Basis Risk in Variable Annuity Separate Accounts

Wenchu Li [*1], Thorsten Moenig [†2], and Maciej Augustyniak [‡3]

[1]St. John's University.
[2]Temple University.
[3]University of Montreal.

Abstract

Variable annuity (VA) policies have become the largest category of liabilities for U.S. life insurers ([1]), now accounting for over $2.0 trillion in net assets. Many of these policies have complex long-term financial guarantees attached that expose insurers to large amount of systematic equity risk. Hedging this risk is paramount, but the effort is complicated by *basis risk*, i.e. the discrepancy between changes to the value of the guarantees in response to financial market movements and the returns of potential hedging instruments.

Prior studies have demonstrated that basis risk is significant at the individual fund/VA account level. For instance, in a comprehensive analysis of VA-underlying mutual funds, [2] find that—even under idealized conditions—at least 20% of the risk (standard deviation) embedded in the fund returns cannot be hedged away, no matter how sophisticated the hedging strategy. In practice, however, the typical insurer sells thousands of VA policies to different people, at different times, and with different underlying fund investments. The liabilities from the embedded financial guarantees are bundled together and hedged as a portfolio, i.e. at the insurer's separate account level.

In this study we show that basis risk can be effectively diversified at the separate account level. We develop a novel portfolio fund mapping strategy that simultaneously addresses the three primary challenges insurers face in practice: (i) reduce basis risk by producing a high-quality fund mapping; (ii) limit transaction costs incurred from rebalancing the fund mapping strategy; and (iii) keep the fund mapping tractable by using few instruments.

The fund mapping strategy proposed by [2] uses LASSO regression and is thus able to limit the number of mapping instruments for each mutual fund to between 5 and 20. However, the instruments differ considerably across funds. Applying this fund-level approach to a large portfolio would require hundreds of instruments at any given time. In addition, the strategy made no attempt to restrain transaction costs as it focused solely on achieving the best fund mapping for each period. However, the method of [2] serves as a good starting point for us, as it demonstrates the suitability of LASSO regression in the context of fund mapping.

[*]E-mail address: liw2@stjohns.edu
[†]E-mail address: moenig@temple.edu
[‡]E-mail address: maciej.augustyniak@umontreal.ca

Building on these insights, we use a two-step approach to identify the fund mapping strategy in month t: we first preselect instruments using the *sure independence screening* (SIS) procedure to identify the instruments that correlate most with the historical returns of the VA portfolio over the prior months; we combine these instruments with the instruments used in the fund mapping of the prior month $(t-1)$ into a set S_t. In the second step we use LASSO regression over the reduced instrument set S_t, but with the important adjustment that we estimate the *changes* in the fund mapping strategy, relative to month $t-1$. Hereby we make use of the LASSO penalty term to discourage non-zero "betas" (i.e., deviations in the instrument allocation from the prior month), unless the benefit of a marginal change outweighs the LASSO penalty threshold. This reduces transaction costs while still aiming to maximize fund mapping efficiency.

To document the real-world effectiveness of our proposed approach, we conduct an empirical study of two U.S. VA providers: a market leader and a minor player, respectively. We use historical monthly returns of the companies' VA-underlying mutual funds from October 2008 to December 2021, with 625 ETFs serving as potential mapping instruments. For the market leader with its 386 unique funds, we find that our approach can lower basis risk to 7.8%—which corresponds to a 0.997 correlation between the VA asset portfolio return and instrument return—while requiring investment in only 9 ETFs on average across our sample period, with a monthly turnover ratio of (only) 2.0%. The smaller firm (with 80 unique funds) requires 12 ETFs on average, with a 5.0% turnover ratio, in order to achieve a 10.7% basis risk level (correlation coefficient 0.994). This demonstrates the benefit of diversification in this context.

We conclude that basis risk can be much less of a concern to VA providers than previously suggested. We present a practical method that helps insurers mitigate basis risk effectively and improve the quality of their VA hedging.

Keywords: Variable annuities; hedging; basis risk.

Acknowledgements: Hopefully I will be able to thank the participants at the 2024 Samos Conference for their helpful comments and suggestions!

References

[1] Koijen, Ralph; Yogo, Motohiro (2022), "The Fragility of Market Risk Insurance." *The Journal of Finance* 77 (2), 815-862.

[2] Li, Wenchu; Moenig, Thorsten; Augustyniak, Maciej (2023), "Improving Fund Mapping: an Application to Variable Annuities. " *Working paper*.