Mortality Compression and Its Impact on Managing Longevity Risk

Sharon S. Yang[1], Jack C. Yue[2], and Pei-Wen Hsieh[3]

Abstract

Due to the advance in medical technology and the change of life style, the human life expectancy has been increasing since the end of the World War II and it is expected to continue the pace of increment. Longer life expectancy implies a longer life after retirement. People living in the 21st century are facing a growing demand for the retirement life, such as the pension funds and medical needs to the individuals, as well as the social welfare and insurance for the elderly to the government. However, longevity risk also bring a great challenge for the pension provider and the government because the uncertainty of lifespan. Thus, the issue whether the lifespan has a limit receives a lot of attentions. In particular, many studies focus on the topic of mortality compression, which means that the expectancy of lifespan has a limit and the variance of lifespan converges. Due to the availability of elderly data, there is still no consensus if the mortality compression is true.

In this study, we attempt to investigate the impact of mortality compression on managing longevity risk. For such purpose, the first part of this research is to use statistical methods to evaluate the mortality compression (or the convergence of variance), with the consideration of data quality. Instead of applying the nonparametric methods used in the previous studies, such as the shortest confidence interval for the distribution of age-at-death and of the modal age, we propose the

[1] Professor, Department of Finance, National Central University, Taiwan. Corresponding author, email: syang@ncu.edu.tw
[2] Professor, Department of Statistics, National Chengchi University, Taiwan.
[3] Master, Department of Risk management and Insurance, National Chengchi University, Taiwan.

optimization methods to estimate modal age and variance of the age-at-death. Three approaches are conducted to examine mortality compression: weighted least squares (WLS) method, nonlinear maximization (NM) method, and maximum likelihood estimation (MLE) method. For a robust check, we compare these three approaches with the method proposed by Kannisto(2000), namely SD(M+). In addition, to consider the issue of data quality, we compare the estimation results of using mortality rates from life table data (i.e., graduated mortality rates) with those using the raw data. The distribution of Human longevity appears negatively skewed, especially when the mortality compression exists. Thus, the second part of this research is to model the effect of negative skewness of lifespan in managing longevity risk. To capture the mortality compression, we adopt a normal distribution whose scale parameter is conditioned on attained age and compare the result with the normality and t distribution assumption to the age-at-death

We first use simulations to evaluate the proposed methods. According to the mortality data from Human Mortality Database, we find that the proposed method can provide reliable estimates of life expectancy and its variance, and the NM method has the smallest MSE. Moreover, the NM and WLS methods can provide stable estimates even when the age-at-death is recorded in integer and only certain age groups of data are given.

Regarding the data quality, the proposed method produces almost identical estimates for either the raw data or the life table data. Still, since the estimates from the raw data are slightly smoother and are not influenced by the life table construction methods, we would suggest using the raw data in practice. To investigate the effect of mortality compression, we also compute the pure premiums for annuity products under various assumptions on the distribution of lifespans. We find that normality distribution would produce larger premiums than using the empirical mortality rates.

Similarity, the bankruptcy probability would be higher if the t distribution is used. Finally, the effect of mortality compression on longevity-linked securities is examined. The existing literature in managing longevity risk doesn't consider the mortality compression. This research investigates the important phenomenon of mortality compression in human mortality and gives a great insight of mortality compression in managing longevity risk.

Keywords: Mortality Compression; Rectangularization of Survival Curve; Distribution of age-at-death; Age-last-birthday; Optimization.