SOCIETY OF ACTUARIES

Article from:

The Financial Reporter

December 2004 – Issue 59

Rethinking Embedded Value:
The Stochastic Modeling Revolution

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In the United States, all publicly traded insurance companies prepare at least three sets of financial statements: statutory, GAAP and tax. These three sets of financials are prepared for different purposes and do not necessarily provide relevant information for measuring the "value" of a company's insurance business.

Statutory financial statements focus primarily on solvency issues and are prepared for insurance regulators. The conservative margins in statutory reserves, together with the general practice of immediate expensing commissions and other acquisition expenses, make statutory surplus an inappropriate quantity to measure the value of an insurance company's covered business.

Relatively speaking, GAAP financial statements are better tools for senior management and outside investors to measure the financial health of an insurance company because GAAP financials are prepared on a "going-concern" basis. GAAP liabilities and deferred acquisition cost (DAC) are based on best -estimate assumptions. Unfortunately, GAAP has its own idiosyncrasies. As an example, companies report some or all of their invested assets at market while GAAP benefit reserves are reported at book. This mixture of market and book values makes it difficult to justify that GAAP equity is a fair representation of the value of an insurance company's covered business.

Embedded value fills a void left by statutory, GAAP and tax financial statements. Tax financial statements are, for the most part used for determining the amount of taxes payable to the governments. Aside from tax planning, the tax financial statements have very little use.

As senior management and outside investors cannot use these readily available financial statements to measure the value of covered business, embedded value (EV) has emerged to fill the void. Many companies now publish EV as a supplemental disclosure item.

Embedded Value

Using embedded value to measure the value of an insurance company's covered business is not a new idea. This concept was born many years ago in the United Kingdom. It has since spread to Canada and Australia, as well as to most of Europe. To some extent, the concept is also spreading within the United States, as many companies prepare EV for their European parent companies. While the concept is spreading and gaining acceptance, the general practice for calculating EV is hardly standardized.

Recently, a group known as the CFO Forum, comprising chief financial officers from 19 European insurance companies, published the European Embedded Value Principles (EEVP) that define the calculation and reporting of EV of the covered business. Participating companies have committed to apply these 12 principles to their EV calculations and disclosure for 2005 year-end, if not sooner. As EEVP applies to insurance contracts rather than to the entity selling the contracts, these principles are also applicable to insurance contracts issued by banks or other non-insurance companies. European CFOs are establishing embedded value principles.

This is an important step in standardizing the general practice for EV. We hope that EEVP serves as a starting point for further refinements, and that the insurance industry and the actuarial profession will ultimately develop an established standard of practice for EV.

Principles 1 and 2 identify the scope of the embedded value calculation. Principles 3-8 provide high-level guidance for the calculation procedures. Principles 9-11 provide guidance for choosing actuarial and economic assumptions. Principle 12 focuses on disclosure.

These principles are also accompanied by "Guidance," an expanded discussion relating to each of the principles, and "Basis for Conclusions," which is supplementary commentary on how these principles should be applied in specific circumstances. Any noncompliance with the underlying guidance should be explicitly disclosed. For more information, please visit the Web site at *http://www.cfoforum.nl/.*

Need for Stochastic Modeling

While Europeans are working feverishly on stochastic models and techniques for embedded value, their American counterparts are not idle. In fact,

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American insurance companies are no strangers to stochastic scenarios. On the GAAP side, the newly promulgated Statement of Position 03-1 calls for using stochastic techniques to determine the additional liabilities for excess benefits. On the statutory side, there are two proposed regulations involving stochastic analysis. If the proposed Actuarial Guideline for VA CARVM and the proposed regulation for Risk-Based Capital (RBC) Phase II are adopted, insurance companies will soon be using stochastic models and techniques to determine statutory reserves and RBC for variable annuities with book guarantees. Companies with adequate resources are already performing the proposed stochastic analyses

Table 1 | Summary of the 12 Principles

Principle	Description
1	EV is a measure of the consolidated value of shareholder's interests in the covered business.
2	The business covered by the EV methodology should be clearly identified and disclosed.
3	EV is the present value of shareholders' interests in the earnings distributable from assets allocated to the covered business after sufficient allowance for the aggregate risks in the covered business. The EV consists of the following components: • Free surplus allocated to the covered business • Required capital less the cost of holding required capital • Present value of future shareholder cash flows from in-force covered business (PVIF) The value of future new business is excluded from EV.
4	The free surplus is the market value of any capital and surplus allocated to, but not required to support, the in-force covered business at the valuation date.
5	Required capital should include any amount of assets attributable to the covered business over and above that required to back liabilities for covered business whose distribution to shareholders is restricted. The EV should allow for the cost of holding the required capital.
6	The value of future cash flows from in-force covered business is the present value of future shareholder cash flows projected to emerge from the assets backing liabilities of the in-force covered business. This value is to be reduced by the value of financial options and guarantees as described in Principle 7.
7	Allowance must be made in the EV for the potential impacts on future shareholder cash flows of all financial options and guarantees within the covered business. This allowance must include the time value of financial options and guarantees based on *stochastic models* (emphasis added) and techniques consistent with the methodology and assumptions used in the underlying embedded value.
8	New business is defined as that arising from the sale of new contracts during the reporting period. The value of new business includes the value of expected renewal premiums on those new contracts and expected future contractual alternations to those new contracts. The EV should only reflect in-force business, which excludes future new business.
9	The assessment of appropriate assumptions for future experience should have regard to past, current and expected future experience and to any other relevant data. Changes in future experience should be allowed for in the value of in-force when sufficient evidence exists and changes are reasonably certain. The assumptions should be actively reviewed.
10	Economic assumptions must be internally consistent and should be consistent with observable, reliable market data. No smoothing of market or account balance values, unrealized gains or investment return is permitted.
11	For participating business, the method must make assumptions about future bonuses and the determination of profit allocation between policyholders and shareholders. These assumptions should be made on a basis consistent with the projection assumptions, established company practice and local market practice.
12	EV results should be disclosed at the consolidated group level using a business classification consistent with the primary statements.

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>> Applied Stochastic Modeling ... from page 21

European CFOs are establishing embedded value principles.

and evaluating their potential financial impacts. Stochastic modeling is growing in the United States.

In its traditional form, EV is generally calculated using a single deterministic scenario with best-estimate assumptions. Although sensitivity testing is common, only a few alternative scenarios are typically considered. For products with financial options and guarantees, a deterministic scenario seldom provides a full and realistic picture of the embedded risks. As the volume of business with embedded financial options and guarantees is growing, Principle 7 calls for companies to abandon using deterministic scenarios to value the effects of financial options and book guarantees on distributable earnings. Instead, the effects should be valued using stochastic models and techniques. The value of financial options and book guarantees is then subtracted from the present (PVIF) of the covered business. The European CFO Forum calls for stochastic modeling for EV.

This guidance in Principle 7 is certainly a big step in the right direction. In our opinion, stochastic analysis is not only the future of financial reporting of insurance business; it is also the state-of-the-art technique for pricing insurance products with complicated financial options and guarantees.

Only a few years ago, companies writing variable annuity business with guarantees surprised analysts and investors, and even their own senior managements, with severe hits to earnings due to reversals in the equity market. Principle 7 is a response to this. Reasonably enough, users of financial statements are no longer satisfied with financial projections based on rosy assumptions about the future. They want to know how bad things can get under reasonably adverse conditions. While the definition of "reasonably adverse" has not been finalized, it is clear that stochastic modeling is the ideal tool to explore the possible range of values. Those who use our reports can then make informed judgments about the risks being undertaken and the degree of leverage inherent in our product designs. This issue is also the driving force for the U.S. GAAP and statutory directives involving stochastic modeling. Companies have suffered because they have not used stochastic modeling.

Challenges of Stochastic Modeling

After recognizing some of the benefits of stochastic modeling, it is time to address the challenges. Generally speaking, stochastic analysis uses a model of invested assets, an actuarial model for the covered business, and a whole array of randomly generated scenarios to simulate financial results. The process involves running the underlying actuarial model multiple times, and generating a large number of statistics that provide the actuary with financial measures, under various interest yield curves and equity market performance for each year of the projection. Other model behavior, such as account values, competitive pressures and lapse rates, vary in response to the stochastic variables, which are typically interest rates and equity returns.

Correlations among assumptions. Assumptions for stochastic models, unlike deterministic models, must take into account correlations among various components, such as lapse and credited interest rates. The credited interest rate, in turn, depends on the projected asset yield rate and the company's strategy for investing and for managing spreads. The actuary must also determine the possible correlation between equity market movements and interest rate changes. Thus, the first issue for stochastic analysis is to objectively define the correlation between interest rate with equity performance, as well as, correlations, among other assumptions.

In most instances, defining correlations among various assumptions is more challenging than setting their baseline assumptions. Baseline assumptions are generally extrapolated from past experience. Unfortunately, there is not credible data to quantify correlations among various assumptions. The assumption-setting process calls for actuarial judgment and a healthy dose of psychology to consider policyholder behavior under various "what if" conditions.

Number of scenarios. A second and closely related issue is (a) how to determine the optimal number of scenarios, and (b) how to validate the results. One possible way to determine the optimal number of scenarios is to use an iterative approach. An initial set of scenarios is run and the process is followed by a second set. Results of the first set of scenarios are then compared with the combined results of both sets of scenarios. If the mean and variance are materially different, a third set is run and the comparison is made between the results of the previously combined sets and the third one. This iterative process is continued until the difference resulting from adding more scenarios falls within a predetermined tolerance. Historical mean and variance is also compared fairly readily. A lot of open questions remain about the tails of the distribution, particularly for equity returns. Debate continues to rage over theories such as mean reversion and regime switching. When considering the extremes of the generated stochastic scenarios, it is not easy to decide whether the pattern is totally unrealistic or merely unlikely.

Eliminating bias. Another related issue is the question of whether the stochastic scenarios are unbiased (that is, whether the generated values for financial options and guarantees using the scenarios are consistent with the market value for derivatives). Such inconsistencies are particularly obvious when performing stochastic modeling for equity-indexed policies that are fully hedged. The main ideas of pursuing a hedging strategy, of course, are to mitigate the hedged risks and to minimize effects of market fluctuations on distributable earnings. When a set of interest and equity scenarios do not reproduce market value of hedging assets, it is likely that there are inherent biases in the scenarios. Adjustments are therefore needed until the market value of hedging assets is properly reproduced.

Computational limitations. A final modeling issue is perhaps the most difficult. Since the actuarial model for the embedded value analysis is based on the values of reserve and surplus as of the valuation date, what shall we do when reserve and surplus are defined stochastically? Layering another set of stochastic projections for each projection and for each projection year generates exponentially growing system demands. We believe that insurance companies should first do adequate homework in identifying a meaningful set of scenarios. Otherwise, we may soon run out of computers for quick turnaround time. There is talk about resolving this "stochastic on stochastic" issue with distributed processing software. Despite this possibility and despite Moore's law (which calls for computer power to double and costs to halve every 18 months), the amount of work to do seems to be growing faster than resources available.

Need for Simplifications

Some clever individuals once noticed the approximate interaction between the interest rate and the time period required to double a sum at compound interest. Based on simple approximations, the rule of 72 emerged, allowing one to quickly recognize that approximately 12 years is needed to double a sum at 6 percent (6 times 12 = 72), or that a 4 percent compound interest will double a sum in about 18 years (4 times 18 = 72).

Wouldn't it be useful to have a similarly approximated method that would allow us to estimate the results of a stochastic model under a new set of assumptions without having to run another 1,000 scenarios? This kind of estimate was useful in the past when profit tests were run overnight on mainframe computers. One output column showed the change in results from a $1 change in premium. However, developing such useful adjustment factors for stochastic models will have to be the subject of a future paper.

Example

To illustrate the importance of using stochastic models and techniques to measure the significance of financial options and guarantees, we constructed a simple example. In order to keep the calculations manageable, this example looks only at the net present value of benefits and the interest adjustment for target surplus.

From this projection, we can see how much the deterministic version of the embedded value may be overstated. Key assumptions are listed below:

- The underlying block is a cohort of variable annuity business with guaranteed minimum death benefits (GMDBs) equal to premium roll-up at 5 percent per annum.
- The fund value as of the valuation date is $100,000, with all deposits invested in equity mutual funds.
- Annualized mortality and expense charges are 2.20 percent.
- Required capital is 4 percent of statutory reserve.
- GMDB is $100,000 at the valuation date (at-the-money).
- For simplicity, the cash surrender value is assumed to be the statutory reserve.
- Equity returns are assumed to follow a Regime-Switching Lognormal Model with Two Regimes (RSLN-2). The average of simulated equity returns is approximately 4.40 percent per annum.
- Discount rate is 9 percent per annum.
- There is no free surplus.

The present value of GMDB payments in excess of account value under a deterministic scenario of 4.40 percent equity return is approximately $1,137. This is compared in Table 2, on page 24, with present values of GMDB payments in excess of account value under a set of 500 stochastically generated equity returns.

The simulated results indicate that there is a wide range of possible financial impacts. Almost all of the chosen statistics (with the exception of median) are greater (worse) than the present value of GMDB payments

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