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Does mortality improvement increase equity risk premiums? A risk perception perspective

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ABSTRACT

Using data for G7 countries over the period from 1950 to 2007, this paper finds that an unexpected shock to the mortality rate is significantly negatively correlated with the equity premium. A one basis point unexpected negative shock to the mortality rate increases both the one-year and five-year equity premiums by 0.54% and 1.66%, respectively. We also demonstrate how financial institutions could use our findings to hedge the risk of mortality-linked securities.

1. Introduction

It has been widely-recognized both in the literature and in the insurance industry that mortality rates have improved and are continuing to improve all over the world. For example, Oeppen and Vaupel (2002) found that life expectancy in the United States is increasing by 2.43 years each decade.[3] The trend toward mortality improvement has attracted the interest of many researchers who have analyzed various related issues.[4] One of the important issues concerns the impact on the equity risk premium.

The literature has asserted that mortality improvement is correlated with the equity risk premium from a demographic structural change point of view. Researchers argue that the change in the participants' age structure reflects the change in the degree of risk aversion and investment needs in the life cycle, and will cause price fluctuations in the capital markets. For example, by using data from the United States, Bakshi and Chen (1994) found that, when the population ages, the demand for

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[3] According to Turner's (2006) estimation, the mortality rate for a 65-year-old UK male in 2013 will fall by 46% in the twenty years between 1983 and 2003.
[4] In addition to the risk premium, other issues include the relationship between aversion to financial risk and the willingness to pay to reduce mortality risk (e.g., Eeckhoudt and Hammitt, 2004), the hedging and pricing of life insurance policies (e.g., Bayraktar and Young, 2007; Cairns et al., 2006; Cox et al., 2010; Lin and Tzeng, 2010; Tsai et al., 2010; Young, 2008), the design of mortality derivatives (see Denuit et al., 2007; Lin and Cox, 2008), and the demand for annuity products and retirement planning (Davidoff et al., 2005; Horneff et al., 2008).

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financial investment increases and the demand for housing decreases. They also found that the change in average age is positively correlated with the risk premium. Goyal (2004) found that outflows from the United States stock market are positively correlated with the change in the fraction of retired people and negatively correlated with the change in the fraction of middle-aged people (aged 45 to 64). He found that an increase in the average age will increase next year's excess stock return. By pooling international data, Ang and Maddaloni (2005) found that the higher the growth rate of the fraction of population in the retired group, the lower the risk premium.

Instead of focusing on population changes among alternative age groups as in the previous literature, our paper adopts a different approach by directly examining the relationship between the unexpected shock to the mortality rate and the equity premium. There are three reasons for doing so. First, while demographic variables could proxy for changes in risk aversion, the impact of an unexpected shock to the mortality rate on the equity premium could be interpreted as a change in risk perception. Both risk aversion and risk perception are essential for individuals to determine their demand for risky assets. When the mortality rate for all the participants in the capital markets changes, the demographic structure may not change right away. However, the investors will immediately modify their risk perception regarding life expectancy when they recognize the unexpected shocks in the mortality rate. Thus, the marginal impact of the unexpected shock to the mortality rate on the risk premium can only represent the effect of a change in risk perception as opposed to that of a change in risk aversion. In addition, as noted by Della Vigna and Pollet (2007), the changes in demographics will affect the future consumption plans and further influence the profits and returns among industries. When observing an unexpected shock to the mortality rate, the investors will anticipate the future changes in revenues for different industries, and will immediately modify their investment strategies among industries. Thus, the changes in portfolio choices will affect the equity premium right away.

Second, financial institutions can use the correlation between the unexpected mortality rate shock and the equity premium to hedge the mortality-linked securities[5] which have been actively introduced by major investment banks and insurers in recent years. A change in demographic structure is determined by several factors, such as the current demographic structure, the mortality rate, the fertility rate, and the immigration policies. Separating the impact of the mortality rate from the impacts of other factors could provide a more accurate measure of the sensitivity of the equity premium with respect to the mortality rate and could reduce the basis risk faced by financial institutions when hedging mortality-linked securities.

Finally, the relationship between the change in the mortality rate and the equity premium has been proposed in theory but has never been examined empirically. Athanasoulis (2006) adopted a general equilibrium overlapping generations model and showed that the mortality rate is positively correlated with the equity premium. Although Athanasoulis (2006) has provided theoretical predictions and supports his results by simulation, whether his results can be supported by real world empirical evidence deserves a further study.

Hence, this paper employs G7 country data to provide the empirical evidence. The methodology underlying our empirical model is similar to that in Ang and Maddaloni (2005) who examined the relationship between the equity risk premium and demographic variables. In addition to Ang and Maddaloni's (2005) dependent variables, we further employ the unexpected mortality rate shock in the regression models.

Our empirical evidence finds strong support for the view that an unexpected shock to the mortality rate is significantly negatively correlated with the risk premiums. By using a one-year horizon, we find that the magnitude of the increase in the risk premium is about 0.54% per year when the mortality rate is one basis point lower than expected. We also find similar results when testing the long-run relationship. For the five-year horizon, the magnitude of the increment in the risk premium due to a one basis point unexpected negative shock to the mortality rate is around 0.331% per year.

We further provide an example to demonstrate the applications of our empirical findings in hedging a mortality-linked product. We derive the immunization strategy for an annuity issuer. By simulation, we further demonstrate that our strategy could improve the performance in terms of hedging the unexpected shocks to the mortality rate.

The remainder of this paper is organized as follows. Section 2 reports our data. The methodology is introduced in Section 3. Section 4 presents our empirical findings. Section 5 illustrates how we use our findings to hedge the longevity risk of annuity issuers. Section 6 concludes the paper.

2. Data

The sample comprises the G7 countries. Our data are merged from three sources, with financial data being collected from the Global Financial Data (GFD), consumption data being gathered from the Center for International Comparisons (CIC), and demographic and mortality data being obtained from the Human Mortality Database (HMD). The data periods are 1950–2007 for Canada, Italy, the United Kingdom and the United States, 1960–2007 for France and Japan, and 1970–2007 for Germany.

The data consist of annual observations for excess aggregate equity returns, dividend yields, term spreads, consumption growth, demographic variables, and mortality rates. The definitions of all variables are provided in Table 1. Besides the explanatory variables used in Ang and Maddaloni (2005), we additionally employ two independent variables: the unexpected shock to the mortality rate and the dividend yield.[6]

[5] For example, longevity bonds, annuities, survival bonds, mortality swaps and forwards, etc.

[6] Fama and French (1988, 1989) have shown that the dividend yield is important in predicting the future risk premium. Thus, we include the dividend yield as one of the independent variables.