Longevity Risk and Regular Discount Sequence

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Abstract

Life expectancy for males and females in many countries has been increased significantly since the turn of the 20th century. The elderly are expected to have the largest mortality improvements in the future, and the study of elderly mortality has received a lot of attention recently. However, because there were not enough elderly data before 1990, it is still unknown whether there is a reliable (stochastic) mortality law that can solve the problem of longevity risk.

In this study, we adapt the idea of regular discount sequence in the bandit problem, and use it to interpret life expectancy, as well as to develop a model for survival probabilities. We found that many frequently used mortality models, such as the Gompertz law and the Coale-Kisker model, and famous mortality assumption (uniform distribution of death, constant force and hyperbolic assumption) all satisfy the requirement of regular discount sequence. It seems that the discount sequence provides another possibility for the mortality models.

We conducted an empirical analysis for the data from the Human Mortality Database, including Japan, the United States, England and Wales, Sweden, France and Taiwan, and found that the discount sequences of life expectancy and mortality ratio do satisfy the regularity condition. In addition, we use the Brownian motion stochastic differential equation to model the discount sequence to predict the future mortality rates and life expectancy. The simulation study shows some promising results. We expect the proposed approach can provide a possibility for predicting mortality rates for the elderly.

In insurance product pricing, Taiwan insurance companies at present use the Taiwan Standard Ordinary Experience Mortality Table of the static approach in calculating the traditional insurance expenses. This causes overestimating the insurance expense for life insurance products and underestimating the risk of annuity products. We apply our proposed model, with Monte Carlo simulation, to build the mortality confidence interval to evaluate if the current practice adequacy in insurance companies. In addition, we also explore if there is an overestimate or underestimate premium in different insurance products or possible natural hedging strategy.

Key Words: Bandit Problem, Brownian Motion, Longevity Risk, Monte Carlo Simulation, Mortality Improvement