SOCIETY OF ACTUARIES

LIVING to 100
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Mortality and Longevity

Aging and Retirement

2020 Living to 100 Discussant Comments
1A: Management of Longevity Risk

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Discussant Comments Session 1A: Management of Longevity Risk

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Both papers are results of careful thoughts using advanced statistical modelling to estimate uncertainty surrounding longevity risks of pension and annuity funds and to propose mathematical framework to hedge longevity risks through the capital market.

A Value-Based Longevity Index for Hedging Retirement Income Portfolios *– Kevin Krahe; Jonathan Ziveyi, Ph.D.; Michael Sherris, FSA, FIAA, FIA;* Andrés M. Villegas*, Ph.D., UNSW Australia*

Jonathan Ziveyi and co-workers have contributed to the literature in 3 ways:

Firstly, they have constructed a value-based longevity index, enabling stochastic forecasting of both longevity and real interest rates of retirement income portfolios.

- The longevity component of the model uses the multi-factor joint affine term structure model (ATSM). It aims to model the mortality intensities of the 'reference' and 'book' populations. The model contains the following features that are potentially useful for financial instruments to hedge longevity risks:
    - It allows for differences in mortality in the 2 populations. This is an important feature because the mortality rates of annuitants are usually lower than that of the population.
    - It considers potential differences in changes in mortality in the populations. This is a useful feature, as we know that some sub-populations, such as from different socio-economic circumstances, may have different mortality trends. It addresses some of the concerns of 'bases risks' of using a reference population index to hedge annuitants. However, I expect the industry to be interested to know how we should parameterize this component that allows for differences in mortality **trends** between book and reference populations.
    - It considers a potential common factor for changes in mortality in the populations. Again, the parameterization and forecasting of this component will need to be acceptable to the industry.
    - It allows for stochasticity for mortality trends, enabling estimates of uncertainties in mortality trends.
- The authors have incorporated a framework for stochastic projections of real interest rates to enable calculations of present values of retirement income for portfolios. This framework allows calculations to estimate the effectiveness of longevity hedging through a series of assumptions, allowing for fluctuations in mortality trends, nominal or real interest rates.

Secondly, the authors have used the value-based index to demonstrate that uncertainty around the present value of retirement income of a portfolio can be reduced progressively through the hedging of longevity, interest rates and inflation rates. The authors have also illustrated some aspects of basis risk quantification, particularly the risk relating to 'randomness' due to small portfolio, by showing that the greater the book size the larger the percentage reduction in variance after hedging. **However, the paper has not discussed the part of basis risk that concerns the industry most, namely the risk that the 'book' population may have a different trend from that of the 'reference' population.** I look forward to further discussions on this area.

Finally, the authors have compared results from the continuous-time ATSM model with discreet-time M7-M5, concluding that the hedge results are not sensitive to mortality models and whether time is modelled continuously or discreetly.

This paper has introduced more sophistication and thoughts into constructing a value-based longevity index as a building block, hoping to accelerate the establishment of a liquid market for trading longevity-linked instruments. However, a liquid longevity market is not yet a reality despite much effort from competent organizations over the last decade. There are many barriers to be overcome before the proposed framework propos is used widely including:

- Longevity hedging through the capital market needs to meet the objectives of longevity risk management of pension funds, life insurance and reinsurers.
- The cost of longevity hedging needs to be competitive with existing solutions of risk management including buy-out, buy-in and reinsurance.
- The methods and results of hedge effectiveness have to be acceptable to regulators.
- The risks and limitations of hedging needs to be understood and acceptable by pension funds and insurers.
- Technical issues such as continuity of mortality data for indices or methodology must be articulated to and risks accepted by the industry.

Quantification and Management of Longevity Risk in China – Johnny Li, FSA, ACIA, Ph.D., University of Melbourne; Kenneth Q Zhou, ASA, ACIA, Ph.D. Arizona State University; Wai-Sum Chan, FSA, CERA, Ph.D., The Chinese University of Hong Kong

Kenneth Zhou and co-workers have proposed that the capital market could help to absorb the growing longevity risks in China, for example the RMB 3 trillion (USD 420 billion) asset related to public pension in 2013 and RMB 200 billion (USD 28 billion) total private pension asset in 2006.

This paper has contributed to literature in the following ways:

- It addresses the challenge of inconsistent and missing population and mortality data in China. For example, population and mortality data are available for 1981, 1989, 2000 and 2010. But 1% of sample data are available for 1986, 1995 and 2005. Data for higher ages such as 85 or 89 are unavailable depending on calendar years. Consequently, there is a need construct estimates historical death rates by addressing the problems posed by missing population and death historical data.
- The authors imputed parameters for mortality models to derive mortality rates and uncertainty around the parameters with a Bayesian statistical method.
- This allows the authors to parameterize stochastic mortality models for the purposes of projection.
- The model can be used to estimate longevity risks, taking account of mortality trends, trend-related parameter and other errors. The authors proposed that the model be used to calculate the minimum capital requirement (MCR) as required by regulations in China.
- The authors proposed a mathematically framework for longevity hedging, based on the stochastic model above.
- The results suggest that index-based longevity hedging could reduce the regulatory capital requirement by about 90%.

The paper has provided a mathematical framework to illustrate the potential benefits index-based hedging for longevity risks. I look forward to further debates and refinement of this framework to contribute to academic literature and practical longevity risk management in China. However, the industry needs to understand more about

China's historical mortality trends and current practice of longevity risk management before a widespread use of Index-based longevity hedging. Examples include:

- We need to know about historical mortality trends in China at the population and sub-population levels, such as pensioners, city/village, socio-economic circumstances etc. For example, what is the consensus average annual rate of improvement in mortality in the last decade? 2%? 4%?
- A consensus of data and methods to be used to understand historical trends.
- Better understanding and acceptance of the method of imputing mortality rates described here.
- A better articulation of future mortality projections by the industry, so that insurers in China can assess mortality projection proposed in this paper. For examples the UK has 'Principal', 'Low' and 'High' mortality improvement projections. Actuaries in the UK also use the CMI mortality projection models as a means of communication and benchmarking future mortality projections.
- A better understanding of current MCR of insurers, so that the industry can compare with the MCR proposed in this paper.
- The cost and practicality of other longevity risk management such as in-house management or reinsurance.

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