Special Issue "Ageing Population Risks"

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An ageing population is a major challenge for every country in the world arising from the declining fertility rate and increasing life expectancy. A longevity risk (the adverse outcome of people living longer than expected) exacerbated by declining equity returns coupled with the record low interest rate environments has significant implications for societies and manifests as a systematic risk for providers of retirement income products. The aim of this special issue is to highlight advances in quantitative modelling of risks related to ageing population problems. We received an enthusiastic response to the call for research papers and are proud of the special issue now being published. This special issue contains seven research papers.

One paper by Marcos Escobar, Mikhail Krayzler, Franz Ramsauer, David Saunders, and Rudi Zagst (Escobar et al. 2016) presents the pricing of variable annuities with guaranteed minimum repayments at maturity and in the case of policyholder death using a closed form approximation. All important risk factors (risky investment asset, interest rate, mortality intensity, and policyholder surrender behaviour) are modelled under an affine linear stochastic framework. The presented pricing framework can be easily implemented, which is important for applications in practice.

There are four papers studying and developing advanced stochastic mortality models.

The paper by Syazreen Shair, Sachi Purcal, and Nick Parr (Shair et al. 2017) evaluates the forecasting accuracy of two recently-developed coherent mortality models (the Poisson common factor and the product-ratio functional models) designed to forecast the mortality of two or more subpopulations simultaneously. The models are applied to age-gender-specific mortality data for Australia and Malaysia and age-gender-ethnicity-specific data for Malaysia, and the results show that coherent models are consistently more accurate than independent models for forecasting sub-populations' mortality.

The paper by Yuan Gao and Han Lin Shang (Gao and Shang 2017) develops a model for the forecasting of mortality rates in multiple populations that combines mortality forecasting and functional data analysis. The model relies on functional principal component analysis for dimension reduction and a vector error correction model to jointly forecast mortality rates in multiple populations. The usefulness of this model is demonstrated through a series of simulation studies and applications to the age-and sex-specific mortality rates in Switzerland and the Czech Republic.

The paper by Jonas Hirz, Uwe Schmock, and Pavel Shevchenko (Hirz et al. 2017) introduces an additive stochastic mortality model which allows joint modelling and forecasting of underlying death causes. The model takes its roots from the extended version of the credit risk model CreditRisk+ that allows exact risk aggregation via an efficient numerically stable Panjer recursion algorithm and provides numerous applications in credit, life insurance, and annuity portfolios to derive profit and loss distributions. Many examples, including an application to partial internal models under Solvency II, using Austrian and Australian data are shown.

The paper by Dorota Toczydlowska, Gareth Peters, Man Chung Fung, and Pavel Shevchenko (Toczydlowska et al. 2017) develops a multi-factor extension of the family of Lee-Carter stochastic mortality models to include exogenous observable demographic features that can be used as additional factors to improve model fit and forecasting accuracy. They develop a dimension reduction robust

feature extraction framework amenable to different structures of demographic data. A detailed case study on the Human Mortality Database demographic data from European countries is performed, where the extracted features are used to better explain the term structure of mortality in the UK over time for male and female populations.

Two papers consider optimal decisions in retirement under the expected utility maximisation models solved as optimal stochastic control problems.

The paper by Jinhui Zhang, Sachi Purcal, and Jiaqin Wei (Zhang et al. 2017) considers the financial planning for a retiree wishing to enter a retirement village. The date of entry is determined by the retiree's utility and bequest maximisation problem within the context of uncertain future health states. In addition, the retiree must choose optimal consumption, investment, bequest, and purchase of insurance products prior to full annuitisation on entry to the retirement village.

The paper by Johan Andréasson and Pavel Shevchenko (Andréasson and Shevchenko 2017) considers the impact of recent changes to the Australian means-tested Age Pension policies. They examine the implications of the new changes in regard to the optimal decisions of a retiree for consumption, investment, and housing. The policy changes are considered under a utility-maximising lifecycle model solved as an optimal stochastic control problem.

All papers appearing in this special issue went through a refereeing process subject to the usual high standards of *Risks*. We would like to thank all of the authors for their excellent contributions and all of the referees for thorough and timely reviews. We hope that this special issue will help to stimulate advanced quantitative modelling, both theoretical and applied in the area of ageing population problems.

Conflicts of Interest: The author declares no conflicts of interest.

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