Optimal Hedging Strategy for Catastrophic Mortality Risk Considering Life settlements

Sharon S. Yang

Professor, Department of Finance,

National Central University, Taiwan.

E-mail: syang@ncu.edu.tw.

Hong-Chih Huang*

Professor, Department of Risk Management & Insurance,

National Cheng-Chi University, Taiwan.

E-mail: jerry2@nccu.edu.tw, *Corresponding author

Jin-Kuo Jung

Actuarial Specialist,

PCA Life, Taiwan.

Abstract

Mortality uncertainty is the primary source of risk for life insurers and annuity providers. Two opposing forms of mortality uncertainty are longevity risk and mortality risk. The insurer suffers longevity risk for its annuity products if future mortality improves relative to current expectations, because it must pay annuity benefits longer than expected. If mortality deteriorates or a catastrophic event occurs, the situation reverses: Insurers face mortality risk for their life insurance products, because the insurance benefits paid out are higher than expected. Therefore, efficient mortality risk management is an increasingly important concern for insurers.

Recent researchers have found the significant mortality improvement globally. Some pandemic diseases and catastrophic natural disaster also frequently cause mortality rate to rise unexpectedly. In order to transfer the catastrophic mortality risk, the insurance companies are seeking alternative hedging strategies. Securitization of mortality has been explored in recent years. Blake et al. (2008) comment that the traditional insurance route for managing this risk is capacity constrained, leaving the capital markets to provide an effective solution. The Swiss Reinsurance Company, the world's second-largest reinsurance company, first issued a three-year catastrophic mortality bond in 2003 (Vita Capital I), with face amount of $400 million in coverage from institutional investors. The second bond (Vita Capital II) was issued in 2008. Both mortality securities aim to transfer mortality risk away from the insurer, using a combined mortality index that measures annual population mortality in five countries and applies predetermined weights to each nation's publicly reported mortality data. Vita Capital I used the annual population mortality rates for France, England, the United States, Italy, and Switzerland; Vita Capital instead relied on annual population mortality rates for the United States, United Kingdom, Canada, and Germany. Swiss

Re also has obtained US$200 million in coverage against North Atlantic hurricane and UK extreme mortality risk through its new Mythen Re program, introduced in 2012. This issuance is comprised of two tranches of note. The US$120 million Class A notes, rated B+ by S&P, combine PCS North Atlantic hurricane risk with UK extreme mortality risks. The second tranche, rated B- by S&P, provides US$80 million in protection for North Atlantic hurricane risk. This bond represents the first time that hurricane and mortality risks have been combined in a bond offering.

Different to the securitization, natural hedging is regarded as the internal hedging strategy that the insurer can hedge longevity/mortality risks with their own business products between life insurance and annuity because these two types of products are sensitive in opposing ways to the changes in mortality rates. In recent year, due to the trend of mortality improvement, natural hedging has been studied to deal with longevity risk for the insurer with greater annuity business. For example, Cox and Lin (2007) find the empirical evidence that annuity writing insurers who have more balanced business in life and annuity risks tend to charge lower premiums than otherwise similar insurers and indicates that insurers who have a natural hedge have a competitive advantage. Wang et al.(2010) investigate the natural hedging strategy to deal with longevity risks for life insurance companies and propose an immunization model to investigate the natural hedging strategy by calculating the optimal life insurance–annuity product mix ratio to hedge against longevity risks. Tsai et al.(2010) further use a conditional Value at Risk to investigate the natural hedging strategy. Wang et al. (2013) propose a natural hedging model that can account for both the variance and mispricing effects of longevity risk at the same time.

When insurance company has more life insurance contracts than annuities in the liability, it will suffer the exposure of mortality risk. For the insurer with greater catastrophic mortality risk, the use of natural hedging cannot eliminate the mortality

risk and there is a need for seeking the external hedging instrument. To date, to the best of our knowledge, fewer studies have addressed the use of natural hedging and the external hedging instrument to deal with catastrophic mortality risk. Thus, this study attempts to propose a hedging framework that the insurer can hedge catastrophic mortality risk not only internally but also externally by incorporating the hedging instrument. We consider the life settlement as the hedging instrument. Life settlement(senior life settlement) is a transaction that individuals aged 65 or above can sell their insurance policy to the investors in the secondary market. The investor is responsible for paying the premium of this policy and has the right to get the insurance benefit when the insured is dead. The life settlement market is growing because the investors can obtain a relatively low volatility asset which is uncorrelated to the financial asset in the capital market. Due to the payoff of life settlement is positive related to the mortality rate, it can be regarded as a hedging vehicle against the mortality risk for insurance company.

To find the optimal hedging strategy for catastrophic mortality risk, we build the objective function according to the insurer's profit function. The profit function is constituted with the insurer's business and the hedging instrument. Thus, the pricing of life settlement and insurance contracts is dealt respectively in this study. Extending from the immunization theory, the insurer attempts to stabilize its profit in response to the mortality risk. We apply Taylor expansion on the profit function to measure the impact of mortality risk and derive the closed-form solution for the optimal hedging strategy. We compare a variety of hedging strategies such as minimizing mean variance, value at risk and conditional tail expectation. The hedging effective of different hedging strategies is examined.

In addition, we take into account basis risk in calculating the hedging strategy to avoid the mismatch problem. Instead of using population mortality, we adopt a unique

mortality data set of annuity and life insurance policies that enable us to calibrate the multi-population mortality dynamics for different lines of insurance policies under the Yang and Wang (2013)'s multi-population model and calculate their liabilities in the profit function. The basis risk is examined empirically and the optimal hedging strategy is calculated in the numerical analysis. Numerical analysis finds that life settlement can serve as an effective hedging instrument against mortality risk. Thus, we demonstrate that combining natural hedging and life settlement can reduce the catastrophic mortality risk and help the insurer to manage catastrophic mortality risk better.

The contributions of this research are fourfold. First, this paper first builds a catastrophic mortality hedging framework for the insurer that utilizes both natural and external hedging strategy using life settlements. Second, this paper considers the basis risk in finding the optimal hedging strategy. We employ Yang and Wang (2013)'s multi-population mortality framework and obtain the optimal hedging strategy analytically according the insurer's profit function. Third, we deal with basis risk using a real mortality data from life insurance industry. We can model the mortality dynamics for different lines of business. Fourth, the optimal hedging strategy is derived analytically, which can benefit the insurer to deal with mortality risk more efficiently.

Keywords: Natural Hedging; Catastrophic Mortality Risk; Life Settlements