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Editorial

Special Issue "Interplay between Financial and Actuarial Mathematics"

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The Special Issue aims to highlight the interaction between actuarial and financial mathematics, which, due to the recent low interest rates and implications of COVID-19, requires an interlace between actuarial and financial methods, along with control theory, machine learning, mortality models, option pricing, hedging, unit-linked contracts and drawdown analysis, among others. Emerging insurance products involve financial instruments and vice versa, which confirms this needed interaction/interplay. For instance, financial models of mortality/longevity are further used to price insurance products Henshaw et al. (2020), or the discussion of interest rates is used in unit-linked insurance policies Baños et al. (2020).

We have invited research on actuarial problems involving financial instruments, stochastic optimal control in insurance, and innovative risk measures featuring both actuarial and financial elements. To close the Issue, we are proud to have attracted high-quality articles at the interface between actuarial and financial applications. Moreover, the methods featured in the Special Issue are of interest for both academia and practice, and provide new perspectives on topical problems.

The first paper by Henshaw et al.(2020), features broken-heart syndrome as a form of short-term dependence, within joint mortality modelling. A stochastic mortality model of the joint mortality of paired lives and the causal relation between their death times is presented for a less economically developed country, where the paired mortality intensities are assumed to be non-mean-reverting Cox–Ingersoll–Ross processes, reflecting the reduced concentration of the initial loss impact that is apparent in the dataset. The effect of the death on the mortality intensity of the surviving spouse is given by a mean-reverting Ornstein–Uhlenbeck process, which captures the subsiding nature of the mortality increase characteristic of broken-heart syndrome. The appropriate premium, considering the dependence between coupled lives through application of the indifference pricing principle, is derived for life insurance products.

Rudolph and Schmock (2020), use a generalisation of the collective risk model and of Panjer's recursion to describe the problem of risk aggregation in insurance mathematics and financial risk management. The considered model consists of several business lines with dependent claim numbers, where the distributions of the claim numbers are assumed to be Poisson mixture distributions. The claim causes have dependence structures of a stochastic, non-negative, linear nature, which may produce negative correlations between the claim causes. Panjer's recursion can be applied by finding an appropriate equivalent representation of the claim numbers. The consideration of risk groups includes the dependence between claim sizes and, when compounding the claim causes by common distributions, Panjer's recursion remains applicable.

Baños et al. (2020) provide another example of the interaction between actuarial and financial mathematics. One of the risks of selling long-term policies in every (insurance) company arises from the random development of interest rates. This paper considers a general class of stochastic volatility models, written in forward variance form, and deals

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with stochastic interest rates to obtain the risk-free price for unit-linked life insurance contracts. The classical Black–Scholes model is compared to the Heston stochastic volatility model with Vasicek-modelled interest rates. In addition, a perfect hedging strategy is obtained by completing the market. An example uses Norwegian mortality rates to illustrate the obtained results.

Bondi et al. (2020) look at one of the classical financial problems—the option pricing. However, they compare two different methods: calibration with an entropic penalty term and valuation by the Esscher measure. The Esscher measure—derived from the Esscher transform—is widely used in actuarial sciences, for instance, as an insurance premium calculation principle. Bondi et al. show that the Esscher measure method slightly underperforms regarding the calibration method in terms of absolute values of the percentage difference between real and model prices, and it could be the only feasible choice if there are not many liquidly traded derivatives in the market.

Falden and Nyegaard (2021) consider retrospective reserves and bonus, within the setup of with-profit life insurance, and study the projection of balances with and without policyholder behaviour. This projection resides in a system of differential equations of the savings account and the surplus, and the policyholder behaviour options of surrender and conversion to free-policy are included. In a concrete scenario, the derivation of accurate differential equations allows for an approximation method that can be used to project the savings account and the surplus, including general policyholder behaviour. The results have immediate practical applications.

Brinker (2021), considers an insurance company that is allowed to invest in stocks with a price following a geometric Brownian motion—a classical model in financial mathematics. Using stochastic optimal control methods, one searches for the investment strategy minimising the expected time when the surplus' absolute difference to its running maximum exceeds some given level.
It was found that the optimal investment strategy is given by a piecewise monotone and continuously differentiable function of the current drawdown—the distance of the running maximum and the current state of the process.

Özen and Şahin (2021), construct a two-population mortality model to measure and assess longevity basis risk. This is necessary for finding an effective hedge against the basis risk when transferring the longevity risk to the capital markets. The mismatches between the liability of the hedger and the hedging instrument cause this longevity basis risk. The authors use different two-population models to investigate the impact of sampling risk on the index-based hedge, as well as to analyse the risk reduction regarding hedge effectiveness.

Ampountolas et al. (2021), tackle the lack of recorded credit history in micro-lending markets. This significant impediment to assessing individual borrowers' creditworthiness is further reflected in the difficulty of setting fair interest rates. Comparing various machine learning algorithms on a real micro-lending dataset, off-the-shelf multi-class classifiers such as random forest algorithms are identified to perform very well by simply using readily available data on customers (such as age, occupation, and location). The method has great potential to be used in practice, as it presents inexpensive and reliable means for micro-lending institutions, especially in the developing world, where people may not have credit history or central credit databases.

Eisenberg et al. (2021), considers the necessity of capital injections and reinsurance for a company's financial stability. If an (insurance) company writes red numbers, the shareholders have to provide money to shift the company's surplus to zero. The question arises of whether the expected value of these payments, discounted to time zero, can be minimised by purchasing reinsurance. The authors develop a recursive approach to find the optimal reinsurance strategy in the presence of Markov switching—describing the changing reinsurance prices on the market.

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