

Multi-Country Mortality Modeling and Hedging Longevity Risk Using a Panel Approach

Sharon S. Yang¹, Jr-Wei Huang², Wen-Yen Hsu³

Abstract

Managing mortality risk or longevity risk for life insurance companies is increasingly critical. The start of the twenty-first century has witnessed the emergence of the Life Market, the traded market in assets and liabilities linked to longevity and mortality. Blake et al. (2012) point out that mortality indices and mortality forecasting are two most important factors regarding the development of longevity/mortality linked securities. As the lesson learned from issuing EIB longevity bond, the single mortality benchmark of EIB bond is considered to be inadequate to create an effective hedge. Thus, the construction of a multi-country mortality index is essential for designing a mortality-linked security to hedge against longevity/mortality risk in life market.

The underlying mortality index for the mortality-linked securities plays an important role in increasing the hedge effectiveness. The mortality index for the existing securities usually depends on a combined mortality index constituting the population mortality rates across countries except for the EIB bond. Blake et al.(2012) point out that this single mortality benchmark of EIB bond is considered to be inadequate to create an effective hedge. The basis risk in the bond was considered to be too great and the EIB bond had not generated sufficient demand to be launched and was finally withdrawal. Coughlan et al. (2011) mention

¹ National Central University, Email: syang@ncu.edu.tw.

² National Central University. Email: jrwei Huang@cc.ncu.edu.tw

³ Feng Chia University, Email: wyhsu@fcu.edu.tw, Corresponding Author.

that basis risk is an important consideration because the longevity experience of the index longevity risk with instruments based on hedged exposure may differ from that of the linked mortality index. Thus, to increase the hedge effectiveness, we can't ignore the basis risk in designing the mortality-linked securities.

Dealing basis risk has become an important issue in developing the capital market solution for transferring mortality risk in recent years. Most of the existing literature work on the measurement of basis risk, see Cairns et al. (2011), Coughlan et al. (2011), Dowd et al. (2011) and Li and Hardy (2011). The other work investigates how population basis risk can affect the price of a mortality-linked security, see Zhou et al.(2012), Yang et al.(2013), Yang and Huang (2015) and Wang et al. (2015). Yang et al.(2013) investigates the long-run equilibrium of mortality rates and introduces mortality correlations across countries as a means for pricing a multi-country longevity bond. Wang et al.(2015) introduce mortality dependence in multi-country mortality modeling using a dynamic copula approach and build a valuation framework for pricing a survivor index swap.

The multi-country mortality correlation has a significant impact on the appropriate pricing of a longevity bond; that is, it is problematic to ignore mortality dependence across countries. Therefore, understanding these relationships of mortality rates across countries is important issue. The above literature has addressed the importance of mortality modeling across countries. However, mortality data in many countries consists of only annual available data with short durations. Campbell and Perron (1991) point out that using the traditional time-series approach with short-duration dataset may weaken the power of unit root, co-integration, and causality tests, such that the results are distorted. Perron (1991) confirms the significance of individual data set duration for the power of the co-integration test. To overcome such problems, Al-Iriani (2006) suggests that adopting the panel techniques, in relation to the unit root, co-integration, and causality tests, could eliminate the problems associated with the low power of traditional tests. Yang and Huang (2015) further detect the

causality and long-run equilibrium relationships of mortality rates across countries using a panel co-integration approach and also point out that the panel approach is more robust in dealing with the limited mortality data set. Yang and Wang (2013) have been using traditional co-integration to examine the long-run relationships with mortality rates but they ignore the problem of short duration in mortality data. To avoid the distorted results, we extend the existing literature that uses the traditional time series analysis on mortality rates and further employ the panel approach to model the mortality rates across countries.

With the data from the Human Mortality Database, we first demonstrate with the mortality rates in France, England, the United States, Italy, and Switzerland based on the Swiss Re mortality bond. We find that the mortality rates in these countries appear to be non-stationary and exhibit a panel co-integration effect. These appear long-run relationship of mortality rates across countries. Our empirical results provide clear support of bi-directional forms of both short-run causality and long-run causality in the five countries except France and England does not short-run causality to Switzerland. However, such effects are inconsistent detected by traditional co-integration approach. Thus, we utilize the panel approach in mortality forecast, extending Yang and Wang (2013). To the best of our knowledge, no prior literature has used panel approach in multi-country mortality rate modeling and forecast. This article contributes to the mortality literature in three ways. First, we provide a methodology to detect the relationships of mortality rate across countries. Second, we further take into account the mortality relationship to forecast the mortality using a newly proposed panel approach. Finally, the proposed approach can help to construct the mortality index underlying the mortality-linked securities for hedging longevity risk and we also demonstrate the pricing of a multi-country longevity bond.

Keywords: Panel approach, Mortality correlation, Mortality Forecasting, Longevity risk