Mortality Risk, Pension Agency Problem, and A Modern Malthusian Theory of Capital Structure

Haikun Zhu, *CentER & Department of Finance, Tilburg University, NL*

Hao Liang[1], *CentER & Department of Finance, Tilburg University, NL*

David K. Ding, *School of Economics and Finance, Massey University, NZ*

Abstract

In this paper, we propose a modern Malthusian theory in relation to finance. We demonstrate that the life expectancy and mortality rates in a society have a simple, yet previously undetected impact on capital structure, especially with the emergence of modern pension systems. We hypothesize that the agency problems between pension plans (especially DB plans) and external investment managers create a new "Malthusian trap": the decreasing mortality rates of population in wealthy countries in the recent decades have induced pension fund managers' myopic behavior. Under the higher pressures of maintaining required funding ratios in relation to the larger population of workforce and retirees, investment managers tend to conduct more risk-seeking investment strategies by investing heavily in equity relative to debt. Given that pension funds are the major player in financial markets and invest heavily in equity, this has ratcheted down the leverage ratio (debt-to-equity ratio) in these economies. We test our modern Malthusian theory based on a dynamic panel data analysis, and find that the aggregated capital structure has a non-linear quadratic relationship with the countrywide mortality rates of the population. This result is robust after controlling for traditional capital structure determinants and macroeconomic factors.

Key words: Capital Structure, Pensions, Mortality Rates, Agency Problem

[1] Corresponding author. Address: 5000 LE Tilburg, the Netherlands. Email: H.Liang@tilburguniversity.edu; Tel: +31 13 466 4056.

Mortality Risks, Pension Agency Problems, and A Modern Malthusian Theory of Capital Structure

INTRODUCTION

More than 300 years ago, Thomas R. Malthus (1789) proposed his theory on the population dynamics and its relationship with economic development and national income in his influential work *An Essay on the Principle of Population*. The Malthusian theory on population substantially demonstrated the determinant influence of demographic characteristics of a society on its economy[2]. One of the most important demographic factors is the mortality rate of ordinary citizens, a measure of death in a population, scaled by the size of the population per unit of time. It has been found that mortality rates can significantly influence, and are also intensively affected by, economic development and national income (e.g., Acemoglu, Johnson, & Robinson, 2001; Preston, 2007).

The renowned Malthusian theory may have a modern version. In this research, we propose a modern population view in relation to finance. That is, there are also strong relationships between finance and demographic dynamics in the modern society, especially with the emergence of modern pension system and its strong reliance on human mortality. The mortality rates of workforce and retirees are one of the major concerns of pension funds to formulate their investment strategy, which further links to the financial structure of firms their investment. The notably increasing in life expectancy and decreasing mortality rates worldwide over the last decades have led to significant increase in private pension liabilities, and such increase in pension liabilities directly lead to strong increase in the

[2] According to the theory, national income was largely stagnant because technological advances only resulted in more people, rather than improvements of living standard, which is widely known as "Malthusian trap".

sponsoring companies' own corporate liabilities. For example, Shivdasani & Stefanescu (2010) show that leverage ratios for US firms with pension plans are on average about 35% higher when pension assets and liabilities are incorporated into the capital structure. As some characteristic of pension plans may last for decades, the volatile change in mortality rates will largely affect prediction on future liabilities, resulting in potential budget deficits in pension plans. This matter could be observed in a wide range of advanced economies[3]. Historical data imply that the uncertainty in the change of mortality makes it difficult to predict its pattern in the future (Stevens, 2010). This uncertainty is what we refer to as "mortality risk" in this paper. More specifically, we define "mortality risk" as the uncertainty of mortality rates faced by pension sponsors and pension funds which further result in financial risks. We focus our discussion on the context of private (corporate) pension system. We are particularly interested in whether and how mortality risk as a socio-structural factor would contribute to the exogenous foundational elements impacting finance, such as capital structure. We aim to address the following questions: (1) *How do mortality risks of private pensions affect capital structure?* (2) *How do such mortality risks to corporate finance vary across countries?*

Defined benefits (DBs)[4] and defined contributions (DCs)[5] are two major forms of pension plans that are offered by corporate pension sponsors to their employees, and are managed by professional trustees, usually external investment managers. But DBs and DCs have different payoff structures. The benefits of DB plans are determined at the beginning of participation and that of DC's are determined

[3] For example, according to a 2012 report by *Investment & Pensions Asia*, the life expectancy in Japan increased by more than 30 years from 51 year-old along with the country's rapid economic development for several decades during the post-war period, and its public pension is suffering 99 billion USD by the year 2011.

[4] Defined Benefit (DB) is a pension plan in which employers promise a specified monthly benefit on retirement that is predetermined by a formula based on the employee's earnings history, tenure of service and age. Contribution is largely made by employers who also bear investment risks.

[5] Defined Contribution (DC) is a pension plan in which the amount of the employer's annual contribution is specified. Individual accounts are set up for participants and benefits are based on employer contributions and employee contributions plus any investment earnings on the money in the account. However, only employer contributions to the account are guaranteed, not the future benefits. This means the investment risks are beard by employees themselves.

by the investment strategy and market performance during the participation (payment) period. Therefore, for a DC plan, there is little financial burden for the sponsoring company since the pension payment is flexible. For this reason we mainly focus our discussion on DB plans in this study. However, even for DB plans, we can only be sure that liabilities of plans can *partly* affect the financial structure and performance of the sponsoring companies, as only one of the funding sources of a DB plan is the sponsoring company's liabilities (Shivdasani & Stefanescu, 2010)[6]. Still, we believe there is no way to eliminate the influence from rising liabilities of DB plans to sponsoring companies' financial structure when we consider this issue countrywide, and individuals' contributions are still not comparable to those from companies in terms of scale. The mortality risk of pensions is mainly reflected by the fact that the costs of payment to pension clients (retirees) in the future usually exceed the funding contributions and investment returns they receive, resulting in a "funding gap"[7]. The longer the survival period of pension participants after retirement, the more pressure of funding gap the pension funds would undertake. The current trend in increasing life expectancy indeed poses a serious challenge not only for the pension industry but also for all sponsoring companies. Pensions as liabilities therefore constitute a link between finance and demographic factors such as mortality, which is under little investigation in the extant studies.

In the traditional finance literature, capital structure and leverage is considered as endogenously determined by a series of financial factors such as profitability, tangibility, market to book value and size (Rajan & Zingales's, 1995). Other market frictions such as tax also explain the variations in capital structure (e.g., Modigliani and Miller, 1963; Miller, 1977; DeAngelo and Masulis, 1980; Graham, 2003).

---

[6] This means that the increasing liabilities of the pension plan are not necessarily imposed on the sponsoring company but can be put as the debt of participants. Moreover, cutting pension payments to beneficiaries is also a way to reduce liabilities.

[7] As reported by *IMF* (April 2012), if human life expectancy increases three years more than expected, the present discounted costs would be as much as 25 to 50 percent of the global GDP.

Faccio and Xu (2012) provided the most recent evidence that both corporate and personal taxes would significantly affect firms' capital structure choice. In a most recent article, Welch (2013) offers a comprehensive summary of capital structure determinants in the literature, in terms of whether they favor equity or debt. For example, deadweight distress costs favor equity as equity holders cannot form the firm into financial distress (Roberts & Sufi, 2009); corporate taxes favor debt due to tax-deductible interests (Graham, 1996); adverse selection favors debt due to negative signaling of issuing lower-priority securities which relates to the pecking-order theory (Myers & Majluf, 1984); Risk shifting favors equity due to its flexibility (Parrino & Weisbach, 1999); ESOPs favor equity due to its role of motivators for employees (Fama & French, 2002); tangibility favors debt for lower costs of recovering creditors' collaterals (Rampini & Viswanathan, 2010). Moreover, "unmitigated managerial agency concerns favor equity, especially when corporate governance is weak, because managers prefer less pressure and the opportunity to build empires (Welch, 2013: 5)", which is more relevant to our argument in this paper. In recent years, more studies have explored the exogenous determinants of financial structures, but more at the country-level rather than at the firm-level, such as laws (La Porta et al., 1998), politics (Rajan & Zingales, 2003; Roe, 2003) and cultures (Stulz and Williamson, 2003).

Other related studies, not purely on capital structure itself though, document substantial effect of pension liabilities on corporate finance variables such as cash flow and capital expenditure (e.g., Fazzari, Hubbard, & Peterson, 1988; Ruah, 2006). Furthermore, the roles of pension funds as institutional investors in financial markets have also been well discussed, such as boosting operating cash flows and returns through shareholder activism (e.g., Chaganti & Damanpour, 1991; Cornett, Marcus, Saunders & Tehranian, 2007), lowering debt-to-capital ratio (Chaganti & Damanpour, 1991), and different ownership effects between public and private pension funds (Woidtke, 2001).

The major deficiency in existing literature linking pension and finance is that, former studies on pension problems mainly focus on how (sponsoring) firms choose their capital structure, cash and cash flow, asset allocation, etc. endogenously based on incentives generated in certain institutional environment like regulations and tax policies. There lacks an in-depth analysis on exogenous social-economic and structural factors such as demographical characteristics. Therefore, in this paper we investigate these exogenous demographical factors. We argue that the death of ordinary citizens of a country would both institutionally and financially affect the corporate financial structure and decisions such as the capital structure choice, and shield light on predicting firms' future capital structure change based on change in mortality rates. In addition, few studies have particularly discussed the influence of pension funds as institutional investors on the financial decision of the companies they invest in. The variation in death rates would first change pension funds' funding ratios and then their investment strategies. These changes will eventually be carried on to firms in which the pension funds hold shares through various corporate governance mechanisms. Existing studies fail to capture such link thus miss an important demographical determinant of corporate finance. In this paper, we aim to fill in this gap by investigating the mechanism and consequences of mortality rates on capital structure.

The paper proceeds as follows: Section II briefly introduces the pensions system worldwide and discusses the potential agency problems in pension plans, also our theoretical prediction on how change in mortality affect corporate finance based on such pension agency problems, which we term as a modern "Malthusian trap". Section III provides empirical evidence on the proposed mortality effects. Section IV discusses the policy and management implications and concludes.

MORTALITY RATE, PENSION FUNDS AND AGENCY ISSUES

Pension Funds Worldwide

Pension funds as financial intermediations are important shareholders of listed and private companies. They are especially important to the stock market where large institutional investors dominate. In almost all developed countries, the market value of pension funds exceeds half of the market capitalization of all public stocks. In the Netherlands, the ratio of pension funds' market value over equity market capitalization even exceeds 100%. In January 2008, Morgan Stanley estimated that pension funds worldwide hold over US$20 trillion in assets, the largest for any category of investor ahead of mutual funds, insurance companies, currency reserves, sovereign wealth funds, hedge funds, or private equity. Pension funds as private retirement plans also emerge rapidly worldwide as an important consideration for corporate capital budgeting and management. In the recent decades, many companies have promised their employees defined benefit (DB) or defined contribution (DC) pensions.

Private (corporate) pension systems vary across countries and regions. For example, pension systems in Western Europe are more mature and in a high level of guarantee of pension payment. The pension systems are normally established with a preliminary public pension plan and different levels of corporate or individual plans. In Central and Eastern Europe, pension reforms have taken place during 1990's. The structure of multi-layer pension system including both public pension funds and private pension funds has been established. Although the system in Eastern Europe is becoming more similar to that in Western Europe, their operational mechanism as well as investment and management styles are still different due to immatureness of the capital markets and the dominance of public pension funds in the whole pension system in Central and Eastern Europe. Corporate pension system in the U.S. mainly consists of DB plans and DC plans, with DC being the dominant one since 1998. The 401K plan is one the most important DC plans, which contributes to popularity of DC plans. In Japan, DC schemes have

existed since October 2001, and as of March 2012 cover more than 4 million workers at about 16,400 companies. The so-called "Japanese 401K plan" is helping companies transform from the traditional DB plans into DC ones.

Even though it is not easy to classify one country's overall pension system as DC or DB due to the fact that pension plans generally present a mixed form of these two, the effects of pensions liabilities induced by mortality risk on corporate capital structure are very different. Our later conjectures on the effects agency problems in pension funds mainly function in DB plans rather than DC plans. Furthermore, in many western European countries, a major proportion of pension plans are DB plans, while in the US and Japan, the DC plans are the major form of private (corporate) pension plans or assume more importance, at least in large corporations. This also helps us to unbundle the effects of DB from DC on the countrywide financial structure.

The Agency Problems in Pension Funds

The linkage between pension funds and corporate finance can be viewed from an agency perspective. The nexus lying in the principal-agent relationship in pension funds is between pension funds and pension sponsors (including beneficiaries). Sponsoring companies and beneficiaries put money into pension plans, which are then pooled to form a fund that is managed by external investment managers. The principal-agent nexus appears. The professional investment managers cautiously choose investment classes such as equity and debts and invest in them. Such principal-agent model also applies to venture capital (VC) and private equity (PE). Similar to VC and PE, pension funds as a major type of financial institutions, manage huge amount of money for retirees and employees, and invest the money into ordinary firms on the capital markets through buying their equity shares and bonds, and distribute

investment returns to pension participants, mostly retirees. However, if decision-makers (trustees) do not bear the full cost of their decisions, inefficiencies can result (Fama and Jensen 1983). Figure 1 conceptually illustrates the mechanism and the principal-agency relationship in a normal private pension system.

[Insert Figure 1 about Here]

Given the above-discussed mechanism in the private pension system, the intuitive relationship between mortality rates and corporate leverage would be that increase in life expectancy (decrease in mortality rate) could ratchet up the liabilities of the pension fund, and subsequently the liabilities of the sponsoring company, thus its capital structure (leverage ratio) when keeping other factors constant, and vice versa. This is in the case of low information asymmetry regarding the funding conditions of the pension plan between trustees and sponsors regarding the mortality risk, and investment managers are less motivated to take risk and simply follow relatively conservative and constant investment strategies on equity and debt markets. As Ruah (2006) indicates, sponsoring companies must contribute to the pension plans according to publicly approved formulas which connect the future payment of pension plans to companies' own liabilities. Thus, the mechanism goes to sponsoring companies where they contribute to the pension plans at fair rates. This logic holds as long as the whole system is operating in a low information-asymmetry environment. Therefore, decreasing mortality rates naturally lead to more liabilities for sponsoring companies thus higher its leverage ratio, and vice versa. Countrywide speaking, when mortality rates decrease but are not low enough to create sufficiently high funding pressures for investment managers, increasing pension liabilities add to higher total liabilities of the sponsoring companies, which results in higher leverage ratio in the economy. This basically means mortality rates and leverage ratios are negatively correlated, keeping other things constant.

However, when mortality rates decrease to too low, funding gaps are increasingly high: pension liabilities increase significantly due to more payments to the retirees who haven't died, while the pension assets – which mainly depend on capital market performance – do not necessarily increase correspondingly. This will drive the funding ratio (assets to liabilities) low and undesirable to investment managers as their jobs largely hinge on maintaining a high funding ratio. Under the higher pressures of maintaining required funding ratios in relation to the larger population of workforce and retirees, investment managers tend to conduct more myopic and risk-seeking investment strategies. In such cases, investment managers would have incentives to make investment in their own interests rather than the interests of the sponsors and beneficiaries. Thus a "modern Malthusian trap" arises: increasingly lower mortality rates leads to more and more severe agency problems between external managers and pension plan sponsors, and induce managerial myopic behavior by investing heavily in riskier assets with higher returns. Of course, agency problem happens in different formations due to different institutional environments. We will show the difference in our subsample of Central and Eastern Europe countries where public pension system dominates.

Our agency arguments are closely related to Besley & Prat (2003), who point out one of the potential sources of agency problems as rooted in investment managers' asset allocation decisions. In market-oriented wealthy economies, such agency issue would be stronger. Ruling out the possibility that pension funds tend to diminish liabilities through cutting payment to beneficiaries, liabilities paid to retirees and employees are mainly influenced by the mortality rates of retirees and employees, while the assets are mainly influenced by returns of the fund's investment based on its asset allocations compared to relatively limited and fixed contribution. This corresponds to the agency problems discussed above.

We argue that due to the existence of the agency problems, investment managers of underfunded pensions would have incentives to engage in more myopic investment strategies by taking more risky projects which may generate higher short-term returns (and also higher possibilities of losses). Given the limited asset classes pension funds can invest in, such argument indicates that pension managers would opt to invest more in equities than in bonds. Countrywide speaking, if most pension managers over-invest in equity markets relative to bond markets as a response to decreasing mortality rates, this "asset allocation agency problem" will drive up both the overall equity demands and prices. In such case, the overall debt-to-equity ratio at the country level would decrease dramatically as mortality rates decrease, keeping other factors constant.

To summarize the aforementioned mechanisms:

- *When mortality rates decrease but are not low enough to create sufficiently high funding pressures for investment managers, increasing pension liabilities add to higher total liabilities of the sponsoring companies, which results in higher leverage ratio in the economy. Thus mortality rates and leverage ratios are negatively related.*

- *When mortality rates decrease to too low, funding pressures are increasingly high, which leads to more and more severe agency problems between pension plans and investment managers and induces managerial myopic behavior ("modern Malthusian trap") by investing heavily in equity relative to debt, which results in lower leverage ratio in the economy. Thus mortality rates and leverage ratios are positively related.*

Given such classification, we can conceptually graph the relationship between corporate leverage of sponsors and mortality rates, both at the country-level, as shown in Figure 2.

[Insert Figure 2 about Here]

The life expectancies of ordinary citizens for countries in our sample are on average about 80s (*WHO Global Health Observatory Data Repository*, 2009). Therefore we first test our proposed theory on the age range of 75-80, and will validate our results with other age ranges. In the following sections, we empirically test these hypotheses with both mortality data and corporate finance data.

DATA AND METHODOLOGY

Data

Mortality rates and life expectancies data are obtained from Human Mortality Database (HMD), developed by University of California, Berkeley and Max Planck Institute for Demographic Research[8]. The database contains original calculations of death rates and life tables for national populations (countries or areas), as well as the input data used in constructing those tables. The input data consist of death counts from vital statistics, plus census counts, birth counts, and population estimates from various sources. Currently there are 37 countries or areas in the database[9]. In order to match with our other financial variables, we further restrict our sample to 30 countries[10]. Sample period for most countries ranges from 1988 to 2009 while for Central and Eastern Europe countries, it ranges from around 1996 to 2009. It is worth noting that we mainly focus on advanced and wealthy countries in the world. This is because of (1) data availability, and (2) the fact that these countries have similar life expectancies, pension schemes and relatively mature pension systems. Similar to Lee-Carter (1992) model,

---

[8] http://www.mortality.org/

[9] The database is limited by design to populations where death registration and census data are virtually complete, since this type of information is required for the uniform method used to reconstruct historical data series. As a result, the countries and areas included here are relatively wealthy and for the most part highly industrialized.

[10] Countries (or regions) in our sample are: Australia, Finland, Spain, Austria, France, Luxembourg, Sweden, Germany, Netherlands, Switzerland, Belgium, New Zealand, Taiwan, Lithuania, Hungary, Iceland, Norway, United Kingdom, Ireland, Poland, Italy, Czech Republic, Israel, Denmark, Russia, Portugal, Estonia, Japan, Slovakia, Latvia.

we use the central death rate to measure country level mortality. Central death rate is defined as observed per capita number of death, that is, the ratio of the number of people died at a specific age in a specific year to the total number of people alive at the same age in the same year. Finally, the difference between *one year death rate* (denoted as *q(x)*) and *one year central death rate* (denoted as *m(x)*) is that, the first one is the ratio of the number of people who have reached age *x* but failed to survive to age *x+1* to the total number of people who have reached age *x*; the second one is the ratio with the same numerator but a different denominator which is the average number of people alive within 12 months. We can describe both of them more clearly as

$$q(x) = d_x / l_x ;$$

$$m(x) = d_x / n_x$$

where d_x is the number of people who die during the 12 months; l_x is the number of people that survived during this period. n_x is the arithmetic mean of the observed population at age *x* at the beginning and at the end of the 12 months. Furthermore, we draw the population size of each country with respect to specific age periods corresponding to the central death rates.

Corporate finance data including the leverage ratio are obtained from Compustat Global and Compustat North America. We search for the entire universe of companies in a specific country on Compustat, imported these firm-level data and aggregated them at the country-level, so as to match with country-level mortality data. Macroeconomic data including GDP and population are drawn from World Bank Database. Combined corporate tax and individual tax are available in Organization for Economic Cooperation and Development (OECD) database. Table 1 below exhibits the definitions of variables that are included in our model.

[Insert Table 1 about Here]

Methodology

To test our mortality risk theory, we use linear dynamic panel data models and estimate the model using General Method of Moments (GMM). We regress the aggregated value-weighted average capital structure of a country on the central death rates at the country-level. Furthermore, we control for country and year fixed effects, as capital structure decision varies significantly across countries with different institutions, laws, macroeconomic policies, GDP, populations, etc., as well as year-specific characteristics. We assume our control variables to be predetermined which is a more general assumption compared to strict exogeneity. Our model is specified as follows:

$$Leverage_{i,t} = \beta_0 + \beta_1 * mortalityr_{i,t} + \beta_2 * mortalityr_{i,t}^2 + \beta_3 * Leverage_{i,t-1} + control\,\mathrm{var}_{i,t} + \alpha_i + yeardummy_t + \varepsilon_{i,t}$$

Dependent variable: corporate leverage aggregated at the country-level (value-weighted debt/equity ratio of a country). It is calculated as the aggregated debts (both short-term and long-term) of the country to the book value of aggregated equities of the country. Such value-weighted leverage measure could average out trivial effects from small firms, since due to the shift of pension assets from DB to DC, small firms tend to sponsor DC plans while large firms like General Electric still stick to the DB plans. A value-weighted measure makes more sense than an equal-weighted measure in this case.

Independent variables: central death rate at a certain age range, as well as its square. Such specification could capture the non-linear quadratic relationship between mortality and leverage to some extent, as the coefficient of the first power captures the slope and the coefficient of the second power captures the curvature. Combining the first power and the second power (square) results will give a more complete

picture of the concave relationship between mortality and leverage. For the "central death rate", we take the logarithm of the central death rate multiplied by 1000 for getting positive numbers.

Control variables: We control for year fixed effects as well as country fixed effects (30 country dummies) which capture macroeconomic policies, country-specific institutions, etc., as pension systems are institutional-specific. In addition, we further control for several factors that are documented in the literature to affect capital structure, such as tangibility, size (logarithm of total sales), profitability, market-to-book ratio, etc (Rajan & Zingales, 1995; Brav, 2009). Most of these determinants are all at the firm-level; since we deal with country-level aggregated data, "size" could have been already captured by the country fixed effect (also, since we take the equal average rather than the weighted average of all listed companies within a country, the size effects might be averaged out). In addition, as we mainly study the constraint effects of liabilities to pension contribution, tangibility is replaced by (short-term) financial constraint measures: cash-to-cash-flow sensitivity and investment-to-cash-flow sensitivity. However, we don't include both in the same regression due to their high correlations[11]. Furthermore, profitability might still matter in our agency story, and we take the average ROA and ROE aggregated at the country-level as the proxy for profitability (however, we don't include them together in the same regression to avoid multi-collinearity). We also control for country-level taxation at both the corporate and the individual levels (Rajan & Zingales, 1995; Faccio and Xu, 2012). Moreover, we include populations and GDPs as macroeconomic variables on top of controlling for country-fixed effect. For population data, we calculated the ratio of age-specific population to the whole population of each country in order to control effects brought by population on and the real size of people within a certain

[11] We report the result of "Investment to cash flow sensitivity" and leave the other one as robust check.

age range for the reason that some age periods might show high mortality rates but the total population of that period could be too small to really affect the economy.

Table 2 below shows the descriptive statistics and correlation table of these variables.

[Insert Table 2 about Here]

RESULTS AND DISCUSSIONS

In this section we show our test results on the quadratic relationship between mortality and capital structure (the debt-to-equity ratio). Before conducting regressions, we first plot the country-level leverage ratio (independent variable x) and the country-level mortality rates (dependent variable y) on a two-dimension chart after ruling out outliers in leverage ratio based on different sample periods (full sample period, pre-2000 sample period, post-2000 sample period) and country coverage (we take the Netherlands as a representative country, as its size of pension funds in relative to equity market capitalization is highest in the world: over 100%), as shown in Figure 3a. Figure 3b plots the case of Central and Eastern Europe, which we will discuss later. Visually it is clear that in most cases, mortality and leverage exhibit a bell shape relationship. This observation corresponds to our conceptual illustration on the quadratic relationship in Figure 2. For the mortality rate in the age range between 75 and 79 year-old, the peak of leverage appears when the central mortality rate is around 3.5 – 4 based on the transformed mortality rates in all of these cases, which rules out the possibility that we are purely observing heteroskedasticity in the error terms.

[Insert Figure 3a and 3b about Here]

Given the robust visual plots on the second power relationship between mortality rates and leverage ratios, we then turn to more formal empirical tests to further justify such quadratic relationship. Table 3 shows the regression results, the first and the second powers of mortality rate for the age range between 75 and 79 year-old as independent variables, together with other demographic and macroeconomic factors and traditional capital structure determinants as control variables. Robust standard errors are clustered at the country level. The column presents the result. It has been found that the coefficients on the mortality rate variable are statistically significant and positive while the coefficients on the square of mortality rate are statistically significant and negative. This combination of the coefficient signs indicates that the mortality-leverage relationship follows a bell shape as shown in Figure 2 & 3a: when mortality rates are high, the funding pressures for investment managers are low, thus the agency problems between pension plans and investment managers are trivial. Then the relationship between mortality rates and leverage ratio is negative, since decreasing mortality rates would mainly result in higher pension liabilities as well as higher corporate liabilities. When mortality rates are increasingly low, the funding ratio is low (the funding pressures are high for investment managers), and the agency problems of pension managers are more and more severe. Then the relationship between mortality rates and leverage ratio is positive (the modern "Malthusian trap"). Such positive relationship, according to our theoretical conjectures, is mainly resulted through pension managers' myopic asset allocation decision of over-investing in the equity markets. In addition, the economic significance of mortality rates on leverage is nontrivial: in the situation where agency problems are severe, a 1% increase in the mortality rate leads to more than more than 8% increase. The marginal effects get larger when as the mortality age range increases. Furthermore, alternative control variables of financial constraints (invest-to-cash-flow sensitivity or cash to cash-flow sensitivity) and profitability (ROA or ROE) do not

change the signs and statistical significance of mortality rates, though we only report the results of including ROA and investment-to-cash-flow sensitivity.

[Insert Table 3 about Here]

So far we have only focused on the mortality rate of the age range between 75 and 79 years old, as we observe the average life expectancies in the advanced economies usually do not exceed 80, and some countries with significantly lower life expectancies (e.g. Russia and Eastern European countries) are included in our full sample. As pension payments to retirees matter for a much broader age range of population, one may wonder whether the aforementioned significant quadratic relationship still holds in other age ranges. Table 4 reports the results with mortality rates of other age ranges after typical retirement ages (70-74 year-old, 80-84 year-old, 85-89 year-old, 90-94 year-old) and their quadratic forms (squares) as independent variables, leaving other variables unchanged. We specify the model exactly the same as we did for the age period 75-79. In unreported regressions, we again interchange between alternative regressors such as ROA and ROE as well as investment-to-cash sensitivity and cash-to-cash flow sensitivity, the significance stays the same. Again, the coefficients on the mortality rate variable are statistically significant and positive, while the coefficients on the square of mortality rate are statistically significant and negative in all specifications with nontrivial economic significance. Also, surprisingly, when we introduce mortality rate (both the linear and quadratic forms) into the regression, those control variables recommended by former literature as important determinants for leverage ratio turn out to be insignificant or with a wrong sign. The only significant regressors are all related to demographic characteristics of a nation.

[Insert Table 4 about Here]

Central & Eastern Europe (CEE):

It is shown in Figure 3b that the plots for Central and Eastern European (CEE) countries seem to be inconsistent to the full sample in Figure 3a, which seem to be outliers in our sample (Even though the shape is unclear so far based on the plot graph, we will show that it is more toward a U-shape according to regression results). Given the fact that most East European countries transited from former the Soviet Union system and the financial markets are relatively immature and unsophisticated, the mechanisms in these countries may be different. The specific investment environment regarding to legislation, corporate governance and European Union integration, etc, contributes to the fact that Central & Eastern European pension funds have limited investment into equities and those cases are largely domestic. (*Investment & Pensions Europe, January 2013*) In addition, the life expectancies in Central and Eastern Europe are lower than that in other wealthy economies, and are usually below 75 (*WHO*, 2009). Therefore we particularly examine the Central and Eastern European subsample at the age range of 70-74 year-old.

A notable feature of the pension systems in Central and Eastern Europe is the dominance of public pension funds (or state pensions) operated by the government and state agencies. Perotti & Schwienbacher (2009), for example, offer theoretical supports for such case from a median voter perspective on why democratic countries in Eastern Europe opt for a more national public pension system instead of private ones. From the classical political economy perspective, the state and the government are considered as the agent of the public citizens and taxpayers, and so the agent of public pension plans. The major difference between the agent of public pension funds and the agent of private pension funds is that the government as the agent can embezzle the funds for other fiscal expenditures. According to Hess and Impavido (2003), agency problems in public pension funds mainly include (1)

traditional problem which is based on direct self-interest of trustees' self-dealing and corruption or shirking, (2) investment goals of funds can be driven by political concerns of trustees, for example, assets could be invested into boosting local business without considering its risks and returns (Musalem & Palacios, 2004). This actually reflects the classic view on the state expropriation on private sectors in institutional economics (North, 1990). In addition, as the capital markets in CEE countries are relatively less developed, the "asset allocation agency problem" is not obvious, while the agency problem mainly takes the form of funding manipulation. In such case, information asymmetry on mortality is not a major concern for the government as the agent. Combining the above reasoning, when mortality rates are high (so there are enough funding to pay retirees) and decrease, the government as the agent of public pensions will have to finance the funds to maintain their funding ratios, which correspondingly eases the liabilities pressure of sponsoring companies in private pensions, thus drives down their leverage ratio. However, when mortality rates keep on declining and are at a low level and the pension deficits become excessive, fiscal transfers by the government to pension funds can be difficult, so the private pension systems bear more such liabilities, which leads to the rise of sponsoring companies' leverage ratios. This means sponsoring companies' leverage will increase eventually as mortality rates decrease, and liabilities generated from low mortality rates excess the amount of government supports. The opposite direction of changing mortality rates also holds. When mortality rates are low (deficits in the public pension system) and increase, liabilities in the private pension system decrease, so as the leverage ratio of sponsoring companies. When mortality rates are high and keep on increasing, there will be sufficient assets in the pension systems and the agency problem will occur in which the government constantly takes away money from public pension funds to finance other political expenditures, and leaving the liabilities burden to sponsoring companies in the private pension to maintain their funding

ratios. In this case, leverage of companies will go up. Therefore we should expect a positive correlation between mortality rates and corporate leverage when mortality rates are high, and a negative correlation when mortality rates are low, for CEE countries. This prediction is further supported by the regression results in Table 5, with mortality rates at 70-74 as well as other age ranges as the key explanatory variables. The linear coefficients are statistically significant and negative, while the quadratic coefficients are statistically significant and positive, both with nontrivial economic significance. For this specific subsample, since our sample size is relatively smaller (only 7 countries) and covers relatively long time period (13-14 years), we estimate using the fixed effect models. The long time period helps cancel off potential biases so that the estimation results would still be consistent. The number of observations in Table 5 drops to 39 due to the fact that missing observations in the control variables "combined corporate tax" and "individual tax" are automatically deleted during estimation. In unreported regressions in which we exclude these two control variables and there are 97 number of observations, the results remain robust using the same estimation method.

[Insert Table 5 about Here]

In sum, our empirical results so far have largely supported our theoretical hypothesis on the relationship between mortality and capital structure, based on the agency theory. Though the forms of agency problem are exhibited slightly differently, depending on who are the agents of the pension plans.

CONCLUSION

Summary of the Paper

Corporate financial structure and decisions are not only influenced by endogenous factors such as

managerial discretion and institutional factors such as law and politics, but might also be influenced by structural demographical factors. In this paper we demonstrate that the life expectancy and mortality rates in a society have a simple, yet previously undetected impact on finance, with a particular focus on capital structure.

Based on an agency perspective, we propose that due to the agency problems between pension plans and external investment managers stemmed from their considerations on asset allocation, mortality rates and leverage ratio have non-linear quadratic relationship, depending on the mortality rates in the population and the funding pressures for investment managers. When mortality rates are high, agency problems are trivial and the relationship between mortality and leverage tends to be negative. When mortality rates are low, agency problems are more severe which leads to a "modern Malthusian trap" in which fund managers invest heavily in equities relative to debts. Given that pension funds are the major player in financial markets and invest heavily in equity, this has ratcheted down the leverage ratio, thus the relationship between mortality and leverage tends to be positive. Our empirical results show that such quadratic relationships largely hold for the wealthy countries in the world at different death ages, though the agency problem in Central and Eastern Europe may exhibit different forms due to the dominance of public pension system in relative to private pension system in these countries. The results are robust after controlling for country-specific factors as well as other capital structure and macro-economic determinants.

Theoretical and Practical Implications

The renowned Malthusian theory is still alive in modern finance, though with some different implications. It seems that not only the death of the CEO can significantly influence a company's financing policies such as changing capital structure, the death of ordinary citizens in the country can

also influence. The agency problem which is widely recognized in corporate finance research in particular in studies on VCs and PEs also exists between pension plans and external investment managers. Understanding the mechanism of agency problems as a conduit for human mortality to affect financial structures as well as its institutional foundations would facilitate studying the corporate governance issues in a broader content and understanding the structural demographical determinants of capital structure at the macro-level.

Since global aging has drawn the attentions from policy makers to ordinary families, it is worth investigating the mortality risks to socio-economic issues. Our findings indicate that as firms in wealthy countries all establish employee pension plan such as DCs and DBs, changing life expectancies would directly force firms to adjust their asset allocations into employee pension plans. The life expectancy and mortality rates in a society are mechanically related to financial structures in the economy. Understanding such mechanism is crucial in designing proper financial policies and improving governance mechanisms in the future.

REFERENCE

Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review* 91(5): 1369-1401.

Besley, T., & Prat, A. (2003). Pension fund governance and the choice between defined benefit and defined contribution plans. *CEPR Discussion Paper series (No. 3955).*

Bodie, Z., Light, J. O., & Morck, R. (1987). Funding and asset allocation in corporate pension plans: an empirical investigation. In *Issues in Pension Economics* (pp. 15-48). University of Chicago Press.

Brav, O. (2009). Access to capital, capital structure, and the funding of the firm. *Journal of Finance*, *64*(1), 263-308.

Carroll, T. J., & Niehaus, G. (1998). Pension plan funding and corporate debt ratings. *Journal of Risk and Insurance*, 427-443.

Chaganti, R., & Damanpour, F. (1991). Institutional ownership, capital structure, and firm performance. *Strategic Management Journal*, *12*(7), 479-491.

Cornett, M. M., Marcus, A. J., Saunders, A., & Tehranian, H. (2007). The impact of institutional ownership on corporate operating performance. *Journal of Banking & Finance*, *31*(6), 1771-1794.

DeAngelo, H., and R. W. Masulis. (1980). Optimal capital structure under corporate and personal taxation. *Journal of Financial Economics* 8, 3-29.

Faccio, M., and J. Xu. (2012). Taxes and capital structure, Working paper available at SSRN: http://ssrn.com/abstract=1781158

Fama, E. F., and M. C. Jensen (1983). Agency problems and residual claims. *Journal Law and Economics*, *26*, 327.

Fama, E. F., and K. R. French (2002). Testing trade-off and pecking order predictions about dividends and debt. *Review of Financial Studies* 15: 1-33.

Fazzari, S. M., Hubbard, R. M., and Petersen, B.C. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity,* 1988(1): 141-206.

Graham, John R. (2003). Taxes and corporate finance: A review, *Review of Financial Studies* 16, 1074-1128.

Guercio, D. D., & Hawkins, J. (1999). The motivation and impact of pension fund activism. *Journal of Financial Economics*, *52*(3), 293-340.

IMF (2012). The financial impact of longevity risk, IMF Global Financial Stability Report. April 2012.

Lee, R. D., & Carter, L. R. (1992). Modeling and forecasting US mortality.*Journal of the American Statistical Association*, *87*(419), 659-671.

López de Silanes, F., La Porta, R., Shleifer, A., & Vishny, R. (1998). Law and finance. *Journal of Political Economy*, *106*, 1113-1155.

Malthus, T. R. (1798). *An Essay on the Principle of Population*, London.

Miller, M. H. (1977). Debt and taxes, *Journal of Finance* 32, 261-275.

Modigliani, F. and M. H. Miller. (1963). Corporate income taxes and the cost of capital: A correction (in Communications), *American Economic Review* 53, 433-443.

Musalem, A. R., & Palacios, R. J. (2004). *Public pension fund management: governance, accountability, and investment policies: proceedings of the second public pension fund management conference*. World Bank Publications.

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, *13*(2), 187-221.

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press.

Preston, S. H. (2007). The changing relation between mortality and level of economic development. *International Journal of Epidemiology*, *36*(3), 484-490.

Parrino, A. A. and S. Viswanaghan (2013). Collateral and Capital Structure. *Journal of Financial Economics*, forthcoming.

Rajan, R. G., & Zingales, L. (1995). What do we know about capital structure? Some evidence from international data. *Journal of Finance*, *50*(5), 1421-1460.

Rajan, R. G., & Zingales, L. (2003). The great reversals: the politics of financial development in the twentieth century. *Journal of Financial Economics* 69: 5-50.

Rauh, J. D. (2006). Investment and financing constraints: Evidence from the funding of corporate pension plans. *Journal of Finance*, *61*(1), 33-71.

Roberts, M. and A. Sufi (2009). Control rights and capital structure: An empirical investigation. *Journal of Finance* 64, 1657-1695.

Roberts, M. and M. Leary (2010). Do peer firms affect corporate financial policy? Available at SSRN: http://ssrn.com/abstract=1623379

Roe, M. J. (2003). *Political determinants of corporate governance: political context, corporate impact* (No. 451). Oxford University Press, USA.

Ross, S. A., Westerfield, R., & Jordan, B. D. (2004). *Essentials of corporate finance*. McGraw-Hill/Irwin.

Shivdasai, A. and Stefanescu, I. (2010). How do pension funds affect corporate capital structure decisions? *Review of Financial Studies* 23(3): 1287-1323.

Stevens, R. (2010). Longevity Risk in Life Insurance Products. Tilburg University PhD thesis

Stulz, R. M., & Williamson, R. (2003). Culture, openness, and finance. *Journal of financial Economics*, *70*(3), 313-349.

Titman, S. and R. Wessels (1988). The determinants of capital structure choice. *Journal of Finance* 43(1): 1-19.

Webb, D. C. (2007). Sponsoring Company Finance, Investment and Pension Plan Funding. *The Economic Journal*, *117*(520), 738-760.

Woidtke, T. (2002). Agents watching agents?: evidence from pension fund ownership and firm value. *Journal of Financial Economics*, *63*(1), 99-131.

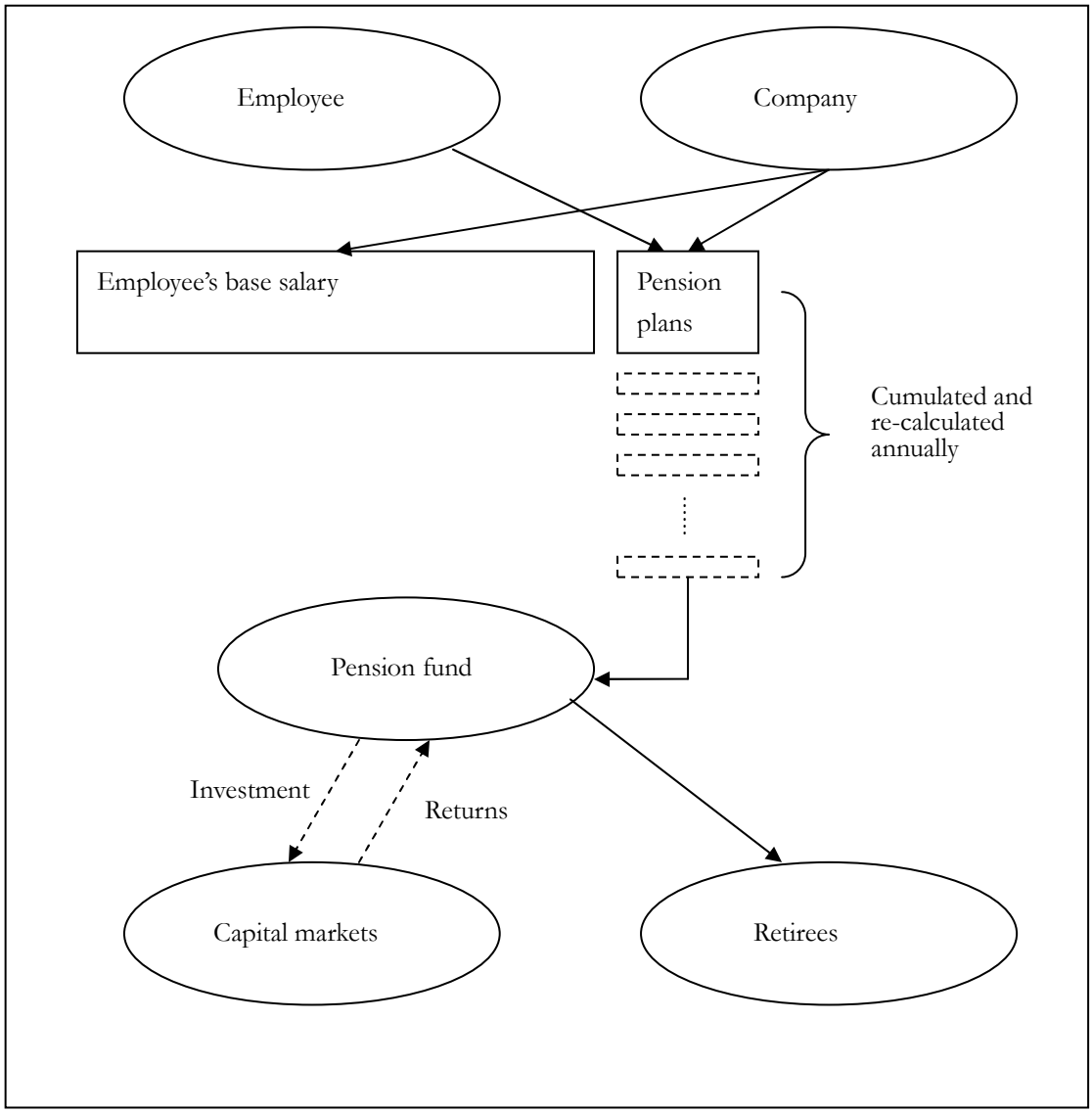


Figure 1. Private (Corporate) Pension System

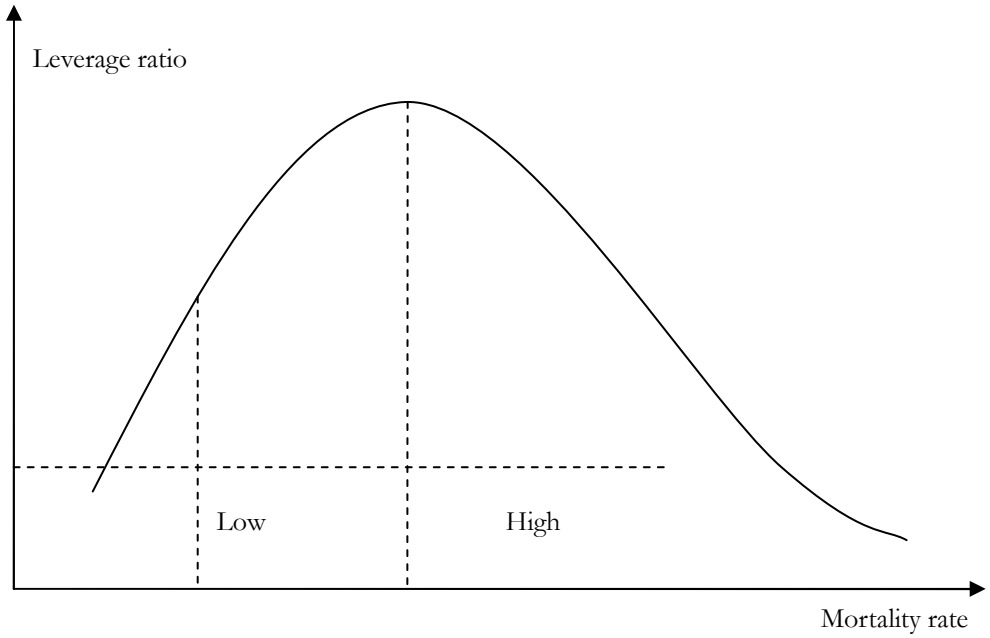
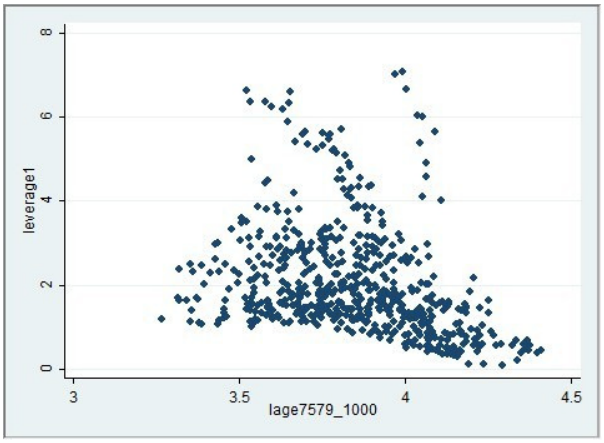
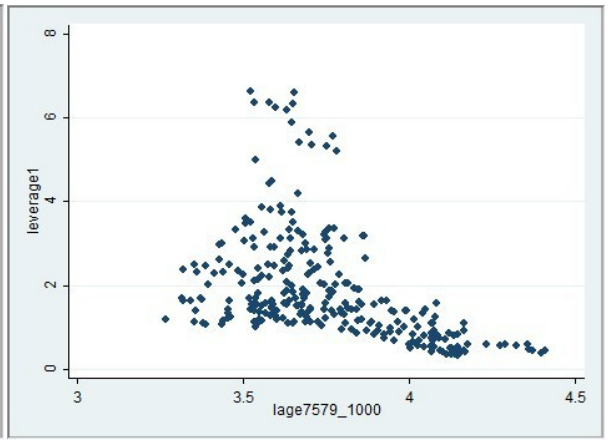


Figure 2. Conceptual relationship between mortality and countrywide Leverage ratio

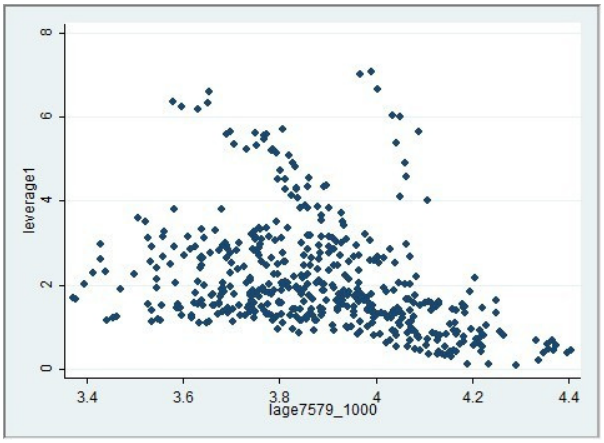
Figure 3a. Plots of leverage v.s. mortality rates



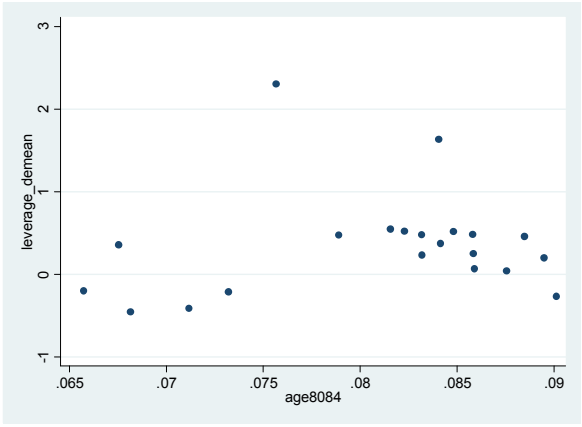
Full sample



Post-2000 sample



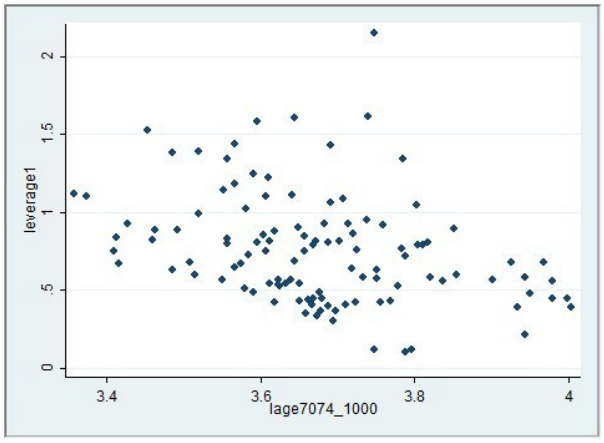
Pre-2006 sample



The Netherlands sample

Figure 3b. Plots of leverage v.s. mortality rates:

Central and Eastern Europe (CEE) sample



Full CEE countries sample

Table 1. Variable Descriptions

Variable Name	Description	Sources
Leverage (value-weighted)	Calculated as the aggregated level of debt book value to the aggregated level of equity book value of a certain country in a certain year.	Compustat
Mortality rate	Calculated as natural logarithm form of central mortality rate after multiplying by 1000Lee-Carter (1992) method on a certain age range of a country.	Human Mortality database
Mortality-squared	Calculated as the second power of the central mortality rate defined above.	Human Mortality database
Population	Population of each sample country.	World Bank
Population size	Population size of a specific age arrange of each country in the sample.	Human Mortality database
Cash to cash flow sensitivity	Calculated as the ratio of annual change in the aggregated level of cash holdings to the annual change in the aggregated level of cash flow from operating activities of a country.	Compustat
Investment to cash flow sensitivity	Calculated as the ratio of annual change in the aggregated level of short-term investment on the balance sheet to the annual change in the aggregated level of cash flow from operating activities of a country.	Compustat
ROA	Return on assets, calculated as the ratio of net income to the book value of total assets.	Compustat
ROE	Return on equity, calculated as the ratio of net income to the equity.	Compustat
Combined Corporate Tax	Statutory corporate tax rate	OECD database
Individual Tax	Individual tax revenue as a percentage of GDP	OECD tax database
GDP	Yearly-based GDP of each country in the sample	World Bank
Population ratio	Raito of the population of a certain period to the whole population	Self calculated

Table 2. Descriptive Statistics and Correlations

	No. Obs	Mean	Std. Dev	Min	Max	Leverage	Mortality (75-79)	Mortality squared (75-79)	Cash-CF sensitivity	Invest.-CF sensitivity	ROA	ROE	Ln(GDP)	Corp. tax	Indiv. tax	Population (75-79)
Leverage	578	1.825	1.004	0.101	7.059	1.000										
Ln(Mortality 75-79)	581	3.852	0.230	3.264	4.407	-0.326	1.000									
Ln(Mortality-squared 75-79)	581	14.893	1.767	10.655	19.420	-0.335	0.999	1.000								
Cash-to-cash-flow sensitivity	458	-0.558	16.001	-233.28	77.64	-0.012	0.042	0.041	1.000							
Investment-to-CF sensitivity	458	-1.401	25.166	-320.42	243.35	-0.033	0.072	0.071	0.748*	1.000						
ROA	577	-0.017	0.137	-1.944	0.205	-0.259	0.099	0.100	-0.010	-0.007	1.000					
ROE	577	-0.373	7.615	-179.86	7.831	-0.019	-0.004	-0.003	-0.002	-0.003	0.000	1.000				
Ln(GDP)	561	26.269	1.438	22.277	29.305	0.470*	-0.548*	-0.548*	0.048	0.010	-0.224	-0.051	1.000			
Combined Corporate Tax	452	33.283	8.943	12.5	60.1	0.421	0.092	0.088	0.006	0.047	-0.050	-0.103	0.377	1.000		
Individual tax (%)	514	6.878	3.769	-3.021	18.232	0.022	0.125	0.125	0.023	0.054	-0.058	0.003	-0.053	0.097	1.000	
Population rate (75-79)	557	0.029	0.005	0.015	0.045	-0.071	-0.305	-0.305	0.011	-0.001	0.077	-0.018	0.190	0.058	-0.291	1.000

* significant at 95% confidence level

Table 3. Mortality and Capital Structure: Full sample

Dependent variable = Leverage	Coef.	Std. Err.
Lag(1) leverage ratio	0.629***	(0.096)
Mortality rate 75-79	8.990**	(4.187)
Mortality-squared 75-79	-1.191**	(0.589)
Investment to cash flow sensitivity	-0.000	(0.000)
ROA	0.054	(0.105)
Combined corporate tax	0.240	(0.190)
Individual tax	0.011**	(0.005)
Population ratio (7579)	-0.027	(0.019)
Log(GDP)	7.526	(6.654)
Constant	-23.19***	(7.635)
No. of observations	331	
Country & Year fixed effect	Y	
Sagan test	0.282	
MA(1)	0.014	
MA(2)	0.510	

Standard errors in parentheses and are clustered at country level

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4. Mortality and Capital Structure: Other Age Ranges

Dependent variable = leverage	Age range: 70-74		Age range: 80-84		Age range: 85-89		Age range: 90-94	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Lag(1) leverage ratio	0.632***	(0.093)	0.614***	(0.095)	0.626***	(0.094)	0.631***	(0.092)
Mortality rate	6.334**	(2.669)	14.56***	(5.385)	16.73*	(8.810)	25.97***	(9.669)
Mortality-squared	-0.918**	(0.386)	-1.631**	(0.655)	-1.644*	(0.937)	-2.357***	(0.898)
Investment to cash flow sensitivity	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)	0.000	(0.000)
ROA	0.050	(0.101)	0.069	(0.086)	0.089	(0.098)	0.084	(0.106)
Combined corporate tax	0.315*	(0.187)	0.115	(0.159)	0.213	(0.168)	0.288	(0.187)
Individual tax	0.010	(0.007)	0.009*	(0.005)	0.007	(0.005)	0.007	(0.005)
Population ratio	-0.023	(0.016)	-0.031	(0.021)	-0.020	(0.021)	-0.019	(0.020)
Log(GDP)	9.875	(10.42)	-13.83**	(6.774)	15.32	(23.70)	66.26	(64.31)
Constant	-19.20***	(7.365)	-34.52***	(8.507)	-47.82***	(18.13)	-78.96***	(25.57)
No. of observations	331		331		331		331	
Country & Year fixed effect	Y	Y	Y	Y	Y	Y	Y	
Sagan test	0.302		0.243		0.248		0.301	
MA(1)	0.015		0.014		0.013		0.015	
MA(2)	0.465		0.413		0.457		0.485	

Table 5. Mortality and Capital Structure: Central and Eastern European Sample

Dependent Variable = Leverage	Age range: 65-69		Age range: 70-74		Age range: 80-84	
	Coef.	(Std. Err.)	Coef.	(Std. Err.)	Coef.	(Std. Err.)
Lag(1) leverage ratio	0.650***	(0.142)	0.807***	(0.264)	0.425**	(0.211)
Mortality rate	-16.293***	(3.490)	-22.718***	(5.983)	-99.100***	(10.823)
Mortality-squared	3.056***	(0.704)	3.493***	(0.667)	10.545***	(1.170)
Investment to cash flow sensitivity	-0.006	(0.042)	-0.044	(0.037)	-0.018	(0.049)
ROA	0.859**	(0.352)	1.215*	(0.625)	0.500	(0.426)
Combined corporate tax	0.010	(0.012)	0.024***	(0.009)	0.036***	(0.010)
Individual tax	0.174	(0.128)	0.054	0.089	-0.101*	(0.060)
Population ratio	22.362	(13.786)	X	X	X	X
Log(GDP)	0.785***	(0.173)	0.798**	(0.333)	-0.008	(0.184)
Constant	X	X	16.010	(21.255)	232.807***	(25.892)
No. of observation	39		39		39	
R-square	82.9%		82.8%		79.9%	

* p < 0.1; ** p<0.05; *** p<0.01; standard errors are clustered at the country-level.