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Projecting mortality rates by a Markov chain

Abstract

In this paper, we present a mortality projection model where future stochastic changes in mortality are driven by a hierarchical Markov chain. The model is inspired by the one discussed by Norberg (2013) except that, rather than involving specific causes of death which may diminish over time, we look at mortality in aggregate terms. In our Markov model, there are several 'Alive' states and a jump to the next state leads to a change in mortality. For fixed values of the transition intensities from one 'Alive' state to the next, the successive factors of mortality change are estimated using a criterion of minimum weighted average quadratic distance between observed mortality rates and expected mortality rates. A two-step estimation procedure is used, and a closed-form solution for the optimal estimates of these factors is derived in the first step, which means that the model can be parameterized very fast and efficiently. For each country, generation effects are assessed by fitting the model for different generations. In order to forecast mortality rates, the change factors are extrapolated using the chain ladder technique. This also permits the estimation of key mortality indices like complete expectation of life and annuity values.

Keywords: stochastic mortality, forecasting, Markov chain, generation effects

References:

Norberg, R. (2013). Optimal hedging of demographic risk in life insurance. Finance and Stochastics 17(1), 197-222.