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Universal Life With Secondary Guarantees: Stochastic Pricing Analysis

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This article is based on an excerpt from a Milliman Research Report on universal life insurance with secondary guarantees (ULSG).

Executive Summary

As part of our research of ULSG products and designs we applied a set of stochastic scenarios as an example of the type of analysis that might be performed when pricing a new product. We observed that, even with a fair mix of up and down scenarios, statutory results and profit measures can be negatively skewed if the products are very sensitive to interest rate volatility. On a GAAP basis, it is cumbersome to review the typical ROE data from the stochastic output. It may be more effective to use point estimate ROE statistics or develop alternative ways to review results.

Introduction

Stochastic profit analysis has become a more important aspect of the pricing process. It can be applied on both statutory and GAAP bases to analyze how profit measures would be affected under adverse, optimistic, or random scenarios. An obvious practice would be to explore interest rate scenarios, but a more intense approach could utilize alternative combinations of lapse assumptions, mortality assumptions, premium payment patterns, and account value withdrawals. The opportunity exists to generate an exponentially larger stochastic set with each possible assumption and a massive amount of output data for analysis.

The discussion in this article centers around samples of two common variants of ULSGs – level specified premium and single-fund shadow account designs. Our specified premium

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product was designed to offer a modest accumulation of account value over its lifetime. Our shadow account design was created as a pure protection product with negligible account value growth. For an additional iteration we considered the impact of a hypothetical situation in which a company selling a ULSG product could reinsure a portion of each policy, including the secondary guarantee, to a captive. This arrangement would use a letter of credit to back the statutory reserve in excess of an economic reserve.

For our analysis we selected a single pricing cell from a larger model office. The cell was male, standard nonsmoker at issue age 55 with a $1 million average face amount. The pricing cell contained seven policies for $7 million of total face amount.

Prior to presenting any results, it should be emphasized that work completed for the research report was based on hypothetical product designs. The pricing results were not adjusted to produce particular return levels because this research report was focused on types of analysis and not the creation of the best design. Additionally, actual pricing exercises would include a complete aggregation of business based on anticipated demographics. The single cell chosen for this project does not necessarily produce return levels that would be expected from new product pricing in today's market, but it is intended to be representative.

Financial reporting basics for ULSG

The analysis was done in a financial reporting construct in accordance with our interpretation and experience with U.S. GAAP and statutory accounting principles, including the UL model regulation, Actuarial Guideline XXXVIII, FAS97, and SOP 03-1. For the projection of the future SOP 03-1 reserve, we used a nested stochastic approach. Our application of these principles represents one of the possible approaches or interpretations.

Profit measures

We utilize two profit measures commonly applied to insurance products—internal rate of return and return on equity. The internal rate of return (IRR) is the interest rate at which the sum of the discounted future stream of profits is equal to zero. IRR provides a single statistic with which to evaluate the product, often by comparing it to a benchmark return. For this report we have determined IRR based on statutory distributable earnings (post-tax profits, after provision for required capital).

The return on equity (ROE) is calculated as the after-tax GAAP profit in a period divided by an equity base. While IRR is a point statistic, the basic ROE calculations yield an array of values. The stream of ROE values can be used to analyze the profitability over time or can be summarized into a single statistic using a range of methods. In practice we have found that the sum of annual profits divided by the sum of equity bases and a discounted version of the same formula are common ROE point statistics. The discounted ROE statistic can be used to incorporate a hurdle rate or cost of equity into the calculation; we used an 8 percent discount rate. For our analysis, we examined the overall pattern of ROEs, but found found that these point statistics allow for easier summary when comparing scenarios.

Stochastic Profit Analysis

To create a simplistic example of stochastic analysis, we applied a range of interest rate scenarios to our sample ULSG products. There could be much debate on the number, balance, and type of scenarios to use in this type of analysis, but we elected to use a set of 50 scenarios based on the Dec. 31, 2010 yield curve from a generator provided by the American Academy of Actuaries. With these scenarios, an investment portfolio of 10- and 20-year bonds was used so that interest rates progress somewhat smoothly. The bonds were assumed to be AAA- and A-rated with appropriate spreads included in the yield. Over the projection period and across the 50 scenarios, the average annual return on investment was just above 5 percent. The pattern of average returns is generally upward sloping and ranges from about 4.4 percent in the first investment year to about 6.5 percent in the final year of the projection. We believe these scenarios represented a reasonable range of variation and a reasonable long-term reversion point.

ULSG Design: Specified premium

- The IRR from the stochastic projections are summarized in Figure (pg. 6, top, left). Note that the base scenario IRR for this product was 7.2 percent.

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Figure 1: ULSG Specified Premium Design IRR From Stochastic Projections	
IRR Range	Number of Scenarios
Undefined	1
0% to 1.99%	1
2% to 3.99%	10
4% to 5.99%	18
6% to 7.99%	14
8% to 9.99%	3
10% and larger	3
Average IRR	5.50%

- The chart in Figure 2 presents stochastic results for the analysis of the GAAP profits. Note that base scenario point statistic ROEs for this product were 6.4 percent using sums and 7.3 percent with discounting.

Figure 2: ULSG Specified Premium Design ROE From Stochastic Projections		
ROE Range	Number of Scenarios	
	Sum	8% Discount Rate
Negative	1	0
0% to 1.99%	3	0
2% to 3.99%	16	5
4% to 5.99%	16	23
6% to 7.99%	9	15
8% to 9.99%	3	4
10% and larger	2	3
Average ROE	4.83%	6.20%

ULSG Design: Shadow account

- The IRR from the stochastic projections are summarized in Figure 3 (above, right). Note that the base scenario IRR for this product was 5.1 percent.

Figure 3: ULSG Shadow Account Design IRR From Stochastic Projections	
IRR Range	Number of Scenarios
Undefined	4
0% to 1.99%	11
2% to 3.99%	16
4% to 5.99%	12
6% to 7.99%	3
8% to 9.99%	3
10% and larger	1
Average IRR	3.61%

- The chart in Figure 4 presents stochastic results for the analysis of the GAAP profits. Note that base scenario point statistic ROEs for this product were 5.4 percent using sums and 4.6 percent with discounting

Figure 4: ULSG Shadow Account Design ROE From Stochastic Projections		
ROE Range	Number of Scenarios	
	Sum	8% Discount Rate
Negative	4	11
0% to 1.99%	6	18
2% to 3.99%	9	10
4% to 5.99%	9	5
6% to 7.99%	6	2
8% to 9.99%	7	1
10% and larger	9	3
Average ROE	6.24%	2.21%

In these tests almost all the results of the stochastic scenarios were skewed negatively, but a handful of scenarios had positive impacts on profitability. We found that this effect was only slightly attributable to scenario bias, because almost half of the scenarios showed an average investment return larger than the average scenario. Our conclusion was that the volatility of the investment returns has a large impact on results. The impact of the investment volatility was visible primarily in the investment income lines of the statutory and GAAP income statements.

The volatility of the investment returns also impacted the projected credited rates on the base account value. In the cases where investment returns were poor, the secondary guarantee in both designs kept the policy in force despite the policy's running out of account value in earlier durations compared to higher return scenarios. However, we found that even in scenarios with generally above average returns, a few, intermittent years of poor investment returns could reduce profitability.

Additionally, the summed ROE point statistics for the shadow account product indicated a generally positive effect of the stochastic scenarios while the IRR and discounted ROE statistics showed mostly negative results. This occurred because both statutory and GAAP profits tended to be lower or negative in early years and higher and positive in later years.

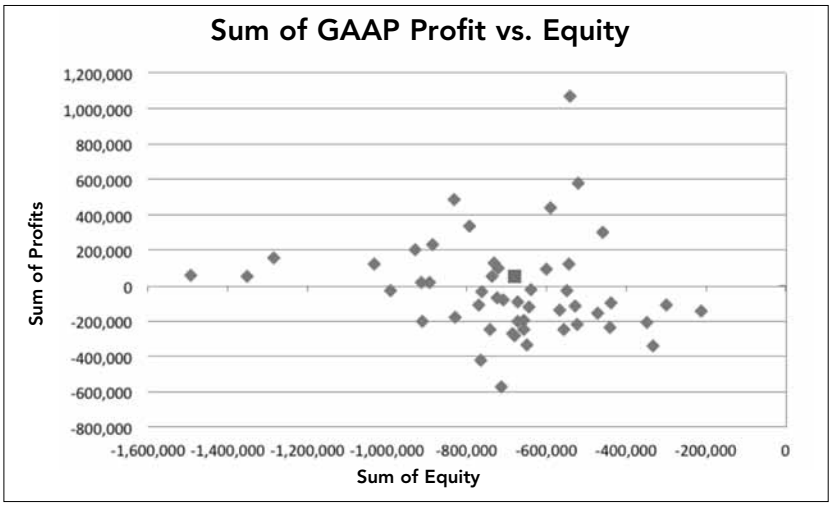
ULSG Design: Shadow account with financing solution

We also applied the stochastic analysis to the shadow account product after creating a hypothetical financing solution. On a statutory basis we found that the present value of profits at sample discount rates increased for almost every scenario. However, the shape of the general profit pattern changed in such a way that an IRR could not be calculated for most scenarios. It turns out that those scenarios had small positive IRRs and negative present values of profit without the financing solution, and even though the financing solution improved the profitability, the present value of profits remained negative. On scenarios where the present value of profits was already positive, the IRRs were calculable and increased compared to the results without financing.

Analyzing the stochastic GAAP profit results for the product with a financing solution, we found that the point estimate ROEs tended to be negative or large because of negative sums of equity in the denominator for the sum statistics and small positive present values of equity in the denominator for the discounted statistics. This reduced the effectiveness of the point estimates for summarizing the underlying profitability.

Because our typical analysis didn't provide much insight, we looked for alternative summaries of the data. An interesting concept is to plot a data point for each scenario with the sum of profits and equity as the coordinates. This allowed us to get some sense of how the scenarios impacted results.

Figure 5: Plot of GAAP Profit vs. Equity



We also considered a quadrant system to categorize results:

- Quadrant I contains scenarios with positive profits and equity, which may be desirable if the ROE for the scenario is sufficient. No scenarios fell into this quadrant, and it is not shown on the chart above.
- Quadrant II contains scenarios with positive profits and negative equity. These scenarios may be considered desirable outcomes.
- The scenarios in Quadrant III can be viewed as a mix of good and bad results. The negative present value of equity means that the projected cell would generate new equity that could be applied elsewhere. For some scenarios the negative present value of profits could represent a fair cost for this equity. A company would have to decide where to draw the line on acceptable outcomes.
- Quadrant IV contains scenarios with negative profits and positive equity. These are the worst outcomes because they consume capital and do not generate a return. No scenarios fell into this quadrant, and it is not shown on the chart below.

The chart in Figure 5 (above) plots the sums of equity and profits. The point marked as a square represents the results from the base scenario. □

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