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NEXUS

RISK MANAGEMENT

White Paper

VIX® for Variable Annuities - Part II

A study considering the advantages of tying a Variable Annuity fee to VIX

July 2013

Executive Summary

This paper explores the use of the CBOE Volatility Index® (VIX)® in setting the risk charge ("fee") for a variable annuity (VA) product guarantee, and will demonstrate the potential advantages – both to variable annuity carriers and to policy holders – of calculating the fee as a function of VIX[1].

We analyze the use of a dynamic (or variable) fee to more closely match the carrier's guarantee and hedging costs through different market environments.

Several challenges are commonly faced by carriers in matching fees and costs on typical VA products, even with a hedging program in place:

- High cost and limited availability of long dated static hedges
- Basis risk of long dated hedges, which is magnified over the duration of the hedge
- Volatility of dynamic hedging costs – mismatch of fee income and ongoing costs of hedging
- Volatility of reserve and capital costs due to the large, long dated Vega exposure of guarantees – an increase implied volatility shift can greatly increase the liability
- Limited Vega offset available from short dated hedging instruments that are cheapest to purchase and roll
- Misalignment of incentives between carriers and policyholders

We discuss these challenges, explore relationship between product design and hedging, and describe the motivation for a variable fee. We then outline how using a fee linked to VIX can help address many of the challenges faced by carriers:

- Better matching of fees and dynamic hedging costs, even in periods of high market volatility
- Better matching of present value (PV) of fees and claims can help reduce the impact of implied volatility changes on reserve and capital costs
- Ability to employ shorter dated hedging instruments with less impact from the tenor mismatch between assets and liabilities.

An illustrative example is provided where the VIX-linked fee approach is applied to a simple guaranteed minimum withdrawal benefit ("GMWB") product.

We demonstrate how carriers can have improved ability to manage cash flow for hedging purposes, and more stable reserve and capital outcomes under certain reserving and capital regimes, while also benefitting policyholders through lower fees in low volatility, rising markets.

Finally, we argue that this risk sharing with policyholders, when designed properly, can improve the ability of the insurer to perform its financial intermediation role, and facilitate more efficient risk transfer from the policyholder to the insurer, and then through to the capital markets.

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[1] Fee-determination systems and methods relating to insurance products that are designed to incorporate a measure of volatility into the fees are subject to a pending patent application filed with the U.S. Patent and Trademark Office (Application number: 12/817,788 Publication number: US 2010/0325063 A1).

Key Challenges Faced by Insurers

A number of challenges are faced by insurers who underwrite variable annuity guarantees; we outline several key challenges below:

Weaknesses in Existing Variable Annuity Product Designs

An ongoing challenge for variable annuity writers is that future costs[2] as well as regulatory capital and reserve requirements for the product are highly scenario-dependent, and thus essentially unknown at the time of issue. These requirements can vary significantly based on a number of economic variables such as actual future changes in equity market levels, interest rates as well as implied volatility.

At the same time, the fees on a typical variable annuity product – which are intended to fund the cost of providing the guarantee – are essentially fixed[3].

This mismatch between fee income and costs can put carriers under painful financial constraints, especially during periods of market turmoil, as was observed during the recent financial crisis.

Volatility of Hedging Costs

Common hedging programs employed by carriers, while significantly reducing the market risk exposure, cannot adequately address this mismatch between fee income and costs. Even after implementing a hedging program, significant uncertainty remains around the future outcomes for variable product guarantees.

Dynamic Hedging

During periods of market turmoil, dynamic hedging solutions generally become much more expensive. Dynamic replication strategies become more costly because the larger market movements both up and down mean greater losses are incurred. Using short dated options rather than futures can provide some protection for the negative gamma from the guarantees, but new options will need to be repurchased regularly and the future cost of these purchases is uncertain – these options become much more costly when implied volatility is higher.

Static Hedging

Static or semi-static hedges using long-dated instruments such as over-the-counter equity put options are very costly to put in place. And even if they are implemented, they can leave the carrier exposed over time to mismatches with the liabilities due to policyholder behavior, and also to basis risk between hedging instruments and the underlying funds.

No "Natural Suppliers" of Long-Dated Volatility

While significant demand exists for long-term equity market downside protection, the "natural production" of long dated options needed to adequately meet this demand does not presently exist. In addition, the prices of long dated options have historically reflected a substantial premium for liquidity and cost of capital. This premium is likely to persist or even increase due to pressure from regulators for liquidity providers to post more collateral against those obligations. This means that carriers are often forced to pay a high premium in order to obtain long-dated hedges, which can make this solution prohibitively expensive.

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[2] These costs include both claim payouts on the guarantee and costs of hedging during the life of the product.

[3] Actual fee income received can also depend on underlying fund performance, sales compensation structures and realized rates of policyholder withdrawals or deaths; however, analysis of these is beyond the scope of this paper.

Volatility of Reserve and Capital Costs

In addition to the expected increased capital constraints for hedging instruments, regulatory reserve and capital calculations in Europe and North America are moving toward more market-consistent (or "fair-value") treatment of their obligations. Requirements for carriers to calculate the value of the obligations based on current market conditions can create balance sheet risk that traditionally has not been there. This can have negative consequences for insurers during times of market turmoil, even if hedging programs are in place.

Because variable annuity guarantees can be considered a put option on the policyholder's portfolio, an increase in the implied volatility in the market place will likely increase the value of the guarantee. Therefore, regulatory requirements for liabilities to be calculated on a market-consistent basis using implied volatility lead to fluctuations in implied volatility having a significant impact on an insurer's balance sheet.

Under Solvency II, both the Technical Provision and the Solvency Capital Requirement ("SCR") are based on a market-consistent measurement of the GMxB liabilities. The one-year forward approach used for the SCR brings the added dimension of how implied volatility varies over time, on a real-world basis.

Contemporaneous Cost Impacts – Potential for "Perfect Storm"

Unless the carrier has found a long dated static hedge for the liabilities, the actual ongoing hedging costs are changing, and yet the fee income is fixed; therefore the insurer can be forced into heavy cash outlays at same the time reserve and/or capital pressures are intensifying.

Dramatic increases in implied volatility often occur precisely at the same time the market has fallen dramatically. When this happens, it means that not only is the liability increased due to increased volatility, but also the guarantee itself has more intrinsic value (i.e., it is more "in-the-money"). Add to this the increased cost of hedging activities during these same periods, and this can become a perfect storm for variable annuity carriers.

Misalignment of Incentives

A moral hazard is a situation where a party will have a tendency to take risks because the costs that could be incurred will not be felt by the party taking the risk. In other words, it is a tendency to be more willing to take a risk, knowing that the potential costs or burdens of taking such risk will be borne, in whole or in part, by others. When carriers manufactured variable annuity products with guarantees, they changed the dynamics of the product and essentially created a moral hazard situation. Investors, who previously had an incentive not to invest in funds/subaccounts that were outside of their risk parameters, now could assume a much higher risk profile because they now had a floor to their potential losses. Insurance carriers then had to absorb the brunt of the impact from these changed dynamics as market volatility increased and interest rates decreased over the past decade.

Hedging and Product Design

There now exists a large base of both academic and industry literature on the hedging of variable annuity guarantees, and industry practices in this area have evolved and matured significantly over the past decade. While there are still opportunities to considerably improve efficiency in existing hedging programs, hedging cannot overcome deficiencies in product design such as overly rich guarantees or insufficient risk charges. Attention has been focused more recently on design and pricing of the products and their associated guarantees. In particular, hedging itself (including any associated costs) is now being reflected at the product design and pricing stage.

This paper will not be exploring the many changes in product design and pricing that have been seen recently. However, we do examine one particular product innovation: use of a variable, VIX-linked fee.

Motivation for a VIX-Linked Fee

If fee revenues could better correspond to hedging costs period-by-period, carriers could have more stable cash flow, more stable reserve and capital requirements, and thus more stable financial positions.

If fees could be lowered when the market is stable or doing well, policyholders could benefit from a lower cost product in these environments.

We will show that linking the variable annuity fee to VIX is a risk-sharing mechanism with potential benefits for both carriers and policyholders, and may achieve both of the above objectives.

What is VIX?

VIX is a published index which measures implied volatility on short-dated options. It is considered an indicator of expected market turbulence.

More precisely, VIX is a normalized sum of option prices across multiple strike prices and time weighted across tenors to reflect a 30 day outlook. As implied volatility increases for the particular options used in the calculation, VIX will increase. It is not our intention to cover the many technical aspects of VIX – for purposes of this paper, a general understanding of VIX will suffice.

Illustrative Example – A Simple GMWB

Modeling and Product Description

To illustrate product dynamics under a variable VIX-linked fee structure, we examine a 25-year variable annuity with a GMWB rider. For this product, no withdrawals occur during the first five years, then for the remaining 20 years guaranteed withdrawals are taken, equal to 5% per annum of the guarantee value. The guarantee value rolls up with interest, and after 5 years increases to the current account value if this is higher.

A block of business with $1 billion total initial account value is assumed. The S&P 500 index is used to represent a typical equity mutual fund. An asset mix of 70% equities and 30% bonds is used.

For simplicity, no additional impacts from policyholder behavior or decrements are modeled. However, we do briefly discuss the potential impacts of dynamic lapsation under a variable fee structure compared to under a fixed fee structure.

Fee Structures

Using the above product, two fee structures are compared:

(i) A fixed fee of 100 bps of account value per annum, and

(ii) A variable fee equal to VIX times 5 per annum

For purposes of calculating present value of fees and claims, the average variable fee over the product lifetime is constrained to no less than an equivalent level fee of 50 bps and no more than an equivalent level fee of 150 bps.

Study Period

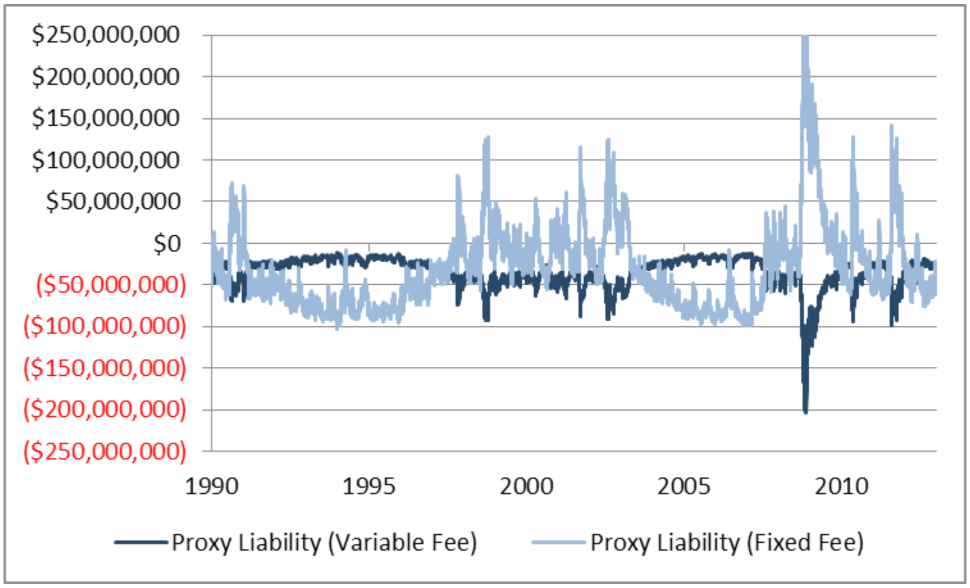
We first analyze the behavior of the product by testing over a historical period from 1990 to 2012.

For this analysis we define a market-consistent proxy liability[4], which is measured as the difference between expected present value of future claims on the GMWB rider, calculated using implied volatility, and expected present value of future fees.

We illustrate how the proxy liability behaves under the fixed fee structure compared to the variable fee structure on a new cohort of business at each date.

Key Observations and Results

Figure 1: Proxy Liability with Fixed Fee vs. Variable Fee



From the chart above we see how much the liability on new business can vary when calculated using a market consistent approach, especially when fees are fixed.

We observe that the volatility of the proxy liability over much of the period is reduced under the variable fee structure, as compared to the fixed fee structure, indicating that the PV of future fees appears to correlate more closely with future claims under this approach.

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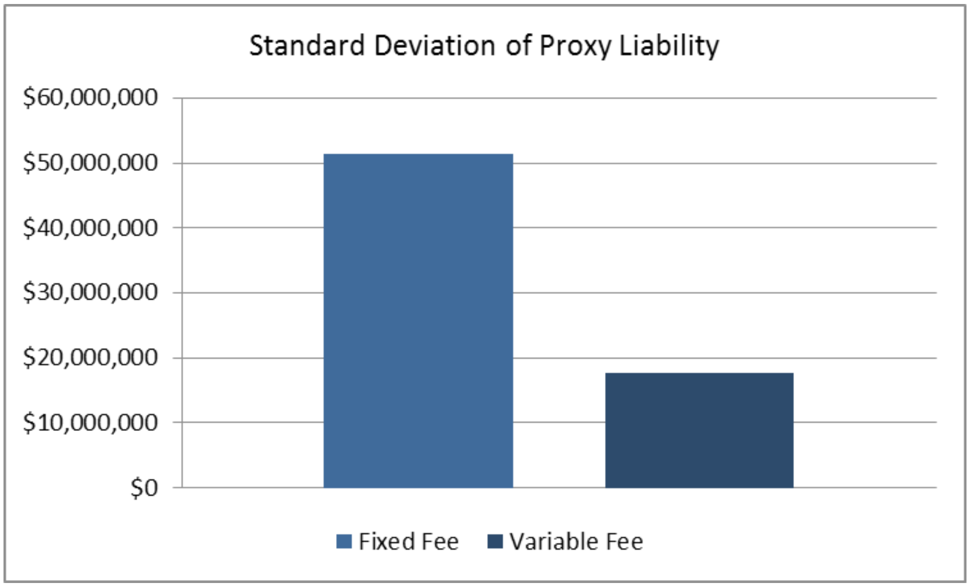
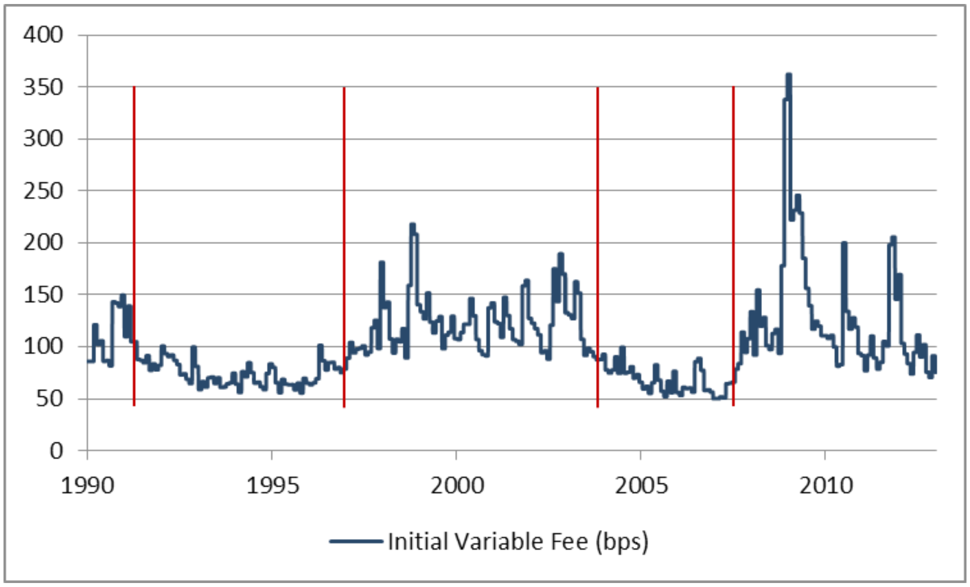
[4] Further in the paper, alternative liability calculations will be illustrated. These are not intended to represent any one particular reserving or capital regime, but rather, to provide additional insights into dynamics of the relationship of fee revenues and claim costs.

Figure 2: Variability of Proxy Liability



Looking at the standard deviation of the proxy liability, we see that this is significantly reduced under the variable fee structure compared to the fixed fee structure.

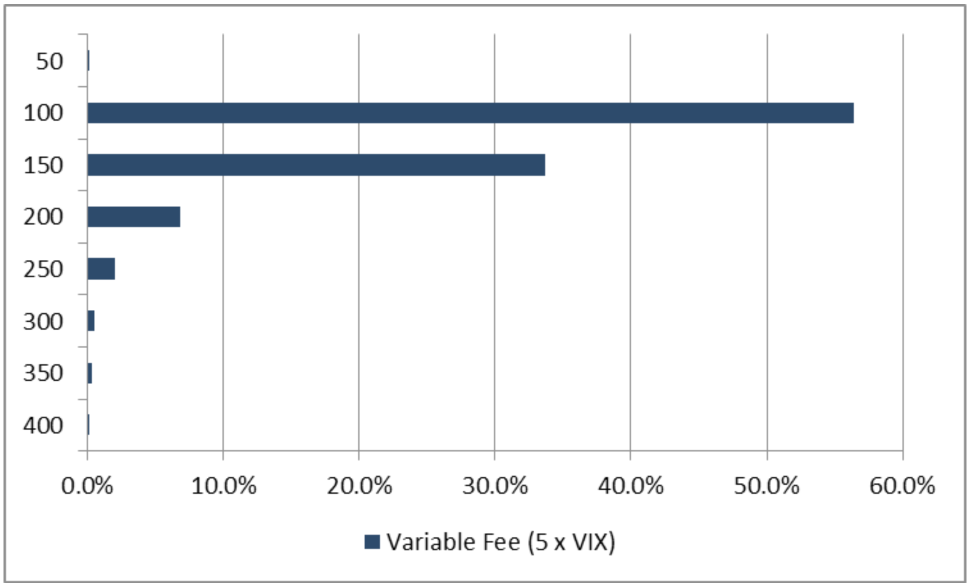
Figure 3: Variable Fee Level



The above chart shows the variable fee over the historical period being studied. We also observe two periods of sustained, low risk charges, which coincide with periods of stable and/or rising markets from mid-1991 through mid-1996, and again from 2004 through mid-2006. These are demarcated in the chart by the red bars. We also see that the fee appears to remain inside a range of 50 bps and 150 bps most of the study period, although it does push well above this range on several occasions, corresponding to periods of extremely high market volatility.

The chart below shows the relative frequency of the variable fee over the study period at 50bp thresholds.

Figure 4: Variable Fee Frequency by Threshold



From 1990 to 2012, the variable fee would have remained less than 150 bps 90% of the time. 99% of the time it would have been less than 250 bps.

For any given starting point, our future expected risk charges (which are based on forward volatility rates) will generally not vary as widely as the initial fee, due to the mean reversion in assumed future implied volatility. This means that the projected total fees over the lifetime of the product will generally be more stable than the initial fee.

In practice, not only is it quite possible to have large differences in total fees between the two approaches depending on the scenario, this is in the potential advantage of the variable fee structure: to have higher fees in those periods and scenarios where the guarantee and hedging costs are higher.

Stabilizing Effect on Product Pricing and Profitability Measures

Unlike a fixed fee structure, the VIX-linked fee structure can eliminate the need for product re-pricing to adjust risk charges due to changes in market volatility. In addition, because the initial fee is lower when volatility is low, the product will appear relatively less expensive when market risks and hedging costs for the insurer are lower, and conversely, appear relatively more expensive when the market risks and hedging costs for the insurer are higher.

In addition, when re-pricing under a fixed fee structure, the "required" risk charge is typically determined as being theoretically sufficient on average. In practice however, there is no assurance of sufficient risk charges over the lifetime of the product as the fee remains fixed while future volatility and hedging costs are not known with certainty. In addition, it may be cumbersome or time consuming to re-price frequently. Competitive considerations may also make this difficult. A variable fee can be thought of as an "embedded" re-pricing feature inside the product.

The following table summarizes average fees for the product under both fee structures over the study period:

Table 1: Summary of Fee Amounts

	Fixed Fee	Variable Fee
Fee (Level (in bps)	100 bps	5 * VIX
Average Annual Fee	$10.0 million	$10.2 million

We should underline that for this example, the variable fee was chosen to closely align overall with fees under the fixed fee approach. The average fee over the study period with the variable fee approach worked out to be slightly higher than, but within 2% of, the fixed fee approach.

Implications for Short-Dated Options Hedging Strategies

Due to the significant risks and costs of hedging with long dated options, many insurers instead employ a strategy using short dated options and variance swaps for hedging the liability Greeks such as gamma and Vega. One serious risk associated with using shorter dated instruments and rolling them, is that the ongoing cost of maintaining these positions can vary greatly over time. During market turmoil, the cost of short dated options hedges can increase significantly.

However, if fee income is tied to VIX, more cash may be available to fund these more expensive hedges, at the time it is most needed, as shown in the table below.

Table 2: Fee vs. Option Cost

VIX	5 x VIX	Monthly Fee	Cost of 90% 30-day Put Option
10	50	416,667	775
12	60	500,000	9,939
14	70	583,333	51,354
16	80	666,667	160,734
18	90	750,000	371,754
20	100	833,333	707,248
22	110	916,667	1,177,993
24	120	1,000,000	1,785,292
26	130	1,083,333	2,524,264
28	140	1,166,667	3,386,556
30	150	1,250,000	4,362,228

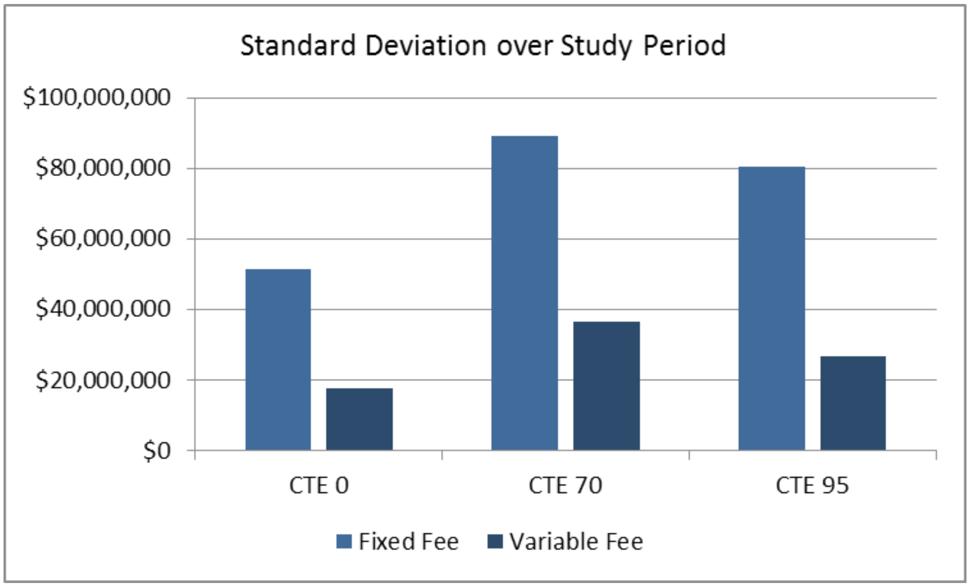
We can see that the increased cost of this semi-dynamic hedging strategy using put options is at least partially matched by the increased fee income that results from higher levels of VIX. Clearly, other formulas for the VIX-linked fee could be designed to even more closely align with the cost of an insurer's particular short-dated options hedging strategy.

Reserve and Capital Costs

In this section we examine the impact of a VIX-linked fee on the risk profile, especially in the tail, under various risk metrics. This should not be considered a formal pricing or valuation exercise or as intended for a specific reserve or capital regime. Rather, our objective is to explore and illustrate the alignment of fees and claims at various points in the risk distribution, and the impact of the variable fee approach under selected risk metrics.

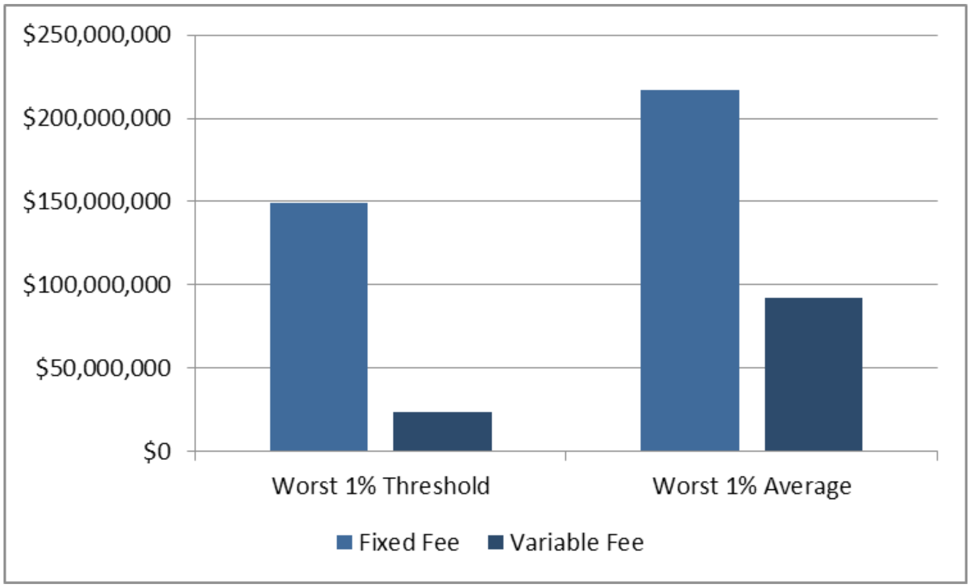
We first examine several liability measures, which are calculated as the value of fees minus claims at various CTE levels as at each date, under both fixed fee and variable fee approaches. The variability (standard deviation) in each of these liability measures over the study period is shown in the following chart:

Figure 5: Volatility of Liability Measures



We now look at the worst 1% of values for our (CTE 0) liability measure over the historical study period. The chart below shows the threshold value for the worst 1% of cases, as well as the average of the worst 1% of cases:

Figure 6: Worst 1% Historical Results



The above exhibits show that a significant reduction in volatility of fees minus claims continues to be evident as we move into the tail of the risk distribution. In addition, we observe a significant improvement in both the threshold and average of the worst 1% of days in the study period.

We should point out that the above results use the expected fee level to compare against the tail values for the GMxB claims. Clearly, a more in-depth analysis could be performed using a stochastic volatility model to examine in detail the behavior of fee levels in tail scenarios, and the impact on matching against the GMxB value. However, we would expect to observe the following:

(i) Better matching of fees and claims compared to using expected fees:

Volatility (and hence fees) would be expected to be higher-than-average in tail scenarios, improving the matching, further increasing the benefit from the variable fee approach (subject to any fee constraints, as described below)

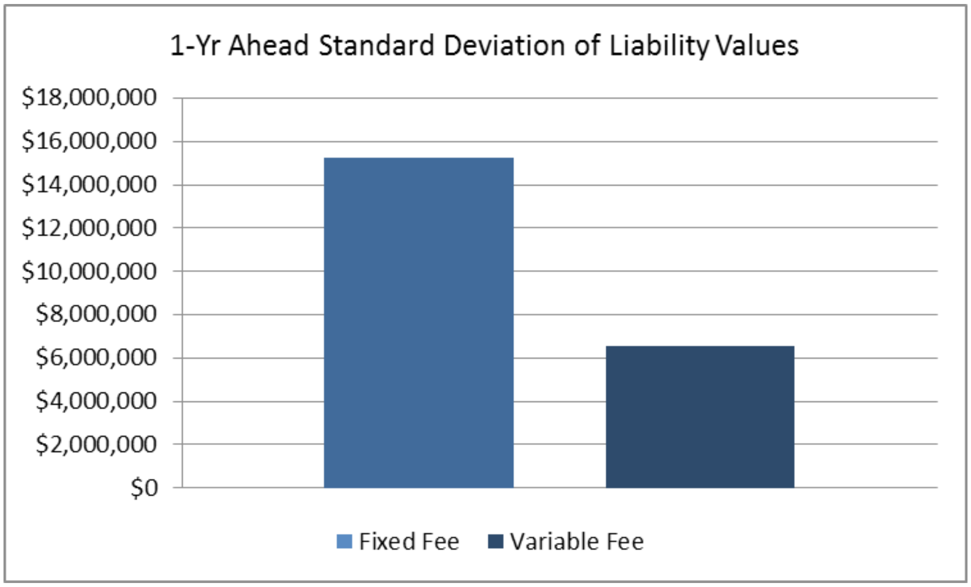
(ii) A larger impact from any constraints (specifically, caps) placed on the fee level:
A cap on the maximum fee level would be expected to apply more often in tail scenarios on average, due to higher expected volatility in those scenarios. Thus, constraining the fee level would be expected to have the greatest impact in the tail scenarios.

Stochastic Results

We now compare one-year-forward results for the two fee structures, using an illustrative set of real-world stochastic scenarios to project forward one year. Market-consistent liability values are then calculated at time one year. (For this analysis, we have assumed that a hedging program covering changes in interest rates and equity values is already in place.)

We first look at the variability in liability values after one year. The following chart shows the standard deviation of one-year-ahead liability values on a market-consistent basis, for each fee structure.

Figure 7: Variability of 1-Yr Liability Values

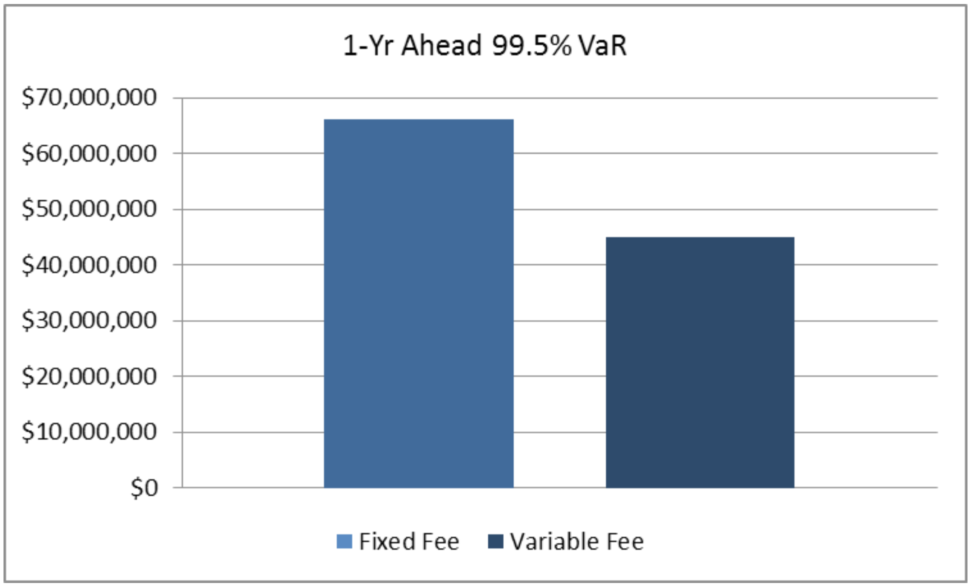


We can see a large reduction in the degree of uncertainty around the market-consistent value after one year, under the variable fee approach. This is consistent with what was observed in our historical testing results shown earlier in the paper.

For regulatory or account regimes that use market consistent measure for liabilities values, this can mean lower volatility in reserves.

We now look at liability values in the tail of the distribution, calculated after one year. The following chart shows the excess of the 99.5% VaR of one-year-ahead liability values above the time-zero liability value, on a market-consistent basis, for each fee structure.

Figure 8: 99.5% VaR for 1-Yr Liability Values



A significant reduction in the one-year-ahead VaR measure can be observed under the variable fee approach. This is consistent with the lower standard deviation we saw in the one-year-ahead liability values.

We expect that the level of VaR improvement could vary considerably, depending on:

- The nature and level of capital market hedging programs already in place
- How tightly the variable fee is constrained (maximum and minimum)
- Specific features of the product and guarantee
- Current moneyness of the guarantee

Policyholder behavior / lapsation

Our earlier analysis did not include any impacts from policyholder behavior such as dynamic lapsation. We now consider the interaction of the variable fee approach with a dynamic lapsation model.

To the extent that policyholders have less propensity to lapse when their guarantees are perceived as more valuable, this can have an adverse impact on the insurer due to more business persisting when the liability, capital requirements (and hedging costs) are higher due either to current market volatility, or account values having fallen closer to the guarantee level.

Implementation of a variable fee potentially mitigates the impact on the insurer in two respects. First, the higher expected fees in scenarios of high market volatility will offset some of the impact on liability, capital requirements and hedging costs that would otherwise be experienced. Secondly, the variable fee can alter the policyholder behavior and lapsation dynamics: the higher fees in adverse market conditions will increase the propensity of some policyholders to lapse than they would otherwise, and the lower fees in calm market conditions will decrease the propensity of some policyholders to lapse than with a higher fixed fee, even though the guarantee is perceived as less valuable.

Risk Management Advantages of a VIX-Linked Fee

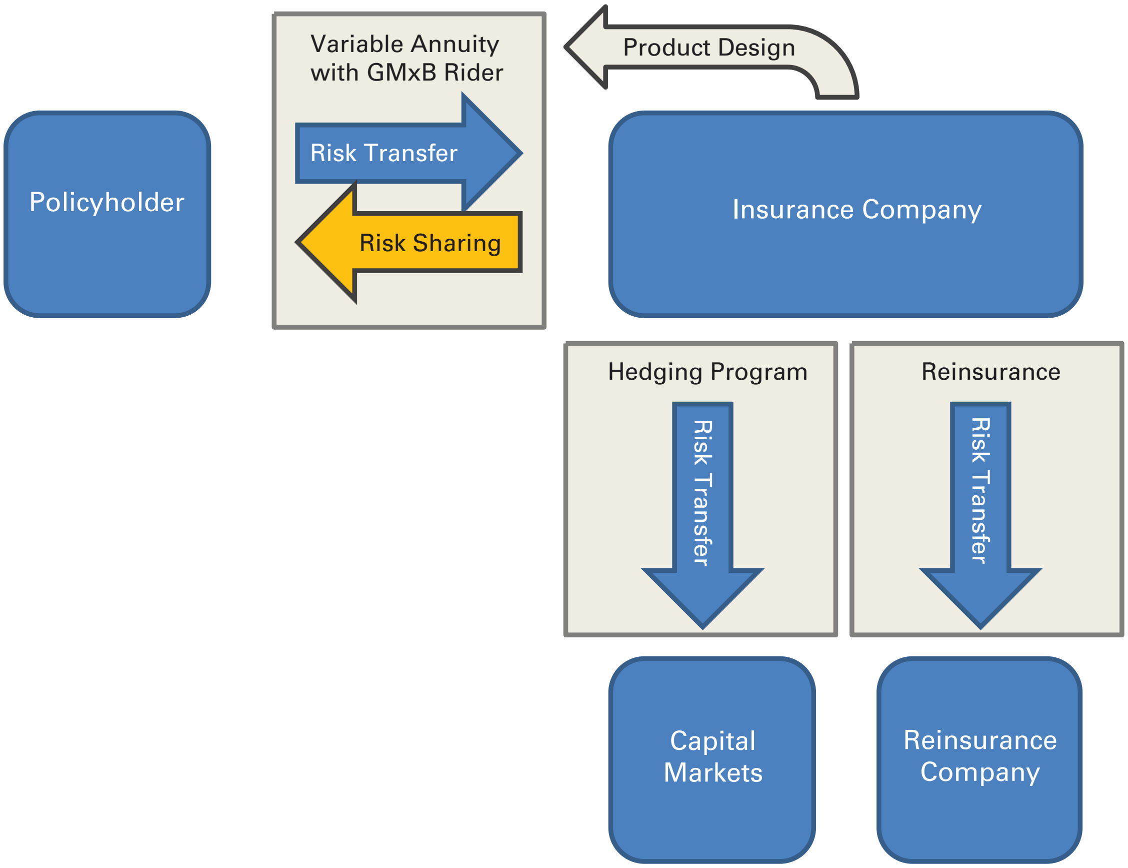
Recent economic and market events have led to insurers re-examining their approach to the variable annuity market and, in many cases, responding with aggressive changes to product design, pricing and management. These have included:

- Product re-pricing through higher risk charges
- Product de-risking through scaling back guarantee and benefit levels and product flexibility
- Reducing breadth of product offering, capping business volumes, or withdrawing from market entirely
- Implementing or enhancing capital market hedging programs

While such changes can impact expected profitability on future business, several challenges remain. Risk charges may be set to achieve a long-term target level of profitability after funding hedge costs and/or realized claims. However, even where a hedging program is in place, a high degree of uncertainty around future outcomes can remain: the long-term nature of many products and uncertain future policyholder behavior means fully hedging the guarantee at inception is not possible.

In addition, ongoing capital utilization and profit emergence will depend on reserve and capital requirements each year.

Role of Variable Fees in an Overall Risk Management Framework


Variable Annuity with GMxB Rider
Product Design
Policyholder
Risk Transfer
Risk Sharing
Insurance Company
Hedging Program
Reinsurance
Risk Transfer
Risk Transfer
Capital Markets
Reinsurance Company

The chart above illustrates several vehicles that have been used by insurance companies to manage their risk exposures, and which help determine the ultimate level of risk that is borne by the insurer on their variable annuity business. We very briefly describe these below, and discuss the usefulness of a VIX-linked fee as a risk sharing mechanism that can complement the role of the insurer as a risk intermediary:

Product Design: Risking and De-Risking

The nature of the risk transfer between the policyholder and insurer is largely determined at the time of product design. This includes constraints on the ability of the insurer to later transfer risk through hedging or reinsurance.

Product de-risking can involve both a reduction in the expected costs through scaling back of the level of future benefits, as well a reduction in the uncertainty (or risk) around those future benefit amounts.

Hedging Program

Hedging represents a transfer of product risk from the insurer to the capital markets. This may be comprised of a static, semi-static, or dynamic capital market hedging strategies.

Reinsurance

Reinsurance represents a transfer of risk from the carrier to another insurance company. We do not discuss reinsurance any further in this paper, other than to note that increased costs and reduced availability have made it a less competitive risk management solution than it may once have been.

Risk Sharing

Risk sharing in this framework represents a transfer of some risk from the insurance company to the policyholder. The nature of the risk sharing may be direct participation, where the policyholder assumes some portion of the same risk being transferred to the insurer, or it may involve the policyholder assuming risk in a different form, which is transferred from the insurance company. The variable fee is an example of the latter.

Risk Sharing / Risk Transformation Effect of Variable Fees

Implementation of a variable fee structure can allow sharing of some product risk to the policyholder, while still preserving the nature of the accumulation, withdrawal or income guarantees that have proved appealing to policyholders.

It can also help facilitate the insurer's own capital market hedging programs. Such programs arguably represent an extremely valuable role the insurer plays as financial intermediary, since it is well positioned to perform (or access) these services, relative to the individual investor. Thus, this risk sharing through the variable fee can be thought of as transforming the nature of the risk being assumed by the insurer via the guarantee – better supporting the assumption of this risk by the insurer – by helping to fund the transfer of this risk from the insurer to the capital markets over the life of the product. That is, there is a more direct linkage of hedging costs each year to the fees paid by the policyholder.

The advantage of this kind of risk sharing for policyholders is the opportunity to benefit from lower risk charges – and thus a less costly product – during periods of stability or growth.

The above represent an improved alignment of incentives between the insurer and the policyholder.

Aligning Costs and Perceived Value

The more benign environment in which these lower risk charges are possible may be the same ones in which policyholders perceive their guarantee as having the least value, either because market turmoil is not a recent memory, or because account growth has made the guarantees further out of the money.

Conversely, it may be in those environments of significant market turmoil and volatility, where the variable risk charges would be higher, that policyholders perceive their guarantee as having the greatest value – either because the possibility of market losses is a very present reality, or because their account value has fallen to such a degree that their guarantee is closer to, or even in, the money.

In addition, the initial fee effective at the time of sale may be much lower than typical fixed fees, if VIX is low. Of course, the impact of periods of higher VIX are also important to understand, and recent history provides some real-world stress tests. However, as mentioned above, these periods are those in which the guarantee may be perceived as most valuable by the policyholder.

Positive Vega Contribution

Another potential benefit of the VIX-linked fee is the positive Vega that is contributed to the portfolio by the fee stream, under this structure.

Implementation of a VIX-linked fee should not be considered a substitute for a more targeted Vega (volatility) hedging strategy. However the variable fee approach may, nonetheless, significantly improve the insurer's net Vega position under many scenarios, when compared to the fixed-fee product.

When assessing the impact on an insurer's net Vega position it is also important to consider the impact over time as the business ages, and as GMxB moves further away from or closer to the money; each of these can contribute to changes in the GMxB Vega from period to period.

Complement to Existing Hedging Programs

The VIX-linked fee can bring significant risk management benefits and dovetail with an existing hedging program to help match their costs. It should not be considered a replacement for hedging; rather, it should be viewed as a valuable complement to these programs, and an ingredient to an overall risk management program.

Conclusion

In this paper, we showed how tying variable annuity fees to VIX may benefit policyholders through lower fees in quiet rising markets, while benefitting carriers through by better matching fees and dynamic hedging costs, reducing the impact of implied volatility changes on reserve and capital costs, and enabling use of shorter dated hedging instruments with less impact from the tenor mismatch between assets and liabilities.

We explored VIX-linked fees as a powerful risk-sharing mechanism that can address many of the constraints faced by variable annuity carriers in their existing product designs and hedging programs, and we suggest that this type of risk sharing with policyholders can directly strength the carrier’s role as a financial intermediary.

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