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Hedging Interest Rate Risk in Traditional Life and Health Products

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Profitability of traditional life and health products has long been considered less sensitive to changes in interest rates than profitability of universal life, SPDAs, or other “interest-sensitive” products. Consequently, traditional products have often been priced with a single deterministic interest scenario. Some type of sensitivity test is often reflected, but few companies price such products on a full stochastic basis.

Recently, Milliman completed a research project for the Society of Actuaries on “Interest Rate Hedging on Traditional Health and Life Products.” The results of this research are available on the SOA Web site at www.soa.org/files/pdf/rsrch-interest-rate-hedging.pdf.

In this article, we summarize our key observations and analysis. Interested readers are encouraged to review the report or contact the authors for further information.

Our analysis indicates that a pricing run of a hypothetical plain vanilla regular premium non-par whole life product over multiple stochastic interest rate scenarios can demonstrate far more profit volatility than one might expect, depending on the investment strategy employed. The distribution of the profitability has rather fat tails on both sides.

The table below shows the distribution of profits for our sample product, assuming that all assets are invested in cash and that there is no interest-sensitive policyholder behavior. Similar results were observed when we performed the same analysis on a typical long-term care product.

Statistical Measures of Profits		
	PV of Pre-Tax Book Profits	Profit Margin
Mean	\$ 670,385	10%
Standard deviation	\$ 435,070	6%
Minimum	(\$ 265,307)	-4%
Maximum	\$1,918,077	27%
Quartile 1	\$ 344,741	5%
Median	\$ 656,761	9%
Quartile 3	\$ 940,135	13%

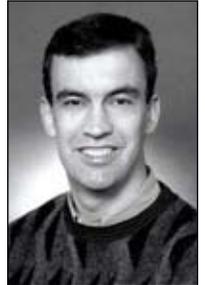
We believe that a good measure of interest sensitivity can help the user when judging how to hedge or manage the interest rate risk of the product. Perhaps the most widely used measure of interest sensitivity is duration, the measure of percentage change in asset or liability market value when interest rates move. However, our analysis shows that duration might send conflicting or confusing messages to the user when ongoing premiums are reflected in the analysis.

If regular premiums are netted from liability cash outflows in our sample, then the duration of the net liabilities is negative at policy inception, implying that assets with negative duration should be desired for asset liability management.

Alternatively, if regular premiums are moved to the asset side and calculated separately, the duration of both liability cash flows and premiums is positive, though the duration of the premiums is much shorter than the duration of the associated liability outflows. This implies that assets with very long positive durations should be desired for asset liability management. This apparently conflicting message makes it difficult to interpret the duration measure.

As an alternative, our research proposes using DV01. DV01 measures the dollar amount change in the value of assets/liabilities when interest rates move by one basis point. DV01 has two advantages over duration. First, it gives a consistent message, irrespective of whether premiums are deducted from liabilities or moved to the asset side. Second, it measures dollar amount change, which is exactly what matters from a hedging perspective.

The idea behind managing the DV01 of the insurance product is to find assets that offer the same amount of DV01 as the embedded liabilities of the insurance product. Our analysis shows that by simulating DV01 hedging, the change in market value of the surplus arising from the insurance product is almost eliminated when the interest yield curve



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changes by a small degree. DV01 hedging becomes less effective when the size of the change in the yield curve gets bigger or when the shape of the yield curve changes. This is not unexpected because DV01, by definition, works only when interest rates change by one basis point and when the entire yield curve shifts in parallel. While we did not address the convexity problem arising from the larger changes in the yield curve, we do suggest that one can compensate for the change in shape by analyzing dollar partial durations.

The table below summarizes the standard deviation of the market value of surplus across the multiple stochastic interest rate scenarios over the first six projection years for four different investment strategies.

- **Strategy 1:** All assets are assumed to be in cash account.
- **Strategy 2:** All assets are assumed to be in a representative mix of bonds and mortgages, with the objective of enhancing investment yields

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Cash only	\$289,131	\$506,341	\$618,574	\$737,305	\$769,614	\$832,017
Mixed pool of assets	\$280,666	\$469,804	\$565,504	\$655,525	\$676,842	\$713,500
DV01 hedge	\$ 36,320	\$ 47,968	\$ 59,993	\$ 78,516	\$ 98,992	\$115,122
Dollar partial duration hedge	\$ 11,152	\$ 25,110	\$ 41,266	\$ 60,690	\$ 48,460	\$ 51,930

Dollar partial durations measure dollar amount changes in the value of assets/liabilities when each of the selected term-to-maturity points on the yield curve changes in turn. In our analysis, we looked at two-year, five-year, 10-year, and 30-year dollar partial durations. When we modified our hedge simulation such that each of the four dollar partial durations was matched between assets and liabilities, the change in the market value of surplus was greatly reduced for scenarios when yield curves changed by a larger degree or when the shape of the yield curve changed.

rather than hedging.

- **Strategy 3:** Hedge assets are simulated to match DV01 of the liabilities.
- **Strategy 4:** Hedge assets are simulated to match the four dollar-partial durations of the liabilities.

This table clearly illustrates that the use of the DV01 hedge can greatly reduce the standard deviation of the market value of surplus across scenarios.

Apparently, traditional life and health products are indeed sensitive to changes in interest rates. With the DV01 or dollar partial duration measures we introduced in our paper, the user could manage the interest rate risk of the products on an economic basis. However, our analysis shows that the same management on an accounting basis would appear less effective because the statutory basis for reserves is currently not sensitive to interest rate changes. Nonetheless, we believe it is still vital for the industry to understand the interest rate risk of the traditional life and health products and consider the appropriate management measure of such risk. This is perhaps more critical as the industry moves toward principles-based accounting or fair value accounting. **δ**

