p. 369.

There is a tendency to assume that model variables are independent. However, the goal of avoiding an overly sensitive model should not deter recognition that some of the selected variables may be correlated (e.g., wall thickness and tank capacity in underground tanks). If two variables are included and the correlation is considered significant, the model will have to be structured to link the two variables in order to rule out unrealistic outcomes.[16]

The issue of parameterization is closely linked with the issues of usability and cost. In the context of statistical models, Steve Philbrick notes that:

> [g]enerally speaking, increasing sophistication of the model produces more accurate results. The selection of an appropriate model for a particular problem requires deciding whether the increased accuracy of the more complex model justifies the increased costs associated with it. Furthermore, in many situations, the available data may be sparse or subject to inaccuracies. In these instances, a simple model may be preferred because the accuracy of results will not be materially improved by the use of a more complex model. .... There may be a need to explain the loss projection process to people without extensive actuarial or statistical training. Although techniques should not, in general, be dictated by the sophistication of the audience, if competing models produce almost identical results, the ease of explanation of one may be an important consideration.[17]

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16 In his 1995 discussion paper, Sholom Feldblum makes the point that, in some cases, "... individual factors are strongly correlated one with another, [and so] only a relatively small group of possible 'simulated' outcomes are realistic." He concludes that, in these cases, scenario testing is more appropriate and informative than stochastic modelling. (Sholom Feldblum, "Forecasting the Future: Stochastic Simulation and Scenario Testing," CAS 1995 Discussion Paper Program, p.158.)

17 Stephen W. Philbrick, "A Practical Guide to the Single Parameter Pareto Distribution," *PCAS* 1985, pp. 45-46.

The British Institute of Actuaries states the tradeoff even more bluntly: "A trap to avoid is clearly that of indulging in mathematical sophistication for its own sake, without regard to the business needs."[18]

Cost / Benefit

PEBLEs tend to be expensive to develop and maintain. In deciding whether to use a model of this type, an insurer needs to weigh the cost against the benefits (e.g., improved management information, better rating). Cost/benefit analysis should also be applied to the source of the model. A large insurer may find it advantageous to build their models in-house, as this may generate greater internal acceptance. Because of the resource commitment required, however, smaller companies may prefer to use the model of an outside vendor that is able to amortize the development costs over several users.

Updates

After a PEBLE model has been completed and put into use, the question of updating both the model and individual results (e.g., Texas windstorm rates) arises. Cost considerations frequently create a certain inertia in this process, but, in some cases, updates are clearly indicated.

The first of these is significant change in the exposed business. This might include changes in underwriting guides (e.g., beachfront property becomes acceptable), policy terms (e.g., replacement cost instead of actual cash value coverage), or reinsurance (e.g., treaty attachment points are increased). Interestingly, even "old" exposures are subject to this sort of change as commutations and policy buyouts become more common.

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[18] Institute of Actuaries, p. D2.2.

The second is significant change in the loss process or an important parameter, requiring changes in the structure of the model or revised parameter selections. This category might include notable external events, such as the enactment of Superfund reform, collapse or expansion of the Georgine asbestos settlement, or new information on global climate change. The changes can also be gradual, as, for example, claims handling practices or court decisions evolve over time. In the latter case, the point at which a "usable" model becomes "unusable" and an update is required may be not be clear.

The third clear reason to update is the availability of significant new data, even in the absence of other changes. This is especially true of the "old" toxic tort exposures, where there is frequently an on-going process of data entry in the claims department, including both new claims and additional data on known claims.[19]

Advantages of PEBLEs

Despite the difficulty of developing them, PEBLEs have important advantages even when other methods (such as claim department case reserving) are available. These include:

- Clarity – Although the details are frequently obscure, the overall structure of most PEBLE models is generally intuitive and easily communicated. This is not always the case with statistical or even triangular analysis. Unlike statistical techniques,[20] every part of a PEBLE model has a real world analog.

- Better understanding of the loss process -- Constructing the model inevitably improves understanding of the problem. This contributes to better management of

19 Reconciliation between reviews can be very difficult in this case, as the revisions may include changes to the prior data (different names, dropped claim records, etc.).

20 Taylor, p. 359.

the exposure and improvement in the estimation process. In addition, since all PEBLE models for a given exposure are attempting to measure the same process, this is likely to lead to convergence of results from different models.

- Documentation of changes – Unlike the diffuse (but more accurate at an individual exposure level) process of case reserving, PEBLEs facilitate documentation of overall changes. For example, a change in the estimated costs of Superfund sites might lead to adjustments in hundreds of case reserves. While clearly documented at the individual file level, these are difficult to compile and explain in aggregate.

- Scenario testing -- What if a force 5 hurricane hit New York? What if the New Jersey Supreme Court decided to impose a manifestation allocation on all sites with coverage litigation in New Jersey? PEBLE models can provide valuable insights on alternative scenarios. This may be true even if significant uncertainty remains in the estimates.[21]

- Understanding variation – Creating the distributions to be used for the parameters in stochastic models forces explicit consideration of the potential range of variability and the skewness in the distributions. The resulting variability in the output can be checked for reasonableness against intuitive expectations, recognizing that past experience may not always provide an adequate indication of potential outliers.

Virtually every discussion of stochastic models makes note of their usefulness in estimating process risk. Less attention is paid to the measurement *and*

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21 A similar situation is noted by James Stanard and Russell John in the introduction to their paper on "Evaluating the Effect of Reinsurance Contract Terms" (*PCAS* 1990, p. 2): "In many reinsurance pricing situations it is not possible to determine a 'correct' *absolute* price without making a large number of tenuous assumptions. However, it is often advantageous to make some general statements about *relative* price adequacy. By *relative* price adequacy we mean statements ... such as ... Deal #1 is better than deal #2."

communication of either parameter risk or model specification risk.[22] The former can be partially attacked by the brute force method of testing multiple versions of each parameter or creating a "meta-model" that randomly selects a distribution for each parameter and then runs the model. However, the worst outcomes may arise from an unsuspected (and therefore untested) correlation between two variables. Due to the cost of model construction, it is likely that, in the absence of "duelling models," model specification risk will remain untested.

More Examples

As noted earlier, PEBLE is also useful in the analysis of auto extended warranty, where the length of the warranties and the turnover of car models prevents the accumulation of a sufficiently long period of relevant historical data. In his paper on these models,[23] Roger Hayne notes that "[t]he primary value of these emergence models is that they can provide insight as to relative loss differences under various situations. ... These models can also be useful in providing insight into the influence of various factors on the overall cost...."[24]

PEBLE applications are not restricted to the examples above. The variety of auto no-fault implementations led to the development of PEBLE-based comparisons in the 1993 paper by Herbert Weisberg and Richard Derrig.[25] The authors specifically note the need for

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22 Roger M. Hayne, "A Method to Estimate Probability Levels for Loss Reserves," Casualty Actuarial Society Forum, Spring 1994, Volume One, pp. 299-300.

23 Roger M. Hayne, "Extended Service Contracts," *PCAS* 1994, pp. 243 - 302.

24 Hayne, *PCAS* 1994, p. 268.

25 Herbert I. Weisberg and Richard A. Derrig, "Pricing Auto No-Fault and Bodily Injury Liability Coverages Using Micro-Data and Statistical Models," Casualty Actuarial Society Forum Special Edition 1993 Ratemaking Call Papers, pp. 103-153.

additional data on both the underlying loss process (i.e., the injured claimant) and its characteristics relative to the policyholder.

Workers compensation has drawn two PEBLE analyses in papers by Venter and Gillam,[26] and Graves.[27]

Many more PEBLEs are in use but have not been documented in the literature. These include models for residual value insurance, mortgage insurance, a stochastic implementation of Chuck Berry's paper on retro reserves,[28] and a super-PEBLE DFA model.

Regardless of how inexpensive desktop computing power becomes, It is unlikely that PEBLEs will ever be the approach of choice for most actuarial problems. However, where the past is an inadequate guide to the future, PEBLE may be the best -- or the only -- method available. When looking out of the back window of the car doesn't work,[29] build a virtual highway.

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26 Gary G. Venter and William R. Gillam, "Simulating Serious Workers' Compensation Claims," Casualty Actuarial Society 1986 Discussion Paper Program, pp.226-258.

27 Gregory T. Graves, "On Pricing Multiple-Claimant Occurrences for Workers' Compensation Per-Occurrence Excess of Loss Reinsurance Contracts," Casualty Actuarial Society 1990 Discussion Paper Program, pp. 217-236.

28 Charles H. Berry, "A Method for Setting Retro Reserves," *PCAS* 1980, pp. 226-238.

29 "An insurance company is just like a car with a fogged-up windshield. The president is steering, ..."

Sudden Initiating Event

Incremental Reported Claim Counts

AY	12 mos	24 mos	36 mos	48 mos	60 mos	72 mos
1990	0	1	0	3	60	30
1991	1	0	2	60	30	
1992	0	4	80	40		
1993	2	30	15			
1994	40	20				
1995	60					

Initiating event occurs in late 1993.
Assume no claims are reported after 1995.

Cumulative and Final Reported Claim Counts

AY	12 mos	24 mos	36 mos	48 mos	60 mos	72 mos
1990	0	1	1	4	64	94
1991	1	1	3	63	93	
1992	0	4	84	124		
1993	2	32	47			
1994	40	60				
1995	60					

Report-to-Report Factors

AY	12-24	24-36	36-48	48-60	60-72	72-84
1990	-	1.00	4.00	16.00	1.47	
1991	1.00	3.00	21.00	1.48		
1992	-	21.00	1.48			
1993	16.00	1.47				
1994	1.50					
1995						
Indicated Factors	6.17	6.62	8.83	8.74	1.47	
Correct Factors	1.00	1.00	1.00	1.00	1.00	

Note: Claim amounts are entirely fictional and are not intended to represent a particular type of loss.

Multiple Occurrence Years

Claim #1 Incurred Loss ('000)*

AY	12 mos	24 mos	36 mos	48 mos	60 mos	72 mos
1990	0	0	0	0	20	20
1991	0	0	0	20	20	
1992	0	0	20	20		
1993	0	20	20			
1994	20	20				
1995	0					

Total Incurred Loss ('000)

AY	12 mos	24 mos	36 mos	48 mos	60 mos	72 mos
1990	0	0	30	30	50	50
1991	0	30	30	50	50	
1992	30	30	50	50		
1993	0	20	20			
1994	20	20				
1995	0					

Claim #2 Incurred Loss ('000)*

AY	12 mos	24 mos	36 mos	48 mos	60 mos	72 mos
1990	0	0	30	30	30	30
1991	0	30	30	30	30	
1992	30	30	30	30		
1993	0	0	0			
1994	0	0				
1995	0					

Report-to-Report Factors

AY	12-24	24-36	36-48	48-60	60-72	72-84
1990	-	-	1.00	1.66	1.00	
1991	-	1.00	1.66	1.00		
1992	1.00	1.66	1.00			
1993	-	1.00				
1994	1.00					
1995						
Indicated Factors	1.00	1.22	1.22	1.33	1.00	
Correct Factors	1.00	1.00	1.00	1.00	1.00	

** Both claims are assumed to be correctly reserved when first reported. Claim #1 ($100,000) is reported in 1994 and recorded in AY 90-94; claim #2 ($90,000) is reported in 1992 and recorded in AY 90-92.*

Note: Claim amounts are entirely fictional and are not intended to represent a particular type of loss.

Disclosure Requirements for Mass Torts

by Brian Z. Brown, FCAS
Jonathan Godown
Gail E. Kappeler, ACAS

DISCLOSURE REQUIREMENTS FOR MASS TORTS

BY: Mr. Jonathan Godown
Mr. Brian Brown, F.C.A.S., M.A.A.A.
Ms. Gail Kappeler, A.C.A.S., M.A.A.A.

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DISCLOSURE REQUIREMENTS FOR MASS TORTS

ABSTRACT

The Securities and Exchange Commission (SEC) and state insurance departments have added increased disclosure requirements for companies with environmental and asbestos (E&A) exposures. For insurance companies, Note 24 of the annual statement requires disclosure of recent E&A payments and reserves. For insurers and non-insurers, the SEC has issued Staff Accounting Bulletin (SAB) No. 92. SAB 92 among other things requires a disclosure of the amount accrued for E&A and the amount of reasonably possible losses in excess of the amount accrued.

The first section of the paper reviews the new disclosure requirements for insurance companies and outlines benchmark ratios which rating agencies and regulators will use to measure E&A reserve adequacy. Specifically, we provide a benchmark analysis based on the newly published Note 24 information for several primary companies and reinsurers. We also outline the differences in ratios for environmental and asbestos and for primary companies versus reinsurers. However, it should be kept in mind that simple analyses of ratios will have several shortcomings which we discuss.

The next section describes the general methods which rating agencies use to measure an insurance company's E&A reserve adequacy. Also, limitations with the standard ratio analysis and the need to factor in additional items are discussed. Trends are extrapolated to the future and likely future reserve additions are projected.

The last section of the paper outlines the disclosure requirements for non-insurers. We also sample a number of 10K's to observe trends in disclosures. Specifically, we compare various statistics for different time periods: the percentage of companies which disclose an accrual amount; the percentage of companies which discount their liabilities; etc.

DISCLOSURE REQUIREMENTS FOR MASS TORTS

Introduction

Recent studies conducted by various groups such as Standard & Poor's (S&P), A.M. Best and the American Academy of Actuaries indicate that the magnitude of ultimate environmental and asbestos (E&A) liabilities for U.S. insurers may not be as devastating as thought a few years ago. This favorable trend is largely due to a reduction in the estimate for environmental liabilities. In its January 1996 study, A.M. Best estimated that the U.S. insurance industry's ultimate cost for environmental liabilities will be $66 billion (significantly less than the $255 billion estimated in their March 1994 study). In contrast, A.M. Best's estimate of ultimate costs for asbestos of $40 billion is virtually unchanged from its March 1994 study. S&P's comparable estimates are $85 billion for environmental liabilities and $45 billion for asbestos liabilities. The decrease in projections for environmental liabilities is attributable to a number of factors including:

- a decrease in the projected ultimate number of sites on the national priority list (NPL);
- a decrease in the estimated average cost per site; and
- lower projected NPL transaction costs (these are largely legal expenses).

Therefore, S&P's and others' recent studies have produced estimates of E&A liabilities which are more manageable for insurers. The concern has now shifted from the devastating impact that E&A liabilities could have on the entire insurance industry, to the impact that E&A liabilities could have on a handful of insurers who either have a large amount of exposure or are not managing their exposure. Rating agencies and regulators are now focusing their attention on ways to identify these companies.

One obstacle third parties face in evaluating a company's E&A liabilities is the lack of information available with which to assess each company's E&A reserve levels. Until recently, there have been no specific E&A disclosure requirements for all insurers.[1] However, beginning with the year-end 1995 statutory annual statements, each insurer is required to provide information regarding its measurement of E&A liabilities. Specifically, Note 24 of the annual statement requires disclosure of E&A payments and reserves.

Additionally, over the past several years, the Securities and Exchange Commission (SEC) has increased its scrutiny of registrants' disclosure requirements. The SEC began to notice in the early 1990's that many public companies (non-insurance companies) took the position that their net liability was insignificant because most of their environmental liabilities will be covered by

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1) The SEC increased its attention on disclosure issues for stock insurers. However, mutual insurers were not required to specifically report information on E&A liabilities in their annual reports.

insurance policies. However, insurance companies claimed that their policies excluded coverage for cleanup of hazardous waste sites. This led the SEC to require more extensive disclosures for insurers and non-insurers. Specifically, the SEC issued Staff Accounting Bulletin No. 92 (SAB 92) in June of 1993 to clarify the SEC position with regard to accounting for and disclosure of contingent liabilities.

In the remainder of this paper, we will:

- discuss the specific disclosure requirements for insurers and non-insurers;
- provide summaries of information disclosed by sample groups of insurers and non-insurers;
- describe some ways that third parties may use Note 24 information to measure a company's E&A reserves;
- discuss the limitations of using Note 24 information to analyze a company's E&A reserves; and
- provide a rating agency's perspective of E&A exposure issues.

I) E&A Disclosures for Insurers

As of year-end 1995, Note 24 to the Statutory Annual Statement required companies to disclose their historical payments and reserves separately for asbestos and environmental liabilities.[2] This information has never before been publicly available. Rating analysts, insurance regulators and actuaries will now be better able to determine the relative reserve adequacy of various insurance companies through year-end 1995. Analysts can compute several ratios for both the company and the industry. Several commonly used ratios include:

- Survival Ratio;
- Reserve Ratio;
- Premium Ratio[3]; and

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[2] Exhibit 1 displays the instructions for filling out Note 24.

[3] The premium ratio is not available from Note 24 but rather is available from various publications. The premium ratio can be analyzed in combination with the reserve and payment ratio (which are available from Note 24).

- Payment Ratio.

The *survival ratio is defined as a company's reserves divided by its calendar year payments.* This ratio measures how many more years of payments the reserves can support, assuming future year payments are equal to the current calendar year payments.

The next measure is the reserve ratio. The reserve ratio is the company's current reserves relative to industry reserves for E&A claims. This ratio should be viewed in combination with other *ratios such as the premium ratio and the payment ratio. If a company's exposure as measured by* the premium ratio is relatively low, and the company's payment ratio is relatively low, a low reserve ratio would not indicate a reserve deficiency. However, if the reserve ratio is significantly below either the premium ratio or the payment ratio, then a potential reserve deficiency may be indicated.

The premium ratio measures the amount of premium written by the company relative to the industry, which would expose it to E&A claims, during the exposure period. It is generally assumed that policies written between 1960 and 1980 for general liability will expose a company to E&A claims. Therefore, one measure of an insurance company's exposure to E&A losses is the company's written premium for general liability between 1960 and 1980. The relative exposure of the company can be computed by dividing its written premium by the written premium for the industry. As a technical note, the relative exposure can also be used as a starting point in projecting ultimate E&A losses via a market share method[4].

The last ratio we will discuss is the payment ratio. This ratio is the calendar year E&A payments of the company related to the calendar year E&A payments of the industry.

The attached Exhibits 2-5 display the four above mentioned ratios for several of the largest reinsurers and primary companies separately for asbestos and environmental.

<u>Survival Ratios</u>

Table 1 displays average survival ratio statistics for 1995 from Exhibit 2.

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[4] See "Estimation of Liabilities Due to Inactive Hazardous Waste Sites" by Raja Bhagavatula, Brian Brown, and Kevin Murphy, CAS Forum Summer 1994.

Table 1	
Average Survival Ratios For Selected Companies	
Environmental	
Reinsurers	17.1
Primary Insurers	6.3
Asbestos	
Reinsurers	8.8
Primary Insurers[5]	9.5

We can draw some preliminary observations from the above table:

- As expected, the average survival ratio for environmental liabilities for reinsurers of 17.1 is significantly greater than the average survival ratio for primary insurers of 6.3;

- As expected, the average reinsurer survival ratio for environmental liabilities of 17.1 is greater than the reinsurer survival ratio for asbestos of 8.8. We would expect a higher proportion of ultimate losses to have been paid for asbestos relative to environmental and therefore the future reserve for asbestos to be less than the future reserve for environmental;

- Unexpectedly, the primary company survival ratio for environmental liabilities of 6.3 is below the primary company asbestos ratio of 9.5. There are several possible explanations of this unexpected result. For example, it is possible that companies can better quantify their asbestos liabilities, due to the fact that asbestos exposures are more mature than environmental exposures. Alternatively, asbestos case law is more fully defined than environmental case law. Many companies may be assuming that future favorable decisions with regard to environmental coverage issues will help to decrease the needed reserves (due to court cases concluding that CGL policies do not afford coverage under Superfund or comparable state laws). Other factors could also lead to the above unexpected relationship: specific insureds, limits of coverage provided, reinsurance programs, years of coverage, etc.

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[5] Excludes one company which is known to have participated in a large asbestos settlement.

- Also unexpectedly, the asbestos survival ratio for primary insurers of 9.5 is higher than the ratio of 8.8 for reinsurers. This could be due to some of the factors mentioned above. Also, it may be more difficult for reinsurers to quantify their exposure (due to the payment and primary company reporting lags).

Note that our analysis is based on a sample of companies. Review of the disclosure for all companies may produce different results.

Other Ratios

There is a wide variation in the ratios from company to company. This variation can lead to differing interpretations. Caution must be used when analyzing this information to assess a company's reserve strength. To illustrate, we have extracted ratios for four companies and will discuss various ways to use this information. Table 2 displays these ratios for the environmental liabilities of four reinsurers:

Table 2				
1995 Financial Ratios - Select Reinsurers				
Company	**Survival Ratio**	**Reserve Ratio**	**Premium Ratio**	**Payment Ratio**
A*	43.0	3.90%	0.20%	0.73%
B*	14.4	2.06	0.60	1.16
C*	10.9	6.26	1.40	4.62
D*	3.6	0.23	0.50	0.53

* The carriers' ratios have been adjusted by a scaling factor to protect their identity.

As the table shows, the companies we selected have a wide variation in their ratios. This could mean that the companies have widely different exposures to loss which the above ratios cannot measure. However, the variation may be interpreted as indicating that some carriers are taking a more pro-active stance in establishing ultimate environmental claim reserves. As Table 2 displays, Company D's premium ratio is 0.50% and its payments ratio is 0.53%, whereas its reserve ratio is 0.23%. This may imply that Company D's:

- 1995 payments are not representative of future activity;

- claims department has been active in making payments to reduce its future exposure (e.g., through commutations);

- reserves are below its peers' reserves; or

- premium share and payment ratios do not measure its exposure to environmental reserves.

To establish reserves, some reserving analysts are benchmarking company reserves based on analysis of industry or peer group companies. For example, Table 1 shows that the average 1995 survival ratio for the selected primary insurers is 6.3 for environmental liabilities. Based on this, if a company's most recent calendar year payments were $10M, it may establish a reserve of $10M x 6.3, or $63.0M. This company may believe it is adequately reserved since it has used industry average ratios in estimating its reserves. However, it is generally believed and documented in A. M. Best's recent study titled "P/C Industry Begins to Face Environmental and Asbestos Liabilities" that, on average, carriers have not yet fully addressed asbestos and environmental exposures. Thus, this procedure will result in inadequate reserves on average.[6)]

There are several factors that could lead one to the wrong conclusion when utilizing industry average factors. For example:

- The level of E&A exposure will depend on the limits of insurance written. It is generally believed that exposure to E&A liability claims will arise more out of primary layers for pollution than for asbestos. Therefore, carriers writing high limits of reinsurance (e.g., above $5M or more) may not be exposed to the degree that their premium share will indicate for pollution claims.

- The type of insured will heavily influence the needed environmental reserves. Several large Fortune 500 Corporations are named on a large number of NPL sites. These potentially responsible parties (PRP's) heavily expose carriers to liabilities, whereas smaller "Mom and Pop" type operations will not expose carriers to the same degree. Therefore, a carrier writing large accounts, especially those named at a number of NPL sites, may be exposed to more environmental claims.

[6)] One method to estimate reserves would be to estimate the carrier's premium ratio and multiply it by an estimate of the insurance industry's ultimate pollution losses. A.M. Best's recent study estimates pollution costs of $66.0 billion; S&P's study estimates pollution costs of $85.0 billion. If the carrier's premium ratio is 1.0%, this would imply ultimate pollution costs of $660 million or $850 million. This method is referred to as the market share method.

- One element which will affect a company's reserves as well as its payment ratio is the number of policy buy-outs or buy-backs used by the carrier. To the extent the carrier is buying policy limits back from its insureds, it is reducing its future E&A exposure. Therefore analysis of the payment ratio and reserve ratio for a carrier aggressively using buy-backs will produce misleading results.

- The use of specific policy language will affect the company's exposure to environmental losses. For example, in general the absolute pollution exclusion has been upheld. Therefore, the earlier the carrier adopted the absolute pollution exclusion the lower the needed reserve, all other factors being equal. Other policy contract provisions also will have a bearing on the court's interpretation with regard to insurance coverage applicability.

Comparison of a company's ratios may indicate conflicting conclusions with regard to relative reserve adequacy. For example, a company may have a high percentage of payments relative to the industry and relative to its reserves. One conclusion may be that the company's payment ratio is higher because it is exposed more heavily to large insureds. However, its payment ratio may be larger because it is using policy buy-backs or making payments on claims currently to reduce its future exposure. Thus, a high payment ratio may actually be an indication of relatively stronger or more aggressive management of environmental exposures than peer companies.

Environmental/Asbestos - A Rating Agency Perspective

Current estimates of calendar year 1995 strengthening for industry environmental and asbestos reserves range as high as $10 billion with a significant portion of the loss attributable to just a handful of companies. While this is an industry issue given the significant number of companies affected, it remains a very company specific problem. It is estimated that six insurers/reinsurers alone represent approximately $6 billion of the 1995 development.

Historically, adverse development for other and products liability for 1985 and prior accident years (which is represented largely by E&A) averaged between $2 billion and $3 billion annually for the industry. The acceleration in loss recognition in 1995 was due to several factors including increased pressure from shareholders, regulators and rating agencies, balance sheet restructurings and other forms of reorganization including mergers and acquisitions. All of these issues were aided by the increased availability of more useful information (both internal and external). *(Additionally, Note 24 in statutory annual statements provides payment and reserve statistics for insurers).* In addition, during 1995, many companies recognized considerable reserve redundancies for workers' compensation which helped to offset the charges taken for E&A as did robust investment returns.

Environmental and asbestos liabilities have been a major factor influencing claims-paying ability ratings in the property/casualty industry for a number of years. Exposure to E&A claims has brought into question the capital adequacy, earnings power, and competitive positioning of the exposed companies. Rating agencies, faced with the high degree of uncertainty surrounding this issue, suffered as well as they appeared to be reactive to the problem rather than proactive.

Historically, an insurer's ability to determine their ultimate exposure to this issue has been hampered by the uncertainty surrounding the extent of pollution, the costs associated with clean-up and/or remediation, individual court interpretations and ongoing coverage disputes. As a result (at least through 1994), companies continued to hide behind the "unquantifiable" argument and therefore that no accurate determination of ultimate loss could be calculated. Many companies elected to fund this liability over time developing a pay-as-you-go mentality.

Insurers and rating agencies alike needed some form of standard or benchmark to compare the E&A reserve levels of one insurer against another. As a result, the ratio of carried reserves to paid losses or "survival ratio" was introduced as a de facto standard of measurement, built on the premise that insurers would fund this reserve deficiency gradually over time. This measure served as an early indicator and soon became the industry benchmark. As a result, companies focused their attention on maintaining a survival ratio comparable to their peers rather than trying to determine their ultimate exposure to this issue. Problems with using the unpaid to paid relationship as a standard of measure include inconsistencies in the claims handling practices of companies, the impact of large single claims, and the differences in reporting for excess versus primary layers of coverage. All of these problems make comparisons of individual companies' ratios very difficult.

The E&A issue, like most others, has been handled very differently by various management teams. Some have been very diligent while others have not. It is the task of the rating agencies to differentiate between these companies in their ratings. In all fairness many companies do not have a relatively significant exposure and therefore, extensive labor in this area would not be cost effective. However, other companies lulled themselves into a false sense of security and did not address the issue as aggressively as they should have.

In order to address these concerns, Standard & Poor's has developed an environmental/asbestos model based on a premium market share distribution. The intent of this model was not to develop an estimate of the industry's ultimate exposure for E&A, but rather what its implications were for individual insurers. An initial number for the industry's potential exposure to E&A was developed and then, based on a straight premium market share approach, S&P selected those companies that were potentially environmentally exposed to analyze in more detail.

This model has obvious shortcomings when applied to individual insurers as premium is not always a good measure of exposure. However, the modeling allowed for the development of an initial estimate that could be used in determining the exposure of individual companies. This early estimate was not made public given potential shortcomings in the model. It was shared with each insurer and compared against their held reserves and a potential deficiency/redundancy was then calculated. Insurers were given the opportunity to explain any significant differences between the Standard & Poor's estimate and their current reserve position. Every company's exposure to E&A is different and dependent upon several factors including the company's list of potential insureds, what coverage's were provided and what years the coverage was in force. Other factors include reinsurance protection (both quantity and quality), as well as claim-handling practices. These are all recognized as factors in determining exposure that cannot be addressed through the use of a market share model.

Adverse development for environmental/asbestos will most likely continue during 1996 and beyond, although perhaps not to the single year magnitude that we saw in 1995. Currently, S&P's estimate of the remaining deficiency on a net present value basis is roughly $14.5 billion. While many other large national carriers increased reserves significantly and rating agencies view this action favorably, reserve strengthening for E&A is not over, barring any Superfund reform. There are several remaining large carriers that have not dealt with this issue as decisively as their peers. Some have the earnings power, financial flexibility and/or strong capital positions to absorb such a charge; others may not.

The next round of E&A strengthening will most likely consist of continued development for some large national carriers (in some instances due to specific exposures), smaller companies that either lack the resources to address this issue more diligently today or are unaware of potential significant exposures, and finally reinsurers.

Reinsurers represented a considerable share of the reserve strengthening taken in 1995 and early 1996. While the level of uncertainty surrounding this exposure for primary companies is staggering, it is even more difficult to gauge for reinsurers. This is particularly true for companies that wrote large amounts of treaty casualty with various layers of coverage provided. A significant level of the strengthening that was taken during 1995 and 1996 was related to facultative and direct excess exposures which are more quantifiable than treaty exposures.

In many ways, reinsurers are in a position very similar to that of primary companies just a few years ago. Current estimates of ultimate exposure are difficult to quantify, companies are in the process of evaluating what their peers are doing (our expectation is that Note 24 will help considerably in this area), and current methodology allows for a gradual funding over time. The expectation is that as more meaningful data becomes available to primary companies, this will filter down to reinsurers and most likely result in similar actions to those we saw on the primary side in 1995. Furthermore, as more meaningful information and modeling becomes available, both insurers and reinsurers should expect continued pressure from rating agencies to better quantify their exposure to E&A. In some cases, this could result in further negative rating actions.

E&A Disclosures for Non-insurers

The SEC has required publicly held companies to disclose E&A information in their 10K financial statements if the exposure is material. The disclosures are intended to provide information to potential investors to allow them to assess the extent of and the management of the company's E&A exposure. Many companies have taken the position that their E&A liabilities are covered by insurance policies, and their net liability is therefore immaterial. Insurers, however, have challenged these claims by arguing that their policies contain exclusions for E&A exposure.

The magnitude of the cleanup costs, the uncertainty associated with insurance recoveries, and the diversity of disclosure practices have led the SEC to increase its scrutiny of registrants' disclosure of environmental liabilities. The SEC staff issued Staff Accounting Bulletin No. 92 (SAB 92) in June of 1993 to clarify the SEC's position with regard to accounting for and disclosure of contingent liabilities.

SAB 92 revisits some of the existing requirements for disclosure of contingent liabilities such as those found in Financial Accounting Standards Boards Statement No. 5 (FASB 5). FASB 5 states that a contingent liability must be recognized when it is probable that a liability has been incurred and the amount of loss can be reasonably estimated. To clarify this statement, FASB issued Interpretation No. 14 (FIN 14), which indicates that registrants are not to delay accrual of a loss until a single amount can be reasonably estimated. If the company can estimate a reasonable range of possible loss amounts, the best estimate within this range should be recognized. If a best estimate is not determinable, the range minimum should be accrued as a liability. When quantifying accruals, SAB 92 requires that measurement be based on currently available facts, current laws and regulations, and existing technology. For example, registrants should not assume that improved remediation techniques will be developed and that future cleanup costs will be reduced.

In addition to disclosure of the amount accrued, companies are required to disclose the amount of reasonably possible losses in excess of the amount accrued as well as judgments and assumptions underlying the calculation of future costs.

SAB 92 also addresses other key issues relating to E&A liabilities: (1) the treatment of potential recoveries (through insurance or other sources) in financial statements; (2) the appropriate discount rate to be used for recording liabilities at a present value; and (3) recommended disclosures regarding contingent liabilities.

SAB 92 states that probable recoveries from insurance companies or other third parties should not be used to offset contingent liabilities. The balance sheet should present the gross amount of the liability. Registrants can separately recognize an asset representing recoveries only if the recoveries are probable and they explain why the recoveries are probable. The SEC's position regarding the treatment of recoveries was strengthened by FASB's Interpretation No. 39 (FIN 39). Effective for fiscal years ending after December 31, 1994, FIN 39 indicates that the requirements for offsetting will be applied more stringently than in the past. It should be noted that this section of SAB 92 does not apply to insurance companies which estimate reinsurance recoveries in the normal course of business practice.

SAB 92 states that discounting is appropriate only if the amount and timing of the payments are fixed or reliably determinable. The discount rate to be used is limited to the rate on risk-free investments, with maturities corresponding to the expected payments.

Examination of Sample Data for Non-insurers

To assess the differences in reporting practices from company to company, we examined a sample of sixty 10K financial statements for fiscal years ending in 1993 and sixty 10Ks for fiscal years ending in 1994 (and 1995) filed by publicly held entities that have been named as PRP's at NPL sites. We selected companies that have been named as PRPs because it is highly probable that these companies have environmental exposures. According to the SEC's requirements, these companies should be disclosing estimates of their environmental liability. Whenever possible, we used the same companies in both our 1994 and 1993 samples. Our samples are equally divided between companies named as PRPs at 1-5 NPL sites (low exposure companies); 10-16 NPL sites (medium exposure companies); and 25 or more NPL sites (high exposure companies).

We examined the 1993 and 1994 (and 1995 when available) 10Ks to determine the current disclosure practices commonly being used and to determine whether or not any differences exist between companies with various exposure levels. Our samples also allowed us to ascertain the degree to which disclosure practices have changed in the last 2 to 3 years. Some of the key areas we focused on were: disclosure of the amount accrued for environmental liabilities (as required by FASB 5); disclosure of amounts in excess of the accrued amount that could reasonably become liabilities (as required by FASB 5); offsets for recoverables; and discounting to present value. If the discussion provided in the statements did not specifically indicate the amount of E&A liability accrued, we assumed that no accrual was made.

A summary of our findings for the four key areas described above is shown in Table 3. We first focused on the percentage of companies which specifically disclosed the amount of environmental liability included on their balance sheet. Our comparison of the low, medium, and high exposure groups suggests that companies with high environmental exposures are more likely to disclose this amount. In 1994 (and 1995), 90% of the high exposure companies disclosed a specific accrual amount greater than zero compared with only 45% of the low exposure companies. The second area we assessed is the disclosure of an amount in the excess of the accrual. The high exposure companies more frequently disclosed an amount of reasonably possible losses in excess of the amount accrued as required in FASB 5. In 1994, 35% of the high exposure companies provided an excess estimate compared to about 15% of the low exposure companies.

For all three groups, the percentage disclosing accrual amounts or possible excess amounts is higher in 1994 than it was in 1993, perhaps because an increasing number of companies are making accruals for environmental liabilities. Another reason could be that companies are becoming more aware of the SEC's requirements and are providing clearer discussions of the environmental accruals included in their balance sheet.

TABLE 3

Percentage* of Companies	E&A Exposure Level					
	Low		Medium		High	
	1993	1994	1993	1994	1993	1994
Disclosing an accrual amount > $0	30%	45%	50%	60%	85%	90%
Disclosing an amount in excess of accrual	5	15	15	20	10	35
Disclosing that accrual is net of recoveries	5	0	15	0	20	5
Disclosing that liability is discounted	0	0	0	5	5	5

* % of companies included in sample

Our third area of focus relates to recoveries. As required by SAB 92 and FIN 39, accruals should be gross of third party recoveries. Only one company in our 1994 sample stated that accruals were net of insurance recoveries, compared to eight companies in our 1993 sample. This decrease again suggests that companies have become more aware of the SEC's requirements and are making appropriate changes to their financial statements.

Lastly, we found that very few companies discount their E&A liability. The few that do, only discount a portion of the operation and maintenance costs. These companies assumed discount rates of 5% - 8%.

For the sampled companies, we also summarized the size of accruals in total and relative to each company's equity. Table 4 shows that there is a wide variation in the accrual amount within each exposure level. As we would expect, these amounts generally increase by exposure level and are clearly significant for the high exposure companies.

Companies with a significant amount of potential liability seem more likely to specifically address FASB 5 and SAB 92 requirements than companies with a smaller relative amount of E&A exposure. However, there is a lack of uniformity in the presentation of E&A liabilities in the financial statements of publicly held companies. This lack of uniformity exists not only in the handling of recoveries and discounting, but also in the procedures used to estimate the amount of liability and the adequacy of such estimates. The SEC is concerned that inadequate information regarding E&A exposure may misrepresent a company's balance sheet.

It appears that the SEC's position on disclosure and estimation of environmental exposure is becoming more aggressive. We believe the trend will accelerate as the data published by the EPA becomes more complete, as the EPA and the SEC cooperate more closely, and as the SEC makes more frequent use of the data.

TABLE 4

E&A Exposure Level

	Low		Medium		High	
	1993	1994	1993	1994	1993	1994
Range of accrual (millions)	$8-$29	$0.1-$445	$2-$77	$3-$111	$90-$2,500	$52-$2,500
Range of accrual/equity	1.0%-11.2%	0.1%-10.0%	0.6%-18.5%	0.6%-14.8%	2.8%-61.3%	2.8%-55.0%

In future years actuaries may be called upon more frequently to estimate environmental liabilities for non-insurance companies. As the above table displays the estimated environmental accrual for one major non-insurer is $2.5 billion. This exceeds the reserve accrual for most insurance companies.

Conclusion

With the year-end 1995 annual statements more information is available to assist in evaluating insurance company's E&A exposure. Many interested parties will begin to perform reserve adequacy comparisons from company to company. However, without making adjustments for relevant factors affecting reserves (e.g., buy-out activity) these comparisons could prove to be faulty. Additionally, rating agencies will be more aggressive in their evaluation of insurance company E&A reserves.

It appears that non-insurance companies are complying with SEC regulations regarding environmental disclosure more fully. However, the liabilities are large and it is not clear that adequate methods are used to estimate accruals in all cases.

INSTRUCTIONS FOR NOTE 24

24. Asbestos/Environmental (Mass Tort) Reserves

Instruction:

If the company is potentially exposed to asbestos and/or environmental claims (mass tort), full disclosure of the reserving methodology for both case and IBNR reserves is required. Disclosure of the amount paid and reserved for losses and LAE for asbestos and/or environmental claims, on a gross and net of reinsurance basis, is also required.

Does the company have on the books or has it ever written an insured for which you have identified a potential for the existence of a liability due to asbestos and/or environmental losses? Yes ( ) No ( )
If yes, describe the lines of business written for which there is potential exposure, the nature of the exposure or exposures and the company's methodology for reserving for both reported and IBNR losses.

If yes, complete the following information, separately for asbestos-related and environmental losses (including coverage dispute costs) for each of the five most current calendar years on both a gross and net of reinsurance basis (more detailed breakdowns are acceptable):

Beginning reserves:	$	________
Incurred losses and loss adjustment expenses:		________
Calendar year payments for losses and loss adjustment expenses:		________
Ending reserves:	$	________

If yes, complete the following, separately for asbestos-related and environmental reserves:

Does the company hold reserves for unreported claims? Yes ( ) No ( )

Does the company hold reserves for future allocated loss adjustment expenses (including coverage dispute cost)? Yes ( ) No ( )

Definition of Environmental Loss –

Any loss or potential loss (including third-party claims) related directly or indirectly to the remediation of a site arising from past operations or waste disposal.

Examples of Environmental Exposure –

Chemical Waste
Hazardous Waste TSD Facilities (Treatment, Storage and/or Disposal)
Industrial Waste Disposal Facilities
Landfills
Superfund
Toxic Waste Pits
Underground Storage Tanks

Illustration:

Yes, Company XYZ has exposure to asbestos claims. The Company's exposure arises from the sale of general liability insurance.

Company XYZ tries to estimate the full impact of the asbestos exposure by establishing full case basis reserves on all known losses and computing incurred but not reported losses based on previous experience.

Company XYZ's asbestos related losses (including coverage dispute costs) for each of the five most recent calendar years were as follows:

Gross of Reinsurance –

	1991	1992	1993	1994	1995
Beginning reserves:	$1,000,000	$ 750,000	$ 950,000	$ 700,000	$ 400,000
Incurred losses and loss adjustment expense:	250,000	1,000,000	1,000,000	500,000	3,000,000
Calendar year payments for losses and loss adjustment expenses:	500,000	800,000	1,250,000	800,000	200,000
Ending reserves:	$ 750,000	$ 950,000	$ 700,000	$ 400,000	$3,200,000

Net of Reinsurance –

	1991	1992	1993	1994	1995
Beginning reserves:	$ 400,000	$ 300,000	$ 380,000	$ 280,000	$ 160,000
Incurred losses and loss adjustment expenses:	100,000	400,000	400,000	200,000	1,200,000
Calendar year payments for loss and loss adjustment expenses:	200,000	320,000	500,000	320,000	80,000
Ending reserves:	$ 300,000	$ 380,000	$ 280,000	$ 160,000	$1,280,000

Company XYZ holds IBNR and/or bulk reserves. It held such reserves in the amount of $1,000,000 on a gross basis and $400,000 on a net basis at December 31, 1995.

Company XYZ held $500,000 on a gross basis and $200,000 on a net basis for future allocated loss adjustment expenses (including coverage dispute cost) at December 31, 1995.

Exhibit 2A

Survival Ratios for Primary Insurers

Primary Insurers	Asbestos 3 yr avg.	Asbestos @12/95	Asbestos @12/94	Asbestos @12/93	Asbestos @12/92	Asbestos @12/91	Environmental 3 yr avg.	Environmental @12/95	Environmental @12/94	Environmental @12/93	Environmental @12/92	Environmental @12/91
A	2.8	4.1	2.6	3.0	2.5	2.8	1.3	0.9	2.0	2.5	2.7	4.2
B	8.7	10.0	4.6	3.3	3.7	4.6	14.7	14.1	2.2	2.8	2.4	2.4
C	10.4	13.0	12.1	2.3	3.2	NA	15.8	11.7	8.6	6.7	4.2	NA
D	6.8	15.5	5.8	3.7	3.0	3.0	3.8	2.7	5.3	4.3	2.9	2.1
E	76.4	8.6	-9.9	53.7	1.5	19.0	10.6	9.1	6.2	11.4	17.7	12.3
F	6.7	5.3	2.3	5.0	3.0	4.4	10.0	6.8	4.1	3.1	1.6	2.6
G	NA	NA	NA	NA	NA	NA	7.0	7.5	4.7	6.0	1.5	1.2
H	3.9	4.3	4.3	3.2	5.0	2.9	5.9	7.2	3.7	2.4	4.1	4.3
I	4.0	4.1	4.7	3.3	4.7	3.1	5.9	7.1	3.6	2.4	4.1	4.1
J	11.2	19.8	8.6	9.3	11.0	50.9	9.7	14.2	7.5	4.9	5.3	10.8
K	5.7	5.6	4.8	5.7	13.1	12.3	3.8	2.3	6.6	4.7	3.0	5.6
L	20.6	21.0	13.7	7.7	7.1	5.6	16.9	17.6	13.2	7.4	8.2	11.4
Weighted Average	7.5	9.5	5.5	4.6	4.8	6.2	7.4	6.3	5.0	4.3	3.4	4.1

Exhibit 2B

Survival Ratios for Reinsurers

Reinsurers	Asbestos 3 yr avg.	@12/95	@12/94	@12/93	@12/92	@12/91	Environmental 3 yr avg.	@12/95	@12/94	@12/93	@12/92	@12/91
A	17.7	16.9	6.3	15.6	NA	NA	80.5	43.0	12.5	20.9	NA	NA
B	9.9	7.9	4.3	3.7	4.8	4.8	14.3	14.4	3.1	4.6	4.0	4.5
C	7.6	5.1	10.0	8.6	6.0	26.9	13.9	10.9	10.4	16.9	22.0	20.4
D	7.2	8.9	12.7	7.4	23.5	21.7	7.5	3.6	28.3	3.3	2.2	2.8
E	3.8	1.7	36.5	9.8	13.7	163.1	8.4	9.1	8.2	9.5	28.3	10.5
F	5.3	156.9	2.8	21.1	6.7	7.5	20.7	20.1	10.1	38.5	15.9	23.5
G	11.5	5.9	-25.1	3.2	6.9	1.3	9.1	4.5	49.4	8.7	11.7	13.1
H	-45.9	-5.7	37.4	6.7	8.2	66.6	-20.9	-4.6	16.1	14.1	33.0	13.0
I	5.6	3.3	8.3	11.2	7.4	NA	18.0	22.8	9.6	25.2	10.1	NA
J	23.0	33.8	13.0	25.0	22.9	12.9	7.4	18.4	3.2	20.7	10.2	7.6
K	6.5	4.2	5.7	9.8	7.8	2.3	22.7	16.4	9.5	46.0	18.7	7.7
L	4.4	NA	3.0	3.2	3.8	2.7	28.8	NA	-66.1	8.0	5.6	2.2
M	2.3	2.1	14.8	2.9	NA	NA	74.5	205.4	21.0	-2819.6	11.0	5731.0
N	3.8	2.5	3.6	11.2	2.8	2.1	15.8	8.8	11.9	107.6	77.7	1606.8
O	5.0	12.5	2.3	8.9	6.3	4.2	4.8	3.8	5.3	4.5	4.2	2.1
P	210.0	69.4	90.9	-84.7	8.1	20.0	72.3	152.1	38.2	26.7	40.3	40.2
Q	17.4	21.5	10.2	16.0	4.9	5.6	12.1	6.5	15.0	40.2	119.2	116.4
Weighted Average	9.7	8.8	5.8	8.7	6.5	8.2	19.8	17.1	9.4	14.1	15.5	13.3

Exhibit 3A

Reserve Ratios for Primary Companies

Primary Insurers	Asbestos 3 yr avg.	Asbestos @12/95	Asbestos @12/94	Asbestos @12/93	Asbestos @12/92	Environmental 3 yr avg.	Environmental @12/95	Environmental @12/94	Environmental @12/93	Environmental @12/92
A	1.00%	0.75%	1.06%	1.28%	1.29%	0.84%	0.49%	0.86%	1.52%	2.19%
B	3.78%	4.78%	3.04%	3.15%	3.68%	3.24%	5.21%	1.57%	1.38%	1.35%
C	1.71%	1.88%	2.30%	0.83%	1.10%	1.99%	2.30%	2.32%	0.97%	1.02%
D	5.44%	4.86%	6.08%	5.57%	3.63%	4.14%	2.95%	5.52%	4.83%	3.59%
E	0.55%	0.50%	0.61%	0.58%	0.36%	1.49%	1.31%	1.41%	1.94%	1.72%
F	1.94%	2.65%	1.54%	1.37%	1.22%	2.44%	3.35%	1.68%	1.58%	1.18%
G	22.68%	18.81%	23.47%	27.35%	26.19%	4.05%	3.37%	4.54%	4.78%	0.83%
H	0.62%	0.52%	0.68%	0.71%	0.61%	0.96%	0.99%	0.86%	1.03%	1.13%
I	0.60%	0.49%	0.67%	0.67%	0.57%	0.91%	0.93%	0.81%	0.97%	1.07%
J	5.29%	4.41%	4.73%	7.16%	8.48%	5.43%	4.67%	6.63%	5.44%	6.20%
K	1.90%	1.65%	2.05%	2.10%	2.50%	1.37%	0.96%	1.84%	1.59%	1.59%
L	0.81%	0.99%	0.79%	0.59%	0.51%	0.77%	0.75%	0.79%	0.78%	0.81%

Reserve Ratio = Net Ending Reserve / Net Industry Ending Reserve
3 year average Reserve ratio = Last 3 Year's Net Ending Reserves/Last 3 Year's Industry Net Ending Reserves

Exhibit 3B

Reserve Ratios for Reinsurers

Reinsurers	Asbestos					Environmental				
	3 yr avg.	@12/95	@12/94	@12/93	@12/92	3 yr avg.	@12/95	@12/94	@12/93	@12/92
A	3.87%	4.97%	3.62%	2.57%	2.04%	2.25%	3.90%	0.66%	0.90%	1.14%
B	2.75%	3.96%	1.87%	2.00%	2.10%	1.48%	2.06%	0.86%	1.07%	1.01%
C	3.81%	3.27%	4.04%	4.32%	3.25%	7.51%	6.26%	8.59%	8.67%	10.13%
D	0.62%	0.40%	0.71%	0.83%	0.92%	0.20%	0.23%	0.17%	0.16%	0.14%
E	0.08%	0.05%	0.12%	0.10%	0.17%	0.17%	0.11%	0.19%	0.24%	0.37%
F	1.68%	1.07%	1.90%	2.33%	1.79%	0.94%	0.80%	0.99%	1.16%	1.20%
G	0.04%	0.06%	0.03%	0.03%	0.03%	0.02%	0.01%	0.02%	0.02%	0.02%
H	0.07%	0.07%	0.07%	0.06%	0.05%	0.47%	0.48%	0.46%	0.47%	0.47%
I	0.56%	0.43%	0.66%	0.64%	0.77%	0.39%	0.32%	0.45%	0.48%	0.57%
J	0.21%	0.19%	0.23%	0.22%	0.26%	0.04%	0.03%	0.05%	0.05%	0.07%
K	0.26%	0.24%	0.26%	0.27%	0.27%	0.15%	0.15%	0.14%	0.15%	0.16%
L	0.17%	0.17%	0.16%	0.17%	0.18%	0.17%	0.14%	0.19%	0.19%	0.13%
M	0.02%	0.01%	0.03%	0.03%	0.09%	0.03%	0.03%	0.04%	0.04%	0.03%
N	0.12%	0.10%	0.14%	0.14%	0.12%	0.12%	0.10%	0.13%	0.15%	0.17%
O	0.21%	0.17%	0.19%	0.29%	0.27%	0.07%	0.06%	0.09%	0.09%	0.08%
P	0.31%	0.30%	0.31%	0.32%	0.37%	0.36%	0.35%	0.38%	0.33%	0.41%
Q	0.06%	0.06%	0.07%	0.06%	0.05%	0.03%	0.02%	0.04%	0.03%	0.04%

Reserve Ratio = Net Ending Reserve / Net Industry Ending Reserve
3 year average Reserve ratio = Last 3 Year's Net Ending Reserves/Last 3 Year's Industry Net Ending Reserves

Exhibit 4A

Premium Ratios for Primary Insurers

Primary Insurers	Net Written Premium ($000's) 1972	1973	1974	1975	1976
A	0.027	0.027	0.023	0.019	0.020
B	0.002	0.002	0.002	0.002	0.004
C	0.028	0.028	0.030	0.017	0.018
D	0.047	0.047	0.056	0.057	0.049
E	0.005	0.005	0.006	0.007	0.006
F	0.024	0.027	0.025	0.029	0.024
G	0.029	0.032	0.024	0.021	0.020
H	0.003	0.005	0.003	0.007	0.008
I	0.005	0.005	0.002	0.007	0.008
J	0.020	0.019	0.019	0.020	0.021
K	0.003	0.003	0.003	0.002	0.002
L	0.003	0.002	0.002	0.003	0.003
Percent of Total Industry*	0.203	0.212	0.205	0.203	0.197

* Commercial Multi Peril and General Liability Net Written Premium for Primary and Reinsurance companies

Exhibit 4B

Premium Ratios for Reinsurers

Reinsurers	Net Written Premium ($000's) 1972	1973	1974	1975	1976
A	0.002	0.002	0.002	0.002	0.002
B	0.004	0.004	0.004	0.005	0.006
C	0.016	0.015	0.014	0.013	0.014
D	0.004	0.004	0.004	0.004	0.005
E	0.000	0.000	0.000	0.000	0.001
F	0.000	0.010	0.012	0.018	0.021
G	0.000	0.000	0.000	0.000	0.000
H	0.000	0.000	0.000	0.001	0.001
I	0.000	0.000	0.001	0.002	0.002
J	0.000	0.000	0.000	0.000	0.000
K	0.002	0.002	0.002	0.002	0.002
L	0.000	0.000	0.000	0.000	0.000
M	0.000	0.000	0.000	0.000	0.000
N	0.000	0.002	0.002	0.002	0.001
O	0.000	0.000	0.000	0.000	0.000
P	0.000	0.000	0.001	0.001	0.001
Q	0.000	0.000	0.000	0.000	0.000
Percent of Total Industry*	0.028	0.038	0.042	0.050	0.056

* Commercial Multi Peril and General Liability Net Written Premium for Primary and Reinsurance companies

Exhibit 5A

Payment Ratios for Primary Companies

Primary Insurers	Asbestos 3 yr avg.	Asbestos @12/95	Asbestos @12/94	Asbestos @12/93	Asbestos @12/92	Environmental 3 yr avg.	Environmental @12/95	Environmental @12/94	Environmental @12/93	Environmental @12/92
A	1.94%	1.25%	2.36%	2.27%	2.78%	3.73%	4.41%	2.77%	3.82%	4.89%
B	4.02%	3.29%	3.77%	5.05%	5.40%	3.56%	2.98%	4.72%	3.07%	3.38%
C	1.32%	1.00%	1.09%	1.91%	1.89%	1.46%	1.59%	1.77%	0.91%	1.44%
D	5.26%	2.17%	6.00%	7.91%	6.67%	7.71%	8.82%	6.77%	7.09%	7.56%
E	0.05%	0.40%	-0.35%	0.06%	1.31%	1.24%	1.17%	1.48%	1.07%	0.58%
F	2.91%	3.47%	3.78%	1.44%	2.24%	3.34%	3.99%	2.66%	3.16%	4.48%
G	11.94%	9.53%	12.34%	14.16%	9.52%	4.83%	3.61%	6.31%	4.99%	3.25%
H	0.97%	0.83%	0.91%	1.18%	0.67%	1.68%	1.12%	1.54%	2.73%	1.67%
I	0.91%	0.83%	0.82%	1.09%	0.67%	1.59%	1.06%	1.46%	2.55%	1.56%
J	2.89%	1.54%	3.17%	4.08%	4.19%	4.82%	2.65%	5.81%	7.02%	6.99%
K	2.14%	2.03%	2.44%	1.95%	1.04%	2.54%	3.34%	1.82%	2.14%	3.15%
L	0.35%	0.33%	0.33%	0.40%	0.39%	0.45%	0.34%	0.39%	0.67%	0.59%

Payment Ratio = Net Annual Payment / Net Industry Annual Payment
3 year average payment ratio = Last 3 Year's Net Annual Payments/Last 3 Year's Industry Net Annual Payments

Exhibit 5B

Payment Ratios for Reinsurers

Reinsurers	Asbestos 3 yr avg.	Asbestos @12/95	Asbestos @12/94	Asbestos @12/93	Asbestos @12/92	Environmental 3 yr avg.	Environmental @12/95	Environmental @12/94	Environmental @12/93	Environmental @12/92
A	2.06%	2.03%	3.28%	0.87%	NA	0.49%	0.73%	0.35%	0.27%	NA
B	2.94%	3.46%	2.47%	2.84%	2.37%	1.45%	1.16%	1.83%	1.46%	1.53%
C	3.17%	4.44%	2.31%	2.64%	2.93%	4.50%	4.62%	5.42%	3.22%	2.76%
D	0.41%	0.31%	0.32%	0.59%	0.21%	0.31%	0.53%	0.04%	0.29%	0.37%
E	0.09%	0.19%	0.02%	0.05%	0.07%	0.13%	0.10%	0.16%	0.16%	0.08%
F	1.47%	0.05%	3.92%	0.58%	1.46%	0.39%	0.32%	0.64%	0.19%	0.45%
G	0.04%	0.07%	-0.01%	0.05%	0.02%	0.01%	0.02%	0.00%	0.01%	0.01%
H	-0.01%	-0.08%	0.01%	0.04%	0.03%	-0.23%	-0.83%	0.19%	0.21%	0.08%
I	0.56%	0.89%	0.46%	0.30%	0.57%	0.18%	0.11%	0.31%	0.12%	0.34%
J	0.06%	0.04%	0.10%	0.05%	0.06%	0.04%	0.01%	0.10%	0.02%	0.04%
K	0.27%	0.40%	0.27%	0.14%	0.19%	0.07%	0.08%	0.10%	0.02%	0.05%
L	0.19%	0.00%	0.31%	0.29%	0.26%	0.03%	0.00%	-0.02%	0.15%	0.14%
M	0.03%	0.04%	0.01%	0.06%	0.00%	0.00%	0.00%	0.01%	-0.00%	0.02%
N	0.19%	0.27%	0.22%	0.07%	0.24%	0.06%	0.09%	0.07%	0.01%	0.01%
O	0.24%	0.09%	0.48%	0.17%	0.23%	0.12%	0.12%	0.11%	0.13%	0.11%
P	0.01%	0.03%	0.02%	-0.02%	0.25%	0.05%	0.02%	0.06%	0.08%	0.06%
Q	0.03%	0.02%	0.04%	0.02%	0.05%	0.02%	0.03%	0.02%	0.00%	0.00%

Payment Ratio = Net Annual Payment / Net Industry Annual Payment
3 year average payment ratio = Last 3 Year's Net Annual Payments/Last 3 Year's Industry Net Annual Payments

Exhibit 6

Total NPL Cost Distribution by Year

Year	% of Total NPL Costs
1945	1.287%
1946	0.939%
1947	1.083%
1948	1.089%
1949	1.042%
1950	0.980%
1951	1.031%
1952	1.724%
1953	1.721%
1954	1.734%
1955	1.936%
1956	2.088%
1957	2.169%
1958	2.271%
1959	2.305%
1960	2.416%
1961	2.468%
1962	2.730%
1963	2.808%
1964	2.851%
1965	3.051%
1966	3.048%
1967	3.138%
1968	3.308%
1969	3.359%
1970	3.547%
1971	3.756%
1972	3.863%
1973	3.671%
1974	3.820%
1975	3.764%
1976	3.769%
1977	3.608%
1978	3.701%
1979	3.338%
1980	2.750%
1981	2.297%
1982	1.786%
1983	1.518%
1984	1.207%
1985	1.029%
Total	100.000%