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Variable Annuity: Risk Management Through Breakthrough Product Innovation¹

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IT IS INCREASINGLY ACCEPTED that large variable annuity writers will not get out of this severe market stress unless tail risks of GMxBs are well mitigated. Under today's environment, variable business faces an uncertain future as the guarantees are more frequently in the money, and this has created extreme stress on the insurers' balance sheets. The current high volatility and low interest rate environment has worsened this situation. Mark-to-market reserves on these embedded derivatives have jumped 10- to 15-fold when compared with the results during 2007 and 2008. In the past insurance writers generally mitigate these GMxB risks through hedging, reinsurance or taking a naked position. However, the current financial crisis shows that these traditional risk mitigation strategies cannot work well under severe market shocks:

- During market turmoil, insurers incur much higher hedging costs to retain the same hedging effectiveness level when done under normal market conditions;
- The reinsurance supply becomes scarce and expensive;
- Capital becomes even more scarce and precious.

Today variable annuity business is facing an uncertain future due to capital strain, regulatory uncertainties and negative market perceptions. The magnitude of the variable annuity writers' dilemma is determined by the nature of the GMxBs and by the limitations of their existing risk management approaches:

- GMxBs are embedded non-standard puts sold to policyholders that imply insurers will benefit from bull markets, but they will be hurt with losses due to increased basis risk and high volatilities. The current market meltdown with soared volatility and low interest rates has harmed the insurers' balance sheets and has created significant stress on their financial standings. Further, some VA features such as ratchets, step-ups, and roll-ups make those options difficult to move out of money, even equity market cycle reverses.

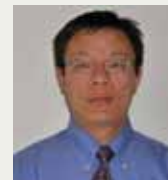
- Hedging programs are conducted by purchasing derivatives to offset the positions that insurers have on their liabilities. However, there can be a timing mismatch. Fees or charges (e.g. the prices of these embedded derivatives) were determined months or years before by using valuation tools calibrated to the market at that time. On the other hand, hedging programs rebalance the hedging portfolio under the current market conditions. Therefore, hedging costs will increase if insurance companies sell their guarantees at a "good" time (e.g. during low volatility) and purchase their hedging derivatives during "bad" days (e.g. high volatility). Escalating basis losses, and higher vega and gamma exposures will put insurers in an extremely difficult situation. This is exactly what has happened since October 2008, when volatilities have soared and interest rates have dropped dramatically.

In the authors' view, current hedging programs are not working very effectively under severe economic shocks. The cause is the downside risk exposure from the GMxBs and the timing mismatch mentioned above. Under today's environment, reasonable increases in GMxBs charges are far from being adequate to compensate for the increased hedging costs. The nature of the business and the existing risk management approach make it very challenging for the insurer to manage this type of risk during downturns in the economy.

Given the difficult situation that the insurer is facing and the insufficient effectiveness of various hedging approaches, it will be a significant task to develop new



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FOOTNOTES:

¹ The views in this article only represent the authors' personal opinions. This article does not represent any statements from the organizations where the authors are employed.

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strategies to manage the various risks associated with the variable annuity business. To this end, we propose an innovative risk management strategy through product design of variable annuities. The primary feature of the new product is to offer the policyholder access to negatively correlated funds. We believe that these additional funds will significantly reduce the downside risk, thus the stress on an insurer's balance sheet.

"NATURAL HEDGING" THROUGH PRODUCT DESIGNS

Current variable annuity product designs only allow account value to change in one direction: policyholders can grow their money only when the equity market rises. When the equity market drops, the policyholder's wealth remains at the guaranteed level and the insurer is responsible for the deep in-the-money GMxBs benefits. Unlike this unilateral design, the proposed new product innovation allows a policyholder's account value to have the opportunity to grow in both directions of equity market movements. It is achieved by providing additional "*inverse funds*," which are *negatively correlated* with the funds available in the current existing variable annuity products. These inverse funds would mirror the "regular funds" (currently available funds, which are linked to the performance of various equity indices such as S&P 500, Russell 2000, etc). Said differently, these inverse funds could move in the opposite direction with the indices. They can be directly linked to the performance of some traded indices (such as Exchange-Traded-Funds), or linked to the performance of synthetic indices. For example, for a fund to mimic the opposite performance of the Russell 1000 financial sector, an underlying synthetic index can be developed by packaging a one third position in the Financial Bear 3X (FAZ) index and two thirds in the Russell 1000 Financial index.

So, as a result, during a bear market, with a certain portion of the funds moved to inverse funds, part of the GMxBs will move out of the money. So, an insurer's stress should be largely reduced due to lowered GMxBs in-the-moneyness. Of course, the upside potential is reduced in a bull market as some policyholders may continue to direct some of their fund allocation to these

inverse funds. Note that if the distribution to regular funds and inverse funds are equal then the in-the-moneyness of the GMxBs will not change over the equity market cycle. From a policyholder's perspective allocation to regular funds are taking a long position on puts on these funds and the GMxBs will protect them from bear markets. On the other hand, those who distribute their wealth to inverse funds are longing puts on the underlying funds that move *inversely* with equity market. From an insurance company's perspective, pooling these two cohorts of people together will lower the total GMxBs in-the-moneyness and substantially diversify the tail risks. The key of this new product design is to allow policyholders to dynamically manage their funds under the different economic cycles. An Insurer's current hedging programs will be essentially actively shorting the market "on the back-end" to offset their positions of the embedded derivatives on the liabilities. This new product design, however, essentially allows policyholders to short the market themselves under bear markets and an insurance company then only takes on a limited residual risk exposure of an extreme market.

During equity market transitions, allowing fund transfers between regular funds and inverse funds would further reduce an insurer's tail risk, assuming that there is a certain level of rational policyholder behavior. In a bear market, it is reasonable to assume that a greater portion of policyholders would move their deposits into the inverse funds. Hence the in-the-moneyness will reduce during severe economic distress as in the last year. In a bull market a greater portion of policyholders will move their deposits into the regular funds to benefit from the favorable equity performance.

A NUMERICAL EXAMPLE AND ANALYSIS

The variable annuity product for this example is a simplified version with only one time period considered. Without loss of generality, we will assume that there will be no reduction in the units in force due to mortality, lapse, partial withdrawal, or annuitization. Other product features and assumptions are listed as follows:

“Offering variable annuity policyholders access to negatively correlated funds significantly reduces downside risk, thus the stress on an insurer’s balance sheet”

Product Specification:

| | |
|---|---------------------------|
| Account value at the beginning of the period: | BOP AV = \$100,000 |
| Base of guarantee at the beginning of the period: | BOP GMxB base = \$100,000 |
| The guarantee has a roll-up feature: | roll-up rate = 0% |
| Charges and expenses: | MER = 2.00% |
| GMxBs utilization/selection rate (e.g., annuitization): | 15% |
| Policies in-force: | 1000 |

For simplicity, only two funds in the separate account are considered: a regular fund and an inverse fund. The first is linked to the performance of S&P 500, and the latter to the opposite of this index. Table 1 shows the hypothetical returns of the two funds during the period for both bear and bull markets.

| | Regular fund (S&P500) | Inverse fund (-S&P 500) |
|-------------|-----------------------|-------------------------|
| Bear market | -20% | 20% |
| Bull market | 20% | -20% |

We will assume that there are only three types of policyholder behavior: a bear market view, a bull market view and a neutral view. We assume that policyholders who hold the bear market view will tend to allocate more of their money to the inverse fund. Where, on the contrary, policyholders who hold the bull market view will be inclined to allocate more into the regular fund. For the third case, policyholders are not sure about the market, and then allocate equally between the two funds to hedge their market risk. Our funds allocation assumptions are displayed in Table 2.

Table 2. fund allocation

| | Regular fund (S&P500) | Inverse fund (-S&P 500) |
|---------------------|-----------------------|-------------------------|
| Bear market view | 0% | 100% |
| Bull market view | 100% | 0% |
| Neutral market view | 50% | 50% |

At an aggregate level, the net effect of overall policyholder behavior can result in the following three scenarios:

- *Balanced allocations:* allocations to the two funds are roughly equal. This scenario is likely to happen when the market is neither a bull nor a bear market. Consequently, most of the people may hold neutral view, or the number of bear views and the number of bull views do not dominate one another.

- *Rational allocations:* here more is allocated to the regular fund than the inverse fund in a bull market, and more to the inverse fund than the regular fund in a bear market. This scenario happens in a typical bull or bear market.
- *Irrational allocations:* more is allocated to the regular fund than the inverse fund in a typical bear market, and more to the inverse fund than the regular fund in a typical bull market. This is less likely to happen if we assume that policyholders want to maximize their wealth.

Table 3 provides hypothetical fund distributions on an aggregate basis under the three scenarios mentioned above.

Table 3. assumption of policyholder distribution under various scenarios

| | Bear market | | Bull market | |
|------------------------|--------------|--------------|--------------|--------------|
| | Regular fund | Inverse fund | Regular fund | Inverse fund |
| Balanced allocations | 50% | 50% | 50% | 50% |
| Rational allocations | 30% | 70% | 70% | 30% |
| Irrational allocations | 70% | 30% | 30% | 70% |

Given the above product features and assumptions, the account value (AV), the GMxB guaranteed base, in-the-moneyness (ITM), GMxB charges, and profits are readily calculated. To see how differently this new product behaves from the currently existing VA products, the same quantities of an existing VA contract are also computed using the same assumptions. The existing VA has the same product features except that it only provides a regular fund. Table 4 summarizes the comparison of the results under various scenarios and equity market conditions. Note that the PH AV is taken as the maximum of the guaranteed base and the actual account value, to reflect their actual wealth.

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Table 4. Results of numerical example (\$mm)

| | | Bear market | | Bull market | |
|------------------------|--------|-------------|-------------|-------------|-------------|
| | | Existing VA | Proposed VA | Existing VA | Proposed VA |
| Balanced allocations | PH AV | 100.00 | 108.80 | 117.60 | 108.80 |
| | ITM | 21.60 | 10.80 | 0.00 | 10.80 |
| | Profit | -1.60 | 0.38 | 2.40 | 0.38 |
| Rational allocations | PH AV | 100.00 | 112.32 | 117.60 | 112.32 |
| | ITM | 21.60 | 6.48 | 0.00 | 6.48 |
| | Profit | -1.60 | 1.19 | 2.40 | 1.19 |
| Irrational allocations | PH AV | 100.00 | 105.28 | 117.60 | 105.28 |
| | ITM | 21.60 | 15.12 | 0.00 | 15.12 |
| | Profit | -1.60 | -0.43 | 2.40 | -0.43 |

It can be seen from table 4 that the existing product incurs a large loss of 1.6 \$mm in the bear market and harvests a profit of 2.4 \$mm in the bull market. For this new product, the insurer's profit ranges from -0.43 \$mm to 1.19 \$mm. The maximum loss is only a quarter of that of the existing product, thereby significantly reducing the stress on their balance sheet. At the same time, however, the upside potential is reduced in a bull market. These two products have the same average PH AVs across the various market conditions and allocation scenarios. But, the volatility is dramatically reduced by the new design. We conclude that a policyholder's wealth is increased on a risk adjusted basis. This is due to the fact that, when compared with the existing product, an option of allocating to the inverse fund is granted to policyholders.

CONCLUSIONS

The new product feature presented in this paper helps insurance companies manage the equity market tail risk and also adds value to policyholders. However, it takes several steps to turn ideas to reality. We suggest that practitioners need to understand any potential risks of this new product and perform complete stress testing under different economic scenarios as well as sensitivity tests on the key actuarial assumptions such as fund allocation and withdrawal. We also would like to extend our conclusions to the original intension of this new idea.

1. Enhance business values on a risk adjusted basis

Current variable annuity product designs are not consistent with the long-term operational nature of insurance business as they have exposed insurers to extreme tail risks. Companies that wish to survive hundreds of years

will find it inevitable to avoid difficulty during severe economic shocks. The management of insurance carriers needs to develop risk management strategies considering various economic and underwriting cycles.

The use of insurance is to manage unintended consequences of actions or activities from a massive population by the use of diversification of these risks. Insurance may cease to function in situations where it is exposed to extreme tail risks or the insured can effectively anti-select against it. Current GMxBs designs fall into one of these situations.

The proposed product design significantly reduces a VA writer's tail risk and increases their business value. At the same time, the new feature is more valuable to policyholders on a risk adjusted basis than the existing counterpart because a non-standard "chooser" option is offered instead of a non-standard put option.

2. Manage risks through product designs

Another intension of this product innovation is to manage business risks through product design. Like the "natural hedging" against mortality risk by running both life insurance and annuity businesses, management needs to consider developing risk management strategies during the product development process, as part of a holistic risk management view. "Back-end" risk management (such as reinsurance, hedging, or securitizations) can then supplement and work seamlessly with the "front-end" risk management (such as product design) to manage risks in an entire control cycle. Solely relying on back-end risk management makes it challenging to keep up with the pace of dynamic market movements.

As a caveat, if, as many believe, today's market is at its bottom level, the authors would warn that it may be risky to offer inverse funds to in-force VA products as there is possibility that policyholders' account values could be locked-in at the current or reduced level. Further, policyholder behavior on these contracts would add greater uncertainty to the insurer's business portfolio.

At the present time, large VA writers are actively re-pricing or re-designing their GMxBs to reduce the risk from their VA products. We believe a large portion of business risk emerges from the product development phase and these can be mitigated by designing risk management strategies during that stage. We hope our suggestions will inspire more innovative ideas in product design. ♦