

**Risk Theoretic Issues  
In The Discounting  
Of Loss Reserves**  
By The CAS Committee  
On Theory Of Risk



## RISK THEORETIC ISSUES IN THE DISCOUNTING OF LOSS RESERVES

A DISCUSSION PAPER BY THE CAS COMMITTEE

ON THEORY OF RISK

### BACKGROUND

The discounting of property/casualty loss reserves to reflect the time value of money has been a controversial issue for some time and recent activity in this area has been significant. In 1986 Congress passed landmark legislation to require discounting for income tax purposes. The National Association of Insurance Commissioners has formed a study group to further explore the advisability of discounting for statutory reporting purposes. Some state Insurance Departments have already begun to permit discounting in the statutory Annual Statement for some lines of business in which discounting had traditionally been prohibited. The AICPA is also studying the implementation of reserve discounting as it relates to GAAP financial reporting. Many insurance companies have been engaging in de facto discounting to some degree by means of overly optimistic reserving assumptions and/or by the purchase of financial reinsurance.

In the public debate over discounting it has been pointed out, though not always appreciated, that a fundamental feature of property/casualty loss liabilities is their uncertainty. Opponents of discounting have argued that carrying loss reserves on an undiscounted basis is in implicit recognition of this uncertainty or risk. According to this argument the amount by which

undiscounted reserves exceed their discounted value provides a buffer against this uncertainty, a "risk margin" of sorts.

For several years now, the CAS Committee on Theory of Risk has been studying and discussing the issue of uncertainty in loss liabilities, particularly as it relates to the discounting of loss reserves. The Committee takes no official position on the discounting issue itself other than to agree with those observers who state that the issue can only be considered in the context of the purpose for which the financial statement is prepared; the issue can conceivably have a different resolution for statutory purposes, for example, than for tax purposes. Moreover, the Committee takes no official position on the proper accounting treatment to reflect uncertainty in reserves, regardless of the accounting context. Rather, our focus has been in the areas of: i) identifying the sources of uncertainty, ii) mathematically modeling and measuring the uncertainty, and iii) expressing the uncertainty in dollar value terms. We hope that this status report on our activities to date will be of value to those professional committees currently debating the discounting issue and its accounting treatment and also to the regulatory bodies ultimately responsible for the resolution of the debate. We also hope to receive feedback from these audiences to assist us in directing and focusing our further research.

#### FUNDAMENTAL ISSUES

The largest liability item on the balance sheet of virtually all insurance companies is also, arguably, the most uncertain. Often, the dollar amount of the liability for losses and loss adjustment expenses is not known

until several years after the liability has been incurred and accounted for. This liability is subject to future uncertain events beyond the control of the insurance company, such as the socio-legal climate, jury sentiments, attitudes toward claim settlement, etc. that will prevail when the claims that give rise to the liability reach their ultimate disposition. A loss reserve is simply an estimate of this liability as of a given point in time, based on currently available information. These estimates are often in error. Since the amount of the loss reserve is typically several times the company's net worth, uncertainty in the reserve estimate can translate into considerably more uncertainty in the financial well-being of the company.

It is generally true that the reserves for the longer-tailed lines of business (i.e., those with greater-than-average time lags between claim incident and disposition) are the more uncertain. It is also a fact that these same lines of business present the greater opportunity for investment income on the assets supporting the reserves and thus for greater amounts of reserve discounting. There is some correlation then between reserve uncertainty and discount potential, and this gives some support to the idea that undiscounted reserves give implicit recognition to risk. The Committee believes that while this correlation exists it does not represent a sufficiently fundamental relationship to be used as a basis for measuring risk. It is, though, the Committee's position that discounting loss reserves does remove a substantial risk margin, however implicit and imprecise, and makes more pronounced the need to develop an explicit measure of risk.

Once a method for measuring and representing risk is developed, it remains to determine the proper method to report it in financial statements. As mentioned above, the resolution of this issue is outside the scope of the Committee's charter, however there are some considerations we would like to highlight for the benefit of those professional committees charged with this responsibility. A fundamental concern is whether a "risk margin" should be derived separately from the loss reserve and whether such a margin should be reported "above or below the line", i.e., as a liability item or as part of surplus. There are two different and somewhat conflicting accounting philosophies that influence the decision on how to report risk margins. According to one, the emphasis is on insurer solvency and on the balance sheet. Including a risk margin as a liability item (separately or not from the loss reserve) would be consistent with the conservatism inherent in this philosophy as it would serve to delay the flow of profits into surplus until the existence of such profits was sufficiently certain. The second philosophy has a going-concern emphasis and the focus is on the income statement. Including a risk margin as earmarked surplus is more consistent with this philosophy as it leaves losses "pure" and allows more direct matching of income and outgo. As is the case with the issue of discounting loss reserves, the Committee believes that the issue of accounting for risk margins depends on the purpose of the accounting document under consideration. A goal of our research is to provide methods of measuring and representing risk that will have sufficient flexibility to accommodate either of the above accounting philosophies.

### SOURCES OF UNCERTAINTY

The sources of reserve uncertainty are many and arise principally from the following elements:

1. the ultimate value of claims reported but unpaid as of the evaluation date
2. the ultimate number and value of claims incurred but unreported as of the evaluation date
3. the ultimate value of claims closed as of the evaluation date but reopened subsequently
4. the payment timing of all unpaid claims for which a liability exists as of the evaluation date
5. investment yields
6. asset values

(Note that this list is not exhaustive.)

Contributing to the uncertainty surrounding these elements are:

- inflation
  
- judicial and legal climate
  
- changes in company practice, e.g., with respect to:
  - asset management
  - claims administration
  
- currency fluctuations
  
- the interaction of the various items, e.g.:
  - interest rates vs. inflation
  - claim severity vs. payment lag

#### **SYNOPSIS OF COMMITTEE ACTIVITIES**

The Committee has examined a number of approaches for modeling and measuring risk in loss reserving, some promising, some not so promising. We believe that a discussion of all approaches considered should be included here since the reasons for deciding against some of them may provide some insight to readers.

We have discussed whether risk could be measured by means of an empirical study of loss development history. Some methods along these lines have already been developed by practicing actuaries. These include measuring



variations in historical age-to-age loss development factors and modeling the factors by means of distribution functions. These methods are relatively straightforward and the necessary data is easy to obtain. However, methods based only on historical development data are likely to underestimate potential future variation since, in simple terms, not everything that could have happened has happened. On the other hand, the potential for adverse development could be overstated in the historical data since recent adverse development may be more reflective of earlier implicit discounting than of failure to reserve correctly. The Committee believes that historical development patterns alone are not sufficient to measure reserving risk but that this history is invaluable in testing and validating the models we will discuss below.

We discussed whether risk could be measured in terms of mean and variance concepts. We also discussed whether estimating a given percentile of the distribution of losses could be sufficient to quantify risk. For several reasons, the Committee believes these measures are insufficient. Many important aspects of a probability distribution are not captured by the first two moments or by a given percentile. (For example, very different excess loss premium factors can be generated from two different loss distributions that happen to have the same first two moments.) This discussion did convince us of the importance of estimating the complete distribution of ultimate aggregate losses before attempting to quantify risk.

A discussion of the construction of such an aggregate loss distribution including treatment of the risks associated with investment yields and the timing of loss payments is presented in the Appendix.

We have discussed approaches by which the distribution of loss liabilities (discounted or undiscounted), assuming this distribution could be determined, would be incorporated into the quantification of risk. One approach popular in European countries is ruin theory. In the reserving applications of this theory, the loss distribution is incorporated into a stochastic financial model of the entire insurance company and the company's surplus is considered to be stochastic process over time. The appropriate loss reserve incorporating reflection of risk is the smallest amount such that the probability of the company's technical insolvency is reduced to a specified level. One distinct advantage of this approach is that the implied necessary risk load is not independent of the company's current financial condition. There are some practical problems with ruin theory, however. The selection of an acceptable probability of ruin is problematical. U.S. company managements are understandably uncomfortable with the concept of an "acceptable probability of ruin". Also, the risk load determined via ruin theory is extremely sensitive to the choice of the probability of ruin.

One approach which offers the prospect of incorporating what can be learned from ruin theory (for example, the use of the entire loss distribution, and the financial modeling of the entire company) for determining risk-adjusted reserves is utility theory. An acceptable ruin probability need not be specified, since utility theory assigns a utility function to the entire continuum of financial outcomes. Once the distribution of aggregate losses has been estimated, utility theory can be used to compute its "certainty equivalent". This is the loss amount which, if known with certainty, would be regarded as equivalent to the uncertain distribution of

outcomes. Specifying the utility function is non-trivial as is the question of whose utility function to model (shareholders, management, regulators, etc. would generally have different utility functions). Moreover, deriving a single utility function to represent a consensus among people with similar viewpoints (e.g., shareholders) is a problem still not fully solved.

[Digression: The capital asset pricing model (CAPM) was discussed by the Committee and discarded as an explicit means of reflecting risk in reserves, however the discussion did identify a concept that might be useful to those committees addressing the issue of accounting for risk margins. In CAPM theory, a central maxim is that "diversifiable risk" should not be "rewarded". In the context of loss reserving, the corresponding rule might be that margins arising from "diversifiable risk" (e.g., due to the use of poor reserving techniques) should not be reported "above the line" but should be reflected in a segregated surplus account.]

#### SUMMARY OF CURRENT COMMITTEE OPINIONS

As a result of our research and discussions to date, the Committee has formed the following opinions:

- Regardless of the method by which reserves are discounted and uncertainty is measured, and regardless of the accounting treatment, full disclosure in public documents of the methods, measurements and treatments is advisable.

- Measurement of the uncertainty in loss liabilities is an essential part of the estimation of those liabilities, regardless of the context in which the liability estimates and risk measurements are presented. The discounting of loss reserves, by eliminating the implicit risk margin, makes the need for explicit measurement of risk more pronounced.
  
- While the ultimate application of the theories the Committee is developing may take the form of simple rules of thumb, it is necessary to more fully develop the theory (including a reasonable methodology for estimating the complete distribution of loss liabilities and a start on building a comprehensive financial model) before such rules can be promulgated.
  
- The development of the necessary theory is a long-term effort, but events, accelerated now by the discounting issue, will not await the perfect theory. The Committee recognizes that, as a practical matter, methods may need to be introduced prior to the full development of the underlying theory. The Committee hopes that the ideas presented herein will assist other bodies (actuarial, accounting, regulatory, etc.) in the development of those methods and further pledges its intention to be actively involved in the effort.

**FUTURE DIRECTIONS**

The Committee intends to pursue the development of methods for the quantification of risk. To this end, work is under way to:

- estimate probability distributions for the items listed above under "sources of uncertainty"
  
- develop an overall company stochastic model to incorporate these distributions
  
- determine a method for calculation of a risk margin from this model

These are clearly long-term projects. In this effort, and in the development of practical alternatives in the intermediate term, we expect to work closely with (at least) the CAS Committee on Reserves, the CAS Committee on Financial Analysis and the AAA Committee on Property and Liability Financial Reporting Principles.

**CAS COMMITTEE ON THEORY OF RISK**

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CAS COMMITTEE ON THEORY OF RISK  
DISCUSSION DRAFT ON DISCOUNTING OF LOSS RESERVES

APPENDIX

COMMENTS UPON MODELING DISCOUNTED AGGREGATE LOSS LIABILITIES

The loss process can be thought of being made up of many probability distributions, arising from all the sources of uncertainty mentioned in the text. From the point of view of setting an appropriate discounted loss reserve for the current loss liability, we may be interested in a representation of the liability  $L$  such as the following:

$$L = V(1)*L(1) + V(2)*L(2) + . . . .$$

where  $L(i)$  is the aggregate loss to be paid in the  $i$ th year, and  $V(i)$  is an appropriate discount factor to present value. (Obviously, time periods other than one year can be used.)

The  $V(i)$ 's may have at least three different meanings:

1. The  $V(i)$ 's could be what the IRS tells you they are.
2. The  $V(i)$ 's could depend upon the asset portfolio supporting the loss reserve and upon future investment returns.
3. The  $V(i)$ 's could be the current utility value to you of future payments to be made by you.

The  $L(i)$ 's can be modeled by first writing each as the sum of individual  $L(i)$ 's for fairly homogeneous exposure groups, accident years, etc. Let us assume that  $L(i)$  now represents such a piece of the total. Traditional risk theory models the aggregate loss process by modeling claim counts and amounts and taking the obvious sum:

$$L(i) = X(i;1) + X(i;2) + . . . + X(i;N(i))$$

where  $N(i)$  = number of claims (or occurrences)  
and  $X(i;j)$  = amount of the  $j$ th claim

Given appropriate models for  $N(i)$  and  $X(i;j)$  and suitable independence assumptions, we can write the moments of  $L(i)$  in terms of the moments of  $N(i)$  and  $X(i;j)$ , and we can approximate the distribution of  $L(i)$ . There are many good papers in the actuarial literature about this.

An advantage of using a claims count/claims severity model is that we can contemplate intuitively satisfying models for various lag distributions, such as the time from loss event occurrence until first report, the time from first report until payment, etc.. And an appropriate model for the claim count could be constructed as follows:

Suppose that the commonly used Poisson distribution, with parameter  $n$  say, is a good model for the total claim count  $N$ . Then the number of claims settled in the  $i$ th year  $N(i)$  will also be Poisson with parameter  $n \cdot p(i)$ , where  $p(i)$  is the lag probability for the  $i$ th year, that is,  $p(i)$  is the probability that a claim will settle  $i$  years after occurrence.

Thus the aggregate losses paid in the  $i$ th year of run-off can be modeled via the standard risk theoretic model under suitable assumptions for the claim sizes. This kind of model also allows us to better understand claim size reserves under changing conditions, such as changing policy limits or changes in retentions net of reinsurance. This model is a powerful tool for describing loss liability.

#### COMMENTS UPON USING PRICING ASSUMPTIONS FOR RESERVING

The loss payment run-off and thus the loss reserves for a given coverage year should relate to the original pricing model distributions as conditional distributions. Suppose that the original pricing model for the loss process said that the total loss payments would have a certain distribution  $F$  and that the loss payment run-off would be according to some time series  $\langle F(L(t)) \rangle$ . As of a any time  $t$  thereafter, the information on reported and paid and settled claims should conditionalize the original distributional assumptions in order to update future loss payment predictions.

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PAPER PRESENTED AT  
1987 RATEMAKING SEMINAR

A very successful ratemaking seminar was held in March of 1987. A number of interesting papers were presented at this seminar. We have chosen one of these papers to be in this issue of the CAS Forum.

Generally, the CAS Forum will publish documents from various seminars that are felt to be of interest to the entire Casualty Actuarial Society. These documents will generally be accepted in the form in which the author initially presented them. This should improve our ability to publish these documents quickly in order to disseminate the available information.

The issue of ratemaking for underinsured motorists coverage has increased in importance as a result of the increasing availability of underinsured motorists coverage and continued pressure on the tort system. It is also a somewhat complicated coverage because assumptions must be made regarding the distribution of limits for vehicles in the general population.

This presentation provides an interesting viewpoint on some of the techniques useful in pricing underinsured motorists coverage.