

## Methodology

In this section, we describe the approaches taken to calculate the fair value of the insurance loss reserves for the companies, lines, and valuation dates in our study. We also describe a variety of assumptions and limitations in applying the various models to the data. The analyses performed and conclusions reached are covered in other sections.

Our approach to calculating fair value reserves was to take undiscounted loss reserves (i.e. U.S. GAAP reserves), subtract an amount from these reserves to allow for discounting for the time value of money, and add a margin (MVM) to account for the risk and uncertainty in these reserves.

### Discounting

We have reflected the time value of money in our fair value accounting scenarios using a risk free interest rate for loss reserve discounting based on US Treasury securities and the associated yield curve at each year-end valuation date. We assumed that cash payments occurred mid-year. We investigated the following two approaches to calculating the level of discount for the time value of money to see if there would be a discernable difference in results:

- Apply a risk-free interest rate that is associated with the duration of the projected future cash flow of the liabilities (i.e., duration approach);
- Apply a schedule of risk-free interest rates matching the projected future cash flows (i.e. yield curve approach) for each future period.

Our selected claim payment patterns were based on those implied by the cumulative paid loss and booked ultimate losses by accident year. These patterns were systematically adjusted to ensure they proceeded to 100% in a monotonically increasing manner, and that non-zero payment amounts were made in each period.

We also applied a systematic approach to allocating the tail factor over the selected period that we assumed the business would ultimately take to pay out. We used a decay factor approach with a manually selected decay percentage from period to period. We assumed that the loss reserves would pay out within 12, 35 and 20 years for the personal auto liability, workers' compensation and medical malpractice claims-made lines of business, respectively. We did not believe these assumptions had a material impact on the findings of this study.

For the payout of reserves associated with all-prior accident years (that is, the accident years prior to the 9<sup>th</sup> prior accident year), we assumed that the payout pattern would be similar to the aggregate pattern for accident years at six to ten years of development. For example, if 50% of the loss reserves held for accident years that were six to ten years developed were expected to be paid out within the next twelve months, we assumed that 50% of the loss reserves for the all prior accident years would be paid out within the next twelve months.

### MVM Methods

We used three different methods for calculating the MVM that resulted in four different models:

1. Return on Capital method
2. Development method with standard deviation approach
3. Stochastic simulation method with standard deviation approach
4. Stochastic simulation method with percentile approach

A brief explanation of the four models is given below and further details are contained in the Appendix.

### **Return on Capital (ROC) Method**

This method assumes that a buyer of a set of insurance loss reserves would require a specified return on capital to undertake the risks involved with assuming the loss liabilities. With this method, the MVM is set so that a specified return on capital is achieved.

The ROC method requires the following assumptions:

- **Capital levels** – we assumed a solvency margin (e.g., capital) requirement equal to two times the U.S. risk-based capital (RBC) company action level by line of business. We assumed that the MVM amount forms part of the reserves on which this solvency margin is calculated.
- **Required return on capital** – we selected a constant annual required rate of return of 10% for the period we reviewed.
- **Payment pattern** – we have described our process to evaluate payment patterns by line of business in the Discounting section above.
- **Tax rate** – we assumed a constant tax rate of 30%.

### **Development Method (DM)**

This method is a formulaic, deterministic method, and makes no assumptions about the distribution of the variability in loss reserves. The algorithm is based on the work of Thomas Mack (Mack, 1993 (1), see Appendix for description) and it generates a measure of variability based on the historical development experience, both for each individual accident year analyzed and for all accident years combined.

Under this model we selected a multiple of the standard deviation to estimate the MVM. We derived the appropriate multiple based on the calibration process described later in this paper.

The Development Method required the following assumptions:

- **Payment pattern** – Our process to select payment patterns by line of business was described in the Discounting section above.
- **Standard deviation for oldest and all-prior accident years** – The Mack algorithm does not derive a measure of variability of loss reserves for the oldest distinct accident period (9<sup>th</sup> prior accident year in this case), or for accident periods older than the 9<sup>th</sup> prior period in the data set used (i.e., for the all-prior accident years). For this study, we assumed the standard deviations of loss reserve for the 9<sup>th</sup> prior accident year and the all-prior accident years were equal to the average of the selected standard deviation of the 7<sup>th</sup> and 8<sup>th</sup> prior accident years.

- **Selected standard deviation** – We applied the Mack algorithm to both the paid and reported loss development data to give two indicators for the variability of the ultimate loss estimate for each accident year. We selected the average of the two indications as the standard deviation of the reserves distribution.
- **Timing variability allowance** – We incorporated an allowance for variability in loss reserve payment timing, which the Mack algorithm does not specifically address. The allowance was based on adjusting the cumulative payment pattern factors by a multiple of the standard deviation of claim payment factors observed at each age. This multiple was the same as that derived in the calibration process.

### **Stochastic Simulation (SS) Models**

The stochastic simulation (SS) method analyzes the variability in historical actual to expected claim payments for all ten accident years combined. We derived expected claim payments using the historical loss payment pattern implied by the current payment position and the recorded reserves. We then fitted a lognormal distribution to the variability in actual versus expected claim payments, and performed a simulation exercise to estimate the loss reserve distribution and the associated statistics for standard deviation of the distribution and the percentiles of the reserve distribution.

Similar to the development method, we relied on a calibration procedure to determine the appropriate target standard deviation and reserve distribution percentile for each line and valuation date.

The SS method requires the following assumptions:

- **Payment pattern** – Our process to select payment patterns by line of business was described in the Discounting section above.
- **Tail factor** – Our measure of variability under this method involved comparing actual and expected loss payments. We evaluated the variability of the ratios of actual loss payments to expected loss payments, from the latest ten accident years included in Schedule P. We assumed that the variability in the tail of the loss reserve payment distribution would be reasonably modeled by the assessment of the variability of the latest ten years of actual to expected payments.

The combination of two discount factor approaches and four MVM models generated a total of eight measures of loss reserves on a fair value basis for a given company, line of business, and year-end. This is illustrated in Table 2 below:

MVM Model	Discounting Method		Fair Value Measures
	Duration	Yield Curve Matched	
Return on Capital	X	X	2
Development	X	X	2
Stochastic Simulation – Standard Deviation	X	X	2
Stochastic Simulation – Percentile	X	X	2
<b>Total</b>			<b>8</b>

**Table 2:** Measures of loss reserves on a fair value basis based on the different approaches to calculating the discount factor and MVM.

## MVM Model Calibration

The DM and SS models generated measures of loss reserve variability (and thus measures of risk to include in the MVM estimates) by calculating either standard deviations (for the DM and SS methods) or percentile distributions (for the SS method). These models, however, by themselves can give no indication as to which standard deviation multiple (e.g. one standard deviation, two standard deviations) or which percentile of the reserve distribution (e.g. 75<sup>th</sup> percentile, 90<sup>th</sup> percentile) would be appropriate to quantify the risk that should be included in the MVM to estimate a market value liability.

As a result, we decided to calibrate the MVM models using the ROC model as a base. The ROC model has the advantage of selecting a MVM amount based on a benchmark – required return on capital -- that is familiar to the investment community. We then calibrated the other three models by selecting the number of standard deviations or the target percentile that generated an MVM for that particular model equal to the ROC model MVM at a given point in time.

Calibrating these models provides the benefit of achieving some level of consistency across the different MVM models, and in turn provides more meaningful comparisons between the results of the different MVM models. Even if a company only uses a single statistical method to calculate their MVM, they may still wish to test their method using a ROC approach as a benchmark to ensure their selected measure of variability over time appears reasonable.

One of the main issues with respect to calibration is how often to perform the calibration. If calibration is to be performed annually, or as frequently as reporting is required, then the DM and SS models cease to add value since by definition they will always provide the same MVM as the ROC method. One option could be to select long-term values for some of the assumptions in a manner akin to life assurance-type valuations. However, at any given year-

end the assumptions may deviate from the expected financial and economic environment, reducing the value of such an approach.

We calibrated the DM and SS models to the results of the ROC method at year-end 2002. As such the calibration for our results is dependent on the low interest rate environment that prevailed at that time as well as the measures of variability in the 10-year paid and reported development triangles valued at year-end 2002, which are indirectly dependent on the level of booked reserves at year-end 2002.

We performed the calibration process for each of the three lines of business by selecting one large, one medium, and one small company from our sample. We selected an arithmetic average of the standard deviation multipliers and the target percentiles from the three companies by line of business to help prevent any one company from unduly affecting the calibration. Table 3 shows the standard deviation multiples and distribution percentiles used by line of business and model after our calibration exercise:

Line of Business	Development Method SD Multiple	Stochastic Simulation SD Multiple	Stochastic Simulation Percentile
Personal Auto Liability	1.2	2.0	90%
Workers' Compensation	1.0	1.5	92%
Medical Malpractice	1.5	2.3	95%

**Table 3:** Model calibration results showing the multiples of standard deviation, and percentile to be used for calculating the Market Value Margin.

The lower multiples for the DM model are largely a product of the distributional assumptions made. The SS method calculated only a variability measure for all accident years combined, whereas the DM also considered the variability of individual years. We believe that this contributes to the DM's higher measure of standard deviation and variability, and hence lead to lower multiples of the larger standard deviation in the above calibration.

Further, the evaluation of variation in the DM model considered the experience on both a paid and reported basis, while the SS model considered only the variation in historical payment patterns.