

# Longevity Swap Pricing through Dynamic Stochastic Programming

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Longevity represents an increasingly important risk for *defined benefit* (DB) pension plans and annuity providers, because life expectancy is dramatically increasing in developed countries. The sponsors of DB pension plans are exposed to the risk that unexpected improvements in the survival rates of pensioners will increase the cost of pension provisions. Longevity swaps are hedging instruments whereby two parties, typically a reinsurer or investment bank on one side, and a pension fund or annuity provider on the other side, agree to exchange fixed payments against variable payments, as in other swaps. The hedge provider is typically the investment bank or re-insurer, that pays variable payments based on the scheme's actual mortality rates, or on a reference mortality index, and receives fixed payments based on agreed mortality assumptions, whereas the hedge buyer is the pension fund or annuity provider, that pays fixed and receives variable payments [1]. We propose a *multistage stochastic programming* (MSP) approach to price longevity swap derivatives, i.e. find the contract fixed rate, on a risk measure based replication framework. In the proposed methodology, the current pension fund liability market value is firstly estimated: given an asset universe of tradable and liquid securities and an investment horizon with discrete rebalancing portfolio periods, we look for the least expensive trading strategy to replicate the pension fund future obligations. The present cost of such portfolio, under self-financing conditions, will provide the current liability value. The pay-off structure of the longevity swap is then inserted in the MSP model, where the contract variable rates will be given by a discrete stochastic mortality model, and the fixed rate of the contract will be set as a variable. In this case, we seek for the least expensive trading strategy, and the least fixed contract rate, which ensure the minimal improvement in the current liability value. This fixed rate will be the price of the longevity swap. This procedure has been used to price different aged-related longevity swaps.

## References

- [1] Biffis, E., Blake, D.: Mortality-linked securities and derivatives. Discussion Paper PI-0901. The Pensions Institute, Case Business School, City University, U.K., 2009.