Hedging and immunization of longevity risk

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Increasing life expectancy rates are extending the liability profiles of annuity income providers. However, the challenge of devising asset allocation strategies to fund these liabilities is complicated by a lack of appropriate assets. This thesis demonstrates portfolio management strategies to address this challenge.

Longevity risk is a significant issue for annuity providers and pension fund managers. Specifically, they face major challenges in managing their long-dated liabilities and longevity risks, due to a lack of appropriate assets in the form of long-dated and suitable longevity bonds.

This thesis investigates immunisation strategies for longevity risk hedging from the perspective of a fund manager and annuity provider. The thesis contributes new insights and methods for the immunisation of annuity portfolios against both interest rate and mortality risks. Methods for effectively selecting optimal assets to hedge both risks are proposed and assessed, using coupon bonds, annuity bonds and longevity bonds.

A comparison of delta-gamma and duration-convexity hedging concludes that, to hedge against both interest rate and mortality risks, delta-gamma hedging requires both longevity bonds and fixed-income securities. A risk analysis to identify the optimal asset allocation for these risks demonstrates the benefits of deferred-longevity bonds. These results provide guidance to market participants and regulators regarding the design of longevity-bonds for portfolio immunisation.

To the best of our knowledge, this thesis is the first to investigate a large number of asset alternatives for immunising portfolios against both interest rate and mortality risk. For the purposes of the study, it is assumed that the risk underwriter's liability consists of whole-life annuities issued to Australian males aged 65 in 2014. It is further assumed that the assets held to cover these liabilities consist of fixed-income securities and longevity bonds.

The study finds that, to effectively hedge against both interest rate and mortality risks, consideration should be given to using delta-gamma hedging with longevity bonds and fixed-income securities. The hedge performance of longevity bonds can be optimised when incorporating both deferred- and immediate-longevity bonds.

This research contributes several extensions to the current literature on portfolio immunisation against mortality risk. Specifically, it adds to, among others, Tsai and Chung (2013), Lin and Tsai (2013), and Luciano et al (2012), in several aspects:

- Incorporation of fixed-income securities and longevity-linked securities to respectively manage interest rate and mortality risk.
- Development of a number of linear programming methods to optimise the portfolio's asset allocation strategy in terms of the number of assets to be held. The number of assets considered in previous research

was limited to the number of equations available for matching surplus, delta and gamma (or duration and convexity).
- Comparison of delta-gamma hedging with duration-convexity hedging under stochastic models for managing both interest rate and mortality risks.
- Examination of static hedging against mortality and interest rate risks simultaneously.
- Provision of suggestions for the future design of longevity bonds.

This thesis provides an assessment of the immunisation strategy for the hedging of longevity risk. It helps annuity providers formulate a better understanding of the different types of hedging methods available for managing both interest rate and mortality risk in the presence of longevity risk.