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DISCUSSION ON RECENT PAPERS

Discussion on "Exchangeable mortality projection" (Shapovalov et al.)

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The Solvency II regulation specifies three main sources of risk related to longevity and mortality. Those should be taken into account in the derivation of the so-called solvency capital requirement, reflecting an adverse 99.5% deviation over 1 year. The sub-risks defined relate to level, trend and volatility. Those take various forms in practice in so-called internal models, where the taxonomy can also differ. Making the analogy with non-life risks, especially in the field of reserving, one can find decompositions such as process error, i.e. the pure stochastic component of the modelling, and estimation error, i.e. the uncertainty in the parameter estimates.

Under the IFRS 17 Standard, the so-called risk adjustment aims to capture the uncertainty in future cash flows related to insurance risks. The Standard specifies a number of requirements on the method used to calculate the risk adjustment, including the fact that the approach should provide a higher risk adjustment if "less is known about the current estimate and its trend […]", and a lower risk adjustment as "emerging experience reduces uncertainty […]". Those requirements do echo the concept of estimation error in risk modelling, where the probability distribution outcome depends on the certainty on the estimates and the richness of the historical data.

Those frameworks (process and estimation errors) for the quantification of longevity and mortality risks remind us that not only the stochastic nature of the mortality model contains risk (process error), but also that the parameters themselves are only estimators and may fluctuate (estimation error). This means that, as the model complexity or inadequacy increases, and the data sample richness decreases, parameter estimates do reflect a higher variance, i.e. are less reliable.

Process error in the modelling of mortality and longevity risks has been the focus of an extensive literature. In comparison, the quantification of estimation error has less been tackled. Studies related to the quantification of estimation error do relate to frequentist or Bayesian approaches. The advantage of the Bayesian point of view in

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this context is to achieve a joint quantification of both process and estimation errors in a coherent framework.

Czado et al. [1] led the way to such a quantification in the context of a Lee-Carter model. In the present paper, Shapovalov et al. provide an extension of this original work in two directions, namely capturing the joint dynamics of multiple populations, and allowing exchangeability between parameters of different populations, following the theory developed by Gill [2]. Exchangeability can be seen as a more general form of the traditional assumption of “independent and identically distributed” random variables.

Shapovalov et al. (2021) apply the theory of exchangeability to the parameters driving the mortality dynamics of the different population groups. This framework is used to build a hierarchical model where the distribution of the population-specific parameters depends on a common hyper-parameter (itself stochastic). In this setting, the paper develops the posterior distributions of the model parameters. The virtue of the approach can be seen, as the overall modelling is unified: in particular, the time series inference is included in the overall model, as opposed to the traditional frequentist approach to stochastic mortality modelling; also, the inference process is based on a balance between population-specific information and the joint knowledge from all populations.

In the past literature, the use of multi-population models may have appeared challenging in some instances, in particular when one assesses the obtained accuracy in comparison to classical single-population models. This could be partly due to the fact that the multi-population is imposing an additional structure on the behavior of the two or more countries, which therefore results into more constraints in the forecast. To counterbalance the effect, the relevance of the specification of the multi-population model combined with the additional population mortality information must add value to the overall prediction power.

The authors demonstrate that the forecasting accuracy can benefit from the exchangeability assumption between populations in comparison to the standard Bayesian single-population approach. Such a result is interesting for practitioners as it reminds us that the problem of mortality and longevity risks quantification for a given population can take advantage of including information on other population groups or countries. In doing so, the modeler is able to improve forecasts or alternatively reduce risk, as opposed to considering single population models solely.

Recalling that the Bayesian approach allows to quantify both process and estimation errors coherently, the method proposed in the present paper appears as a promising toolbox for the quantification of mortality and longevity risks. As shown by the Solvency II and IFRS 17 requirements, this quantification is of specific importance to financial measurement and disclosure of long term insurance risks, by taking into account parameter uncertainty while leveraging wider information on other populations.

There are a number of open challenges related to the modelling of multiple populations, including how the country groups are designed. The present paper advocates to rely on statistical criteria to derive population pairing strategies as opposed to linking populations based on similar characteristics (e.g. demographic or economic). This is to us an interesting idea, expanding the scope of possible data that can be leveraged, which would need to be further explored to propose a systematic method to grouping multiple populations.

The COVID-19 crisis has shown how difficult it is to anticipate mortality deviations in general and reminds us that the quantification of mortality and longevity risks remain a challenging task. As another example, the long term mortality impact of climate-related risks is, by nature, uncertain. Regulatory scrutiny is increasing towards the proper quantification of those risks in view of further improving the awareness and stability of the insurance sector. This leaves the way for leveraging the information embedded in the joint evolution of population mortality worldwide for better risk assessment and forecasting.

References

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