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Evidence from Corporate Pension Contributions and Investment Risk

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Testing Moral Hazard and Tax Benefit Hypotheses: Evidence from Corporate Pension Contributions and Investment Risk

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Abstract

We jointly test moral hazard and tax benefit hypotheses related to the defined benefit pension plan funding and investment risk-taking decisions by incorporating the pension plan termination probabilities. We hypothesize that sponsors with different plan termination probabilities are dominated by different incentives. In particular, sponsors are dominated by the moral hazard incentive when they face high plan termination probabilities, as the put option derived from the Pension Benefit Guaranty Corporation (PBGC) guarantee has the greatest value. In contrast, the tax benefit incentive dominates if sponsors have low termination probabilities. As the value of the PBGC put option is low, maximizing tax benefits associated with pension contributions and investment earnings becomes a dictating incentive. The findings based on sponsors' voluntary contributions strongly support our hypotheses after controlling for endogeneity issue. However, in examining sponsors' investment risk-taking incentives, the results based on pension beta and asset allocation do not support either of the hypotheses.

JEL Classification: G11; G23; G33
Keywords: Moral Hazard; Tax Benefit; Plan Contributions; Pension Beta; Asset Allocation; Pension Plan Termination Probabilities

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Testing Moral Hazard and Tax Benefit Hypotheses: Evidence from Corporate Pension Contributions and Investment Risk

It is arguably a situation from the perspective of the (pension) sponsor in which "heads, the sponsor wins, and tails, the taxpayer loses." – Chester Spatt, Chief Economists of the SEC at an Executive Policy Seminar of Georgetown University in November 2005

Investing in my pension as long as we get the tax deduction for it is a very good investment for us. – Harry Stonecipher, President and CEO of Boeing at a conference call in October 2004 [1]

1. Introduction

The objective of this study is to jointly test two hypotheses related to corporate defined benefit (DB) pension plan funding and investment risk-taking decisions – moral hazard and tax benefit hypotheses. Different from previous studies that test these two hypotheses separately, we test them within a unified framework by incorporating sponsors' pension plan termination probabilities. The incorporation of pension termination probabilities is important in our framework because such probabilities directly relate to the put option value derived from the Pension Benefit Guaranty Corporation (PBGC) insurance. We hypothesize that the sponsors with different termination probabilities are governed by different incentives. In particular, sponsors with high termination probabilities are dominated by the moral hazard incentive, as the put option to the PBGC guarantee has the greatest value. In contrast, the tax benefit incentive dominates if sponsors face low termination probabilities. For these sponsors, the value of the PBGC put option is low, and maximizing the tax benefits associated with pension plan contributions and plan investment earnings therefore becomes a dictating incentive.

The theoretical framework of sponsors' incentives for moral hazard and tax benefit has been well developed by previous studies. Sharpe (1976) and Treynor (1977) first conceptualize the PBGC insurance as a put option, with a strike price equal to the gross value of the pension benefit claim. They show that in the absence of taxes and given the structure of a fixed insurance premium charged by the PBGC, firms can maximize the put value (and accordingly maximize shareholders wealth) by employing a "mini-max" strategy in their pension plan management –

[1] According to The Wall Street Journal (2005), Boeing contributed a total of $3.6 billion to its DB pension plans in 2004. Assuming an effective tax rate of 30% to 35%, Boeing received a tax benefit between $1.1 and $1.3 billion from its pension plan contributions.

maintaining a minimum level of pension funding while investing a maximum level of plan assets into risky assets.[2] As an interesting contrast, Black (1980) and Tepper (1981) suggest a "max-mini" strategy from a tax benefit perspective and show that a tax arbitrage opportunity exists if sponsors invest all the pension assets into bonds.[3] As pension contributions are tax-deductible and the investment income accumulated in pension plans is tax exempt, they argue that sponsors should maintain a maximum level of funding and invest a minimum level of pension funds into risky assets.

The pension plan funding and investment practice, however, appears to be inconsistent with the above theoretical predictions. Many sponsors forgo much of the tax benefit by not fully funding their pension plans. In addition, few sponsors pursue either a mini-max or a max-mini pension investment strategy – on average the assets allocation for a typical large DB plan is 63% in equities, 30% in bonds, and 7% other, according to a Pension & Investment Survey (2004). The relatively high exposure to stock market implies that these sponsors are willing to give up the tax benefit associated with pension plans' favorable tax status. The apparent conflict between theory and practice has prompted a number of studies to explore other possible explanations. In particular, Bicksler and Chen (1985) suggests that, given the presence of capital market imperfection (i.e., pension termination costs and progressive corporate income tax structure), neither a "mini-max" nor a "maxi-min" strategy is optimal. Instead, a non-corner interior solution in pension funding strategy could be necessarily best.[4] But the implication of Bicksler-Chen model has never been investigated.

This paper seeks to provide new empirical evidence on the corporate pension plan contributions and risking-taking decisions by considering the probabilities that the sponsors will terminate their pension plans. We use two measures for pension termination probabilities at both a plan and a sponsor (or firm) level: (1) pension

[2] Other theoretical work related to the PBGC's insurance effect includes Marcus (1987), Pennacchi and Lewis (1994), Cooper and Ross (2003), and Neuberger and McCarthy (2005).
[3] Feldstein and Seligman (1981) also suggest that sponsors can maximize firm value through full funding of their pension liabilities.
[4] Other possible explanations for pension fund investment include earnings management incentive through investing in risky equities (Bergstresser, Desai, and Rauh, 2006), corporate risk management incentive (Rauh, 2009), and hedging needs against increases in real wages (Lucas and Zeldes, 2006).

plan funding ratios; and (2) a sponsor's expected default frequency (EDF). The selection of these two measures is motivated by two types of pension plan terminations: (1) an involuntary termination initiated by the PBGC; and (2) a voluntary termination initiated by financially distressed sponsors. On the one hand, the PBGC can terminate a pension plan if it determines that the sponsors are not able to pay pension benefits when due or the sponsors have not made their minimum funding contributions (MFC) mandatorily required by pension laws. The MFC is primarily calculated based on pension funding levels. Generally, the worse a pension plan funding, the more MFC required by the law. The pension termination probabilities are thus expected to increase for severely underfunded sponsors, to the extent that the sponsors cannot make their required MFC. One the other hand, sponsors can terminate their pension plans if they demonstrate to the PBGC that they are facing liquidation under bankruptcy proceedings and the costs of continuing the plan will cause the firms to fail. Therefore, sponsors with higher expected default probabilities are more likely to terminate their pension plans. We measure sponsors' expected default probabilities using Moody's KMV EDF (expected default frequency). The KMV EDF measures are based on the Merton Distance to Default (DD) model, and have been widely used in investment industry. A growing number of academic studies have also used this measure for firm credit risk (e.g., Coronado et al., 2006).[5]

Our first set of empirical tests is designed to examine sponsors' moral hazard and tax benefit incentives when making pension contributions. Following Rauh (2006), we decompose total pension contributions into mandatory contributions and voluntary contributions. Our interest is in the voluntary contributions as they are the components of pension contributions that are directly related to a sponsor's capacity and willingness to fund their pension plans.[6] Our second set of tests is related to pension assets investment. We use pension beta (Jin, Merton, and Bodie, 2006) and the percentage of pension assets allocated to equity market (a.k.a equity

[5] It should be noted that the pension funding ratio and the EDF are highly correlated. Franzoni and Marin (2006) find that firms with severely underfunded plans (low funding ratios) have the highest probability of default. However, as pointed by Rauh (2006), it is also possible that firms with high distress risk may have overfunded pension plans (and thus lower plan termination probability).

[6] Rauh (2006) focuses on mandatory pension contributions as his research objective is to examine how pension mandatory contributions affect sponsors' capital expenditure and investment decisions.

percent) to measure sponsors' pension investment risk. Pension beta is the difference between pension assets beta and pension liabilities beta; where pension assets beta is estimated as the weighted average of systematic risk of various categories of pension plan assets, and pension liabilities beta is estimated using 30-year Treasury Bond as a benchmark for pricing pension benefit obligations. Equity percent has been widely used in previous studies (i.e., Bodie et al. 1987; Coronado et al., 2006; Rauh, 2009), and it is a simple and straightforward measure for pension investment risk. In contrast, pension beta is a new measure and it has the following advantages. First, in addition to a traditional bond-stock mix, a growing number of pension plans have started investing in private equity, venture capital, hedge funds and other alternative investments.[7] These assets apparently have higher risks than stocks. The use of the equity percent therefore could underestimate the true level of pension risk. Second, pension beta directly indicates the extent to which a sponsor's pension assets mismatch its pension liabilities (Merton, 2006); while equity percent only considers pension assets side.[8] Finally, pension beta also considers the weight of pension assets and pension liabilities over a sponsor's total firm value, as such risk misalignment is particularly severe for sponsors with large pension assets relative to firm market capitalization.[9]

An important issue is that pension funding ratios, the EDF, pension contributions, and sponsors' operating profitability could be endogenously determined. But a majority of previous studies (e.g., Coronado et al., 2006; Bereskin,

[7] The US Government Accountability Office (2008) reports that a considerable number of plans have investment in private equity and hedge funds. The survey data shows that the average portion of plan assets allocated to hedge funds for large DB pension plans is between 21-27% (GAO-08-692 August 14, 2008).

[8] To illustrate, suppose there are two companies. Company A invests 70% of its plan assets into equity market and company B invests 50% into stock market. Common sense tells that company A is taking more risk as it has higher percent of assets invested in stock market. However, from an asset-liability management perspective, what if company A's asset allocation has the same duration as its pension liabilities; while company B's assets mismatch its pension liabilities by a large extent? This simple example highlights the importance of the risk mismatch between plan assets and pension liabilities.

[9] For example, GM had $93 billion pension fund as of January 2006, which was more than six times the firm's $13 billion of market capitalization. GM invested about $60 billion of its pension assets into stock market. As commented by Merton (2006), "If you're holding $60 billion in equities, even a 10% standard deviation – way at the low end for equities historically – is a $6 billion swing in value." Note that this $6 billion change in pension assets already equals half of GM's total market capitalization.

2009) are silent on this issue.[10] To control for the potential endogeneity arising from the contemporaneous measurement of these variables, similar to Chen et al. (2006), we employ a three-stage least square simultaneous equation model using four equations that represent each of the potentially endogenous variables in the system. Our empirical evidence from pension voluntary contributions strongly supports our hypotheses. We find that sponsors with high probabilities of pension plan termination and high expected default frequencies tend to make lower voluntary contributions. These sponsors are dominated by the moral hazard incentive. In contrast, sponsors with low probabilities of plan termination and low firm default risk are more likely to make higher voluntary contributions for the tax benefit purpose. These findings provide supportive evidence for Bicksler-Chen's non-corner interior pension funding solutions.

A puzzling fact, however, is that the evidence from pension beta and pension asset allocation does not support either moral hazard or tax benefit incentive hypotheses. The reasons could be the risk management incentive in pension investment policy (Rauh, 2009), or the inaccuracy of measuring pension risks. We also find that several accounting rules and law changes have made pension termination probabilities a more binding constraint on the sponsors' pension funding. But these changes do not have significant effects on sponsors' pension asset allocation and risk-taking decisions. Finally, we show that pension termination probabilities have more significant effects on sponsors' voluntary pension contributions during the credit crisis period. Collectively, our findings shed new light on the determinants of pension funding and investment risk-taking decisions.

This study contributes to the current literature in the following aspects. First, to our best knowledge, it is the first empirical study to jointly test the moral hazard and tax benefit hypotheses within a unified framework by incorporating pension plan termination probabilities. It stands a sharp contrast with most of the prior studies that test either the moral hazard or the tax incentive separately, but not both. Second, in addition to a conventional measure of equity percent in pension assets, we

[10] One exception is Rauh (2007). In examining the effects of financial condition on capital investment and financing, Rauh (2007) uses several instrumental variables, including the return on the pension assets scaled by the book value of equity, the change in the market leverage ratio deriving from actual investment returns on pension assets, and the change in the book leverage ratio deriving from actual investment returns on pension assets.

follow Jin, Merton, and Bodie (2006) and use pension beta to capture pension risk misalignment between pension assets and liabilities. The use of pension beta has further practical implications given current severe pension underfunding issues caused by the recent market crash. Third, compare to previous studies, we use a unique and long-span pension database from Form 5500. Previous studies have reported inconclusive findings on sponsors' incentives.[11] One reason could be due to the lack of comprehensive and accurate data on pension plan contributions and asset allocation.[12] Fourth, with such longer period data, we are able to examine the effects of changes in pension legal requirement, accounting standard and pension-related information disclosure on sponsors' pension funding and investment risk decisions, given pension sponsors' various economic incentives. This study therefore has important policy implications.

The rest of this paper is organized as follows. In Section 2, we discuss DB pension plan background and develop our major hypotheses. In Section 3, we describe the data and construct the major variables. We report the empirical results in Section 4. Finally, we conclude in Section 5.

2. Pension Background and Hypotheses Development

With a DB pension plan, employees are entitled at retirement to receive a certain amount of benefit based primarily on their years of service, age and salaries. The passage of the Employee Retirement Income Security Act (ERISA) in 1974 has a significant impact on the corporate pension system. Firms are required by the ERISA to allocate a certain amount of funds to meet their pension benefit obligations. These funds usually invest in stock and bond markets, and should be managed solely for the interest of employees, not for the interest of employers. Under

[11] Bodie, Light, Mørck, and Taggart (1987) find a negative correlation between risk-taking and pension funding, whereas Petersen (1996) reports a positive correlation. Hsieh, Kenneth, and Chen (1997) find no significant difference in pension asset allocation and funding status. Coronado and Liang (2005, 2006) test the effect of the government insurance and report lower contributions and funding ratios as firms are close to bankruptcy, but this study does not consider sponsors' tax benefit incentive.

[12] For example, Bodie et al. (1985) and Bodie et al. (1987) use a dataset of 939 firms in 1980. Hsieh et al. (1997) draw on a cross-sectional dataset of 176 firms in 1989. Coronado and Liang (2005) have a sample of 363 observations in 2002. In fact, current accounting standard requires sponsors to report their pension asset allocation information on the annual earnings report (10K) starting from the fiscal year 2003. Before the fiscal year 2003, sponsors did not report this information in 10K, and it is therefore difficult for researchers to obtain comprehensive data.

the ERISA, the pension liabilities have become an integral part of corporate liabilities, and management of pension assets has become an important component of the overall corporate financial policy (Bicksler and Chen, 1985).

Previous studies have documented two incentives related to pension funding and investment risk-taking decisions: the moral hazard and tax benefit incentives. Below we briefly discuss these two incentives and develop our hypotheses after considering the effects of pension termination probabilities on sponsors' incentives.

2.1 Moral Hazard Incentive

The pension benefit insurance provided by the PBGC creates strong moral hazard incentive for sponsors to underfund their pension plans and to assume high pension investment risks. In addition, the current pension accounting rules encourage sponsors to allocate more pension funds into risky assets for the earnings management purpose.

2.1.1 PBGC Insurance Effect

The PBGC was established by the ERISA of 1974 to insure the benefits of DB pension plan participants in the event that (1) the sponsors enter bankruptcy; and (2) the value of pension assets is not sufficient to meet pension obligations.[13] The insurance for pension benefit provided by the PGBC is one of the important economic incentives that influence the corporate pension funding strategy. Bradley Belt (2005), the PBGC Executive Director, states that "any insurance system runs the risk of encouraging bad behavior, but the level of moral hazard plaguing the pension insurance system is staggering." [14] This is because sponsors make pension funding and risk-taking decisions, while the consequences of these decisions are borne

[13] If an insolvent sponsor has pension assets short of pension obligations, the PBGC takes over the pension plan and guarantees benefits up to a certain limit (i.e., $51,750 in 2008 for employees retiring at age of 65). In addition, PBGC has the authority to place a lien on the sponsor's assets up to 30% of the net asset value. This lien would be senior to all unsecured liabilities of the firm except employee wages.

[14] If a sponsor files bankruptcy, the pension beneficiaries were generally bound to accept whatever pension could be provided to them by the default sponsors using the pension assets (Rauh, 2006). The moral hazard issue thus has existed even before the creation of the PBGC. The guaranteed pension benefit from PGBC further exacerbates the moral hazard incentive.

by the PBGC (pension beneficiaries, or ultimately, tax payers), not decision-makers themselves.

This moral hazard issue is further exacerbated by the PBGC risk-independent insurance premium structure. The PBGC collects insurance premiums from pension plan sponsors based on two types of annual premium schedules: (1) the flat-rate premium, which applies to all plans; and (2) the variable-rate premium, which applies only to single-employer plans. The Deficit Reduction Act of 2005 (DRA) increased the PBGC premiums for both single-employer and multi-employers defined benefit plans. It also created a special per participant termination premium to be paid by underfunded single-employer plans in certain voluntary (distress) or involuntary termination situations. For single-employer plans, the DRA increased the flat-rate per participant premium from $19 to $30. With this flat-rate premium system, the PGBC cannot discriminate against the sponsors with significant underfunded pension plans and the sponsors with high default risks by charging risk-based premium to reduce the moral hazard issue. Although severely underfunded pension plans are recently required to pay an additional premium of $9 for every $1,000 (or fraction thereof) of unfunded vested benefits, this variable-rate premium does not fully reflect the bankruptcy risk that a plan sponsor poses to the PBGC.[15] Sponsors therefore have an incentive to make smaller pension contributions, particularly when they have higher probabilities of filing bankruptcy or terminating their pension plans.

2.1.2 Pension Accounting Effect

The Financial Accounting Standards Board (FASB) issued SFAS 87 in 1985 to standardize the accounting rules for DB pension plans. SFAS 87, subsequently amended in 1998 by SFAS 132, requires that sponsors (1) disclose the major pension assumptions, including the expected rate of return on pension plan assets (ERR), the discount rate, and employee compensation increase rate; and (2) report annual pension expenses on the income statement. An important assumption is the ERR.

[15] This information is from the PBGC website (http://www.pbgc.gov). The variable-rate premium system based on pension funding status appears to be related with of potential plan termination risk, but the fairly low rate fails to reduce a firm's moral hazard incentive. For example, suppose a sponsor has pension underfunding of $1 billion, the required additional premium is $9 million, which is in fact not a significant amount for most big firms.

Previous studies (i.e., Bergstresser, Desai, and Rauh, 2006) find that the sponsors may higher equity allocations to justify their selection of a higher ERE. This is because higher ERR would result in lower pension expenses, thus inflating firm operating earnings. The trick is that sponsors do not directly record pension contributions as expenses on their income statement. Rather, they record net periodic pension cost (NPPC), which consists of four parts: service costs, interest costs, other costs, and expected returns on pension plan assets. The expected returns on plan assets, equal to the ERR multiplying by the market value of plan assets, offset the interest costs, service costs, and other costs. The higher the ERR, the higher dollar value of the expected returns on plan assets; *ceteris paribus*, the less the net periodic pension cost, or the less pension expenses reported on the income statement; and lower expenses then lead to higher earnings.

Managers also have much discretion in determining the ERR. The ERR could depart significantly from the realized return of pension assets. For example, if managers assume the pension plan can earn 10% rate of returns, but in reality the pension plan lost the value, or earn a negative 5% instead, managers can still use the assumed 10% gain to compute the annual pension expenses, with the difference between the expected and realized returns being amortized over a long period, subject to other accounting requirements. Risky assets inherently have higher expected returns, so an allocation toward risky assets could help managers justify their use of a high ERR. Burgstresser, Desai, and Rauh (2006) find that a 25 basis point increase in the ERR are associated with five percent increases in equity allocations.

2.2 Pension Plan Tax Treatment and Tax Benefit Incentive

DB pension plans receive a favorable tax treatment. The special tax status of corporate pension plans includes: (1) a sponsor's pension contributions are immediately deductible in calculating corporate income taxes; and (2) the investment earnings on pension plan assets are not taxed.

Pension sponsors must make (minimum) financial contributions to their pension funds according to legally specified formulas. These contributions are normal business expenses that are deductible under the corporate income tax. The annual

minimum pension contributions depend on the funding status of the pension plan. To avoid sponsors using excessive tax deductions, limits are placed on pension contributions. Once sponsors have made contributions to their pension plans, the investment earnings generated from pension funds are not taxed. This aspect of the tax treatment of pension plans is called "inside buildup" (Turner, 1999). Pension assets maintained in the pension plan are also free of tax. Although unfunded pension benefit obligations are an integral part of a sponsor's liability, the excess pension assets do not entirely belong to a sponsor. This is because sponsors are subject to heavy excise taxes when terminating an overfunded pension plan and reverting plan surplus to firm assets. [16]

2.3 Hypotheses Development

The seemingly conflicting incentives between the moral hazard and tax benefit could be reconciled by integrating an important factor that has been observed recently to have significant effects on pension funding and risk-taking decisions – the pension termination probabilities (Spatt, 2005). Consideration of the plan termination probability is critical in our analysis because such probability determines the value of the put option derived from the PBGC insurance, which, in turns, affects the sponsors' various incentives between moral hazard and tax benefit.

On the one hand, as previously discussed, the PBGC insurance of pension benefits creates strong incentive for pension sponsors to take excessive investment risks and make minimum contributions. Additionally, the complicated and opaque pension accounting rules hide the true economic status of pension funding, and induce sponsors to artificially lower their pension expenses (thus to report higher earnings) through using risky investment strategies. As the default option to the PBGC has its greatest value for these sponsors with high pension termination probabilities, the moral hazard incentive becomes most pronounced. On the other hand, for sponsors with low pension termination probabilities, the value of the put option to the PBGC insurance is low. Given the favorable tax treatment of pension

[16] In particular, the excess pension assets are taxed at the corporate income tax rate plus an excise tax of 20 percent. The excise tax rate is increased to 50 percent unless the employer transfers part of the excess assets to a replacement plan or provides a benefit increase under the terminating plan. This tax treatment has significantly discouraged firms from terminating overfunded defined benefit plans.

plan contributions and plan investment earnings, making the maximum possible contributions is optimal. These sponsors are therefore dominated by the tax benefit incentive. To further maximize the potential tax benefits, sponsors are motivated to invest heavily taxed assets (i.e., bonds) in a tax-sheltered account like DB pension plans.[17] Based on the above analysis, we develop our new moral hazard and tax benefit hypotheses after considering pension plan termination probabilities as follows:

> Moral hazard hypothesis: The sponsors with relatively high pension termination probabilities tend to make smaller voluntary contributions and take higher investment risks in their pension funds.
>
> Tax benefit hypothesis: The sponsors with relatively low pension termination probabilities tend to make larger voluntary contributions and take lower investment risks in their pension funds.

3. Data and Variable Construction

The major sources to our data are IRS Form 5500 Data and Compustat. CRSP data are used to estimate a sponsor's stock beta, if a pension plan invests in the sponsor's own stocks. Firm simulated marginal tax rates data are obtained from John Graham and the expected default frequency (EDF) data are from Moody's KMV. We describe the sample construction in details in Table 1. Our final sample expands from 1990 to 2007, with 16,841 firm-year observations.

Form 5500 contains detailed information about plan asset allocation, participants and administrators, plan performance, and actuarial assumptions. All sponsors of pension plans (both DB and DC plans) with more than 100 employees must file the Form 5500 annually to the IRS. The Department of Labor (DoL) is entrusted with keeping the information on file. The government agencies (e.g., IRS, DoL, PBGC) use the form to monitor plan compliance with the ERISA and the Internal Revenue Code. A full filing consists of many schedules and attachments with hundreds of pension-related items. There have been several major changes in the format and items of Form 5500. Take 2007 Form 5500 as an example, the basic plan information is reported in the main 5500 Form; plan asset allocation is reported in Schedule H, which contains a breakdown of asset allocation into standardized

[17] Dammon et al. (2004) and (2005) suggest that from a tax perspective it is optimal for the employees to hold only bonds in the tax-deferred account (e.g., 401(k)) if they have access to sufficient liquidity in their taxable account.

categories; the actuarial information is in schedule B; and pension coverage information is reported in Schedule T. We restrict our sample to DB pension plans.

The major variables include (1) pension termination probabilities, measured by pension funding ratios and sponsors' expected default frequency (EDF); (2) voluntary pension contributions; and (3) pension risks, including pension beta and the percentage of pension assets invested in stock market. The constructions of these variables are described below. Appendix I summarizes definitions for the above variables as well as some other variables used in this study.

3.1 Pension Termination Probability

3.1.1 Pension Funding Ratio

Following Rauh (2006), we define pension funding ratio (FR) as the fair value of pension plan assets (FVPA) minus the present value of pension obligations (PBO), scaled by pension obligations. [18]

$$\mathrm{FR}_{i,t} = \frac{FVPA_{i,t} - PBO_{i,t}}{PBO_{i,t}} \tag{1}$$

We use Compustat database to estimate pension funding ratios. Following Franzoni and Marin (2006), for sponsors with fiscal years before December 1986, the FVPA is set equal to Pension Benefits - Net Assets (#245), and the PBO is set equal to the present value of vested benefits (#243). From Fiscal year ending 1988 to 1997, we set the FVPA equal to the sum of overfunded pension plan assets (#287) and underfunded pension plan assets (#296), and set PBO equal to the sum of overfunded pension obligations (#286) and underfunded pension obligations (#294). After the fiscal year 1997, we set the FVPA equal to #287 and set the PBO equal to #286.[19]

[18] Franzoni and Marin (2006) choose market value as a deflator because market value is correlated with a firm's future cash flow and credit ratings. However, one potential issue of using market value as a deflator, as suggested by Franzoni and Marin (2006) is that this ratio could correlate to a higher B/M ratio, not necessarily implying a better funding status. Another issue is that market value could also relate to a sponsor's default risk and operating performance. Other deflators include total assets, book value of equity, and pension plan assets. We use these different measures for robustness check, and obtain the similar results.

[19] This is because, as first identified by Franzoni and Marin (2006), Compustat makes two structural changes in the way it reports pension related items, corresponding to the introduction of two important pension accounting rules: the SFAS 87 (effective for fiscal years beginning after December 15, 1986) and the SFAS132 (effective for fiscal years beginning after December 15, 1997).

We classify a pension plan as overfunded or underfunded based on its funding ratio. If funding ratio is zero or positive (FVPA $\geq$ PBO), a sponsor is viewed to have overfunded pension plans. If funding ratio is less than zero, a sponsor is considered to have underfunded pension plans.

3.1.2 Expected Default Frequency

The expected default frequency (EDF) for pension sponsors is measured by Moody's KMV EDF. The KMV EDF is estimated based on the Merton Distance to Default (DD) model, which is derived from Merton's (1974) bond pricing model. The Merton DD model produces a probability of default for each firm in each month. To calculate the probability, the model subtracts the face value of the firm's debt from an estimate of the market value of the firm and then divides this difference by an estimate of the volatility of the firm (scaled to reflect the horizon of the forecast). The resulting Z-score, which is sometimes referred to as the distance to default, is then substituted into a cumulative density function to calculate the probability that the value of the firm will be less than the face value of debt at the forecasting horizon (or the firms go bankruptcy). The market value of the firm is simply the sum of the market values of the firm's debt and the value of its equity. [20]

3.2 Voluntary Pension Contributions

Sponsors are required by laws to make pension contributions to maintain a certain level of pension funding in order to meet their pension obligations. Pension contributions can be decomposed into two parts: mandatory contributions and voluntary contributions. Mandatory contributions are based on certain legally specified formula. If sponsors fail to make required mandatory contributions, the PBGC has the authority to place a lien against sponsors' assets and it can also take over the pension plans under certain circumstances. Besides to mandatory contributions, sponsors can make voluntary contributions, subject to full funding limitations and maximum tax deductible contributions. We use the voluntary pension contributions as a percentage of total assets in our empirical tests because they are pertinent to sponsors incentives to fund their pension plans.

[20] See Bharath and Shumway (2008) for a detailed discussion of EDF estimation.

The laws that specify the calculations of pension mandatory contributions have changed a few times since the passage of the ERISA in 1974. As our sample period is from 1990 to 2007, we follow applicable laws and regulations to estimate a sponsor's mandatory and voluntary contributions using Form 5500 Data. Appendix II provides a detailed description on our estimations.

3.3 Pension Investment Risk

3.3.1 Pension Beta

Pension beta (Jin, Merton, and Bodie, 2006), is the difference between pension plan asset beta and pension plan liability beta.

$$\text{PENSION\_BETA}_{i,t} = \frac{\beta_{plan\_asset_{i,t}} \times FVPA_{i,t} - \beta_{plan\_liability_{i,t}} \times PBO_{i,t}}{Firm\ Equity_{i,t} + Firm\ Debt_{i,t}} \tag{2}$$

β_{plan_asset} or pension asset beta is measured as the weighted average beta for the systematic risk of various categories in plan assets. $\beta_{plan\_liability}$ or pension liability beta is estimated using 30-year Treasury Bond as a benchmark for pricing pension benefit obligations. We follow Jin, Merton, and Bodie (2006) to estimate the sponsor's pension asset beta, pension liability beta, and pension beta. The pension asset beta is estimated as the weighted average beta of all the asset classes in sponsor's pension plan. The data on the asset classes and the value of each asset class are from Form 5500. The beta of individual asset class is from Jin, Merton, and Bodie (2006, p9). If the sponsors invest a portion of pension funds into their own stocks, we estimate the sponsors' stock beta using weekly data for one year (up to 52 observations). Stocks that have not been traded for more than 43 weeks during a year are excluded. To adjust for nonsynchronous trading, we follow Dimson (1979) and use one lag and no leads to calculate the beta. [21]

To estimate pension liability beta, we use the 30-year Treasury bond rate as the benchmark for pricing pension liability, as in Jin, Merton, Bodie (2006). [22] The pension liability beta is estimated to be 0.43 if we do a 60-month rolling regression estimate, using all the monthly returns up to the end of the previous year. An

[21] Our empirical results do not change qualitatively if we use different specifications of leads and lags to estimate firm stock beta.

[22] See Jin, Merton, and Bodie (2006) for a detailed discussion on the estimation of pension liability beta.

estimate using all the in-sample data from 1990 to 2007 generates a beta of 0.13. These estimates are comparable to the estimates of 0.46 and 0.18 from Jin, Merton, and Bodie (2006). Firm equity value is estimated as the share price multiplying by total shares outstanding. We use book value of total debt as a proxy for the debt market value. The pension plan beta is then estimated to be the difference between pension plan asset beta and plan liability beta, as in equation (2)

3.3.2 Equity Percent

Another measure for pension risk is the percentage of pension assets invested in equity market. This information is from Form 5500.

3.4 Summary Statistics

We report time-series summary statistics in Table 2. All variables are winsorized at the top and bottom 1% in each year to control for the influence of outliers. As shown in Panel A, sponsors contribute an average (median) 0.66% (0.32%) of total assets to their pension plans, among which 0.10% (0.07%) and 0.57% (0.25%) are made as mandatory and voluntary contributions, respectively. On average, sponsors' pension assets are short of their pension obligations by 3.03%. In estimating sponsors' expected default probability, we follow Coronado et al. (2006) and use the average KMV EDF measure over the twelve months before the beginning of the year. The average 1-year (5-year) EDF is 1.56% (1.45%), with standard deviation of 4.18% (2.96%). We also include several firm-level financial measures for sponsor's profitability and financial resources. Pension sponsors are generally large and matured firms, with the average (median) profitability of 6.04% (5.28%) and the average (median) Tobin's Q of 1.66 and (1.39).

Panel B reports summary statistics on pension plan asset allocation and pension beta. Sponsors on average invest 55.07% of their pension assets into equity market and 39.24% into bonds market. Interestingly, the minimum equity percent and bonds percent are zero; with the maximum percent close to 100%. We also report the asset allocation statistics for several sub-classes of equities and bonds. For instance, the average percent of plan assets invested into common stocks is 43.28%, joint venture 0.48%, registered investment, such as mutual fund and private equity

8.52%, and preferred stock 2.06%. The sponsors' own stock percent in total plan assets on average is trivial, although the maximum percent is 34.13%. The average percent of plan assets invested into government bonds is 4.78%, and corporate bonds 34.39%. Pension beta ranges from -0.02 to 1.05, with an average (mean) of 0.11 and 0.06 if we use 0.13 as a proxy for pension liability beta. The average (mean) of pension beta decreases to 0.07 (0.03) if we use 0.43 as a proxy for pension liability beta.

4. Empirical Results

We first examine the effects of pension termination probabilities on sponsors' moral hazard and tax benefit incentives using the evidence from pension voluntary contributions. We then examine how the sponsors' investment risk-taking decisions are affected by pension termination probabilities based on the evidence from pension beta and equity percent. We also investigate the effects of changes in pension accounting rules and laws on sponsors' pension funding and investment decisions, as well as sponsors' pension contributions and pension risk-taking during the credit crisis period.

4.1 Evidence from Voluntary Pension Contributions

4.1.1 Sort

We begin our tests by using a univariate sort methodology to examine the relation between pension voluntary contributions and pension termination probabilities. In year *t*, we first sort all sample firms into five portfolios based on their expected default frequency or KMV EDF and pension funding ratios in previous year t-1. We then form equally weighted portfolios, and compute the time-series averages of annual voluntary contributions in each portfolio. We also estimate the differences between the portfolio with the lowest EDF/funding ratios and the portfolio with the highest EDF/funding ratios (D1- D5). [23]

[23] Sort methodology has been widely used in asset pricing studies to detect anomalies (Fama and French, 2008). The main advantage of sort used here is a simple picture of how pension contributions vary across the spectrum of firm expected default frequency.

The results are reported in Table 3. In Panel A, the portfolio with the lowest EDF or the safest portfolio (D1) has an average voluntary contribution of 0.75%, while the portfolio with the highest EDF or the riskiest portfolio (D5) has an average contribution of 0.63%, with the difference of 0.12% (t = 1.73). In Panel B, after sorting voluntary pension contributions in year t based on pension funding ratios in year t-1, we find that sponsors with lower pension funding ratios (D1) make smaller voluntary contributions than those with higher pension funding ratios (D5), with the difference of -0.27 (t = -5.06).

The preliminary evidence reported above is consistent with moral hazard hypothesis. However, the fact that the sponsors with higher bankruptcy risk or lower funding ratios make small voluntary contributions could be simply because they are constrained by financial sources and cash flows, not necessarily driven by the moral hazard incentive. In unreported table, we find a negative correlation between the EDF and sponsors' free cash flows, suggesting that high bankruptcy risks are correlated with financial constraint. To control for the effect of sponsors' financial constraints on voluntary pension contributions, we double sort voluntary contributions on both the EDF/funding ratios and cash flows. In particular, in year t, we first sort all sample firms into five portfolios based on their EDF/funding ratios in year t-1. Within each portfolio, we sort all observations into five portfolios based on their cash flows in year t-1. We then compute the time-series averages of voluntary pension contributions across 25 portfolios (5 x 5), as well as the differences across extreme portfolios ranked on the EDF/funding ratios and cash flows.

The results for the bivariate sort are reported in Panel C and D. In Panel C, holding the cash flows constant, we observe that the riskiest firms ranked by the EDF exhibit the least voluntary contributions and the difference between the extreme portfolios (D1-D5) are generally positive and significant at conventional levels. Next, holding the EDF constant, we find that voluntary contributions increase as the rank of cash flow increases, indicating that sponsors generally make more voluntary contributions as they have more cash flows available. The differences between extreme portfolios (F1 – F5) ranked by cash flow are generally negative and significant. We report similar results in Panel D when double sorting voluntary pension contributions on funding ratios and cash flows. Overall, our bivariate sort result supports the moral hazard hypothesis after controlling for the cash flow effect.

We now test tax benefit hypothesis using the similar sort methodology. We expect that for the sponsors with low expected default probabilities, those with high marginal tax rates are likely to make more voluntary pension contributions than those with low marginal tax rates. We first obtain a sub-sample of the sponsors with low expected default probabilities after sorting all the observations into three groups based on the EDF in year t-1: low, medium, and high bankruptcy risk groups. For the low bankruptcy risk group, we then sort sponsors into five portfolios, as previously described.

The results are reported in Panel A of Table 4. As expected, the portfolio with the lowest marginal tax rate (D1) has an average voluntary contribution of 0.63%, while the portfolio with the highest tax rate (D5) has an average voluntary contribution of 0.75%, with a difference of -0.12% (t = -2.40). For the same argument that was made previously, we need to control for the effect of sponsor's financial constraints on pension contributions. We double sort pension voluntary contributions on both marginal tax rates and cash flow. Again, the results reported in Panel B are consistent with the tax benefit hypothesis.

4.1.2 Regression Analysis

In this section, we use the following regression to examine the moral hazard and tax benefit hypotheses for sponsors' pension contributions decision:

$$VCT_{i,t}=\alpha+\beta_1 EDF_{i,t-1}+\beta_2 TAX_{i,t-1}+\beta_3 CF_{i,t-1}+\beta_4 PROFIT_{i,t-1}+\beta_5 FR_{i,t-1}+\beta_6 LNASSET_{i,t-1}+\beta_7 TOBIN_{i,t-1}+\beta_8 UNION_{i,t-1}+\varepsilon_{i,t-1} \quad (3)$$

The variables EDF, FR and TAX are used in the regression equation to test the moral hazard and tax benefit hypotheses. We expect to have a negative coefficient for EDF, a positive coefficient for FR, and a positive coefficient for TAX. CF and PROFIT are included to control the effect of sponsors' financial sources and profitability on pension voluntary contributions. We use Tobin's Q to control for sponsors' growth opportunity. Appendix I provides detailed definitions for the variables.

We also include UNION, a measure of labor force unionization into the regression because previous studies have found that labor union has a significant

effect on sponsors' pension funding and contributions. For example, Ippolito (1985) shows that pension plans of the unionized firms are generally underfunded because sponsors can use underfunded pension plans to discipline hold-up incentives by unions. Ippolito also reports that when the rate of unionization of a firm rises from the industry average of 40% to 80%, the probability of pension plan termination due to bankruptcy increases by 70%. We obtain the industry unionization data from the Union Membership and Coverage Database maintained by Barry Hirsch and David Macpherson. Due to the lack of detailed data on labor unionization at the firm level, this industry-level labor unionization measure has been widely used in labor economics (i.e., Connolly, Hirsch, and Hirschey, 1986) and in recent finance studies (i.e., Chen, Kacperczyk, and Ortiz-Molina, 2010) as a proxy for firm-level labor unionization.[24]

The Fama-MacBeth regression results are reported in Table 5. The estimated coefficients for EDF and FR are all consistent with our expectations across various models. Using the full model result to illustrate, for example, a one standard deviation increase of sponsors' EDF is associated with a reduction of 0.07% of voluntary pension contribution; while a one standard deviation decrease of funding ratios is associated with a reduction of 0.04% of voluntary contributions. Given the average total assets of $10,458 million in our sample, such changes in EDF and FR translate into $7.84 and $4.18 million reduction of pension voluntary contributions, respectively. The pension termination probabilities therefore have economically significant effects on sponsors' pension funding decisions. Turn to the estimated coefficients for TAX, we find that they are all positive and significant, also consistent with our expectations – sponsors with high marginal tax rates tend to make more voluntary pension contributions to take advantage of the favorable tax status of pension contributions

As previously discussed, the reduction of pension contributions may not be due to sponsors' incentive to exploit the PBGC guarantee but due to the limited cash flows and poor profitability. As expected, the coefficients for cash flows and profitability are positive and statistically significant. The negative and significant coefficient of Tobin's Q indicates that the sponsors with high growth prospects tend

[24] See Hirsch and Macpherson (2003) for details on the construction of the data set.

to make less voluntary contributions. The reason could be that these sponsors make more capital expenditure to exploit growth opportunities, thus leaving less financial sources for voluntary pension contributions. Finally, the measure of labor unionization, UNION has a negative and but insignificant coefficient in the full model. The reason could be due to the declining influence of labor unions on corporate finance decisions as a result of the recent decrease of labor unionization rate.

4.1.3 Endogeneity

An important issue is that the sponsors' voluntary contributions, expected default frequency, funding ratios, and operating profitability could be endogenously determined. In particular, the deterioration of pension funding could be simply because the sponsors have poor operating profitability, high credit risk, and limited cash flows available to fund their pension plans. From a theoretical perspective, Cooper and Ross (2002) show that the level of pension underfunding is determined by the credit ratings (another measure of firm default risk), to the extent that a sponsor's ability to borrow is influenced by its credit ratings. On the other hand, severely underfunded pension plans could also cause poor operating performance and reduced financial resources. This is because these underfunded sponsors have to reduce their capital expenditures in response to the reduction in internal financial resources caused by required mandatory pension contributions (Rauh, 2006). Such investment and financing constraints due to pension plan underfunding become more significant for the sponsors with severely underfunded pension plans and for sponsors with high default risk, as these sponsors have to divert valuable financial resources from their operating activities to make mandatory pension contributions. To illustrate, Rauh (2006) finds that for every dollar of mandatory pension contributions to underfunded pension plans, sponsors will have to reduce their capital expenditure by \$0.60 to \$0.70. However, this endogeneity issue related to pension funding has been largely ignored by previous studies (e.g., Coronado et al., 2006; Bereskin, 2009).

To control for the potential endogeneity problems arising from the contemporaneous measurement of voluntary pension contributions, expected default frequency, funding ratios, and sponsors' operating profitability, following Chen et al.

(2006), we employ a simultaneous equation model using four equations that represent each of the potentially endogenous variables. The system of equations is specified as follows:

$$VCT_{i,t}=\alpha+\beta_1 EDF_{i,t-1}+\beta_2 TAX_{i,t-1}+\beta_3 CF_{i,t-1}+\beta_4 PROFIT_{i,t-1}+\beta_5 FR_{i,t-1}+\beta_6 LNASSET_{i,t-1}+\beta_7 TOBIN_{i,t-1}+\beta_8 UNION_{i,t-1}+\varepsilon_{i,t-1} \quad (4a)$$

$$EDF_{i,t}=\alpha+\beta_1 FR_{i,t-1}+\beta_2 PROFIT_{i,t-1}+\beta_3 LNASSET_{i,t-1}+\beta_4 CF_{i,t-1}+\beta_5 VCT_{i,t-1}\ \varepsilon_{i,t-1} \quad (4b)$$

$$PROFIT_{i,t}=\alpha+\beta_1 FR_{i,t-1}+\beta_2 EDF_{i,t-1}+\beta_3 TAX_{i,t-1}+\beta_4 VCT_{i,t-1}+\beta_5 TOBIN_{i,t-1}+\beta_6 CF_{i,t-1}+\varepsilon_{i,t-1} \quad (4c)$$

$$FR_{i,t}=\alpha+\beta_1 TAX_{i,t-1}+\beta_2 CF_{i,t-1}+\beta_3 VCT_{i,t-1}+\beta_4 TOBIN_{i,t-1}+\beta_5 PROFIT_{i,t-1}+\beta_6 LNASSET_{i,t-1}+\beta_7 UNION_{i,t-1}+\varepsilon_{i,t-1} \quad (4d)$$

We estimate the parameters of the simultaneous equation model using the three-stage least squares method with the estimation results presented in Table 6. The potential endogeneity bias does not significantly affect the relation between sponsors' voluntary contributions and pension plan termination probabilities. In column B (equation 4a), EDF remains to be negative and significant and FR remains to be positive and significant. The coefficient of TAX is positive and significant. Column C (equation 4b) reports results when KMV EDF is a dependent variable. The coefficients of PROFIT, CF, and FR are all negative and significant, suggesting that sponsors with high (low) profitability, more (less) cash flows, and strong (weak) funding ratios tend to have low (high) default risk. The coefficient of VCT is also negative, implying that higher voluntary contributions are associated with lower default risks. In Column D (equation 4c) and E (equation 4d), we set sponsors' profitability and pension funding ratios as dependent variables, respectively. It shows that sponsors' expected default frequency, pension funding ratios, and voluntary pension contributions are all associated with sponsors' profitability; while voluntary pension contributions are also positively related with funding ratios.

In sum, after controlling for the potential endogeneity problems, our empirical evidence from pension voluntary contributions remains to be consistent both moral hazard and tax benefit hypotheses.

4.2 Evidence from Pension Investment Risk

4.2.1 Sort

We first test the moral hazard hypothesis using a similar sort methodology as described previously. As shown in Panel A of Table 7, the safest portfolio (D1) has

an average equity allocation of 56.61%, while the riskiest portfolio (D5) has an average equity allocation of 55.76%, with a slight and insignificant difference of 0.84% (t = -0.92). When using pension beta as a measure for pension investment risk, we find that the sponsors with the highest default probabilities (D5) do take higher pension asset-liabilities mismatch risk relative to those with lowest default probabilities (D1) (0.1115 vs. 0.1071); however, the difference is not significant at a conventional confidence level (t = 0.72). Interestingly, when using pension funding ratios as a measure for pension termination probabilities, the sort result in Panel B actually indicates that sponsors with lowest (highest) funding rations (D1) allocate a smaller (larger) percent of their pension assets into equity market and assumes lower (higher) pension risk, with significant differences between D1 and D5. These findings are contrary to the results predicted by the moral hazard hypothesis.

To test the tax benefit hypothesis, we again use a sub-sample of sponsors with low expected default probabilities. The result is reported in Panel C. The portfolio with the lowest marginal tax rate (D1) has an average equity allocation of 58.23% and pension risk of 0.1202, while the portfolio with the highest tax rate (D5) has an average equity allocation of 56.78% and 0.1143. The differences between D1 and D5 are not significant. The results are not consistent with the tax benefit hypothesis.

4.2.2 Regression Analysis

We now use the following regressions to examine the moral hazard and tax benefit hypotheses associated with sponsors' pension investment risk-taking decisions:

$$RISK_{i,t}=\alpha+\beta_1 EDF_{i,t-1}+\beta_2 TAX_{i,t-1}+\beta_3 CF_{i,t-1}+\beta_4 PROFIT_{i,t-1}+\beta_5 FR_{i,t-1}+\beta_6 LNASSET_{i,t-1}$$
$$+\beta_7 TOBIN_{i,t-1}+\beta_8 UNION_{i,t-1}+\varepsilon_{i,t-1} \quad (5)$$

The regression results are reported in Table 8. The estimated coefficients for EDF, FR, and TAX are not significant. The positive and significant coefficient for PROFIT suggests that sponsors with high (low) profitability tend to allocate larger (smaller) percent of their pension funds into equity market. When using pension beta as a dependent variable, we fail to find a significant relation between pension risk and EDF/TAX. However, the coefficient for FR is positive and significant (β = 0.2857, t = 4.63), implying that sponsors with high (low) pension funding status are

more likely to assume high (low) pension risk. Again, these finding are not consistent with the moral hazard and tax benefit hypotheses.

4.2.3 Discussions

The evidence from pension risk does not support either moral hazard or tax benefit hypothesis. One possible explanation is the risk management incentive in pension asset management. According to Rauh (2009), the required pension contributions, particularly for severely underfunded plans, motivate sponsors to limit their risk-taking rather than to shift risks to the PBGC, as predicated by the moral hazard hypothesis. The is because "should the firm avoid bankruptcy but face poor performance in its pension fund, it must continue to fund the pension plans with liquid resources" (p3). Therefore, the underfunded (overfunded) firms tend to invest more in safe (risky) asset to reduce the volatility of pension assets as well as to minimize the variation of pension contributions in the future.

Another reason could be due to the measurement inaccuracy of pension risk. Our estimations of pension beta and equity percent both require the weight of various asset classes in pension assets. But such weight could have been changed as a result of (1) a decline in the market value of the asset; and/or (2) an active asset rebalancing initiated by sponsors. In the first situation, the change of a certain asset allocation is purely passive; and should not included in estimating asset allcation. But our measures incorrectly include the first situation[25]. To thoroughly examine sponsors' risk-taking decisions, we need to decompose asset allocation into two components: a passive allocation due to the asset value changes and an active allocation due to portfolio rebalance. The focus should be on the active asset allocation. However, to decompose asset allocation into passive and active allocation, we need detailed pension plan rebalancing information, which is not available.

4.3 Changes in Pension Accounting and Legal Requirement

[25] For instance, suppose a pension plan has \$1,000 in bonds and \$1,000 in equities in year t. Suppose the market crash has caused the market value of equities to reduce to \$600 in year t+1. In such a case, the weight of stock in year t+1 is 600/1600, as opposed to the weight in year t of 1,000/2,000. However, this change of stock weight does not necessarily mean that sponsor has actively reduced stock allocation.

In this section, we investigate the effects of changes in pension accounting standard and funding legal requirement on sponsors' pension contributions and investment risk-taking decisions. There have been several important pension accounting rules and laws since the passage of ERISA in 1978, including SFAS 87, RPA of 1994, SFAS 132, SFAS 132(R), SFAS 158, and PPA of 2006. We select the RPA of 1994 and the SFAS 132(R) for our tests because of their important roles in promoting pension information transparency and strengthening pension funding requirements. For example, the major provisions of the RPA 1994 (passed in December 1994) include strengthening pension funding for underfunded sponsors and requiring more reporting to PBGC for sponsors with large underfunded plans. The SFAS 132 (R) (effective fiscal year after December 15, 2003) requires additional disclosures of pension asset allocation, pension obligations and pension expenses.

We add a binary variable RULES on the regression equation (3), and interact RULES with EDF, TAX, and FR to test how these changes in pension accounting and pension laws affect sponsors' incentives. RULES equals to 1 if sponsors make pension contributions or allocate pension assets after the passage of the RPA of 1994 and after the effective date of SFAS 132(R) (post-period); and 0 if otherwise (pre-period).

The results are reported in Table 9. When using voluntary pension contributions as a dependent variable, the coefficients for EDF, TAX and FR are similar to those reported in Table 5. The coefficient for RPA94xEDF is negative and significant, and for RPAxFR is positive and significant, implying that the EDF has more significant effects on voluntary contributions after the introduction of the RPA of 1994. Similar results are reported when interacting EDF and FR with SFAS132(R). The results suggest that these accounting rules and law changes have made pension termination probabilities (both funding ratio and EDF) a more binding constraint on the sponsors' funding decisions. However, these changes do not have any significant effects on sponsors' pension asset allocation and risk-taking decisions, as reported in model (c) to (f).

4.4 Pension Funding and Asset Allocation during Market Crisis

Corporate pension funding has deteriorated significantly during the recent market crisis. Large corporate pension plans lost about $100 billion of pension plans over just five days of October 2008, according to a report by Pensions & Investments. This could drive the already deteriorating funding levels of corporate pensions even deeper into deficit. In this session, we examine sponsors' pension funding and investment risk-taking decisions from 2008 to 2009.

As our Form 5500 Data ends at 2007, we use Compustat Pension Annual Data to estimate voluntary pension contributions and equity percent.[26] We include a binary variable CRISIS in the regression equation (3), and interact it with EDF, TAX, and FR. CRISIS equals to 1 if pension contributions are made (or pension assets are allocated) between 2008 and 2009; and 0 if otherwise (pre-period). The regression results are reported in Table 10. The coefficient for CRISISxEDF is negative and significant when using both voluntary pension contributions and equity percent as a dependent variable. This suggests that pension termination probabilities have more significant effects on sponsors' voluntary pension contributions and investment risk-taking during the credit crisis period.

5. Conclusions

With one unified framework, we jointly test two hypotheses related to defined benefit (DB) pension funding and investment risk-taking behaviors: (1) moral hazard hypothesis; and (2) tax benefit hypothesis by incorporating sponsors' pension termination probabilities. The evidence from voluntary pension contributions supports our hypotheses. That is, the sponsors with different expected bankruptcy probabilities are governed by different incentives. The moral hazard incentive becomes dominant for the sponsors with low funding ratios and high pension termination probabilities – these sponsors make smaller voluntary pension contributions. In contrast, the tax benefit incentive dominates when sponsors have high funding ratios and low pension termination probabilities. As the value of the PBGC guarantee option is low, the sponsors are likely to make more voluntary

[26] Compared to Form 5500 Data, the asset categories in the Compustat are fairly coarse (four categories: equity, bond, real estate, and other versus more than 15 categories reported in Form 5500). We are able to estimate voluntary pension contributions and equity percent based on Compustat data; but are not able to estimate sponsors' pension beta. Consequently, our test in this session does not include pension beta.

contributions to maximize the tax benefit. However, the evidence from pension asset allocation and pension beta are not consistent with our hypotheses, suggesting that future research is needed to explore this puzzling finding.

This study has important policy implications, particularly considering recent stock market crash triggered by sub-prime mortgage crisis. It helps regulators, government, the PBGC, the SEC, and the FASB develop optimal pension plan funding policies, premium structure, and tax/accounting rules. For example, the PBGC's flat premium schedule has been long criticized for the center on the moral hazard issue. Although severely underfunded pension plans are required to pay an additional premium based on the underfunding level, this structure does not fully reflect the bankruptcy risk that a plan sponsor poses to the PBGC. Further, because both sponsors' stock price and pension plans assets lost their value dramatically amid the market meltdown during 2008, the probabilities of sponsors' bankruptcy and pension plan termination are expected to have increased significantly. This could cause even stronger moral hazard incentive for pension plan sponsors, which, in turns, poses a high risk to the financial viability of the PBGC and to the retirees' social welfare as well.[27]

[27] The PBGC lost $4.1 billion on its investments in fiscal year 2008, including $1.7 billion loss in September alone, with the total deficit of $10.7 billion at the end of fiscal year 2008. The deficit increased 97% to $21.1 billion at the end of fiscal year 2009.

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Appendix I: Variable Definitions

Variable	Definitions	Source
FR_PBO FVPA PBO FUNDING FR_MKV FR_ASSET	Pension funding ratio (FR_PBO) is defined as fair value of pension assets (FVPA) minus pension projected benefit obligation (PBO), and scaled by PBO (Equation 1). The difference between FVPA and PBO is defined as FUNDING. Following Franzoni and Marin (2006), for companies with fiscal years before December 1986, the FVPA is set equal to Pension Benefits - Net Assets (#245), and the PBO is set equal to the present value of vested benefits (#243). From Fiscal year ending 1988 to 1997, we set the FVPA equal to the sum of overfunded pension plan assets (#287) and underfunded pension plan assets (#296), and set PBO equal to the sum of overfunded pension obligations (#286) and underfunded pension obligations (#294). After the fiscal year 1997, we set the FVPA equal to #287 and set the PBO equal to #286. FR_MKV and FR_ASSET are alternative measures of pension funding ratios using firm equity market value and firm total assets as scalars, respectively.	Compustat
VCT TCT MCT	Sponsors' voluntary contributions (VCT), equal to total contributions (TCT) minus mandatory contributions (MCT), scaled by sponsors' beginning of the year total assets.	Form 5500 and Compustat
PENSION_BETA	Pension plan beta, estimated as the difference between pension plan asset beta and pension plan liability beta (Equation 2), as in Jin, Merton, and Bodie (2006). Pension plan asset beta is measured as the weighted average beta for the systematic risk of various categories in plan assets. Pension plan liability beta is estimated using 30-year Treasury Bond as a benchmark for pricing pension benefit obligations. Pension liability beta is estimated to be 0.43 if we do a 60-month rolling regression estimate, using all the monthly returns up to the end of the previous year. An estimate using all the in-sample data from 1990 to 2007 generates a beta of 0.13. PLAN_BETA1 is the pension beta when βplan_liability=0.13 and PLAN_BETA2 is the pension beta when βplan_liability=0.43.	Form 5500, CRSP, and Jin, Merton, Bodie (2006, $p9$).
EQUITY_PCT	Percentage of total plan funds invested in equities.	Form 5500
BOND_PCT	Percentage of total plan funds invested in bonds.	Form 5500
CASH_PCT	Percentage of total plan funds invested in cash.	Form 5500
ESTATE_PCT	Percentage of total plan funds invested in real estate.	Form 5500
KMV_EDF KMV_EDF5	KMV_EDF is one year firm expected default frequency, and KMV_EDF5 is annualized five year firm expected default frequency.	Moody's KMV
PROFIT	Firm profitability, measured as net income (#18) divided by total sales (#12).	Compustat
TOBIN	Tobin's Q is the market value of equity (#199*#25) plus book assets (#6) minus the book value of common equity including deferred taxes (#60 + #74) over assets, as described in Baker, Stein, and Wurgler (2003) and Rauh (2006).	Compustat
CF	Nonpension cash flows equal to net income plus depreciation and amortization plus the accounting definition of the pension expense (#14 + #18 +#43), scaled by total assets, as described in Rauh (2006).	Compustat
TAX	Sponsors' simulated firm marginal tax rate.	John Graham
UNION	Labor unionization rate, measured as the percentage of workers in a Census Industry Classification (CIC) industry who are union members.	Barry Hirsch David & Macpherson
AGE	Firm age (in logarithm), measured as the years that a firm appears in Compustat database.	Compustat
PROFIT	Firm profitability, measured as net income (#18) divided by total sales (#12).	Compustat

Appendix II: Estimation of Sponsor's Voluntary Pension Contributions

Our sample period for estimating pension contributions is from 1990 to 2007. As the laws that specify the calculations of pension plan contributions have changed a few times since the passage of the ERISA in 1974, we follow applicable laws and regulations to estimate a sponsor's mandatory and voluntary contributions using IRS Form 5500 Data. In particular, the applicable laws are as follows: (1) from 1990 to 1994: pension contributions are estimated based on the ERISA of 1974 and the Pension Protection Act of 1987; (2) from 1995 to 2005: pension contributions are estimated based on Retirement Protection Act (RPA) of 1994; and (3) from 2006 to 2007: pension contributions are estimated based on the Pension Protection Act of 2006.

From 1990 to 1994: A sponsor's mandatory pension contributions (MCT) are the maximum of two components: the minimum funding contributions (MFC) and the deficit reduction contributions (DRC). The MFC was first instituted by the ERISA of 1974 and codified in §412(b) (1) of the Internal Revenue Code (IRC) (Rauh, 2006). It is defined as the normal cost (or service cost) plus 10% of the ERISA underfunding (or the difference between fair value of pension assets and project benefit obligations). DRC was introduced by the Pension Protection Act of 1987 and was used to increase funding of underfunded pension plans by requiring sponsors to deposit into the plan as a deficit reduction or "catch-up" contribution. Usually a pension plan requires a minimum contribution when the assets of the plan become less than 80 to 90% of the current liabilities of the plan. The formula to estimate the first-year DRC under the Retirement Protection Action (RPA) of 1987 is min {0.30, [0.30 − 0.25*(funding status − 0.35)]} before 1995, whereas the funding status is defined as fair value of pension assets over projected benefit obligations. [28] After estimating a sponsor's mandatory contributions, the voluntary pension contributions (VCT) are then defined as the total employer's contributions minus mandatory contributions, scaled by the beginning-of-year balance sheet total assets.

From 1995 to 2005: The Retirement Protection Action (RPA) of 1994 changed the formula to estimate the first-year DRC to min {0.30, [0.30 − 0.40*(funding status − 0.60)]}. We thus use this new formula to estimate a sponsor's mandatory contributions and the voluntary pension contributions (VCT). We again scale total contributions and mandatory and voluntary contributions by the beginning-of-year balance sheet total assets.

For 2006 and 2007: Under the Pension Protection Act of 2006, the amount of contributions required for a plan year under the minimum funding rules is "generally the amount needed to fund benefits earned during that year plus that year's portion of other liabilities that are amortized over a period of years, such as benefits resulting from a grant of past service credit" (Technical Explanation of the PPA of 2006, p2). Under the new rules, sponsors of underfunded plans are required to make substantially more contributions than the previous law, with significant volatility in mandatory contributions from year to year. A plan sponsor's minimum funding contribution (MFC) is based on the plan's target normal cost and the difference between the plan funding target and the value of plan assets. If the value of plan assets is less than the funding target, the MFC is the sum of (1) target normal cost; (2) any shortfall amortization charge; and (3) any waiver amortization charge. If the plan value is above the funding target, the MFC is the target normal cost, reduced by the excess of plan value over the funding target (Technical Explanation of PPA, 2006). Additional contributions are waved under the PPA of 2006 if pension plan funding status is above 90% (FVPA over PBO). However, additional contributions are required if pension plan funding status is below 90%. The amount of the additional contributions required is generally estimated as an excess amount, if any, of (1) the deficit reduction contributions (DRC), over (2) the contribution required under the normal funding rules. The DRC is calculated as the sum of three components: unfunded old liability amount; (2) unfunded new liability amount; and (3) the expected increase in current liability due to benefits accruing during the plan year.

[28] Note that our definition of pension funding ratios (equation 1) is consistent with the definition of pension funding status here, as we use pension obligations as a scalar.

Table 1: Sample Construction

We first merge Form 5500 Data with Compustat by the Employment Identification Number (EIN), as in Madrian and Gron (2004) and Jin, Merton, Bodie, 2006). The combined Form 5500-Compustat data is then merged with Moody's KMV EDF data, Graham simulated marginal tax rate data, and CRSP by PERMNO and GVKEY using CRSP PERMNO link file, resulting in 16,841 firm-year observations from 1990 to 2007.

Item	Key Variables	Data Source	Data Range	# of Observations
(a)	Pension assets, liabilities, funding ratios, and other accounting measures	Compustat	1981 - 2007	48,895 firm-years
(b)	Pension contributions (mandatory and voluntary) and asset allocations	IRS Form 5500	1990 - 2007	220,617 firm- years
(c)	Merge (a) and (b)	---	1990 - 2007	17,961 firm-years
(d)	Firm stock beta (to estimate pension beta for pension plans holding their employers' stocks)	CRSP	1990 - 2007	155,022 firm-year
(e)	Moody's KMV EDF measure	Moody's KMV Data	1990 - 2007	40,754 firm-year
(f)	Simulated marginal tax rate	John Graham MTR Data	1990- 2007	116,171 firm-year
(g)	Merge (c), (d), (e), and (f)	---	1990 - 2007	16,841 firm-years

Table 2: Summary Statistics

Panel A reports time-series summary statistics of plan funding and sponsors' financial measures. The sample includes 16,841 firm-year observations from 1990 to 2007. Panel B reports summary statistics of pension beta and asset allocation. We provide variable definitions in Appendix I.

Panel A: Pension Plan Funding and Sponsors' Financial Characteristics

	Mean	MIN	25th	median	75th	MAX	Standard Deviation
FVPA (pension assets)	575.3572	0.7568	27.1834	104.0899	417.6806	15221.2222	1488.5886
PBO (pension liabilities)	597.3530	0.9594	31.6860	112.1803	425.6741	15571.2778	1511.8112
FUNDING	-14.4599	-1,129.6442	-38.2872	-7.2991	12.6888	1716.3132	222.9562
TCT (total contributions)	0.0066	0.0000	0.0007	0.0032	0.0091	0.0496	0.0086
MCT (mandatory contributions)	0.0010	0.0000	0.0002	0.0007	0.0013	0.0065	0.0012
VCT (voluntary contributions)	0.0057	0.0000	0.0004	0.0025	0.0078	0.0465	0.0081
FR_PBO (funding ratio)	-0.0303	-0.6153	-0.1719	-0.0502	0.0870	0.8481	0.2247
FR_MKV	-0.0176	-1.4836	-0.0305	-0.0060	0.0154	0.4323	0.1436
FR_ASSET	-0.0035	-0.1447	-0.0203	-0.0051	0.0101	0.1719	0.0405
KMV_EDF (expected default frequency)	1.5559	0.0150	0.0959	0.2126	0.7328	29.6240	4.1808
KMV_EDF5	1.4502	0.0312	0.2102	0.4299	1.1205	20.9474	2.9630
ASSET	10,458.21	6.98	400.14	1,340.77	5,319.06	664,022.09	45,478.22
PROFIT	0.0604	-0.4153	0.0200	0.0528	0.1026	0.3334	0.0873
TOBIN	1.6619	0.0523	1.1019	1.3909	1.9201	6.7475	0.9109
CF (cash flow)	0.0786	-0.1733	0.0335	0.0741	0.1175	0.3194	0.0672
TAX (simulated marginal tax rate)	0.3091	0.0132	0.3384	0.3500	0.3505	0.3814	0.0922
UNION (labor unionization rate)	15.9442	3.9833	7.8667	14.5167	24.0500	31.9167	9.2394
Firm age (years)	31.4281	3.8333	15.1667	34.0000	44.8333	53.5000	16.5882

Panel B: Summary Statistics of Pension Beta and Asset Allocation

Pension Asset Categories	Mean	MIN	Q1	Median	Q3	MAX	STDEV
EQUITY_PCT	0.5507	0.0000	0.4892	0.5000	0.6117	0.9987	0.1652
Common stock	0.4328	0.0000	0.4181	0.4926	0.5000	0.9028	0.1680
Joint venture	0.0048	0.0000	0.0000	0.0000	0.0000	0.1873	0.0211
Employer stock	0.0073	0.0000	0.0000	0.0000	0.0000	0.3413	0.0334
Interest in registered investment companies	0.0852	0.0000	0.0000	0.0000	0.0517	0.2972	0.1127
Preferred stock	0.0206	0.0000	0.0000	0.0000	0.0008	0.2833	0.0974
BOND_PCT	0.3924	0.0000	0.2992	0.4755	0.5000	0.9074	0.1680
Government bonds	0.0478	0.0000	0.0000	0.0000	0.0493	0.7843	0.1036
Corporate bonds	0.3439	0.0000	0.1670	0.4625	0.4999	0.6823	0.1866
Loans to participants	0.0000	0.0000	0.0000	0.0000	0.0000	0.0153	0.0009
Loans secured by mortgages & other loans	0.0007	0.0000	0.0000	0.0000	0.0000	0.0810	0.0060
CASH_PCT	0.0552	0.0000	0.0000	0.0146	0.0631	0.9583	0.1193
Non-interest bearing cash	0.0019	0.0000	0.0000	0.0000	0.0000	0.2715	0.0198
Certificate of deposit	0.0533	0.0000	0.0000	0.0135	0.0616	0.9311	0.1156
ESTATE_PCT							
Both income & non-come producing real estate	0.0017	0.0000	0.0000	0.0000	0.0000	0.0768	0.0084
PENSION_BETA1 (β_{pl} =0.13)	0.1120	-0.0191	0.0167	0.0632	0.1528	1.0501	0.1417
PENSION_BETA2 (β_{pl} =0.43)	0.0683	-0.0946	0.0071	0.0346	0.0960	0.7230	0.0967

Table 3: Sort of Pension Voluntary Contributions on Pension Funding Ratios, Sponsor Expected Default Frequency and Cash Flows

In Panel A, all sample firms at the year *t* are first sorted into five portfolios based on their expected default frequency at previous year *t*-1. We then form equally weighted portfolios in each portfolio, and compute the time-series averages of pension contributions. We also estimate the differences between the portfolio with the lowest bankruptcy risk (D1) and the portfolio with the highest bankruptcy risk (D1- D5). Similarly, in Panel B, we sort pension voluntary contributions in year *t* based on pension funding ratios in year *t*-1. In Panel C, we double sort voluntary contributions on both EDF and cash flows. Particularly, in year *t*, we first sort all sample firms into five portfolios based on their EDF in year *t*-1. Then, within each portfolio, we further sort all observations into five portfolios based on their cash flows in year *t*-1. We compute the time-series averages of voluntary contributions across 25 portfolios (5 x 5), as well as differences across extreme portfolios ranked on the EDF and cash flows.

Panel A: Univariate Sort of Pension Voluntary Contributions (VCT) on EDF

EDF Rank	VCT	*t* - statistics
D1 (Lowest EDF)	0.0075	7.70
2	0.0061	6.41
3	0.0051	7.15
4	0.0056	10.59
D5 (Highest EDF)	0.0063	6.83
D1 – D5	0.0012	1.73

Panel B: Univariate Sort of Pension Voluntary Contributions on Funding Ratios

Funding Ratios Rank	VCT	*t* - statistics
D1 (Lowest FR)	0.0036	9.26
2	0.0069	6.81
3	0.0071	8.93
4	0.0071	6.61
D5 (Highest FR)	0.0063	5.94
D1 – D5	-0.0027	-5.06

Panel C: Bivariate Sort of Voluntary Pension Contributions on EDF and Cash Flows

	Cash Flows Rank						
EDF Rank	F1	2	3	4	F5	F1 – F5	*t*-stat
D1 (Lowest EDF)	0.0040	0.0062	0.0055	0.0066	0.0092	-0.0052	-4.31
2	0.0044	0.0072	0.0055	0.0077	0.0095	-0.0051	-4.95
3	0.0035	0.0053	0.0077	0.0094	0.0098	-0.0063	-6.32
4	0.0017	0.0017	0.0031	0.0049	0.0071	-0.0054	-9.01
D5 (Highest EDF)	0.0012	0.0012	0.0014	0.0014	0.0014	-0.0002	-5.86
D1 – D5	0.0028	0.0050	0.0041	0.0052	0.0078	-	-
t-stat	2.00	3.05	6.76	3.07	1.69	-	-

Panel D: Bivariate Sort of Voluntary Contributions on Pension Funding Ratios and Cash Flows

	Cash Flows Rank						
Funding Ratio Rank	F1	2	3	4	5	F1 – F5	*t*-stat
D1 (Lowest Funding)	0.0013	0.0041	0.0071	0.0074	0.0107	-0.0103	-11.83
2	0.0026	0.0049	0.0060	0.0082	0.0094	-0.0068	-6.25
3	0.0024	0.0036	0.0055	0.0061	0.0078	-0.0054	-6.00
4	0.0021	0.0053	0.0061	0.0065	0.0084	-0.0063	-6.98
D5 (Highest Funding)	0.0048	0.0062	0.0081	0.0086	0.0116	-0.0059	-4.72
D1 – D5	-0.0035	-0.0021	-0.0010	-0.0012	-0.0009	-	-
t-stat	-1.95	-4.67	-1.91	-1.88	-1.15	-	-

Table 4: Sort of Voluntary Contributions on Sponsor Simulated Marginal Tax Rates

In Panel A, we first obtain a sub-sample of firms with low expected default frequency by sorting all the sample firms into three groups based on their EDF in year *t*-1: low, medium, and high bankruptcy risk groups. For low bankruptcy risk group, we then sort firms into five portfolios based on their simulated marginal tax rates in year *t*-1, and calculate the time-series averages voluntary contributions in each portfolio, as well as the differences between the portfolios with the lowest tax rate and the portfolios with the highest tax rate (D1- D5). In Panel B, we double sort voluntary contributions on both marginal tax rate and cash flows.

Panel A: Sort of Voluntary Contributions on Marginal Tax Rate for Sponsors with Low EDF

Marginal Tax Rate Rank	VCT	*t* - statistics
D1 (Lowest Tax Rate)	0.0063	6.82
2	0.0076	4.51
3	0.0059	2.10
4	0.0076	6.70
D5 (Highest Tax Rate)	0.0075	6.31
D1 – D5	-0.0012	-2.40

Panel B: Sort of Voluntary Contributions on Marginal Tax Rates and Cash Flows for Sponsors with Low EDF

	Cash Flow Rank						
Marginal Tax Rates Rank	F1	2	3	4	F5	F1 – F5	*t*-stat
D1 (Lowest Tax Rate)	0.0027	0.0021	0.0034	0.0045	0.0063	-0.0036	-0.87
2	0.0038	0.0039	0.0046	0.0054	0.0054	-0.0016	-2.29
3	0.0059	0.0054	0.0062	0.0046	0.0074	-0.0016	-2.00
4	0.0075	0.0083	0.0090	0.0071	0.0107	-0.0032	-2.22
D5 (Highest Tax Rate)	0.0112	0.0099	0.0117	0.0074	0.0092	0.0020	-2.57
D1 – D5	-0.0084	-0.0078	-0.0083	-0.0030	-0.0029	-	-
t-stat	-2.12	-1.98	-2.88	-2.34	-2.81	-	-

Table 5: Fama-MacBeth Regression of Voluntary Pension Contributions on Pension Termination Probabilities and Marginal Tax Rates

The dependent variable is sponsor's voluntary pension contributions. Newy-West adjusted t-statistics is reported in parenthesis. We provide variable definitions in Appendix I.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
EDF	-0.0516	-0.0465	-0.0673	-0.0553	-0.0527	-0.0478	-0.0176
	(-2.34)	(-2.30)	(-2.30)	(-2.07)	(-1.99)	(-1.97)	(-2.48)
TAX		0.0034	0.0058	0.0045	0.0045	0.0033	0.0107
		(2.28)	(2.61)	(2.13)	(2.19)	(2.28)	(2.14)
CF			0.0331	0.0443	0.0445	0.0414	0.0100
			(6.80)	(6.64))	(6.57)	(6.28)	(2.87)
PROFIT				0.0192	0.0191	0.0156	0.0277
				(3.37)	(3.38)	(3.03)	(2.43)
FR					0.0024	0.0020	0.0017
					(2.04)	(2.66)	(2.38)
LNASSET						-0.0004	-0.0011
						(-5.49)	(-2.12)
TOBIN							-0.0011
							(-2.06)
UNION							-0.0016
							(-0.39)
Adjusted R^2	0.02	0.03	0.04	0.05	0.08	0.10	0.12

Table 6: Three-Stage Least Squares Estimation of Simultaneous Equations of Pension Voluntary Contributions

This table reports the parameters of the simultaneous equation model using the three-stage least square method. The dependent variables are VCT in equation 4a, EDF in equation 4b, PROFIFT in equation 4c, and FR in equation 4d. The *t*-stat is reported in parenthesis. We provide variable definitions in Appendix I.

(A)	(B)	(C)	(D)	(E)
	Equation (4a)	Equation (4b)	Equation (4c)	Equation (4d)
EDF	-0.0249		-1.7225	
	(-1.93)		(-2.13)	
TAX	0.0285		0.0659	0.6695
	(2.57)		(0.73)	(1.45)
CF	0.0492	0.5698	1.0905	3.8835
	(2.98)	(-6.29)	(4.53)	(2.42)
PROFIT	0.0323	-0.4670		5.7913
	(2.05)	(-4.40)		(2.50)
FR	0.0018	-0.0390	0.1268	
	(2.78)	(-8.69)	(3.36)	
LNASSET	-0.0109	-0.0092	0.0168	0.0509
	(-2.41)	(-4.47)	(2.67)	(2.44)
TOBIN	-0.0035		0.0087	0.1114
	(-1.89)		(0.82)	(1.20)
UNION	-0.0010			
	(-1.39)			
VCT		-0.0022	0.0550	0.2064
		(-3.44)	(3.42)	(2.46)

Table 7: Sort of Equity Allocation and Pension Beta on EDF, Pension Plan Funding Ratios and Simulated Marginal Tax Rates

In Panel A, all sample firms in year *t* are sorted into five portfolios based on their expected default frequency in year *t*-1. We form equally weighted portfolios, and compute the time-series averages of equity allocation and pension beta in each portfolio. We also estimate the differences between the portfolios with the lowest bankruptcy risk and the highest bankruptcy risk (D1- D5). Similarly, in Panel B, we sort firms in year *t* into five portfolios based on their pension plan funding ratios in year *t*-1. In Panel C, we first sort all the sample firms in year *t* into three groups based on the EDF in year *t*-1: low, medium, and high bankruptcy risk groups. For low bankruptcy risk group, we then sort firms into five portfolios based on their marginal tax rates in year *t*-1, and calculate the time-series averages of equity allocation and pension beta in each portfolio, as well as differences between the portfolios with the lowest tax rates and with the highest tax rates (D1- D5).

Panel A: Sort of Equity Allocation on EDF for All Sponsors

EDF Rank	Equity Allocation	*t* - statistics	Pension Risk	*t* - statistics
D1 (Lowest EDF)	0.5661	71.82	0.1071	23.84
2	0.5523	53.54	0.1000	26.51
3	0.5516	56.40	0.0955	28.20
4	0.5813	46.64	0.1023	30.33
D5 (Highest EDF)	0.5576	35.53	0.1115	21.24
D1 – D5	-0.0084	-0.92	0.0044	0.72

Panel B: Sort of Equity Allocation on Pension Funding Ratios for All Sponsors

Funding Ratio Rank	Equity Allocation	*t* - statistics	Pension Risk	*t* - statistics
D1 (Lowest FR)	0.5462	36.4800	0.0554	26.84
2	0.5586	51.7243	0.0904	35.40
3	0.5646	53.1185	0.1094	27.87
4	0.5662	60.7771	0.1269	31.39
D5 (Highest FR)	0.5690	61.2171	0.1389	19.87
D1 – D5	0.0228	3.3467	0.0835	11.87

Panel C: Sort of Equity Allocation and Pension Beta on Marginal Tax Rates for Sponsors with Low EDF

Effective Tax Rate Rank	Equity Allocation	*t* - statistics	Pension Risk	*t* - statistics
D1 (Lowest Tax Rate)	0.5823	43.58	0.1202	37.22
2	0.5758	99.26	0.0890	24.79
3	0.5344	31.85	0.1474	6.65
4	0.5460	81.22	0.1299	15.79
D5 (Highest Tax Rate)	0.5678	48.90	0.1143	11.67
D1 – D5	-0.0145	-1.35	-0.0059	-0.66

Table 8: Fama-MacBeth Regression of Pension Asset Allocation and Pension Beta on Expected Default Frequency and Simulated Marginal Tax Rate

The dependent variable is percentage of sponsors' pension assets invested into equity market (model a) and pension beta (model b). Newy-West adjusted t-statistics is reported in parenthesis. We provide variable definitions in Appendix I.

	(a)	(b)
	Dependent Variable: Equity Percent	Dependent Variable: Pension Beta
EDF	-0.0060	-0.0002
	(-1.49)	(-1.00)
TAX	-0.1176	-0.1009
	(-1.56)	(0.70)
CF	0.7973	0.3894
	(2.25)	(4.98)
PROFIT	0.5814	0.6099
	(3.32)	(3.97)
FR	0.0023	0.2857
	(1.45)	(4.63)
LNASSET	-0.0326	-0.0011
	(-5.48)	(-0.39)
TOBIN	0.0258	-0.0086
	(1.23)	(-2.11)
UNION	-0.1983	-0.1071
	(-1.38)	(-0.90)
Adjusted R^2	0.08	0.15

Table 9: Effects of Changes in Pension Accounting Rules and Funding Legal Requirement on Sponsors' Incentives

RPA94 and SFAS132R are binary variables in the regression models which equal to 1 if pension contributions are made (or pension assets are allocated) after the passage of the RPA of 1994 and after the effective date of SFAS 1532(R) (post-period); and 0 if otherwise (pre-period). We estimated the models using pooled OLS regressions after controlling for industry and year fixed effect. The heteroscedasticity-adjusted t-value is reported in parenthesis.

	Dependent Variable: Voluntary Contributions		Dependent Variable: Equity Percent		Dependent Variable: Pension Beta	
	(a)	(b)	(c)	(d)	(e)	(f)
EDF	-0.0195	-0.0145	-0.0045	-0.0040	-0.0002	-0.0002
	(-2.57)	(-2.10)	(-1.50)	(-1.51)	(-0.42)	(-1.23)
TAX	0.0192	0.0075	-0.1281	-0.1327	0.0886	0.1156
	(2.43)	(2.80)	(-0.18)	(-0.78)	(1.03)	(1.12)
CF	0.0111	0.0097	0.5618	0.6532	0.2421	0.2421
	(2.88)	(2.48)	(2.24)	(2.00)	(1.69)	(1.69)
PROFIT	0.0089	0.0065	0.3819	0.4004	0.3656	0.4323
	(2.80)	(2.31)	(1.71)	(1.69)	(2.87)	(2.45)
FR	0.0035	0.0026	0.0025	0.0019	0.2861	0.3211
	(2.79)	(2.58)	(0.15)	(0.89)	(5.83)	(4.46)
RPA94	-0.0048		-0.1580		0.0000	
	(-1.17)		(-1.97)		(0.50)	
RPA94 x EDF	-0.1807		-0.6302		-0.2013	
	(-4.99)		(-0.90)		(-0.50)	
RPA94 x TAX	-0.0118		-0.2926		0.0271	
	(-0.98)		(-1.27)		(0.21)	
RPA x FR	0.0061		-0.0918		-0.0078	
	(2.98)		(-0.75)		(-0.11)	
SFAS132R		0.0022		-0.1456		0.0001
		(1.09)		(-1.61)		(1.22)
SFAS132R x		-0.1546		-0.5897		-0.1545
EDF		(-3.45)		(-1.06)		(-1.34)
SFAS132R x		0.0094		-0.3015		0.0244
TAX		(1.13)		(-1.33)		(0.89)
SFAS132R x		0.0055		-0.1002		-0.0090
FR		(2.45)		(-0.86)		(-1.23)
LNASSET	-0.0010	-0.0008	-0.0316	-0.02197	-0.0023	-0.0019
	(-3.02)	(-2.65)	(-1.95)	(-1.88)	(-0.78)	(-0.59)
TOBIN	-0.0020	-0.0026	0.0271	0.0266	-0.0080	-0.0065
	(-1.29)	(-1.09)	(0.45)	(0.85)	(-0.89)	(-1.14)
UNION	-0.0031	-0.0045	-0.1780	-0.1554	-0.1013	-0.1020
	(-0.63)	(-0.84)	(-1.06)	(-1.45)	(-1.28)	(-1.01)
Adjusted R^2	0.14	0.14	0.09	0.09	0.16	0.16

Table 10: Regression Analysis of Pension Voluntary Contributions and Asset Allocation during Credit Crisis

We use a binary variable CRISIS and interact it with EDF, TAX, and FR in the regression equations. CRISIS equals to 1 if pension contributions are made (or pension assets are allocated) between 2007 and 2009; and 0 if otherwise. The data to estimate voluntary pension contributions and equity percent are from Compustat Annual Pension Database. We estimated the models using pooled OLS regressions after controlling for industry and year fixed effect. The heteroscedasticity-adjusted t-value is reported in parenthesis.

	(a)	(b)
	Dependent Variable: Voluntary Contributions	Dependent Variable: Equity Percent
EDF	-0.0187	-0.0053
	(-2.37)	(-1.84)
TAX	0.0125	-0.1000
	(2.22)	(-1.44)
CF	0.0095	0.6874
	(2.31)	(2.03)
Profit	0.0077	0.4417
	(2.33)	(1.98
FR	0.0032	0.0023
	(2.17)	(0.84)
CRISIS	-0.0048	-0.0062
	(-1.17)	(-1.39)
CRISIS x EDF	-0.2257	-0.2744
	(-3.25)	(-2.01)
CRISISx TAX	-0.0205	-0.0309
	(-1.48)	(-1.30)
CRISIS x FR	0.0077	0.0082
	(2.28)	(1.15)
LNASSET	-0.0011	-0.0284
	(-2.05)	(-4.03)
TOBIN	-0.0016	0.0211
	(-1.45)	(1.10)
UNION	-0.0012	-0.1175
	(-0.26)	(-1.39)
Adjusted R^2	0.18	0.09