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Conditional Stochastic Pricing

By Feng Sun



Feng Sun, FSA, CERA, lives in Avon, Conn. He can be reached at (860)674-9730 or sunfengiowa@gmail.com.

Last year's financial market crisis resulted in significant declines in equity values. As a result, Variable Annuity (VA) writers and their organizations are under stress test. Most companies realized that their guarantee riders within VA were underpriced. They decided to reduce risks and/or increase the rider charges.¹

So, what went wrong with current VA guarantee pricing? Stochastic methodology has prevailed in variable annuity pricing, especially for VA with living and/or death benefit guarantee riders. The stress scenarios had been tested in the pricing model. What would actuaries do differently this time? Would simply updating assumptions such as higher volatilities of assets returns and rerunning the pricing model do the job? The author believes there is more that needs to be done. One lesson learned from this experience is that capital swing caused the chaos. Companies need to step back and rethink stochastic pricing methodology.

Conditional Stochastic Pricing Methodology

Conditional stochastic pricing methodology believes that the projected profitability is contingent on the solvency or ratings of insurers. If the company solvency or ratings are under pressure, the profitability along these paths needs to be investigated or reconsidered.

Let us start with a casino math example. Gary, a gambler, has a simple, but well-known strategy to play in a casino. He walks away when he wins; he doubles his previous bet and continues to play if he loses. This strategy would guarantee Gary to win if he has enough money (assuming the casino has no up limits on bets, and the odds of winning are slightly less favorable than 50/50). Unfortunately, in reality Gary walks away with nothing in most instances because Gary does not have enough money to stay in the game, whereas, the house has enough chips (same as money in casino) and shifts to play with Gary.

From a statistical point of view, insurers, like the casino, also play with odds, but with good faith. They can design and price products with odds being in their favor. However, insurance businesses are regulated. Similar to gambling, the casino should have enough cash to backup the chips in house; insurers need to meet a list of requirements to stay in business. One of them is minimum assets requirement or capital requirement. For a VA guarantee writer in the United States, the C3

¹ Variable Annuity Providers Face Tough Decisions in the Midst of the Financial Crisis, Towers Perrin, December 2008 http://www.towersperrin.com/tp/getwebcachedoc?webc=USA/2008/200812/Update_VariableAnnuities_1208.pdf

Phase II capital requirement is the regulatory assets requirement to ensure insurers have enough money to back up policyholders' benefits.

If we assume Gary plays a game that allows him to flip a coin two times in a row. The odds of winning are 90 percent, and the bet is \$1.00. In theory, Gary is expected to win \$1.60.

$$E(x) = 2 \times (0.9 - 0.1) = 1.6$$

This expected value is unconditional. It has an underlying assumption that Gary has at least \$2.00 to start with. The average of outcomes converges to the expected value as the number of trials increases.

What if Gary has only \$1.00 to start with? The amount he expects to make is \$1.52 instead of \$1.60, given everything else being equal.

$$E(x|Capital = 1) = 1 \times (0.9 - 0.1) + 1 \times 0.9 \times (0.9 - 0.1) = 1.52$$

The \$0.08 reduction in expected value is due to the fact that favorable odds in the second trial cannot be realized if Gary lost in the first trial.

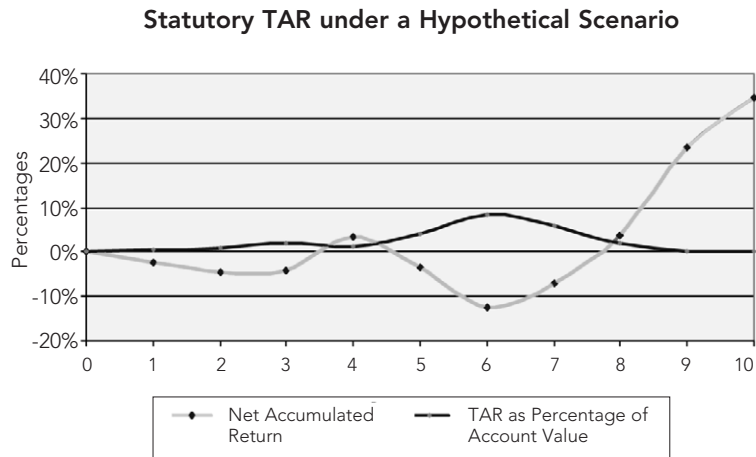
Similar to Gary's situation, if insurers do not have enough capital under all scenarios, some profits or losses cannot be realized.

Current stochastic pricing² focuses on the cost of capital when calculating distributable earnings in pricing, but overlooks the magnitude of capital requirements at a certain point in time that potentially ruins the companies.

Under C3 Phase II, the Total Assets Requirement (TAR) could reach high levels under stress scenarios. According to a Tillinghast study,³ for VA policies with an aggressive guaranteed minimum withdrawal benefit (GMWB) for life feature issued in 2007, the C3 Phase II capital requirement as of Oct. 31, 2008 could go as high as 34 percent of account value.

The chart below illustrates the relationship between

underlying VA fund return and TAR under a hypothetical scenario.



Net accumulated return is defined as wealth ratio⁴ minus one. TAR is expressed as a percentage of account value. These two are negatively correlated. When the accumulated return increases, the capital requirement decreases. At year six, the accumulated return is -12.5 percent, the TAR is about 8.2 percent of account value. At year 10, the net accumulated return is 34.8 percent, and the TAR is about 16 basis points.

² Stochastic Pricing for Embedded Options in Life Insurance and Annuity Products, Milliman, Inc. October 2008, <http://www.soa.org/files/pdf/research-2009-stochastic-pricing.pdf>

³ Stochastic Pricing for Embedded Options in Life Insurance and Annuity Products, Milliman, Inc. October 2008, <http://www.soa.org/files/pdf/research-2009-stochastic-pricing.pdf>, table 2 on Page 4 of Footnote 2.

⁴ Wealth Ratio – The cumulative return for the indicated time period and percentile (e.g., 1.0 indicates that the index is at its original level.)

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For this particular scenario, what pricing actuaries need to be conscious of is the company needs to survive year six before they can calculate the present value of future profit over the 10-year time horizon.

If the company plans to reduce TAR by implementing risk/capital management strategies such as hedging, these strategies need to be reflected in pricing. The profitability before and after needs to be captured and the cost/benefit trade-off needs to be assessed.

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Implications of Conditional Stochastic Pricing

Conditional stochastic pricing believes that actuaries should examine asset requirement (balance sheets) to ensure the companies' solvency or rating status is intact in any given scenario path before analyzing the distribution of profitability (income statements) over time and across scenarios. Pricing actuaries need to consider or incorporate risk/capital management such as hedging or reinsurance, or a strategy of raising capital, especially under stressful scenarios in pricing. This methodology has a number of implications for VA pricing and enterprise risk management.

1) Capital First

Well capitalized companies can offer relatively competitive products. These companies can sustain large capital swings; get compensated from staying in business longer and having more chances to realize favorable odds.

On the other hand, companies who are not able to raise or afford huge capital, have to either have high prices, or less competitive product designs, or an effective risk management program in place to lower TAR to reach the same profitability goal. This forces companies to find other ways of attracting customers and generating sales.

2) Incorporate risk management in pricing

In order to ensure the company can go through tough times, risk management such as hedging, reinsurance, etc., need to be considered to reduce TAR under severe scenarios. In this case, the cost of implementing and operating a risk management program and the costs and benefits associated with these need to be taken into account in pricing.

3) Monitor In-force Business

Unexpected things can happen. Risk dynamics may change as the market evolves over time. Pricing assumptions may not be realized. Conditional stochas-

tic pricing logic can also be used to monitor an in-force block on a regular basis. In particular, the future capital position needs to be projected and profitability needs to be analyzed along with capital positions. Certain measures may be taken to ensure the business stays in shape.

4) Control Sales and Rethink Acquisitions

Experience in the insurance industry showed that a pooling of non-correlated exposures reduces risk for the pool and achieves greater predictability. Unfortunately, VA with guarantees does not belong in this category. Higher than expected sales volume may not always be a good thing because it may result in higher than expected capital requirements. Therefore, sales need to be monitored and managed regularly to ensure companies are immunized to potential capital swing in the future. Similarly, before acquiring a block of a similar line of business, consideration needs to be given on the impact on the consolidated capital position.

Practical Challenges to Implement Conditional Stochastic Pricing

To implement this methodology, pricing actuaries should be conscious of asset requirements from regulators and rating agencies and their impact on the company's financials relative to its business size and examine and analyze profitability along with the TAR amount under any given scenarios.

In practice, there are a number of modeling challenges when implementing conditional stochastic pricing:

- 1) From a modeling perspective, both income statement and balance sheet related items need to be captured and analyzed from model output for each time interval and over all scenarios. This could lead to another layer of technical and modeling challenges. Actuaries need to capture the balance sheet items (such as TAR results) under

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each scenario and along the path from model output, along with the profitability results. More profitability analysis needs to be done under capital-hefty scenarios because these results (either profits or losses) may not be realized.

- 2) As a common practice, a few sample pricing cells are selected to represent the potential sales, and sales volume is usually arbitrarily assumed or based on sales history. The TAR amount may not look enormous when testing a few pricing cells, but it can be when the scale is applied. Actuaries need to review the TAR not only in absolute dollar amount, but also review it relative to benchmarks such as assets under management (account value), guaranteed amount, or risk exposure, etc., associated with guarantees.
- 3) Stochastic-on-stochastic simulations are needed to estimate statutory and GAAP earnings. If hedging needs to simulate in the projection, there should be stochastic-on-stochastic-on-stochastic, which can be technically challenging.
- 4) For the C3 Phase II capital calculation, calibrated scenarios at each node over all scenarios (usually used at nested level) may be difficult to generate and validate. Some approximation may not be avoidable.
- 5) When actuaries find that the impact of asset requirements is too severe under a number of scenarios, they can consider reducing the tail risk via product design or risk management such as hedging or reinsurance, which means more sets of sensitivity runs.
- 6) Pricing is usually done at line of business level, whereas asset (or capital) requirements are assessed at both line of business level as well

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as enterprise level. For companies that have multiple lines of business, this could create some challenges if asset requirements from other lines of business are not available for aggregation.

Conclusion

Conditional stochastic pricing suggests assessing the business circumstance such as total asset requirements to ensure the companies' solvency or ratings status stays intact under each stochastic path before doing profitability analysis. Introducing conditional pricing methodology creates a number of challenges for pricing

actuaries and risk managers, but it leads to a better understanding of the business, more precise pricing and better risk/capital management, and eventually will help the company sustain capital swings and have a smooth ride along the way. □

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