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# Hedging Variable Annuity Guarantees With Long-Dated Equity Derivatives

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## Introduction

**C**ompetition for space in distribution channels has resulted in a proliferation of exotic options embedded in variable annuity (VA) products. This comes at a time when there is enhanced focus on risk management capabilities from external constituencies such as rating agencies and equity analysts, and internal constituencies such as senior executives and boards.

Meanwhile, the accounting and regulatory framework governing quarterly reporting to shareholders and reporting to regulators for solvency purposes continues to evolve. The NAIC looks set to pass the new risk-based capital (RBC) rules for VA guarantees (known as C-3 Phase II) effective for this year-end 2005, and is in the process of revising statutory reserving rules. In addition, interpretations of GAAP accounting rules for embedded guarantees continue to evolve as new product features are developed, and as capital markets for various hedging instruments become more liquid so as to increase the reliability of data available for GAAP mark-to-market calculations. This changing GAAP and regulatory environment has increased the focus on the need to manage capital efficiently and on certain drivers of GAAP earnings volatility.

Given these developments, insurers have added incentive to find more efficient ways to transfer their VA guarantee risks into the capital markets. “Best in class” insurance companies at the forefront of risk management have begun to approach hedging as an integral part of competing in a crowded marketplace by:

- Incorporating hedging strategy design into the product development and pricing process, to ensure that rider charges adequately cover hedging costs.
- Actively managing in-force blocks to reduce risk accumulations and to free up capital for future business.

In response to the demand driven by these developments, derivatives markets are offering a wider range of solutions to support insurance

company risk management efforts. The evolution of a relatively liquid long-dated derivatives market has changed the risk management toolkit available to insurance companies. This will enhance insurers’ capabilities to manage their risk and capital efficiently and to comfortably grow their books of business and innovate product design. The rapidly growing long-dated derivatives market and the implications for insurers are the focus of this article.

## Putting the Spotlight on Vega Risk

VA policies with living and/or death benefit riders include long-term options sold to policyholders for a rider fee. The value of these options is a function of (among other factors) equity market volatility, interest rates, rate volatility, policyholder behavior and some fixed time period or expected lifespan.

Prior to the bursting of the tech bubble in 2000, many VA riders were priced using assumptions very different from those used in the derivatives markets. In particular, equity scenarios often assumed an equity risk premium in the mean returns—based on historic equity market performance—and this resulted in rider fees considerably lower than those charged today for similar riders. Following the bursting of the bubble and the subsequent withdrawal of reinsurance capacity, hedging using capital markets instruments took over as the primary risk transfer mechanism for VA writers. Hand-in-hand with this development went a change in certain VA rider pricing practices to become consistent with those used in the derivatives markets in which companies were purchasing hedging instruments. Most notably, companies



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started using risk-neutral scenario sets with no equity risk premium.

However, some common pricing practices still incorporate a hybrid of market-consistent and historical market performance assumptions. One example of this is the term structure of equity market volatilities (i.e., the assumed width of the projected market distribution over time) used in pricing VA guarantees, where a variety of practices exists. One common approach to setting the term structure has been to use implied volatilities from the exchange-traded options market for short terms, and to grade to a long-term historic average volatility for long terms (of 10 years or more). This hybrid approach was developed several years ago, before the emergence of today's more liquid and transparent long-dated equity derivatives market—a development that is described more fully in the following section.

The pricing practice of using historic long-term market volatility assumptions can lead to rider fees that apply over long new business issue periods, regardless of changes in implied volatility over that time and hence, regardless of changes in the price of the derivative hedge. Thus in times of high volatility, the insurer may be writing long-dated options at significantly below their market-consistent value, and consequently, below the cost of hedging the guarantee. This could be considered to have a detrimental effect on shareholder value since, for taking on a similar amount of risk, the shareholder could have written a similar option at the higher fair market price.

By issuing options priced using historic long-term volatility assumptions, companies are selling long-term implied volatility in return for a rider fee based on historic volatility. A company that then wishes to delta hedge with futures would use that fee to pay for actual realized volatility over the life of the contract, including the cost of any market dislocations or “gaps.” Actual realized volatility may be significantly more or less than either implied volatility at the contract issue date or historic volatility used to the price rider fees. The important thing to note is

the exposure to these volatility and gap risks over a long time horizon if they are not hedged.

While a number of companies have established sound delta hedging programs, many companies have accumulated significant vega (or volatility) and gap exposures that may not be fully captured by risk metrics currently in use (such as marked-to-market values or the new C-3 Phase II RBC component), to the extent these metrics also rely on historic volatility assumptions. However, now that there is more reliable implied volatility data emerging from the long-dated equity derivatives market, this may change.

While there has been a trend toward more vega hedging in the past few years through the use of both variance swaps and long-dated options, it is still a sizeable exposure at many companies. It is likely that more comprehensive risk management practices will develop here as companies start to utilize implied volatilities from the long-dated derivatives market, and rely less on historic volatilities in both pricing and financial reporting.

A disciplined risk management practice would be to price riders using current market implied volatility (and other market) assumptions, and to use the rider fees to finance hedges priced using these same market assumptions. This may require flexibility for pricing riders for new business more frequently as a function of market parameters and/or other product development innovations to facilitate hedging at costs consistent with the rider fee. Another option may be to lock into volatility for new business issued over a certain period at the same rider fee, by possibly buying hedges in advance of sales (state investment and other laws permitting.)

### The Evolution of the Long-Dated Equity Derivatives Market

Over the past few years the market for long-dated derivatives (10 years and beyond) on equity indices has grown to unprecedented levels, driven partly by demand from the insurance sector. On the supply side, broker-dealers and hedge funds have become large and active players in this market.

Liquidity has improved in the inter-dealer market to the point where large amounts of long-dated equity derivatives trade frequently,



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enabling more efficient risk transfer amongst broker-dealers. Insurance companies will find considerable consistency in pricing across the market as a result of this development. In the past year alone, insurance companies have purchased notional amounts of long-dated equity derivatives totaling several billion dollars, and these volumes are growing rapidly.

All this means that a much deeper and more liquid market in long-dated equity derivatives now exists compared with the situation several years ago. The development of a liquid, transparent, inter-dealer market means that there is reliable data to support fair market values for these long-dated options that can be used both for insurer pricing of VA guarantees and for financial reporting mark-to-market calculations.

Figure 1 at the right shows three points on the term structure of implied volatility over the past three years. Implied volatilities are displayed for options struck at-the-money-forward with terms of one year, five years and 10 years.

Implied volatilities moved from highs of over 30 percent in the latter half of 2002 to less than 20 percent by August 2005. It is notable that this decline in implied volatility occurred in the face of rising VA hedging demand, and is an encouraging sign of the deeper liquidity and maturity of the long-dated derivatives market.

Implied volatility at every term varies over time, as does the relationship between long- and short-term implied volatility. It should be noted that in late 2002, when the S&P 500 index was at the 800 level, one-month implied volatility traded above 40 percent, while 10-year implied volatility only reached the high 20s. Principally, this differential represents expectations about future volatility—in 2002, market participants did not expect the high levels of market volatility to be sustained.

Conversely, in the recent low volatility environment, the implied volatility of options at longer terms relative to short terms suggests that market participants believe equity volatility will rise in the future. This partly explains the upward sloping term structure of implied volatilities over the past year.

Another factor not often considered when analyzing the term structure of implied volatility is

Figure 1: Term Structure of SPX (S&P500) Implied Volatility July 2002–August 2005



Source: Goldman Sachs Equities Division

the impact of interest rate volatility on the equity forward price. In recent years long-term interest rates have reacted to a stressed equity environment by falling as stock prices fall. The decline in the risk-free rate implied by bond prices rising causes equity forward prices to fall faster than their spot prices. This effect has been used to explain the somewhat steeper term structures of implied volatility in recent times. Whatever the magnitude of this effect, lower stock prices (poor asset performance) and lower interest rates generally represent the worst-case scenario for writers of VA guarantees.

Companies that delta hedge have, in the past, shown some reluctance to paying the extra premium between short- and long-dated implied volatilities (when the term structure is positively sloped) and locking into a known volatility cost upfront. In addition to companies taking certain views on the direction of future market volatility, this reluctance may also be partly due to not pricing in the full-implied volatility curve when rider fees were set. Rather, companies may have used historic volatilities at long terms and have expectations that, on average, historic volatilities will be realized over this period. Where the full-term structure of implied volatility has not been incorporated into the rider pricing process (including implied volatilities for terms of 10 years or more), it can become costly to hedge vega risk once the business is on the books.



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A final, and important, development in the long-dated derivatives market has been the growth in long-dated structures in addition to plain *vanilla* long-dated put options. Such structures may be tailored to better approximate the economics of various features of variable annuity guarantees such as ratchets, roll-ups and extended withdrawal periods. As the long, dated vanilla market has grown over the past few years, so too has the trading activity in these more exotic instruments.

### What Do These Market Developments Mean for Insurers?

Insurers have been writing long-dated equity derivatives embedded in variable annuity policies since the mid to late 1990s. However, only relatively recently has hedging activity by insurance companies become significant.

Hedging of variable annuity guarantees increased markedly after reinsurance capacity contracted following the bursting of the tech bubble and the end of the long bull market of the 1990s. Another key driver of hedging activity was the development of VA guarantees that are marked-to-market under GAAP accounting, particularly guaranteed withdrawal benefits, and their phenomenal growth since 2002.

Now that the long-dated derivatives market is more liquid, insurers have the opportunity to re-think their hedging programs. Companies may also conclude that they should be charging policyholders market prices for vega risk and for other market risks that might be mitigated through hedging with long-dated equity derivatives. In that case, newly priced rider fees should be made sufficient to cover the cost of hedging these market risks so that insurers can avoid accumulating volatility, gap and other market exposures on their own books. By laying off these risks to the capital markets, companies can focus more on managing actuarial and policyholder behavior risks.

The developments in the more structured long-dated derivative market, where simple equity puts are enhanced with features that better mimic the hedged guarantees, such as ratchets,

roll-ups and extended withdrawal periods, create more opportunities for product development and more effective risk management. Companies now have a more extensive suite of tools available to them during the product development process to price guarantees in light of the costs of hedging their major market exposures and to develop the hedging program hand-in-hand with product development.

### The View from Outside

Shareholders, analysts, regulators and rating agencies are increasingly focused on the risk exposures in variable annuity blocks and the types of hedging strategies companies are implementing to mitigate these risks. They are likely to respond favorably to a pricing and risk management framework that takes advantage of these developments in the long-dated equity derivatives market.

With the increased liquidity of the long-dated equity derivatives market, it is possible that GAAP accounting practices for marking-to-market VA guarantees classified as derivatives will shift to using implied volatility to the 10-year time point and beyond. With this development, vega hedging would mitigate the resulting GAAP earnings volatility.

In terms of credit for hedging from both an RBC and rating agency perspective, the case for capital relief can be much simpler to demonstrate for currently held long-dated derivatives whose payouts are well defined, than for hedges expected to be put on in the future under a dynamic hedging strategy. Furthermore, gap risk—the risk of being subject to discontinuities in times of market stress (as is more likely in the tail scenarios that drive capital needs)—is significantly reduced by entering into long-dated hedges prior to market distress. Long-dated derivatives can provide significant capital relief today, as well as protection against significant unexpected increases in required capital in the future.

Finally, utilization of some of the more exotic structures being traded over the counter should have a positive impact on required capital levels and rating agency views. Specially tailored derivatives that better match the economics of VA guarantees are more efficient (than vanilla options) in that you only pay for protection that more closely matches the exposure, and they

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tend to be much more effective in tail scenarios than plain vanilla options.

## Where to from Here?

Despite the growing use and benefits of long-dated equity derivatives, some insurers have been reluctant to enter this market. They often cite the following reasons for not trading larger volumes in this market:

1. Do not wish to pay the extra premium to hedge volatility and gap risk over a long period.
2. Fearful of over-hedging if lapses are higher than expected, or of mishedging if other policyholder behavior is different than expected.
3. Fearful of not being able to liquidate positions if hedge strategy changes.
4. To date, only the S&P 500 long-dated options market has significant depth, but insurers have significant amounts of underlying funds that are more closely correlated with other equity indices (e.g., NASDAQ, Russell 2000).

The first concern was discussed extensively in the prior sections of this article. Basically, this concern can be addressed through rider pricing practices that are more in line with derivatives market pricing so rider fees can cover the cost of locking into a fixed volatility over a long time period.

The primary market-related risk that any hedging strategy will have difficulty addressing is market-sensitive policyholder behavior. While long-dated derivatives are effective in mitigating other key market risks, their effectiveness as policyholder behavior deviates from expected will vary depending on their structure. Customized options can be designed to withstand a range of possible behaviors other than lapse and fund allocation changes. In contrast, unexpected lapse and fund allocation changes may require changing the notional amount of a hedge (increasing or decreasing). Another way to address these concerns may be to use a combination of core long-dated derivatives supplemented by dynamic hedging to provide added flexibility in responding to unexpected policyholder behavior.

Liquidity in long-dated equity derivatives is expected to continue as long as there is demand for

this product. In terms of liquidating more exotic options, transparency in pricing and structure, and ability to replicate with simpler instruments, combined with competitive pressures in the vanilla market, should help to alleviate insurers' concerns here.

As to the concern about indices, this can be addressed in a fashion similar to the concern about policyholder behavior. That is, companies can use core hedges that are S&P 500 based. Because the S&P 500 index is imperfectly correlated with other indices, the differences might be hedged through dynamic hedging with futures and shorter-dated options. In any case, as happened with S&P 500 derivatives, more liquid markets for long-dated options on other indices may develop in the future if demand persists.

As insurers become more comfortable with transacting in the long-dated equity derivatives markets, we expect to see hedging strategies incorporate a growing amount of long-dated derivatives, and increasing alignment between hedging strategy design and the product/rider development process. Such a change in product development, more aligned with derivatives market practices, still offers tremendous value to the consumer by providing them with access to exotic options generally unavailable elsewhere in the retail market. This change in practice also ensures that their insurance company can access the capital markets to distribute this risk more broadly, rather than accumulate significant portions on its own books. Regulators, ratings agencies and shareholders should be similarly pleased with this increased ability to distribute risk. ♦



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