SOCIETY OF ACTUARIES

Article from:

Risk Management

June 2009 – Issue 16

Basis Risk in Annuity Guarantees: Pricing and Enterprise Risk Implications

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BACKGROUND Sales of variable annuities have increased in recent years, due in part to the proliferation of aguarantee riders offered by insurers. Living benefit riders are now seen as a means to protect retirement income while preserving the goal of wealth accumulation well into the retirement years. Variable annuity sub-account offerings now include a lineup of commodity funds, actively managed funds and exchange-traded funds, as well as passively managed funds.

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Sales have also been enhanced by the variety of actively managed funds offered by reputable asset managers. These funds aim to provide superior returns—relative to a broad-based index—in return for higher management fees. Superior returns are typically achieved through leverage, or by overweighting or underweighting components of the index on a tactical basis. Active fund managers thus introduce tracking error relative to the benchmark index, in order to produce incremental returns.

Annuity insurers generally provide guarantees on the performance of variable annuity sub-accounts. These guarantees are typically priced under the implicit assumption that returns on the funds in which these sub-accounts are invested—including *actively managed* funds—can be completely explained by a basket of *passively* managed funds. This attribution does not reflect the risks and rewards associated with active management. Consequences of this approach can include mispricing of equity guarantees and hedge breakage, both of which can have a significant impact on the capital position of the underwriting company.

Insurers are now recognizing the impact of actively managed funds on the performance of their hedge programs and are mitigating this through product design. It is anticipated that passively managed funds will feature more prominently in variable annuities than they have in the recent past. Nevertheless, actively managed funds still occupy an important position in the average in-force variable annuity fund profile. The risk management of actively managed funds is thus still an important consideration.

We review a key method currently employed in risk-managing actively managed funds, highlight its benefits and shortcomings and propose a technique that preserves the benefits of the current method and incorporates the risks and rewards of active fund management.

THE STATUS QUO

Annuity carriers offer a wide variety of funds in variable annuities. The selection and approval of funds to be offered in a variable annuity involve conducting the appropriate due diligence on fund managers, assessing how the marginal decision meets the needs of a spectrum of risk appetites and tolerances and ensuring that fund operating expenses are reasonable.

From an insurer risk-management perspective, an important step in this process involves decomposing the returns of each fund to the returns from a combination of benchmark indices that completely explain the fund's systematic and idiosyncratic performance history. This decomposition is typically done through a linear regression that requires that the benchmark indices completely explain the systematic performance of the prospective fund. Benchmark indices are typically a set of passive indices of broad-based market performance. These include (but are not limited to) the S&P 500, the Russell 2000, the NASDAQ 100, the EAFE and the Lehman Aggregate Bond indices.

The functional form of this linear regression is given by

$$R = \alpha + \Sigma\beta_i r_i + e_i \quad ,$$

Such that $\Sigma\beta_i = 100\%$ and $\beta_i \geq 0$

Where

- R represents the returns of the actively managed fund under consideration
- α is the bias or incremental return achieved through active management
- β_i represents the factor or weight associated with benchmark index i
- r_i represents the return periodic return on benchmark index
- e_i is the error term

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Incremental returns (also known as "alpha") are generally non-zero for actively managed funds. This stems from the fact that these funds aim to beat the returns on broad-based passive benchmark indices through superior stock, sector and country selection. Active fund managers thus introduce tracking error relative to their benchmarks with the hope of earning marginally superior returns.

Alpha is generally ignored in the pricing, valuation and risk management of guarantees for various reasons. One is the widely held view that alpha converges to zero in the "long run." In the light of hedge program losses in the past year that were driven by differences between expected and actual fund performance, it is certainly more prudent to evaluate the impact of active fund management in the pricing of guarantees.

Furthermore, alpha could still be significant for funds that do not closely track a broad-based index in the long run.

Mapping funds to passive benchmark indices is a key step in pricing and hedging rider guarantees of fund performance in a variable annuity. To the extent that alpha is left unincorporated, pricing of equity guarantees is then done under the assumption that the underlying funds are all passively managed. Guarantees are thus likely to be mispriced. Any hedge positions set up to hedge market returns, convexity or volatility can be affected by this mischaracterization. The implications of not properly reflecting alpha in pricing warrant a review of potential remedies. One such remedy, and associated implications on pricing and economic capital, is reviewed next.

REFLECTING ACTIVE MANAGEMENT IN P RICING: THE REGIME ALPHA APPROACH

This approach involves determining expected alpha for each of two regimes: when historical fund returns are positive, and when historical fund returns are negative. Historical performance data for benchmarks and the fund under consideration are subdivided two categories: all returns for periods in which the active fund enjoys positive returns, and all returns for periods in which the active fund experiences negative returns. Linear regressions are performed on entire sample as well as the two categories. The alpha estimates derived from the subsample regressions are designated as regime alphas. These regime alphas are added (when appropriate) to risk-free rates employed in projecting risk-neutral return scenarios associated with the constituent benchmark indices. Factor weights for the benchmarks are derived from the regressions performed on the entire sample return data.

In addition to the enabling assumptions governing any linear regression method, the regime alpha approach—as described—assumes the following:

1) *Regime alphas represent incremental performance in both the real world and the risk-neutral world.* To the extent that alpha represents incremental returns achieved through management behavior in the real world, it can be argued that this incremental real-world return remains unchanged in a risk-neutral context. This assumption is crucial for risk-neutral pricing.

2) *Tracking error associated with active management has no material impact on benchmark index volatility assumptions employed in risk-neutral pricing.* This assumption is reasonable if the predictive power of the regression is sufficiently high. Highly predictive regressions demonstrate that volatility is driven by systematic influences that are well captured in the benchmark-index constituents.

3) *Benchmark factor weights, i.e., Betas obtained from the entire sample data do not vary by alpha regime.* To the extent that the data strongly suggests otherwise, adjustments will have to be made to pricing results. These adjustments are not considered here.

The primary rationale for the regime alpha approach lies in the fact that liabilities on guarantee riders are triggered by sustained, negative market performance. Biases in fund management that amplify negative benchmark-index performance should thus be analyzed and evaluated for materiality.

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Table 1: Regime Alpha Regression Results

	Entire Sample	Positive-Return Regime	Negative-Return
Months of data	77	47	30
A	0.15%	0.8%	-0.7%
ß S&P	73%	75%	56%
ß NASDAQ	21%	11%	24%
R-Squared	89%	82%	75%

Table 2: Assumptions for Illustrative Pricing Example

Product Features	
Underlying Fund	American Growth and Income Fund "R" Series
Death Benefit	Account Value
Total Expenses	2.15%
Market Assumptions	
Risk-free Rate	3% (all years)
Implied Volatility	S&P – 25% NASDAQ – 35%
Benchmark Indices and Weights	S&P 500 – 78% NASDAQ 100 – 22%
Regime Alphas	Positive regime – 10% annualized Negative regime – (8%) annualized
Benchmark Index Correlation	70%
Market Return Model	Geometric Brownian Motion
Option Pricing Model	Black-Scholes
Key Actuarial Assumptions	
Income Utilization Rate	100% of Lifetime Income Immediately
Lapse Rates	1, 2, 3, 4, 5, 6, 15, 10, 10, … 10
Mortality	100% of Annuity 2000 Table

Table 3: Pricing Results

Age	Baseline Case (bps)	With Regime Alpha (bps)	% Difference
60	150	170	13%
80	35	43	22%

APPLYING THE REGIME ALPHA APPROACH: AN ILLUSTRATIVE EXAMPLE

Monthly returns—over a seven-year period ending in December 2008—for the American Funds Growth and Income "R" series were obtained from a public Web site. This actively managed fund has a large cap value style, a bias for growth and may invest in bonds from time to time. Returns were thereafter grossed up for fund operating expenses. The fund's profile suggests that the S&P 500 and NASDAQ 100 are potential candidates for benchmark constituents. Comparable returns from these two indices were obtained from the same Web site. The results of the regression for all sample data and the two regimes—positive fund returns and negative fund returns—are shown in Table 1.

The analysis deserves a few comments. For the entire sample, alpha is generally positive. This apparently suggests that active management for the funds is a net benefit—before expenses—in the long run. However, a closer look at the regime alphas indicates that active management beat its constituent benchmarks in periods of positive returns but underperformed its constituents in periods of negative returns. This observation is consistent with anecdotal evidence of fund manager behavior in general. Factor weights also differed significantly between regimes, as evidenced by the increased weight of the NASDAQ 100 in the negative regime. This shift may explain the higher volatility of fund performance in periods of negative returns. Nonetheless, the overall predictive power of each regression remained within tolerable limits.

In order to apply the regime alphas in pricing, we illustrate using a hypothetical guaranteed minimum withdrawal benefit (GMWB) with an income guarantee of 5 percent for life for a 60-year-old and an 80-year-old. Pricing assumptions for this example are listed in Table 2.

From the results in Table 3, we can deduce that pricing for active-fund management could raise rider charges by 10 percent or more for a common growth and income fund. In addition, it should be noted that the severity of active management risks is a direct function of the expected

"Active management beat its constituent benchmarks in periods of positive returns but underperformed its constituents in periods of negative returns."

lifetime of the rider. This confirms that though alpha is less of an issue over the long run, it still remains an important consideration for pricing and capital management.

ECONOMIC CAPITAL IMPLICATIONS OF REGIME ALPHA APPROACH

U.S. regulatory capital guidelines for variable annuities recognize the impact of active fund management on risk-capital consumption. They effectively require that the methodology for mapping underlying funds to benchmarks meet certain calibration requirements, and that provision be made for hedge ineffectiveness due to alpha. However, the guidelines do not prescribe a specific method for quantifying active-management-driven basis risk. Employing the regime alpha approach can help in quantifying both regulatory and economic capital implications of active fund management. We illustrate its application with the hypothetical GMWB issued to the 60-year-old that was previously described. For purposes of this illustration, we assume that the internal economic capital methodology is the one-year value at risk (VAR) of net assets. We assume that a 50 percent market drop and a 15-percentage-point increase in implied volatility are equivalent to the 98th percentile of annual potential outcomes. The results are summarized in Table 4.

Table 4: Economic Capital Implications of Active Management

Item	One-year Value at Risk (% of Issue Premium)
Hedge Assets	22%
Liability (with Regime Alpha)	23%
Net Assets	(1%)

Hedge assets in Table 4 reflect a proxy liability value that ignores the impact of active management, while the liability value shown reflects the regime alpha method. Results show that the economic capital associated with active management could be in the order of $10 million for every $1 billion of newly issued business. At face value, the additional annual charge of 20bps—or $2 million per $1 billion of new business, derived earlier for the same GMWB—provides a meaningful return on the additional capital required for basis risk.

IMPLICATIONS OF ALPHA ON ENTERPRISE RISK MANAGEMENT

The preceding examples, however instructive, assume that only one fund is offered. In reality, a wide variety of funds—each with varying degrees of active management risk— are offered on a typical variably annuity. This does present the opportunity to diversify and reduce the impact of active management on risk-capital consumption, within the variable annuity product line. For example, the active management risk of the growth and income fund could perhaps be somewhat offset by the active management risk of a bond fund offered in the same portfolio. *Ceteris paribus*, the greater the diversity of active management styles, the lower the aggregate impact of active management on annuity-rider risk and rewards. Lowering the negative impact of active management increases the ability for an insurance carrier to compete in today's market for guarantees.

Achieving "capital-efficient" fund diversity within the annuity product line may be even more challenging from a sales and distribution perspective. Insurance carriers have complex relationships with both fund managers and annuity sales representatives. Funds that have the potential to bring about favorable active management diversity may have limited capacity to absorb annuity cash flow. Others may not have the brand name that can help generate sales. It is thus crucial to temper the benefits of fund diversification with the realities of distribution and other competing organizational constraints. The ability to reflect active management risks in pricing and risk capital will help in achieving much-needed balance.

Reflecting the impact of alpha on guarantee liability "greeks" could also be a viable approach. Employing the regime alpha approach could provide greeks that are reflective of active management biases, in the same manner that dynamic policyholder behavior also

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impacts liability greeks. This approach could have a modest impact on the existing model risks and should be considered carefully.

To the extent that active management amplifies the downside market risks associated with variable annuity guarantees, finding meaningful risk offsets in other life company product lines remains a challenge. Diversifying the existing fund lineup within the annuity line is still the next best alternative to imposing a marginal price for active management.

SUMMARY AND CONCLUSIONS

Actively managed funds feature prominently in most variable annuities today. It is expected that these funds will outperform their respective benchmarks over the long run, providing wins for both the customer and underwriting company. However, market performance—both in the long and short run—drives the lifetime (time till benefits commence) of rider guarantees. It is therefore important to evaluate the materiality of factors that amplify market performance. Active management "alpha" is a significant factor. We have shown that the regime alpha approach provides insight into the impact of alpha, through the segregation and regression of fund performance. For the actively managed fund that underlies the illustrations and examples, alpha has a significant impact on the price and associated capital requirements of a GMWB rider overlay.

The enterprise risk implications of alpha can be managed through fund diversification and hedging. Each management tool comes with its advantages and drawbacks. These approaches need to be considered carefully, in light of various competing organizational objectives.

The regime alpha method is not free of the risk that reality could diverge from what is modeled. Expected alphas may differ from actual alphas and require an additional level of performance attribution. Nevertheless, the regime alpha method represents a step forward in incorporating the realities of active fund management in the pricing, hedging and capital management of variable annuity guarantees. ✦