Estimation, Comparison and Projection of Multi-factor Age-Cohort Affine Mortality Models

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Abstract

Affine mortality models, developed in continuous time, are well suited to longevity risk applications including pricing and capital management. A major advantage of this mortality modelling approach is the availability of closed-form cohort survival curves, consistent with the assumed time dynamics of mortality rates. We make new contributions to the estimation of multi-factor continuous-time affine models including the canonical Blackburn-Sherris, the AFNS and the CIR mortality models. We discuss and address numerical issues with model estimation. We apply the estimation methods to age-cohort mortality data from five different countries, providing insights into the dynamics of mortality rates and the fitting performance of the models. We show how the use of maximum likelihood with the univariate Kalman filter turns out to be faster and more robust compared to traditional estimation methods which heavily use large matrix multiplication and inversion. We present graphical and numerical goodness-of-fit results, and assess model robustness. We project cohort survival curves and assess the out-of-sample performance of the models for the five countries. We show that across these countries, although the CIR mortality model fits the historical mortality data well, particularly at older ages, the canonical AFNS affine mortality models provide better out-of-sample performance. We also show how these affine mortality models are robust with respect to the set of age-cohort data used for parameter estimation.

Keywords: Longevity Risk, Kalman filter, State-space models, Affine mortality models

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