In Good Times and in Bad:
Defined-Benefit Pensions and Corporate Financial Policy

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Keywords: Pension plans, corporate finance, employer contributions, funding deficit, pension assumptions, expected returns on plan assets, discount rate

JEL Classification: G3, F4, F3

1 Introduction and Motivation

While occupational defined-benefit pension plans of U.S. firms were well-funded in the 1990s, funding levels have steadily deteriorated since the beginning of the 21st century. The recent financial crisis has been described as a "perfect storm" for defined-benefit pension funds, as the value of their assets have plummeted with the collapse of financial markets, while low interest rates have made their plan obligations balloon. This environment has been even more challenging, as the Pension Protection Act (PPA) of 2006 has tightened the funding requirements of U.S. firms. Despite some increase in contributions by employers to their pension plans in the last couple of years, the average firm still faces a larger funding deficit of today than before the crisis.

Against this backdrop, this paper investigates the relation between the general financial management of 4,134 U.S. non-financial firms and their defined-benefit plans over the years 1992-2014, using data on defined-benefit pension plans that has become available due to recent changes in disclosure requirements. In particular, it examines to what extent firms manage their pension plans independently, or integrate them into their overall financial strategy, and what the consequences of such policies are. Given the fact that pension assets are held in a trust fund and are thus legally separated from the operating assets of plan sponsors, firms might manage their pension plans independently as a function of plan characteristics. This would entail that the funding level and plan investment strategy are chosen in a way to best meet future plan obligations, that the discount rate reflects the risk of plan obligations, and that performance expectations are linked to plan features such as the asset allocation, past performance or the investment horizon. In contrast, plan sponsor characteristics would not be systematically related to plan characteristics.

On the other hand, pensions may be viewed as an integral part of overall corporate financial policy, where shareholders own corporate and pension assets and are responsible to the extent of their equity for both sets of liabilities. Firms then manage an extended balance sheet, and they might use their discretion to set pension plan assumptions, time contributions, and determine the plan investment strategy as it best suits the core activity of their business operations. This might create additional degrees of flexibility for plan sponsors and allow them to use the pension plan to exploit tax benefits and to shift risk to other stakeholders in order to maximize the interests of shareholders.

If firms appreciate their pension plan assets and obligations as an extension of their balance sheet, the financial condition of the plan sponsor will have a bearing on the situation of the pension

plan, which may not always be in the interest of plan beneficiaries; for instance, if the plan sponsor prioritizes corporate investment opportunities over plan contributions. At the same time, it could be in the interest of plan participants to avoid the sponsor defaulting due to missed contributions if insured benefits are significantly lower. Since the PBGC is statutorily self-financing, its premia should reflect theoretically true economic conditions and realistic estimates of the prospective costs of future plan terminations and payouts by the insurance scheme.

The paper considers the plan contributions and funding levels, the assumptions about the long-term rate of return on plan assets and the discount rate, as well as the investment risk of occupational defined-benefit plans and how these relate to a broad set of asset and liability characteristics of plan sponsors (as well as other features of the pension plans). An investigation of these relations is particularly important and interesting in the context of major economic downturns, since the deterioration of plan funding levels combined with the challenges plan sponsors face, both with regards to their operating business as well as their financing, provides stronger incentives for firms to lower contributions and change pension plan assumptions or the investment strategy even though the underlying economics might not justify that. Thus, periods such as the global economic recession in 2001 and the global financial crisis in 2008 offer natural experiments to assess how firms manage the assets and liabilities both of their pension plans and their business operations, and to what extent they recognize and/or exploit their economic linkages.

This analysis is facilitated by recent changes in U.S. disclosure requirements, such as FASB 132R, that require firms to disclose details on their pension plan characteristics, plan assumptions, returns on and allocation of plan assets, thus avoiding the need to match data from the IRS form 5500 or the *Pensions and Investment* survey, which only cover domestic plans and which prior research has described as challenging, cumbersome and possibly a source of error or smaller sample size (see, for example, Petersen (1996, 1992)). The resulting sample of plan sponsors using this dataset is significantly larger than that of related prior studies, and does not suffer from matching issues or sample biases. The pension data includes U.S. and foreign plans and thus properly corresponds to the consolidated accounting data of the sample firms.

The paper is the first to investigate to what extent firm characteristics affect the size of employer contributions. Contributions by employers are much larger and more time-varying compared to contributions by plan participants. The empirical evidence suggests that plan sponsors integrate their pension plans, since they make larger contributions if they have more cash, higher profitability,

less leverage, and a higher Z-Score, though there is no consistent evidence that firms make larger contributions when their marginal tax rates are high. Moreover, pension plans have higher funding levels if the sponsor is more profitable and is further away from financial distress. The finding that plan sponsor contributions and funding levels are significantly lower for plan sponsors that have weaker fundamentals has important implications for the design of pension plan funding rules, since the financial condition of the pension plan and its sponsor may often be correlated.

Sponsors of defined-benefit plans need to make assumptions about various parameters of their pension plan, such as longevity, employee turnover, retirement age, *et cetera*. Two key economic assumptions are the long-term expected rate of return on the plan assets, and the assumed discount rate to calculate the projected benefit obligations. In principle, these should be set as a function of the pension plan, such as the asset allocation, or the composition of the pool of plan beneficiaries. However, if firms understand their defined-benefit plan as part of their general financial management, factors outside the plan could play a role in making these assumptions, and firms might, for example, choose discount rates in a manner that systematically varies with their financial condition.

Indeed, the results show that sponsor firm characteristics are also important determinants of these plan assumptions, indicating again that firms integrate their pension plans into their overall financial management. The main lever appears to be the expected return on plan assets, possibly because it offers the highest degree of discretion. In particular, firms with lower cash holdings and less PPE make more aggressive return assumptions for their pension plans. In contrast, the discount rate is related to fewer dimensions of plan sponsors, even though each year a high fraction of firms change their discount rate assumption. The observation that plan sponsors appear to choose their plan assumptions as a function of their financial situation suggests that the rules governing the choice of these assumptions are important dimensions for policy design.

The investment risk of occupational defined-benefit pension plans is measured by the volatility of plan returns. This measure has not been used previously, but has the advantage of being an actual measure of portfolio risk that is not dependent on assumptions. Moreover, in contrast to earlier research, the assets and liabilities of the plan sponsors are characterized in a very detailed and comprehensive way. When relating pension investment risk to characteristics of sponsors' assets and liabilities, there is only limited evidence of plan integration, despite using a broad range of firm characteristics. In particular, only few plan sponsor characteristics are significant in regressions with just asset or financial characteristics, and none are significant in more comprehensive specifications. In contrast to

the low (adjusted) R-Squareds in some prior research, all independent variables together explain more than 40% of the volatility of the return on plan assets (or alternatively roughly 30% of the variation of the percentage of plan assets invested in equities).

While pension plan funding levels vary across sponsors and time, it is interesting to examine the effect that major economic downturns have on plan sponsors, since they cause extreme pressures both with regards to firms' business operations in recessions as well as with regards to dire funding levels, which may strengthen incentives to integrate plans such as risk-shifting. Thus, hard economic times, for instance after the burst of the internet bubble or the collapse of Lehman Brothers, might reveal the incentives that drive corporate actions when push comes to shove. The results show indeed that the relations of several determinants of plan characteristics change in economic downturns. In particular, firms that have less cash are more optimistic about expected returns on plan assets. Moreover, there is evidence of risk shifting by firms investing their pensions in riskier assets if they have higher asset risk and leverage. In recent years, firms have continued to invest the majority of their pension assets in risky securities while maintaining significant levels of underfunding, which is a passive form of risk shifting (Harrison and Sharpe, 1983). In particular, allocations to equity remain at around 50 to 60% despite significant and persistent drops in the funding level of pension plans since the early 2000s.[1] Consequently, given the integration of pension plans by their sponsors during major economic contractions, rules and regulations governing pension fund investment policies are a third important dimension for policy implications.

This paper contributes to the literature on defined-benefit pensions. Bergstresser, Desai and Rauh (2006) study earnings management in the context of corporate action and CEO compensation and find that firms use higher assumed rates of return when they prepare to acquire other firms, when they are near critical earnings thresholds, and when their managers exercise stock options. Anantharaman and Lee (2014) focus on the role of management compensation and find that risk shifting through pension underfunding and asset allocation is stronger with compensation structures that create high wealth-risk sensitivity. While these papers also provide evidence of pension plan integration by plan sponsors, this paper is the first to examine the relation of pension plan contributions, expected

[1] The literature suggests that firms should either overfund their plans and invest in bonds (to maximize tax savings), or underfund the plan and invest in riskier assets (to maximize the value of the default option (see, e.g. Petersen, 1996)). While pension funds of U.S. firms were well funded in the 1990s, they went from overfunding to underfunding in the early 2000s, and funding levels remained low since then, while asset allocations stayed similar.

returns on plan assets, and plan discount rates with comprehensive and detailed sets of variables characterizing the assets and liabilities of the U.S. firms sponsoring these plans.[2]

Moreover, it adds in important ways to the limited existing evidence regarding the relation of funding levels and investment risk with plan sponsor characteristics. In particular, Rauh (2009), Bodie, Light, Mørck and Taggart (1985), and Friedman (1983) study the asset allocation of pension plans and provide mixed conclusions whether firms use their defined-benefit pension funds for risk management or risk shifting. Rauh (2009) notes that a large fraction of the variation in pension fund asset allocation at the firm level remains unexplained and suggests that future studies seek to identify additional factors that affect variations in pension fund investment strategies. Given this recommendation and prior mixed evidence, we investigate pension fund investment risk with direct (as well as, alternatively, with previously used indirect) proxies of portfolio risk and detailed characteristics of the assets and liabilities of plan sponsors yielding high (adjusted) R-Squareds. Moreover, in contrast to the pension plan asset allocation, the volatility of pension plan returns is not consistently related to firm sponsor characteristics, yielding different conclusions about the integration of pensions plans for investment risk.

In summa, the results of this paper suggest that firms treat their pension plans as an integral part of overall corporate financial policy. Plan characteristics and assumptions are not just determined by other pension plan dimensions, but the nature and riskiness of the assets and liabilities of the firm sponsoring the plan also play an important role. In particular, firms that have fewer liquid assets, are less profitable and are closer to financial distress make smaller contributions, have lower funding levels and make more aggressive return assumptions. When the internet bubble burst and during the global financial crisis, cash-poor plan sponsors made more aggressive plan assumptions, and firms with high asset risk and leverage took more investment risk shifting risk to the PBGC, employees and/or bondholders. Plan sponsors have also engaged in risk shifting in recent years by leaving their defined-benefit plans significantly underfunded while continuing to invest heavily in risky assets. The results suggest that funding rules, pension plan assumptions and investment policies are areas to consider for pension policy. In order to protect plan beneficiaries from adverse interactions with the situation of the plan

[2] In related work, Blankley and Swanson (1995) examine the determinants of changes in the discount rate and expected return on plan assets, and Shivdasani and Stefanescu (2010) suggest that firms integrate their pension plans into their capital structure decisions.

sponsor, plan assumptions would have to be subject to less discretion and funding requirements would have to be tighter or a function of the sponsor's financial condition.

The paper is organized as follows. Section 2 presents the hypotheses and empirical predictions, while the sample and data are discussed in Section 3. Section 4 presents the results of the empirical analysis, and Section 5 concludes.

2 Hypotheses and Methodology

The objective of this paper is to relate important dimensions of occupational defined-benefit plans to characteristics of the sponsors of these plans in order to gain insights into the determinants of plan features and whether plans are managed independently or integrated into the financial management of their sponsors. In particular, the facets of pension plans that are being considered are pension plan contributions and funding levels, key pension plan assumptions, and plan investment risk.

2.1 Plan Contributions and Funding Levels

Given the persistent funding deficits in corporate defined-benefit pension plans over the last decade, it is important to understand the determinants of this phenomenon. Both employers and employees make contributions to corporate defined-benefit plans in order to fund the benefits. While the literature to date has not analyzed the relation between total pension plan contributions and plan sponsor characteristics, it is interesting to document the level of contributions that are being made, and to investigate what determines the level of contributions by plan sponsors both over time and cross-sectionally. Related to contributions is the funding level of a pension plan, defined as the difference between the value of the plan assets and obligations.

If pension plans are managed independently, plan contributions and funding levels should only be related to other characteristics of the pension plan. In contrast, plan integration would suggest that the economic condition of plan sponsors, captured by their asset and financing characteristics, are also significant determinants in regressions of pension plan contributions and funding levels. While companies are required to increase their contributions over a period of time if the plan is severely underfunded (mandatory contributions), they have discretion to make voluntary contributions. Companies can take advantage of this feature in order to maximize the associated tax shields by making larger contributions when marginal tax rates are high, rendering taxes one motivation for plan integration.

Higher contributions will also reduce the required minimum contributions in future years. In fact, firms can maintain some financial slack in the form of pension assets, in addition to liquid assets and unused debt capacity (Bartram, 2015; Ballester, Fried and Livnat, 2002; Bodie, Light, Mørck and Taggart, 1985; Friedman, 1983). The latter may be more readily accessible, while the former has tax advantages. At the same time, firms may sometimes reduce or even forego the funding of a period's pension expense ("contribution holiday") when possible, to meet competing investment or financing cash needs such as plan expansions, corporate acquisitions, debt retirement or dividend increases.[3] Plan sponsors also have some discretion in determining actuarial valuations of the plan assets that differ from the current market values of these assets. In particular, investment returns can be smoothed over a two-year (previously five-year) period, and average asset values can deviate by 10% (previously 20%) from fair market values.

These relations can be investigated in regressions of pension plan contributions and funding levels on plan sponsor characteristics. If firms integrate their pension plans and have cash available, are profitable, face less business risk, have a stable business, low leverage and high credit rating, they might put more money in the pension fund and afford higher funding levels, especially when they face high marginal tax rates and have few attractive alternative investment opportunities. In contrast, firms that either have attractive investment opportunities and/or are financially constrained or distressed likely only make small contributions. Similarly, firms in financial distress might focus on their obligations on the balance sheet as opposed to pension obligations, use pension plan assumptions to reduce their PBOs, and rely on the insurance of the PBGC.

2.2 Long-Term Expected Rate of Return and Discount Rate

Two of the key economic assumptions that plan sponsors have to make are the long-term expected return on plan assets and the discount rate.[4] The expected long-term rate of return on plan assets should reflect the average rate of earnings expected on the funds invested to provide for the benefits.

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[3] The focus of the paper is on actual total contributions, not mandatory contributions. Bakke and Whited (2012) show that the strong sensitivity of investment to *mandatory* contributions in Rauh (2006) stems from heavily underfunded firms that constitute a small fraction of the sample and that are different from the rest of the sample in important ways. Campbell, Dhaliwal and Schwartz (2012) find that for a sample of U.S. firms with bond issues an increase in *mandatory* pension contributions increases the cost of capital, but only for firms facing greater external financing constraints.

[4] Note that the distinction between these two rates is blurred in practice because it is often assumed that they are the same. To illustrate, Government Accounting Standards Board (GASB) ruling 25 and Actuarial Standards of Practice (ASOP) item 27 stipulate that public pension liabilities are to be discounted at the expected rate of return on pension assets (see Novy-Marx and Rauh, 2011). This presumes that the pension assets closely match (and thus hedge or immunize) the pension liabilities, which may often not be the case.

As a result, it is a function of the expected returns for each major asset class in which the plan invests and the weight of each asset class in the target mix, based on historical experience and market projection of the target asset allocation set forth in the investment policy. The discount rate is used to calculate the projected benefit obligation, i.e., the present value of pension obligations, as well as the interest cost portion of the pension expense. U.S. accounting standards indicate that the discount rate should represent the rate at which the pension obligations could be settled. They require it to be based on yields on high quality (usually AA-rated) corporate bonds of appropriate maturity, taking into account the term of the relevant pension scheme's liabilities. Corporate bond indices are often used as a proxy to determine the discount rate. At the same time, it has become more common among U.S. plan sponsors to match expected cash flows from the plan to either a portfolio of bonds that generate sufficient cash flows, or to a notional yield curve generated from available bond information.

While the discount rate is intended to adjust to current market conditions, the ROA is long-term in nature and should not be adjusted unless there are significant shifts in asset allocation, capital market expectations, or structural shifts in the economy in general. However, firms have significant discretion setting both parameters based on their preferences, and it appears that they vary significantly more among companies than underlying differences in interest rates and workforce demographics would justify (Sprinzen, 2003). Therefore, plan sponsors might choose these pension parameters in part as a function of their own economic condition if they integrate pension plans into their overall financial management. Thus, discount rates and expected returns on plan assets as dependent variables in regression analysis might not just relate to plan other pension plan features, but also show significant relations to plan sponsor characteristics. To illustrate, plan sponsors might make more optimistic assumptions about the returns on their pension plan assets in order to boost corporate profits. Highly levered firms might choose more aggressive discount rate assumptions in order to reduce consolidated leverage, since rating agencies increasingly consider off-balance forms of debt in their solvency assessments (Bartram, 2016). In contrast, lower discount rates increase the plan obligation, reduce the funding level and might consequently allow firms to increase funding and build financial slack in their pension plan. More generally, changes in return assumptions and discount rates may be used for earnings management (Bergstresser, Desai and Rauh, 2006).

2.3 Investment Risk

If firms integrate their defined-benefit pension plans, the pension plan investment strategy may also be related to characteristics of the plan sponsor. Financial theory provides a number of predictions

regarding the relation between pension plan risk and plan sponsor risk. Asset substitution or risk shifting suggests that managers acting in the interests of shareholders have an incentive to underfund the pension plan and to invest the pension funds in risky assets, because it effectively increases the overall risk of the firm and thus amounts to a wealth transfer from bondholders or employees to shareholders. This is particularly true for firms with very high business and financial risk, because the PBGC provides insurance for pension claims and thus picks up some of the pieces in case of default. Thus, it might be optimal for firms close to financial distress to fund their pension funds only minimally and invest pension assets in the riskiest possible securities, since they have a put option in case of default, the value of which increases with the riskiness of the underlying. Risk shifting is a realistic concern in the case of pension assets, since the asset allocation is typically not restricted by the creditors of the firm (via bond covenants, for example), even though this would be possible in principle.

However, if a firm stays in business, the high investment risk of an underfunded pension plan, combined with high business and financial risk, can put a lot of pressure on the financial resources of the firm and might result in the need to pass up valuable investment opportunities due to mandatory pension contributions. Since equities are not highly valued in hard economic times, they cause high contributions to the pension fund when the firm can least afford to pay them (Black, 1980). Thus, if firms are managing risk, high business or financial risk of the plan sponsor would suggest that firms invest their pension plan assets more conservatively. Investing pension funds in lower-risk securities will lower a firm's leverage, increase its debt capacity, and make the benefits more secure. Consequently, incentives for both risk management and risk shifting increase as firms come closer to financial distress (Rauh, 2009).

We measure the investment risk of a pension plan as the standard deviation of the realized returns on plan assets. In contrast to proxies based on the asset allocation of funds that have been used in the existing literature, the volatility of plan returns is a direct measure of fund investment risk. In fact, the correlations of the volatility of the return on plan assets with the equity asset allocation or the pension asset beta are only 0.22 and 0.20. Pension plan investment risk as regressand is expected to relate to relate to other dimensions of the pension plan, but if firms integrate it into their general financial policy, variables capturing the asset and liability characteristics of plan sponsors would also be important regressors.

2.4 Major Economic Downturns

Major economic downturns, such as the global recession of 2001 in the wake of the burst of the internet bubble and the recent global financial crisis, provide particularly interesting episodes and laboratories to investigate whether firms integrate their pension plans when the incentives to do so are particularly strong (Alderson and Betker, 2009; Merton 2014). First, the dot-com crash and the financial crisis resulted in significant drops in the prices of financial assets across countries, industries and asset classes (Bartram and Bodnar, 2009). As a result, the investments of pension funds dropped significantly in value. Second, the ensuing policy intervention aimed at supporting liquidity in financial markets and restoring the confidence of market participants involved, among other actions, the slashing of interest rates. Record low interest rates, however, result in lower discount rates for pension plan liabilities and thus larger projected benefit obligations. These two effects combined put significant pressure on defined-benefit plans by drastically reducing funding levels and investment returns, as shown in Figures 1 and 2.

Moreover, U.S. Congress passed the Pension Protection Act on 28 July 2006, the most comprehensive reform of its pension laws since the enactment of the Employee Retirement Income Security Act of 1974. It established new funding requirements for defined-benefit pensions in order to avoid the possibility that the termination of defined-benefit pension plans with large unfunded liabilities could eventually lead to the PBGC becoming financially insolvent, requiring a public bailout. In particular, the PPA established new rules for determining whether a defined-benefit pension plan is fully funded, the contribution needed to fund the benefits that plan participants will earn in the current year, and the contribution to the plan that is required if previously earned benefits are not fully funded.[5]

As a result of the PPA, there is more pressure on firms to increase pension plan contributions and reduce plan deficits (in principle since 2008, though eased by a long phase-in period and subsequent pension relief provisions such as MAP 21). Given the challenging economic climate, however, plan sponsors might choose to integrate their pension plans and make use of their discretion with regards to pension plan assumptions in order to reduce some of the short-term pressure from their

[5] Among many other changes, the PPA requires plan funding to be equal to 100% of the plan's liabilities, and any unfunded liability will have to be amortized over seven years (with some exceptions; for example, commercial airlines). Sponsors of severely underfunded plans that are at risk of defaulting on their obligations are required to fund their plans according to special rules that result in higher employer contributions to the plan. The PPA requires plans to discount future liabilities using three different interest rates, depending on the length of time until the liabilities must be paid.

pension plans. Moreover, plan sponsors might face incentives to consider shifting the asset allocation to riskier assets. This asset substitution would shift risk to creditors, employees and the PBGC, and would create value for shareholders if the crisis and ensuing recession affects their normal business activity and pushes them towards financial distress. Thus, the recent crisis and the internet bubble offer natural experiments to assess how firms manage the assets and liabilities both of their pension plans and their business operations, and to what extent they recognize and/or exploit their economic linkages. The deterioration of pension funding levels and the requirements of the PPA 2006, combined with the challenges firms faced both with regards to their operating business as well as their financing, provide stronger incentives for firms to lower contributions, and change pension plan assumptions or the investment strategy, even if the underlying economics might not justify that. Consequently, pension plan dimension should be more strongly related to plan sponsor characteristics during these periods.

3 Sample and Data

The sample consists of all U.S. firms with a defined-benefit pension plan, excluding utilities (SIC code 49) and financial firms (SIC codes 60-64), as well as firms with missing industry classification during the period 1992 to 2014.[6] FASB 132R requires firms to disclose details on their pension plan characteristics, plan assumptions, returns on and allocation of plan assets. The resulting sample of 4,134 unique U.S. non-financial firms with defined-benefit plan is substantially larger than that of related prior studies.[7] Since these pension variables have been added to the Compustat database, the data is easily combined with other accounting as well as stock return data. The benefits of using pension data from the annual reports are that they include U.S. and foreign plans so that all accounting data including pension variables are for the consolidated entities (while previously used data sources only capture domestic plans). The various measures are internally consistent; for example, discount rates and PBOs properly relate to each other.

[6] The sample includes all firms on Compustat excluding utilities and financial firms as well as firm-year observations with missing or non-positive values for Total Assets and without defined-benefit pension plan. Multivariate analyses require the joint availability of all variables.

[7] To illustrate, Bodie, Light, Mørck and Taggart (1985) study 515 firms, Rauh (2009) studies 448 firms, the sample in Bergstresser, Desai and Rauh (2006) has 2,442 firms, and Anantharaman and Lee (2014) study 1,030 unique firms.

The pension asset beta is calculated by using betas of 1, 0.175, and 0.150, and 1.2 for equity securities, debt securities, real estate and other assets, and weighting them according to the asset allocation, as in Jin, Merton and Bodie (2006) and Mohan and Zhang (2012). Equity investments include international equities, venture capital, and investments in the company's own stock. Debt securities include fixed-income securities, cash and short-term securities, U.S. Government and Government Agency securities, corporate bonds and notes, and mortgages. Other assets refer to investments in other equity, debt or real estate, such as hedge funds, private equity, and commodities.

The investment horizon is calculated as the ratio of pension projected benefit obligation to pension service cost. An older workforce should lead to a smaller ratio of PBO to service cost, indicating a shorter investment horizon (Amir, Guan and Oswald, 2010). Following the literature, actual returns on plan assets are calculated by dividing the change in the market value of the pension plan assets during the year (excluding contributions to and payments by the plan) by the beginning of period plan values, both of which are available from Compustat. The volatility of the return on plan assets is calculated as the prior five-year standard deviation of the return on plan assets. The funding level of the plan is calculated as the difference between the fair value of plan assets and projected benefit obligations (scaled by PBO). Since more information is available on defined-benefit pension plans, the focus of the paper is on these types of benefits, which also tend to be larger than other post-retirement benefits plans.

Various other firm characteristics are sourced from Compustat as well. Marginal tax rates based on Blouin, Core, and Guay (2010) are from WRDS. The S&P long-term domestic issuer rating is transformed into a numeric variable by numbering ratings from AAA to D from 1 to 22. Market capitalization data for individual stocks is obtained from CRSP. Accounting data are winzorized at the top and bottom 1% and for values more than five standard deviations from the median. In order to reduce the chance of the results being influenced by economic cycles, three-year averages of variables are used where this impact seems most relevant (for example, profit margin). Appendix A provides all variable definitions, and Appendix B shows detailed summary statistics.[8]

[8] Variance inflation factors are below 2 for all variables.

4 Empirical Results

The empirical analysis explores in turn the interrelations of plan contributions and funding level, pension plan assumptions, and pension plan investment risk with plan sponsor characteristics based on the empirical predictions in Section 2, during the full sample period as well as the dot-com crash and the financial crisis.

4.1 Employer Contributions and Funding Levels

While participant contributions are small and relatively stable over time, employer contributions to defined-benefit pension plans increased in the late 1990s, but have plateaued in the last 10 years, with only small increases since the PPA of 2006 (Figure 1).[9] Table 1 reports results from regressions of employer contributions on measures of asset risk and financial risk of the plan sponsor and plan characteristics. In this table, and in the following tables, all independent variables are lagged by one period in order to mitigate endogeneity. Regressions include year and industry fixed effects (based on 48 Fama-French industries), and standard errors are clustered by firm.[10]

The table shows evidence that plan sponsors integrate their pension plans with regards to plan contributions. Specifications (1) and (2) focus on asset characteristics of the plan sponsor. Employer contributions are related to a number of asset characteristics of the plan sponsor. In particular, employers make larger contributions when they are cash rich, are younger and have higher marginal tax rates. Other asset characteristics are not important. Next, specifications (3) and (4) focus on the financial risk of plan sponsors and show that contributions are larger for sponsors that have lower leverage and a higher Z-Score, but also a lower credit rating. Regression (5) considers other plan features as determinants of pension contributions by employers. Larger contributions are associated with lower funding levels, smaller plans, longer investment horizons and lower participant contributions.

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[9] Since most plans in the United States do not require contributions by plan participants, these could be expected to be zero. The patterns in Figure 1 are similar for alternative scaling, such as by Total Assets. While the data do not allow separating domestic and foreign plans, funding levels are similar when splitting between firms with and without foreign sales or assets, those with and without foreign pension plans or international data sources used by Compustat. Funding deficits are somewhat smaller when using the median to define the typical firm, when value-weighting the averages and/or when only considering the largest 100 plans. The data include unqualified defined benefit plans, such as Supplemental Employee Retirement Plans (SERP) that do not require funding.

[10] Correcting standard errors for heteroscedasticity and autocorrelation with the Newey-West (1987) method leads to similar conclusions. Estimating regressions with changes in variables or firm fixed effects also supports the conclusion of firms integrating their pension plans with some variation in the strength of the results across pension plan dimensions and plan sponsor characteristics.

The last two specifications in Table 1 combine variables from the different groups of determinants, with a focus on those that capture different economic effects and/or that were important in the earlier regressions, while also considering the correlations between variables to avoid multicollinearity. These specifications report marginal effects calculated as the regression coefficient multiplied by one standard deviation of the regressor to allow assessing economic significance. As before, sponsors make larger contributions if they have more liquidity, lower leverage and a higher Z-Score. Firm profitability is also significant with a positive coefficient in regression (7). In addition, contributions are larger for plans with lower funding levels, smaller size, higher expected returns, longer investment horizons and lower participant contributions.

Even though firms have incentives to make larger contributions when their marginal tax rates are high, the tax rate is insignificant in the comprehensive regressions, possibly reflecting CEOs' concerns about not being able to get their money out of pension plans. Pension plan characteristics have, by far, the largest explanatory power for variations in sponsor contributions, but firm leverage and cash holdings are also among the variables with the largest marginal effects. Overall, these results suggest that plan sponsors determine their contributions not only as a function of the situation of their pension plans, but that corporate characteristics play an important role as well, documenting that firms integrate the pension plans into their financial management.

Table 2 shows further evidence of plan integration based on regressions with the funding level as a dependent variable. In terms of plan sponsor characteristics, profitability, asset tangibility, dividends, and age are positively associated with funding levels, while capital expenditures and FX exposure are negatively related to funding levels. Moreover, firms with shorter debt maturity, higher Z-Score and higher credit rating have better funded plans. With regards to pension plan characteristics, the funding level is mechanically related to the size of the projected benefit obligations (scaled by total assets), since larger obligations reduce the funding level, *ceteris paribus*. Interestingly, however, there is also a positive relation with the absolute size of the plan obligation, which proxies for the size of the plan, indicating that larger plans tend to be better funded. Higher funding levels are also associated with higher realized (and expected) returns on plan assets.

Most of these effects are robust to combining variables for sponsors' asset risk and financial risk, controlling for pension plan characteristics. While many plan characteristics are very important in economic terms, firm leverage and profitability are among the more important determinants as well. These results suggest that more profitable firms fund their plans better when they have lower leverage

and a higher Z-Score. The profitability effect is consistent with the tax hypothesis and the financial slack argument (Bodie, Light, Mørck and Taggart, 1985). For the design of funding rules, it is important to appreciate that firms that are financially weaker (less cash, lower profitability, lower Z-Score, higher leverage) make lower contributions and have lower funding levels.

4.2 Plan Assumptions

One of the key economic assumptions that plan sponsors have to make, and that provide significant flexibility, is the long-term expected rate of return on the assets of the plan. Figure 2 shows that on average, the long-term expected rate of return is very stable across firms, though it seems to have slightly decreased over the sample period. The average expected return for U.S. firms in 2014 is 5.93%. The figure also shows that the expected rate of return on plan assets is on average 1.31% higher than the discount rate applied to plan obligations. As discussed above, these rates should diverge to the extent that the plan assets differ from the nature of the obligations. The figure also shows the realized return on plan assets, which follows a similar pattern as the equity market index.

Table 3 examines which plan sponsor characteristics are associated with higher or lower levels of return expectations. If firms manage their pension plan independently, firm characteristics should not matter for pension plan assumptions. The empirical results show, however, that firms make more optimistic return assumptions for their pension plans if they have less cash, lower profitability, lower profit volatility, lower R&D, and less FX exposure. Moreover, a higher Z-Score is associated with higher return expectations. Thus, as with other dimensions of pension plans, firms seem to integrate the return expectations into their financial policy. Overall, a comprehensive set of independent variables can explain 50% of the variation of the long-term expected return.

Another key assumption by plan sponsors is the rate used to discount the future benefits of plan participants in order to arrive at the projected benefit obligation. Table 4 explores its determinants, documenting that plan sponsors integrate discount rate assumptions as well. In particular, they make higher discount rate assumptions if they have higher book/market ratios, lower FX exposure, longer debt maturity and positive book equity. With regards to pension plan characteristics, there are significant relations to the realized and expected returns on plan assets, the funding level, and the investment horizon.[11]

[11] The earnings of plan sponsors with a high ratio of plan assets (or obligations) to operating earnings are particularly sensitive to the assumed rate of return on the plan assets. In line with the resulting managerial incentives to raise

While there may be less discretion for plan sponsors to choose the discount rate, small changes have a significant effect on the size of the plan obligations. Figure 3 shows that each year a high number of plan sponsors change their discount rate assumptions, with many firms increasing the discount rates during the burst of the dot.com bubble and during the recent financial crisis. Contrary to the common characterization of return assumptions as the most flexible pension plan parameter, about twice as many firms change their discount rate assumption compared to the return on plan assets. Importantly, firms choose high discount rates at the same time as they make assumptions of high expected returns on plans assets, both of which will appear to make the defined-benefit plan look better. Since firms make more aggressive assumptions about these pension plan parameters when their financial situation is more difficult, policy needs to consider how to trade off desirable flexibility with the protection of the interests of plan beneficiaries.

4.3 Pension Plan Investment Risk

Table 5 shows results of regressions of pension plan investment risk, measured as the volatility of the return on plan assets, on plan sponsor characteristics. Following the suggestions by Rauh (2009) for future research, the regressions include a comprehensive set of potential determinants of plan investment risk as well as control variables, in order to identify additional factors that affect the variation in pension fund investment strategies and to avoid potential omitted variable biases. He suggests specifically including a measure of foreign currency exposure. The results show that firms invest their pension funds in riskier assets if they have less FX exposure, are larger, have shorter debt maturity and positive book equity. This would suggest that firms with more business or financial risk are more conservative with their pension investments. Moreover, Figure 4 shows that there are few firms that do not invest in bonds at all, which is what would be expected if risk shifting was the driving motive of the asset allocation.[12] Furthermore, none of the characteristics of plan sponsors matter in the more comprehensive specifications that include variables capturing characteristics of plan sponsor asset and financial risk as well pension plan features, suggesting that firms may not integrate pension plan investment risk into their business and financing decisions after controlling for pension plan characteristics.

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assumed returns opportunistically, plan sponsors with higher earnings sensitivity make higher expected return assumptions.

[12] The graph is based on firm-year observations, but looks very similar when using firm averages.

The results for other plan features show that firms invest their pensions in riskier assets if they have larger plans with low past returns. Higher investment risk is also associated with higher return expectations. The negative coefficient on the funding level is consistent with highly underfunded firms being willing to take more investment risk because investing in safe assets would recognize that they will not be able to make the promised pension payments to plan participants. Thus, this would be in line with risk shifting. Managers might also increase the risk of their pension investment in order to justify increases in assumed returns. Beyond statistical significance, the results in the last two columns show that return expectations are by far the most important determinant of investment risk, followed by plan size and past returns.

Rauh (2009) also notes that a large fraction of the variation in plan investment risk (measured using the asset allocation) remains unexplained (R-Squares of 5 to 15%). The results here show that the explanatory power for the volatility of pension fund returns is greatest for pension plan characteristics, followed by plan sponsor characteristics. The comprehensive regressions explain about 30 to 40% of the pension return volatility. Note that in contrast to the finding in Rauh (2009), the credit rating is not significant, which might be due to differences in the underlying data sources, sample firms, sample period and choice of dependent and independent variables.

4.4 Economic Downturns

Two recent episodes, namely the global recession in 2001 and the global financial crisis in 2008, provided plan sponsors with unparalleled challenges in terms of depressed asset values, increased plan obligations, tougher general economic conditions, and stricter funding requirements. Table 6 explores whether these more extreme circumstances lead to stronger evidence for the integration of defined benefit plans, such as exploiting wealth transfers through asset substitution. It uses one of the multivariate specifications of the previous tables with comprehensive sets of independent variables and interacts these with dummy variables for the burst of the dot-com bubble (2000-2002) and the global financial crisis (2007-2014).[13]

The results indicate stronger plan integration in periods of major economic contractions. In particular, firms with higher asset risk took more investment risk with their pension plan during the dot-com crash. In the global financial crisis, higher investment risk is related to higher leverage, though it is also associated with lower asset risk (higher book/market, lower FX exposure). Firms also increase

[13] Given the smaller set of variables, the number of observations is larger in Table 6 compared to Tables 1-5.

their investment risk if they have lower realized returns on plan assets, and firms with low cash balances make more optimistic expected returns assumptions. Thus, several relations provide evidence of risk shifting of plan sponsors during hard economic times, while there is hardly any evidence from Tables 5 and 6 that firms generally integrate the riskiness of their pension plan investments.

Similarly, firms were taking substantial investment risks with their pension assets despite high levels of underfunding of their pension plans over prolonged periods of time. Figure 5 illustrates the asset allocation of pension plans over time. It shows that the majority of plan assets are invested in equities (50 to 60%), followed by fixed-income securities (35 to 45%), other assets (3 to 7%) and real estate (1 to 2%). The fraction of assets invested in equities has slightly declined over time, while allocations to debt securities and real estate have increased. The figure suggests that pension plan allocations to equities drop around 2007 to 2008 as a result of the financial crisis, as equity markets collapsed. However, sponsors increased their allocations in alternative asset classes, and the last decade is characterized by significant, persistent levels of pension plan underfunding, combined with large allocations in risky securities, thus shifting risk to the PBGC (Harrison and Sharpe, 1983).

4.5 Robustness Tests

A number of additional tests are undertaken to verify the robustness of the results and put them into perspective. In particular, a robustness test assigns firms with missing credit rating a value of 23, i.e., below the lowest credit rating. This increases the sample size for regressions with credit rating, but the results are similar. In the same way, results do not change when using alternative definitions of the marginal tax rate or the average tax rate. Another robustness test includes stock option-based incentives of CFOs and their interaction with distress risk as additional controls, following Anantharaman and Lee (2014). While the inclusion of these variables reduces the sample size significantly, the main results of the paper are robust to the additional controls.

Regressions with the investment risk of pension plans use the volatility of the return on plan assets as a measure of risk. In contrast, the previous literature has employed proxies based on the asset allocation of the pension fund to capture plan investment risk. In order to provide analyses that are more comparable, Appendix C presents results using the percentage of assets of defined-benefit pension plans invested in equity securities and debt securities, and the plan asset beta as dependent variables. Overall, the results based on these measures differ along a number of dimensions from those using pension return volatility, showing that analyses of pension plan investment risk are sensitive to the risk measure employed. In particular, the pension asset allocation and asset beta are significantly

related to plan sponsor asset characteristics (cash, profitability, profit volatility, PPE, R&D) and financial characteristics (debt maturity, Z-Score). Thus, traditional measures of pension plan investment risk appear to be systematically related to firm sponsor characteristics, while this not the case for pension return volatility for the same sample and regression specifications, yielding different conclusions about the integration of pensions plans for investment risk.

5 Conclusion

This paper investigates the relation between the general financial policies of firms and their defined-benefit pension plans, based on a sample of 4,134 U.S. non-financial firms. In particular, it considers characteristics of the asset risk and financial risk of plan sponsors, and investigates how they relate to several dimensions of occupational defined-benefits plans. This analysis of pension plan integration is of particular interest with regards to the recent period, when the financial crisis provided a negative shock to firms' business operations and the funding levels of pension plans, while new regulation tightened funding requirements. As a result, the incentives might be stronger to use pension plans in the best interest of shareholders, such as for shifting risks. Similarly, the global recession in 2001 created a perfect storm for pension plans with falling stock prices and bond yields (Alderson and Betker, 2009).

The empirical results show overall that firms manage their pension plans as part of their overall financial strategy, since various pension plan dimensions are closely related to the economic condition of the sponsor, i.e. plans sponsors integrate their plans. Firms make smaller contributions, have larger funding deficits and make more optimistic assumptions about the expected return on plan assets if they have less cash, are less profitable and are closer to bankruptcy. In contrast, there is little evidence of firms using pension plans to maximize tax benefits by making larger contributions when marginal tax rates are high.

Even though the evidence of plan integration is mostly supportive of risk management in general, there is some evidence of risk shifting during major economic downturns, such as firms with higher business and financial risk taking higher investment risk with their pension plan. In hard economic times, firms also make more optimistic pension plan return assumptions if they have less cash. Moreover, during the past decade, firms maintained significant levels of underfunding while investing largely in risky assets, which amounts to passive asset substitution (Petersen, 1996; Harrison and Sharpe, 1983). The results of the paper identify funding rules, pension plan assumptions and investment policies as important levers for pension plan regulation. Future research should investigate

whether and under what conditions the integration of defined-benefit plans into the overall financial management of non-financial firms is in the interest of plan participants.

Concrete suggestions for policy, however, ultimately depend on the broader question of who in the economy should bear the costs and risk of occupational pension plans, and what guarantees employees should be awarded and by whom. DB pension schemes tend to provide relatively generous benefits, and compared to DC schemes the investment risk is borne by the employer as opposed to the employee. However, the defined benefits of DB schemes are only as good as the guarantees provided by the plan sponsor and the PBGC. In case of plan sponsor default, plan participants will lose the linkage of their benefits to future salaries, and the benefits provided by the PBGC are capped. Thus, while strict mandatory funding rules may ensure adequate funding of accrued benefits, it may be in the interest of pension plan beneficiaries to avoid the default of sponsors caused by mandatory contributions if plan sponsors can recover. Since corporate defaults are correlated, the available degrees of flexibility may however be limited. Moreover, while the PBGC has no legal claim on the general fund of the Treasury, the government provides implicit guarantees and is generally expected to cover any major funding deficits (Kiska, Lucas and Phaup, 2005). This raises the question of the level and adequacy of the required insurance premia paid to the PBGC and to what extent the general taxpayer should provide insurance for DB pension schemes. These are challenging questions for policy makers that are beyond the scope of this paper.

References

Alderson, M.J., and B.L. Betker, 2009. Were internal capital markets affected by the 'perfect' pension storm?, Journal of Corporate Finance 15, 257-271.

Amir, E., Y. Guan, and D. Oswald, 2010. The effect of pension accounting on corporate pension asset allocation. Review of Accounting Studies 15, 345-366.

Anantharaman, D., and Y.G. Lee, 2014. Managerial risk taking incentives and corporate pension policy. Journal of Financial Economics 111, 328-351.

Bakke, R.-E., and T.M. Whited, 2012. Threshold Events and Identification: A Study of Cash Shortfalls. Journal of Finance 67 (3), 1083-1111.

Ballester, M., D. Fried, and J. Livnat, 2002. Pension Plan Contributions, Free Cash Flows and Financial Slack. New York University Working Paper.

Bartram, S.M. 2015. Corporate Post-Retirement Benefit Plans and Real Investment, Management Science, forthcoming.

Bartram, S.M. 2016. Corporate Post-Retirement Benefit Plans and Leverage, Review of Finance 20 (2), 575-629.

Bartram, S.M., and G.M. Bodnar, 2009. No Place to Hide: The Global Crisis in Equity Markets in 2008/09, Journal of International Money and Finance 28 (8), 1246-1292.

Bartram, S.M., G.W. Brown, and W. Waller, 2015. How Important is Financial Risk?, Journal of Financial and Quantitative Analysis 50 (4), August, 801-824.

Bergstresser, D., M.A. Desai, and J. Rauh, 2006. Earnings Manipulation, Pension Assumptions and Managerial Investment Decisions. Quarterly Journal of Economics 121, 157–95.

Black, F., 1980. The Tax Consequences of Long-Run Pension Policy, Financial Analysts Journal 36, 21-29.

Blankley, A.I., and E.P. Swanson, 1995. A Longitudinal Study of SFAS 87 Pension Rate Assumptions. Accounting Horizons 9 (4), 1-21.

Blouin, J., J.E. Core, and W. Guay, 2010. Have the tax benefits of debt been overestimated? Journal of Financial Economics 98, 195-213.

Bodie, Z., J.O. Light, R. Mørck, and R.A. Taggart, Jr., 1985. Corporate Pension Policy: An Empirical Investigation. Financial Analysts Journal 41 (5), 10-16.

Campbell, J.L., D.S. Dhaliwal, and W.C. Schwartz, 2012. Financing Constraints and the Cost of Capital: Evidence from the Funding of Corporate Pension Plans. Review of Financial Studies 25(3), 868-912.

Friedman, B.M., 1983. Pension Funding, Pension Asset Allocation, and Corporate Finance: Evidence from Individual Company Data. In Z. Bodie and J. Shoven, eds. Financial Aspects of the U. S. Pension System, University of Chicago Press, Chicago, 107–147.

Harrison, M. J. and W.F. Sharpe. 1983. Optimal Funding and Asset Allocation Rules for Defined-benefit Pension Plans. In Z. Bodie and J. Shoven, eds. Financial Aspects of the U. S. Pension System, University of Chicago Press, Chicago, 91-106.

Jin, L., R.C. Merton, and Z. Bodie, 2006. Do a firm's equity returns reflect the risk of its pension plan? Journal of Financial Economics 81, 1-26.

Kiska, W., D. Lucas, and M. Phaup, 2005. The Risk Exposure of the Pension Benefit Guaranty Corporation, CBO Working Paper.

Merton, R.C., 2014. The Crisis in Retirement Planning. Harvard Business Review 92 (7/8), 43–50.

Mohan, N., and T. Zhang, 2012. An Analysis of Risk-Taking Behavior for Public Defined-benefit Pension Plans. Journal of Banking and Finance 40, 403-419.

Novy-Marx, R., and J. Rauh, 2011. Public Pension Promises: How Big Are They and What Are They Worth?, Journal of Finance 66 (4), 1211-1249.

Petersen, M., 1992. Pension Reversions and Worker-Stockholder Wealth Transfers. Quarterly Journal of Economics 57, 1035-1056.

Petersen, M., 1996. Allocating Assets and Discounting Cash Flows: Pension Plan Finance. In P.A. Fernandez, J.A. Turner, and R.P. Hinz, eds. Pensions, Savings, and Capital Markets, Washington, D.C., U.S. Department of Labor.

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

Rauh, J.D., 2009. Risk Shifting versus Risk Management: Investment Policy in Corporate Pension Plans. Review of Financial Studies 22 (7), 2687-2733.

Shivdasani, A., and I. Stefanescu, 2010. How Do Pensions Affect Corporate Capital Structure Decisions? Review of Financial Studies 23 (3), 1287-1323.

Sprinzen, S., 2003. Pitfalls of U.S. Pension Accounting and Disclosure, Standard and Poor's, Corporate Ratings.

Figure 1: Funding Level, Employer and Participant Contributions

The figure shows the average funding level (dotted line), contributions by employers (bold solid line) and participants (thin solid line) to U.S. defined-benefit pension plans for pensions over time. All variables are scaled by projected benefit obligations. All variables are defined in Appendix A.

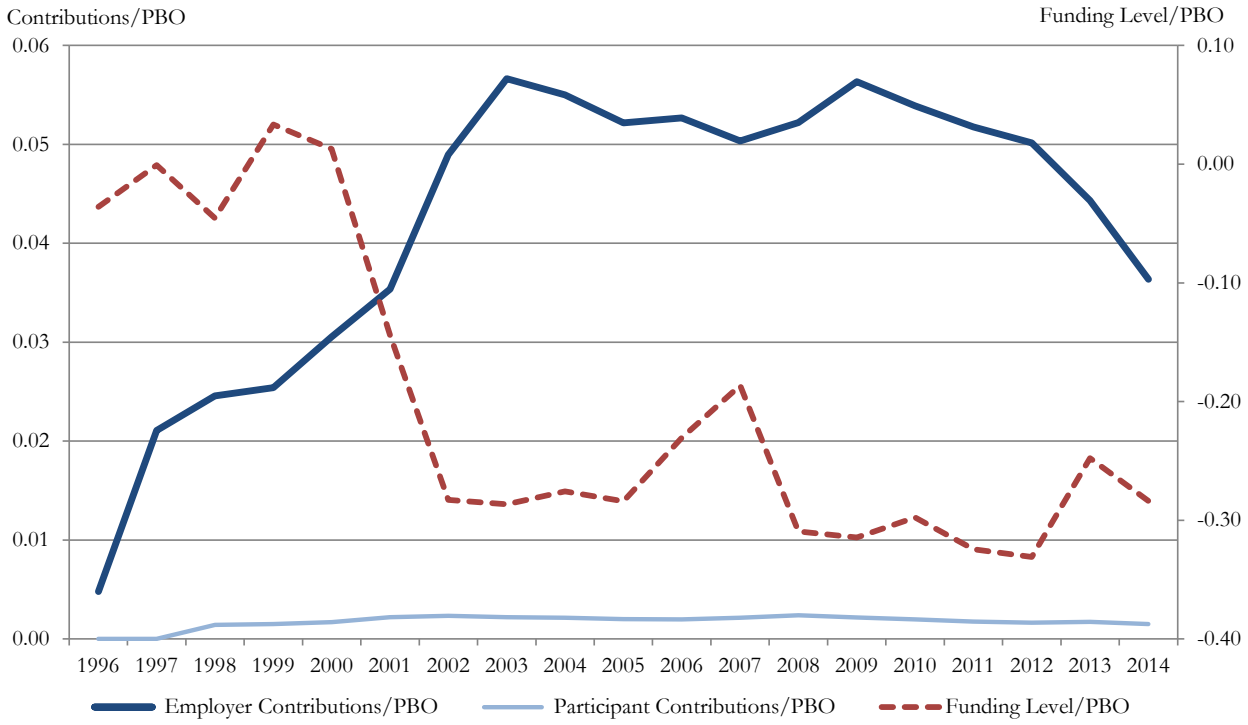

Figure 2: Expected and Actual Returns on Plan Assets

The figure shows the average actual returns on plan assets (bold solid line), the long-term expected return on plan assets (light dashed line), as well as the assumed weighted average discount rate (dotted line) for U.S. defined-benefit pension plans. All variables are defined in Appendix A.

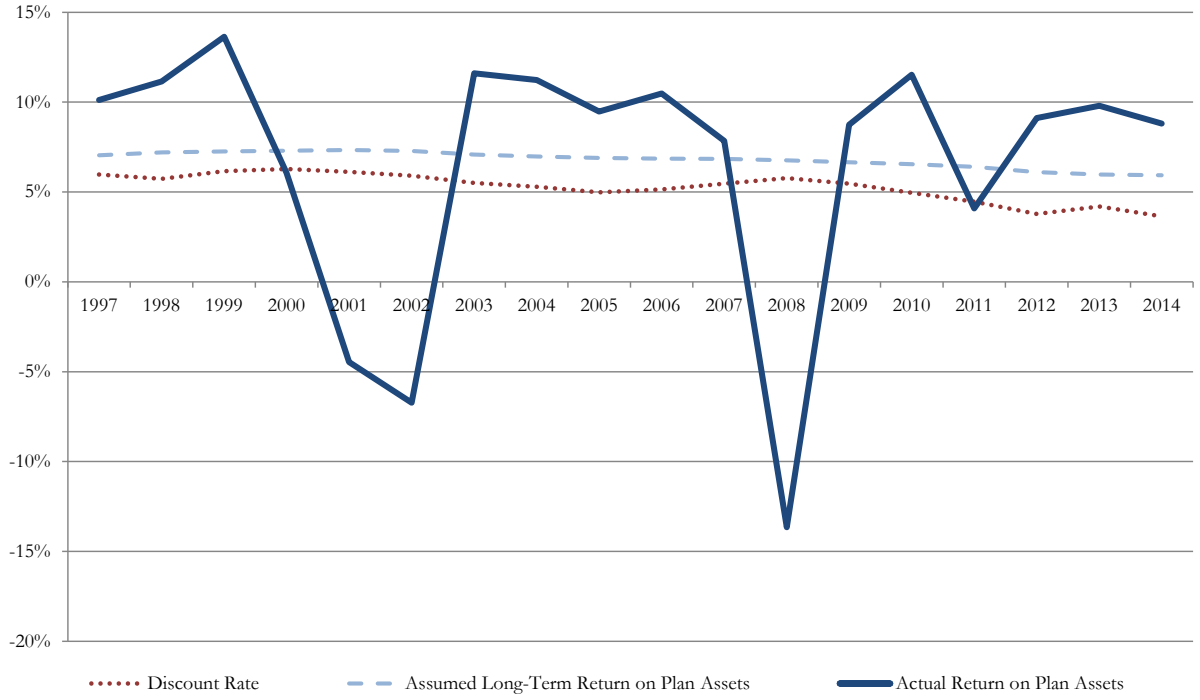

Figure 3: Changes in Plan Assumptions

The figure shows the proportion of sample firms that increase or decrease their assumptions for the expected return on plan assets and discount rate. All variables are defined in Appendix A.

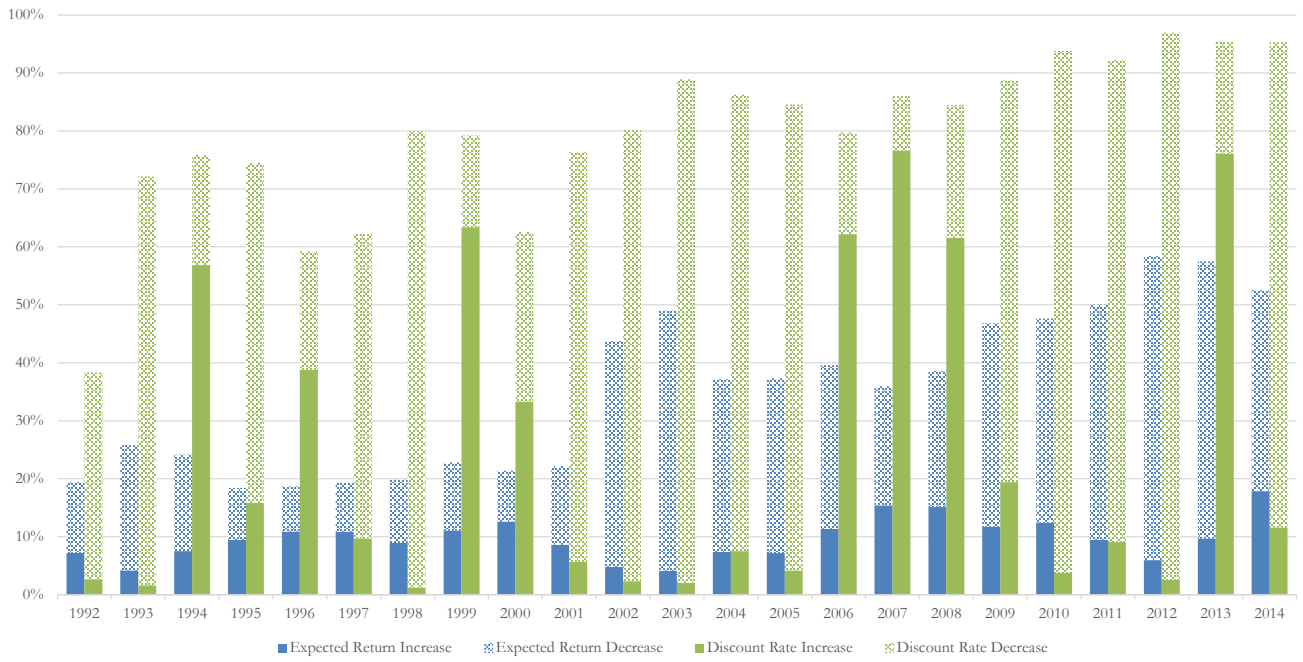

Figure 4: Pension Plan Investments in Debt Securities

The figure shows the proportion of sample firms as a function of the percentage of pension plan assets invested in debt securities (in buckets of 5%). The sample period is 2002-2014. All variables are defined in Appendix A.

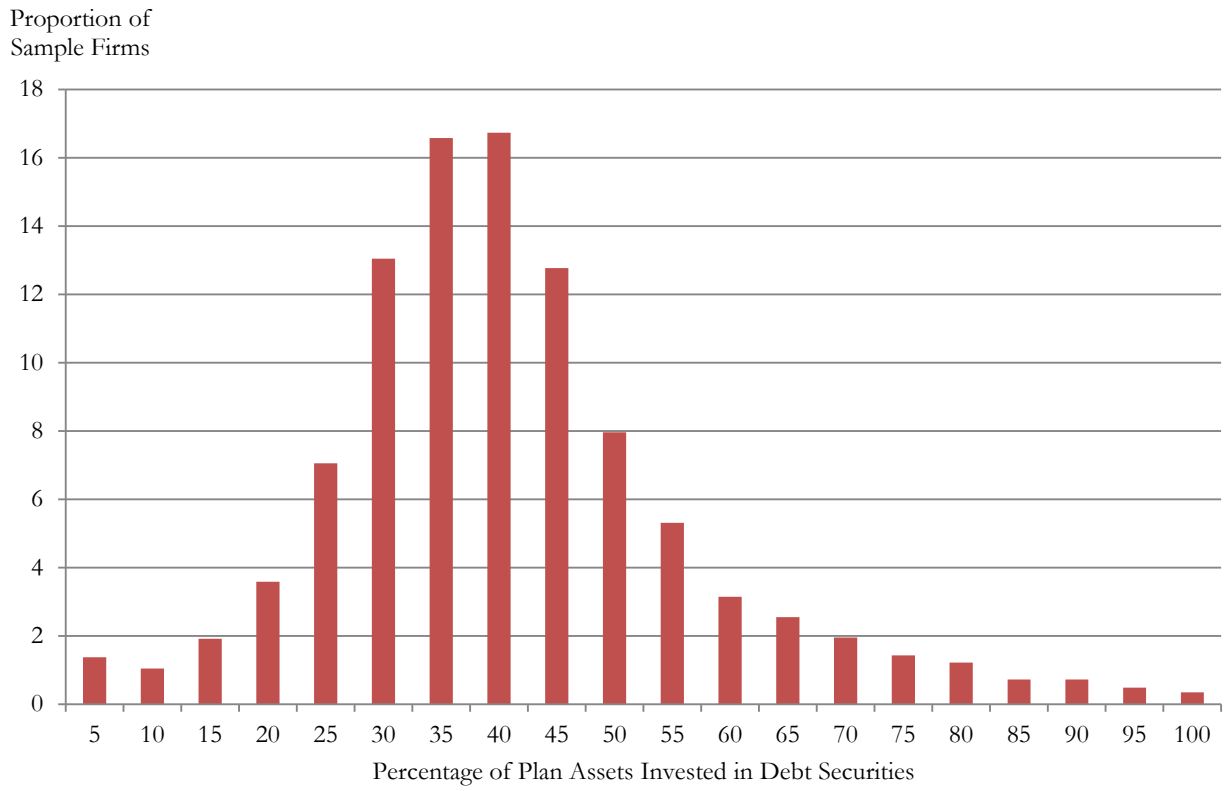

Figure 5: Pension Plan Asset Allocation

The figure shows the average fraction of assets of U.S. defined-benefit pension plans invested in equity securities (bold solid line), debt securities (bold dashed line), real estate (thin solid line), and other assets (thin dashed line). The figure also shows the return on the value-weighted U.S. equity market index (dotted line). All variables are defined in Appendix A.

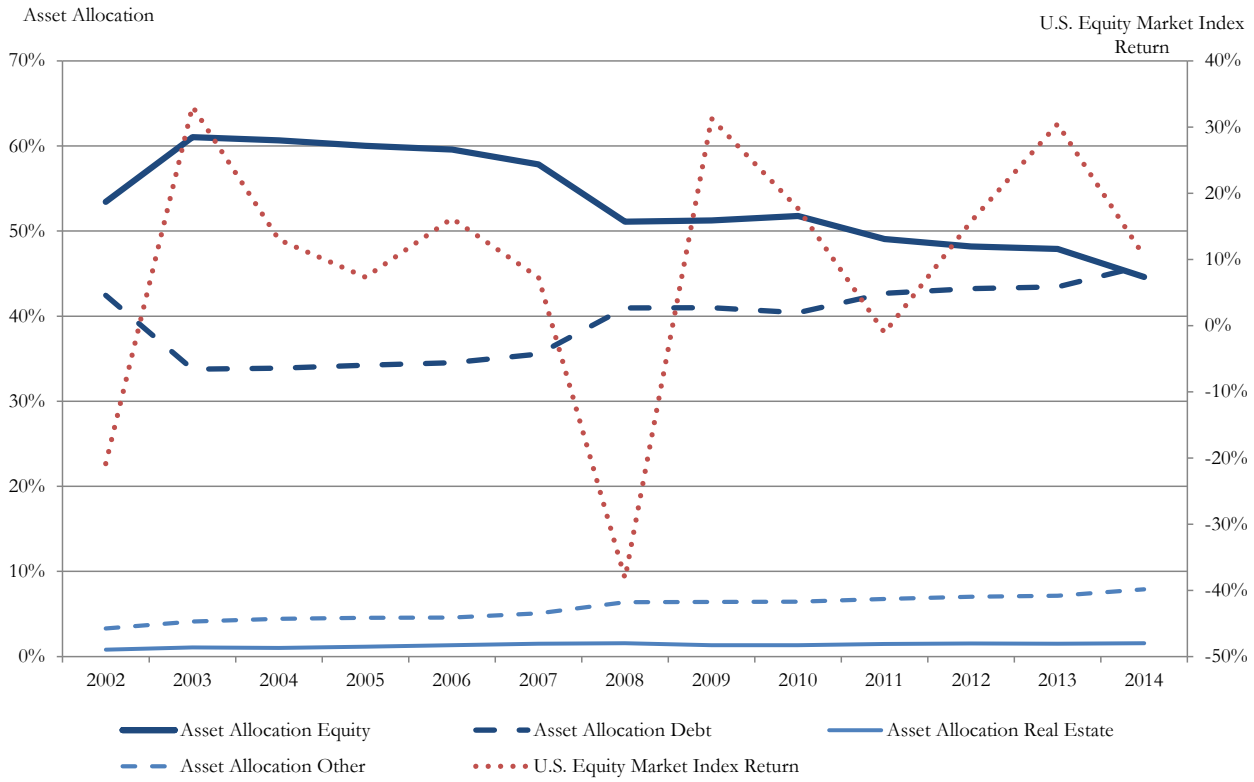

Table 1: Employer Contributions to Pension Plans

The table shows results from regressions of employer contributions to U.S. defined-benefit pension plans scaled by the size of the plan as measured by the projected benefit obligation as dependent variable. In particular, it shows the coefficients (or marginal effects) and associated *t*-statistics of independent variables capturing a firm's asset risk, financial risk and pension plan characteristics. Marginal effects are calculated as the regression coefficient multiplied with the standard deviation of the regressor (except for the intercept, which just reports the regression coefficient). Measures of asset risk are the Quick Ratio, the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of ROA, the natural logarithm of the Volatility of GrossProfitMargin, the three-year average of GrossProfitMargin, Book/Market, Tangible Assets/Total Assets, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Capital Expenditures/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, the natural logarithm of the market value of size, the natural logarithm of Age, and the Tax Rate. Measures of financial risk are leverage using market values, debt maturity, Z-Score, the S&P long-term domestic issuer rating, and an indicator for negative book equity. Pension plan characteristics are the funding level (scaled by PBO), the natural logarithm of PBO, PBO/Total Assets, the long-term expected return on plan assets, the actual return on plan assets, the natural logarithm of the investment horizon, the volatility of the returns on the plan assets, and Participant Contributions/PBO. The table also shows the Adjusted R-Squared and the number of observations. Regressions include year and industry fixed effects as indicated. Standard errors are clustered by firm. *, **, and *** indicate statistical significance at the 10% (5%, 1%) significance level. All explanatory variables are lagged by one period. The sample period is 1998-2014. All variables are defined in Appendix A.

(continued)

Table 1: Employer Contributions to Pension Plans (continued)

	(1)			(2)			(3)			(4)			(5)			(6)			(7)		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		MarEff	t-stat		MarEff	t-stat	
Asset Risk																					
Quick Ratio	0.004	[2.52]	**																		
Log (CashAndSTInvestment/Total Assets)				0.002	[2.36]	**										0.002	[2.36]	**	0.002	[2.80]	***
Log (Volatility of ROA)	-0.001	[0.70]																			
Log (Volatility of GrossProfitMargin)				-0.001	[1.28]											0.000	[0.27]		-0.001	[0.87]	
Gross ProfitMargin (3-year average)	-0.001	[0.07]		0.010	[0.73]														0.002	[1.77]	*
Book/Market	-0.001	[0.66]		0.000	[0.30]											-0.001	[1.25]				
Tangible Assets/Total Assets	-0.007	[1.10]																			
Net PPE/Total Assets				0.001	[0.17]											0.000	[0.15]		0.000	[0.17]	
R&D Expense/Total Assets	0.048	[1.14]		0.041	[0.98]											0.001	[0.98]		0.001	[1.50]	
Capital Expenditures/Total Assets	0.043	[1.33]																			
Dividend (dummy)	-0.002	[1.12]		-0.003	[1.18]											0.000	[0.50]		0.000	[0.34]	
Net FX-Exposure	-0.003	[0.77]		-0.003	[0.89]											-0.001	[1.26]		-0.001	[1.51]	
Log(Size Market Value)	0.001	[0.68]		0.000	[0.18]																
Log (Age)	-0.006	[3.88]	***	-0.006	[4.03]	***										0.000	[0.47]		-0.001	[0.66]	
Tax Rate	0.024	[1.82]	*	0.029	[2.19]	**										-0.001	[0.63]		0.000	[0.07]	
Financial Risk																					
Leverage (Market Value)							-0.021	[3.68]	***							-0.005	[5.00]	***			
Debt Maturity							0.006	[1.22]		0.004	[0.94]					0.000	[0.60]		0.000	[0.12]	
Z-Score										0.001	[2.63]	***							0.002	[1.73]	*
Rating							0.001	[2.37]	**												
Negative Book Equity							-0.004	[0.84]		-0.002	[0.41]								0.000	[0.25]	
Pension Plan																					
Funding Level/PBO													-0.067	[12.09]	***	-0.015	[12.32]	***	-0.015	[12.20]	***
PBO/Total Assets													-0.018	[3.58]	***	-0.004	[3.88]	***	-0.003	[3.15]	***
Log (PBO)													-0.001	[1.55]		-0.002	[1.84]	*	-0.002	[1.45]	
LT Expected Return on Plan Assets													0.202	[1.60]		0.002	[1.90]	*	0.002	[1.77]	*
Actual Return on Plan Assets													-0.006	[0.71]		-0.001	[0.66]		-0.001	[0.64]	
Volatility of Return on Plan Assets													-0.016	[0.83]		-0.001	[1.12]		-0.001	[1.00]	
Log (Investment Horizon)													0.012	[10.12]	***	0.009	[9.00]	***	0.009	[8.94]	***
Participant Contributions/PBO													-0.440	[1.69]	*	-0.002	[1.76]	*	-0.002	[1.74]	*
Intercept	0.051	[4.46]	***	0.056	[4.77]	***	0.038	[6.44]	***	0.039	[7.71]	***	0.074	[5.92]	***	0.083	[5.41]	***	0.068	[4.44]	***
Industry fixed effects	yes			yes			yes			yes			yes			yes			yes		
Year fixed effects	yes			yes			yes			yes			yes			yes			yes		
Adj. R-Squared	0.11			0.10			0.10			0.10			0.22			0.23			0.23		
Observations	5,069			5,069			5,069			5,069			5,069			5,069			5,069		

Table 2: Plan Funding Levels

The table shows results from regressions of the funding level scaled by projected benefit obligations as dependent variable. In particular, it shows the coefficients (or marginal effects) and associated *t*-statistics of independent variables capturing a firm's pension plan characteristics, asset risk, and financial risk. Marginal effects are calculated as the regression coefficient multiplied with the standard deviation of the regressor (except for the intercept, which just reports the regression coefficient). Pension plan characteristics are the projected benefit obligations scaled by total assets, the natural logarithm of PBO, the discount rate, the long-term expected return on plan assets, the actual return on plan assets, the volatility of the return on plan assets, the natural logarithm of the investment horizon, and employer and participant contributions scaled by PBO. Measures of asset risk are the Quick Ratio, the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of ROA, the natural logarithm of the Volatility of GrossProfitMargin, the three-year average of GrossProfitMargin, Book/Market, Tangible Assets/Total Assets, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Capital Expenditures/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, the natural logarithm of the market value of size, the natural logarithm of Age, and the Tax Rate. Measures of financial risk are leverage using market values, debt maturity, Z-Score, the S&P long-term domestic issuer rating, and an indicator for negative book equity. The table also shows the Adjusted R-Squared and the number of observations. Regressions include year and industry fixed effects as indicated. Standard errors are clustered by firm. *, **, and *** indicate statistical significance at the 10% (5%, 1%) significance level. All explanatory variables are lagged by one period. The sample period is 1998-2014. All variables are defined in Appendix A.

(continued)

Table 2: Plan Funding Levels (continued)

	(1)			(2)			(3)			(4)			(5)			(6)			(7)		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		MarEff	t-stat		MarEff	t-stat	
Asset Risk																					
Quick Ratio	0.000	[0.06]																			
Log (CashAndSTInvestment/Total Assets)				0.004	[1.17]											-0.001	[0.15]		0.000	[0.05]	
Log (Volatility of ROA)	0.002	[0.55]																			
Log (Volatility of GrossProfitMargin)				0.001	[0.15]											0.006	[1.21]		0.003	[0.57]	
Gross ProfitMargin (3-year average)	0.214	[3.06]	***	0.207	[2.96]	***													0.027	[3.57]	***
Book/Market	0.000	[0.04]		-0.001	[0.16]											0.002	[0.61]				
Tangible Assets/Total Assets	0.095	[2.63]	***																		
Net PPE/Total Assets				-0.058	[1.26]											-0.006	[0.70]		-0.011	[1.34]	
R&D Expense/Total Assets	-0.064	[0.30]		-0.041	[0.19]											-0.005	[0.92]		-0.004	[0.72]	
Capital Expenditures/Total Assets	-0.329	[2.04]	**																		
Dividend (dummy)	0.022	[1.87]	*	0.023	[1.97]	**										0.008	[1.58]		0.006	[1.22]	
Net FX-Exposure	-0.049	[1.70]	*	-0.048	[1.69]	*										-0.010	[1.26]		-0.012	[1.52]	
Log(Size Market Value)	0.016	[2.95]	***	0.015	[2.79]	***															
Log (Age)	0.024	[2.84]	***	0.025	[2.95]	***										0.007	[1.20]		0.005	[0.84]	
Tax Rate	0.045	[0.68]		-0.001	[0.01]																
Financial Risk																					
Leverage (Market Value)							-0.044	[1.38]								-0.030	[4.95]	***			
Debt Maturity							-0.030	[1.39]		-0.072	[3.01]	***				-0.005	[1.33]		-0.008	[1.91]	*
Z-Score										0.014	[4.02]	***							0.020	[2.96]	***
Rating							-0.012	[6.22]	***												
Negative Book Equity							0.018	[1.12]		-0.001	[0.07]								-0.001	[0.34]	
Pension Plan																					
PBO/Total Assets													0.075	[2.14]	**	0.017	[2.43]	**	0.022	[3.12]	***
Log (PBO)													0.016	[3.87]	***	0.017	[2.08]	**	0.020	[2.54]	**
LT Expected Return on Plan Assets													1.447	[1.84]	*	0.015	[1.81]	*	0.014	[1.74]	*
Actual Return on Plan Assets													0.212	[8.59]	***	0.026	[8.44]	***	0.026	[8.48]	***
Volatility of Return on Plan Assets													0.034	[0.34]		0.001	[0.13]		0.001	[0.16]	
Log (Investment Horizon)													-0.001	[0.14]		-0.005	[0.79]		-0.005	[0.83]	
Employer Contributions/PBO													-0.110	[0.97]		-0.006	[1.14]		-0.006	[1.07]	
Participant Contributions/PBO													2.121	[1.35]		0.010	[1.71]	*	0.010	[1.65]	*
Intercept	-0.543	[9.03]	***	-0.412	[6.86]	***	-0.015	[0.50]		-0.140	[5.96]	***	-0.426	[5.20]	***	-0.347	[3.36]	***	-0.457	[4.65]	***
Industry fixed effects	yes			yes			yes			yes			yes			yes			yes		
Year fixed effects	yes			yes			yes			yes			yes			yes			yes		
Adj. R-Squared	0.29			0.29			0.29			0.26			0.30			0.32			0.33		
Observations	5,085			5,085			5,085			5,085			5,085			5,085			5,085		

Table 3: Expected Long-Term Rate of Return on Plan Assets

The table shows results from regressions of assumed long-term expected rates of returns on the plan assets of U.S. defined-benefit pension plans as dependent variable. In particular, it shows the coefficients (or marginal effects) and associated *t*-statistics of independent variables capturing a firm's pension plan characteristics asset risk, and financial risk. Marginal effects are calculated as the regression coefficient multiplied with the standard deviation of the regressor (except for the intercept, which just reports the regression coefficient). Pension plan characteristics are the funding level (scaled by PBO), the natural logarithm of PBO, PBO/Total Assets, the actual return on plan assets, the volatility of the return on plan assets, and the natural logarithm of the investment horizon. Measures of asset risk are the Quick Ratio, the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of ROA, the natural logarithm of the Volatility of GrossProfitMargin, the three-year average of GrossProfitMargin, Book/Market, Tangible Assets/Total Assets, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Capital Expenditures/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, the natural logarithm of the market value of size, the natural logarithm of Age, and the tax rate. Measures of financial risk are leverage using market values, debt maturity, Z-Score, the S&P long-term domestic issuer rating, and an indicator for negative book equity. The table also shows the Adjusted R-Squared and the number of observations. Regressions include year and industry fixed effects as indicated. Standard errors are clustered by firm. All explanatory variables are lagged by one period. *, **, and *** indicate statistical significance at the 10% (5%, 1%) significance level. The sample period is 1998-2014. All variables are defined in Appendix A.

(continued)

Table 3: Expected Long-Term Rate of Return on Plan Assets (continued)

	(1)			(2)			(3)			(4)			(5)			(6)			(7)		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		MarEff	t-stat		MarEff	t-stat	
Asset Risk																					
Quick Ratio	-0.095	[2.28]	**																		
Log (CashAndSTInvestment/Total Assets)				-0.043	[2.03]	**										-0.059	[2.53]	**	-0.080	[3.38]	***
Log (Volatility of ROA)	-0.062	[2.32]	**																		
Log (Volatility of GrossProfitMargin)				-0.062	[1.91]	*										-0.056	[2.45]	**	-0.044	[1.94]	*
Gross ProfitMargin (3-year average)	-0.816	[2.13]	**	-0.909	[2.36]	**													-0.037	[1.18]	
Book/Market	-0.023	[1.09]		-0.025	[1.18]											0.009	[0.50]				
Tangible Assets/Total Assets	0.054	[0.27]																			
Net PPE/Total Assets				0.206	[1.06]											-0.017	[0.52]		0.002	[0.07]	
R&D Expense/Total Assets	-2.185	[1.45]		-1.952	[1.29]											-0.065	[2.18]	**	-0.072	[2.43]	**
Capital Expenditures/Total Assets	0.088	[0.11]																			
Dividend (dummy)	-0.001	[0.02]		0.006	[0.10]											-0.021	[0.90]		-0.030	[1.27]	
Net FX-Exposure	-0.362	[3.11]	***	-0.349	[2.98]	***										-0.052	[2.12]	**	-0.053	[2.16]	**
Log(Size Market Value)	0.081	[3.12]	***	0.093	[3.68]	***															
Log (Age)	0.134	[3.05]	***	0.140	[3.21]	***										0.009	[0.33]		0.000	[0.01]	
Tax Rate	0.303	[0.83]		0.410	[1.16]																
Financial Risk																					
Leverage (Market Value)							0.330	[2.35]	**							0.025	[1.15]				
Debt Maturity							-0.035	[0.35]		-0.108	[1.00]					0.006	[0.41]		0.003	[0.18]	
Z-Score										0.000	[0.01]								0.064	[2.11]	**
Rating							-0.045	[4.34]	***												
Negative Book Equity							0.088	[0.80]		0.003	[0.03]								0.035	[1.50]	
Pension Plan																					
Funding Level/PBO													0.119	[0.89]		0.029	[0.98]		0.026	[0.85]	
PBO/Total Assets													0.582	[3.84]	***	0.124	[3.90]	***	0.117	[3.56]	***
Log (PBO)													0.123	[7.51]	***	0.225	[7.64]	***	0.235	[7.86]	***
Discount Rate													0.608	[8.92]	***	0.567	[8.78]	***	0.567	[8.92]	***
Actual Return on Plan Assets													0.465	[3.72]	***	0.054	[3.53]	***	0.055	[3.62]	***
Volatility of Return on Plan Assets													3.751	[7.76]	***	0.194	[7.91]	***	0.195	[8.00]	***
Log (Investment Horizon)													-0.010	[0.34]		0.002	[0.07]		-0.004	[0.19]	
Intercept	6.472	[18.36]	***	5.997	[18.94]	***	8.016	[35.70]	***	7.725	[35.80]	***	3.729	[9.99]	***	3.496	[8.29]	***	3.501	[8.30]	***
Industry fixed effects	yes			yes			yes			yes			yes			yes			yes		
Year fixed effects	yes			yes			yes			yes			yes			yes			yes		
Adj. R-Squared	0.38			0.38			0.35			0.34			0.52			0.53			0.53		
Observations	5,245			5,245			5,245			5,245			5,245			5,245			5,245		

Table 4: Discount Rates of Pension Plans

The table shows results from regressions of the discount rates of U.S. defined-benefit pension plans as dependent variable. In particular, it shows the coefficients (or marginal effects) and associated *t*-statistics of independent variables capturing a firm's pension plan characteristics, asset risk, and financial risk. Marginal effects are calculated as the regression coefficient multiplied with the standard deviation of the regressor (except for the intercept, which just reports the regression coefficient). Pension plan characteristics are the funding level (scaled by PBO), the natural logarithm of PBO, PBO/Total Assets, the long-term expected return on plan assets, the actual return on plan assets, the volatility of the return on the plan assets, and the natural logarithm of the investment horizon. Measures of asset risk are the Quick Ratio, the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of ROA, the natural logarithm of the Volatility of GrossProfitMargin, the three-year average of GrossProfitMargin, Book/Market, Tangible Assets/Total Assets, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Capital Expenditures/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, the natural logarithm of the market value of size, the natural logarithm of Age, and the tax rate. Measures of financial risk are leverage using market values, debt maturity, Z-Score, the S&P long-term domestic issuer rating, and an indicator for negative book equity. The table also shows the Adjusted R-Squared and the number of observations. Regressions include year and industry fixed effects as indicated. Standard errors are clustered by firm. All explanatory variables are lagged by one period. *, **, and *** indicate statistical significance at the 10% (5%, 1%) significance level. The sample period is 1998-2014. All variables are defined in Appendix A.

(continued)

Table 4: Discount Rates of Pension Plans (continued)

	(1)			(2)			(3)			(4)			(5)			(6)			(7)		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		MarEff	t-stat		MarEff	t-stat	
Asset Risk																					
Quick Ratio	0.006	[0.33]																			
Log (CashAndSTInvestment/Total Assets)				-0.009	[1.13]											-0.004	[0.49]		-0.007	[0.74]	
Log (Volatility of ROA)	-0.002	[0.12]																			
Log (Volatility of GrossProfitMargin)				-0.017	[1.14]											-0.007	[0.62]		-0.003	[0.23]	
Gross ProfitMargin (3-year average)	-0.178	[1.19]		-0.170	[1.15]														-0.009	[0.70]	
Book/Market	0.015	[1.41]		0.015	[1.42]											0.017	[2.18]	**			
Tangible Assets/Total Assets	-0.035	[0.38]																			
Net PPE/Total Assets				0.101	[1.20]											0.012	[0.81]		0.014	[0.93]	
R&D Expense/Total Assets	-1.258	[1.62]		-1.106	[1.45]											-0.021	[1.25]		-0.023	[1.38]	
Capital Expenditures/Total Assets	0.274	[0.74]																			
Dividend (dummy)	0.015	[0.60]		0.012	[0.46]											0.000	[0.02]		-0.004	[0.37]	
Net FX-Exposure	-0.208	[3.90]	***	-0.197	[3.71]	***										-0.034	[2.82]	***	-0.034	[2.76]	***
Log(Size Market Value)	0.012	[1.02]		0.011	[0.96]																
Log (Age)	0.018	[1.13]		0.018	[1.11]											-0.007	[0.76]		-0.007	[0.73]	
Tax Rate	0.098	[0.53]		0.107	[0.53]																
Financial Risk																					
Leverage (Market Value)							0.099	[1.61]								0.007	[0.61]				
Debt Maturity							0.078	[1.62]		0.080	[1.57]					0.013	[1.68]	*	0.014	[1.73]	*
Z-Score										-0.003	[0.31]								0.002	[0.11]	
Rating							-0.005	[1.12]													
Negative Book Equity							-0.103	[2.68]	***	-0.103	[2.52]	**							-0.022	[2.15]	**
Pension Plan																					
Funding Level/PBO													0.139	[2.33]	**	0.031	[2.22]	**	0.030	[2.18]	**
PBO/Total Assets													-0.009	[0.14]		0.000	[0.04]		0.002	[0.14]	
Log (PBO)													-0.007	[0.86]		0.004	[0.24]		0.000	[0.02]	
LT Expected Return on Plan Assets													0.196	[9.61]	***	0.191	[9.36]	***	0.191	[9.37]	***
Actual Return on Plan Assets													0.328	[4.56]	***	0.038	[4.34]	***	0.038	[4.30]	***
Volatility of Return on Plan Assets													-0.246	[0.95]		-0.013	[0.95]		-0.013	[0.99]	
Log (Investment Horizon)													0.024	[1.64]		0.022	[1.81]	*	0.021	[1.70]	*
Intercept	4.446	[27.22]	***	4.291	[33.01]	***	4.541	[60.77]	***	4.521	[72.29]	***	3.250	[18.12]	***	3.150	[16.13]	***	3.200	[15.59]	***
Industry fixed effects	yes			yes			yes			yes			yes			yes			yes		
Year fixed effects	yes			yes			yes			yes			yes			yes			yes		
Adj. R-Squared	0.79			0.79			0.78			0.78			0.81			0.81			0.81		
Observations	5,252			5,252			5,252			5,252			5,252			5,252			5,252		

Table 5: Pension Plan Investment Risk

The table shows results from regressions of the volatility of the return on the plan assets of U.S. defined-benefit pension plans as dependent variable. In particular, it shows the coefficients (or marginal effects) and associated *t*-statistics of independent variables capturing a firm's asset risk, financial risk and pension plan characteristics. Marginal effects are calculated as the regression coefficient multiplied with the standard deviation of the regressor (except for the intercept, which just reports the regression coefficient). Measures of asset risk are the Quick Ratio, the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of ROA, the natural logarithm of the Volatility of GrossProfitMargin, the three-year average of GrossProfitMargin, Book/Market, Tangible Assets/Total Assets, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Capital Expenditures/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, the natural logarithm of the market value of size, the natural logarithm of Age, and the Tax Rate. Measures of financial risk are leverage using market values, debt maturity, Z-Score, the S&P long-term domestic issuer rating, and an indicator for negative book equity. Pension plan characteristics are the funding level (scaled by PBO), the natural logarithm of PBO, PBO/Total Assets, the long-term expected return on plan assets, the actual return on plan assets, the natural logarithm of the investment horizon, the volatility of the returns on the plan assets, and Employer and Participant Contributions scaled by PBO. The table also shows the Adjusted R-Squared and the number of observations. Regressions include year and industry fixed effects as indicated. Standard errors are clustered by firm. *, **, and *** indicate statistical significance at the 10% (5%, 1%) significance level. All explanatory variables are lagged by one period. The sample period is 1998-2014. All variables are defined in Appendix A.

(continued)

Table 5: Pension Plan Investment Risk (continued)

	(1)			(2)			(3)			(4)			(5)			(6)			(7)		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		MarEff	t-stat		MarEff	t-stat	
Asset Risk																					
Quick Ratio	0.171	[1.18]																			
Log (CashAndSTInvestment/Total Assets)				0.020	[0.25]											0.064	[0.62]		0.097	[0.92]	
Log (Volatility of ROA)	-0.009	[0.08]																			
Log (Volatility of GrossProfitMargin)				0.125	[0.95]											0.188	[1.63]		0.168	[1.48]	
Gross ProfitMargin (3-year average)	0.441	[0.31]		0.180	[0.13]														0.181	[1.30]	
Book/Market	0.040	[0.42]		0.041	[0.44]											0.062	[0.72]				
Tangible Assets/Total Assets	-0.199	[0.26]																			
Net PPE/Total Assets				0.891	[1.17]											0.132	[0.96]		0.075	[0.52]	
R&D Expense/Total Assets	1.110	[0.24]		1.116	[0.24]											0.103	[0.91]		0.110	[0.98]	
Capital Expenditures/Total Assets	1.271	[0.48]																			
Dividend (dummy)	0.117	[0.45]		0.112	[0.43]											0.035	[0.32]		0.023	[0.21]	
Net FX-Exposure	-0.987	[2.16]	**	-0.978	[2.15]	**										-0.168	[1.45]		-0.177	[1.53]	
Log(Size Market Value)	0.262	[2.46]	**	0.252	[2.38]	**															
Log (Age)	-0.037	[0.21]		-0.037	[0.21]											-0.161	[1.31]		-0.152	[1.24]	
Tax Rate	1.092	[0.72]		1.826	[1.20]																
Financial Risk																					
Leverage (Market Value)							0.088	[0.14]								-0.094	[0.79]				
Debt Maturity							-0.883	[1.88]	*	-0.998	[2.14]	**				-0.130	[1.59]		-0.125	[1.52]	
Z-Score										-0.007	[0.10]								-0.061	[0.42]	
Rating							-0.053	[1.32]													
Negative Book Equity							-0.550	[1.33]		-0.757	[1.72]	*							-0.152	[1.42]	
Pension Plan																					
Funding Level/PBO													-0.110	[0.22]		-0.040	[0.35]		-0.054	[0.46]	
PBO/Total Assets													-1.809	[2.61]	***	-0.399	[2.85]	***	-0.357	[2.49]	**
Log (PBO)													0.186	[2.44]	**	0.389	[2.69]	***	0.367	[2.51]	**
LT Expected Return on Plan Assets													1.197	[9.31]	***	1.289	[9.46]	***	1.295	[9.55]	***
Actual Return on Plan Assets													-2.656	[4.34]	***	-0.312	[4.29]	***	-0.309	[4.25]	***
Log (Investment Horizon)													0.201	[1.53]		0.147	[1.35]		0.152	[1.40]	
Employer Contributions/PBO													-0.519	[0.32]		-0.036	[0.46]		-0.037	[0.48]	
Participant Contributions/PBO													-5.469	[0.21]		0.004	[0.04]		-0.001	[0.01]	
Intercept	8.509	[4.70]	***	8.465	[4.79]	***	12.722	[8.90]	***	12.332	[8.92]	***	2.359	[1.16]		3.898	[1.75]	*	3.557	[1.60]	
Industry fixed effects	yes			yes			yes			yes			yes			yes			yes		
Year fixed effects	yes			yes			yes			yes			yes			yes			yes		
Adj. R-Squared	0.40			0.40			0.39			0.39			0.44			0.44			0.44		
Observations	5,496			5,496			5,496			5,496			5,496			5,496			5,496		

Table 6: Pension Plans and Economic Downturns

The table shows results from regressions of various characteristics of U.S. defined-benefit pension plans as dependent variables, such as the ratio of employer contributions to PBO (1), the funding level scaled by PBO (2), the long-term expected return on plan assets (3), the discount rate (4), and the volatility of the return on pension plan assets (5). The table shows the coefficients and associated *t*-statistics of independent variables capturing a firm's asset risk, financial risk, and pension plan characteristics. Measures of asset risk are the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of ROA, Book/Market, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, and the natural logarithm of Age. Measures of financial risk are leverage using market values, and debt maturity. Pension plan characteristics are the funding level scaled by PBO, the projected benefit obligations scaled by total assets, the natural logarithm of PBO, the discount rate, the long-term expected return on plan assets, the actual return on plan assets, the volatility of the return on plan assets, the natural logarithm of the investment horizon, employer contributions scaled by PBO, and participant contribution scaled by PBO. All independent variables are also interacted with a dotcom dummy and a crisis dummy that take the value of one in the years 2000-2002 and 2007-2014, respectively, and zero otherwise. The table also shows the Adjusted R-Squared and the number of observations. Regressions include industry fixed effects. Standard errors are clustered by firm. All explanatory variables are lagged by one period. *, **, and *** indicate statistical significance at the 10% (5%, 1%) significance level. The sample period is 1998-2014. All variables are defined in Appendix A.

	(1)			(2)			(3)			(4)			(5)		
	Employer Contributions/PBO			Funding Level/Total Assets			LT Expected Return on Plan Assets			Discount Rate			Volatility of Return on Plan Assets		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat	
Asset Risk															
Log (CashAndSTInvestment/Total Assets)	0.050	[0.68]		0.000	[0.10]		-0.043	[2.56]	**	-0.010	[0.98]		-0.010	[0.13]	
Log (CashAndSTInvestment/Total Assets) * Crisis	0.106	[1.12]		0.004	[0.76]		-0.054	[2.52]	**	-0.018	[1.22]		0.010	[0.09]	
Log (CashAndSTInvestment/Total Assets) * DotCom	-0.048	[0.37]		-0.007	[1.12]		0.020	[0.97]		-0.018	[1.31]		0.148	[1.18]	
Log (Volatility of ROA)	-0.064	[0.57]		0.002	[0.30]		-0.049	[2.07]	**	0.011	[0.83]		-0.088	[0.72]	
Log (Volatility of ROA) * Crisis	0.057	[0.43]		0.002	[0.30]		-0.018	[0.59]		0.022	[0.98]		0.161	[1.06]	
Log (Volatility of ROA) * DotCom	-0.112	[0.65]		-0.017	[1.76]	*	0.044	[1.36]		-0.021	[1.02]		0.371	[1.96]	*
Book/Market	-0.179	[1.84]	*	0.016	[3.49]	***	-0.024	[1.31]		0.012	[1.00]		-0.094	[1.03]	
Book/Market * Crisis	0.054	[0.48]		-0.015	[2.80]	***	-0.091	[3.63]	***	0.053	[3.05]	***	0.288	[2.35]	**
Book/Market * DotCom	0.227	[1.78]	*	-0.005	[0.77]		0.025	[1.01]		-0.013	[0.75]		0.029	[0.19]	
Net PPE/Total Assets	0.617	[1.04]		-0.047	[1.29]		-0.470	[3.41]	***	0.157	[1.63]		-0.982	[1.40]	
Net PPE/Total Assets * Crisis	-0.453	[0.77]		0.034	[1.20]		0.199	[1.54]		-0.178	[1.73]	*	1.093	[1.53]	
Net PPE/Total Assets * DotCom	-1.241	[1.54]		0.001	[0.01]		0.163	[1.30]		-0.162	[1.78]	*	0.060	[0.07]	
R&D Expense/Total Assets	5.858	[1.58]		-0.413	[2.68]	***	-2.516	[2.32]	**	0.049	[0.10]		4.006	[0.79]	
R&D Expense/Total Assets * Crisis	-11.610	[3.19]	***	0.057	[0.34]		-0.944	[0.98]		-0.776	[1.04]		-5.624	[0.99]	
R&D Expense/Total Assets * DotCom	8.798	[1.23]		0.172	[0.69]		2.972	[2.30]	**	0.727	[1.08]		-0.103	[0.01]	
Dividend (dummy)	-0.018	[0.08]		0.026	[2.34]	**	-0.048	[1.01]		0.011	[0.42]		-0.155	[0.60]	
Dividend (dummy) * Crisis	-0.102	[0.37]		-0.008	[0.57]		0.071	[1.08]		-0.055	[1.19]		-0.411	[1.24]	
Dividend (dummy) * DotCom	-0.180	[0.45]		0.019	[1.12]		0.038	[0.58]		0.043	[1.05]		1.064	[2.81]	***
Net FX-Exposure	-0.526	[1.32]		-0.064	[2.85]	***	0.026	[0.31]		0.031	[0.54]		0.574	[1.30]	
Net FX-Exposure * Crisis	0.446	[1.01]		0.016	[0.75]		-0.047	[0.48]		-0.151	[1.85]	*	-2.016	[3.80]	***
Net FX-Exposure * DotCom	-1.531	[2.10]	**	0.059	[1.75]	*	-0.098	[0.85]		-0.200	[2.46]	**	-0.193	[0.32]	
Log (Age)	-0.091	[0.68]		0.022	[2.89]	***	0.146	[4.19]	***	0.002	[0.10]		0.091	[0.51]	
Log (Age) * Crisis	-0.263	[1.66]	*	-0.019	[2.52]	**	0.083	[2.15]	**	-0.137	[5.02]	***	0.617	[2.86]	***
Log (Age) * DotCom	-0.094	[0.41]		-0.001	[0.09]		-0.144	[3.50]	***	0.011	[0.41]		-1.006	[4.14]	***

(continued)

Table 6: Pension Plans and Economic Downturns (continued)

	(1)			(2)			(3)			(4)			(5)		
	Employer Contributions/PBO			Funding Level/Total Assets			LT Expected Return on Plan Assets			Discount Rate			Volatility of Return on Plan Assets		
	Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat		Coef.	t-stat	
Financial Risk															
Leverage (Market Value)	-1.175	[2.59]	***	-0.086	[3.50]	***	0.045	[0.48]		0.032	[0.52]		-0.481	[0.94]	
Leverage (Market Value) * Crisis	0.458	[0.87]		-0.034	[1.23]		-0.116	[0.91]		0.083	[0.87]		1.402	[2.13]	**
Leverage (Market Value) * DotCom	-0.291	[0.40]		-0.009	[0.26]		-0.016	[0.13]		0.022	[0.25]		-0.506	[0.65]	
Debt Maturity	-0.419	[1.02]		-0.028	[1.38]		0.451	[4.93]	***	-0.079	[1.29]		-0.263	[0.69]	
Debt Maturity * Crisis	0.531	[1.09]		0.007	[0.32]		0.079	[0.76]		-0.152	[1.91]	*	0.339	[0.67]	
Debt Maturity * DotCom	0.423	[0.68]		-0.003	[0.12]		-0.390	[3.17]	***	0.181	[2.27]	**	1.632	[2.45]	**
Pension Plan															
Funding Level/PBO	-5.812	[9.93]	***				0.120	[0.84]		0.103	[1.39]		-1.875	[3.16]	***
Funding Level/PBO * Crisis	2.400	[3.67]	***				-0.114	[0.71]		0.431	[3.95]	***	0.044	[0.06]	
Funding Level/PBO * DotCom	-0.160	[0.23]					0.003	[0.02]		0.031	[0.37]		5.074	[6.54]	***
PBO/Total Assets	-2.240	[4.00]	***	0.098	[2.97]	***	0.883	[6.01]	***	-0.025	[0.31]		-1.546	[2.35]	**
PBO/Total Assets * Crisis	1.428	[2.35]	**	0.034	[1.12]		0.266	[1.88]	*	-0.094	[0.81]		-0.164	[0.21]	
PBO/Total Assets * DotCom	0.312	[0.39]		0.044	[0.95]		-0.561	[3.27]	***	0.213	[2.04]	**	-0.754	[0.82]	
Log (PBO)	-0.096	[1.38]		0.009	[2.46]	**	0.043	[2.95]	***	-0.074	[8.03]	***	0.407	[5.34]	***
Log (PBO) * Crisis	-0.141	[1.87]	*	0.004	[1.28]		-0.027	[1.63]		0.021	[1.61]		-0.348	[4.06]	***
Log (PBO) * DotCom	0.006	[0.06]		-0.010	[1.82]	*	0.081	[4.82]	***	0.024	[1.97]	**	-0.037	[0.34]	
Discount Rate							0.971	[26.83]	***						
Discount Rate * Crisis							-0.190	[6.04]	***						
Discount Rate * DotCom							-0.043	[0.59]							
LT Expected Return on Plan Assets	0.264	[2.83]	***	0.015	[2.83]	***				0.434	[20.85]	***	0.715	[6.17]	***
LT Expected Return on Plan Assets * Crisis	-0.039	[0.37]		0.000	[0.06]					0.113	[5.59]	***	0.285	[2.53]	**
LT Expected Return on Plan Assets * DotCom	-0.235	[1.30]		-0.007	[0.66]					-0.182	[5.49]	***	-0.206	[0.93]	
Actual Return on Plan Assets	-2.014	[2.51]	**	0.134	[4.99]	***	1.308	[9.22]	***	-0.694	[7.75]	***	-2.630	[4.21]	***
Actual Return on Plan Assets * Crisis	0.382	[0.43]		0.036	[1.25]		0.389	[2.47]	**	-0.195	[1.74]	*	-7.099	[10.11]	***
Actual Return on Plan Assets * Dotcom	-2.718	[1.69]	*	1.141	[14.05]	***	-0.640	[2.27]	**	2.734	[17.23]	***	-8.184	[6.18]	***
Volatility of Return on Plan Assets	-0.008	[0.34]		-0.001	[0.72]		0.034	[7.57]	***	-0.009	[2.97]	***			
Volatility of Return on Plan Assets * Crisis	0.045	[1.79]	*	0.001	[0.72]		0.010	[1.80]	*	-0.038	[9.95]	***			
Volatility of Return on Plan Assets * DotCom	-0.013	[0.38]		0.007	[3.38]	***	-0.022	[3.40]	***	0.013	[3.23]	***			
Log (Investment Horizon)	1.368	[7.68]	***	-0.023	[2.64]	***	-0.029	[0.94]		-0.016	[0.73]		0.349	[2.02]	**
Log (Investment Horizon) * Crisis	-0.210	[1.03]		0.021	[2.42]	**	-0.051	[1.46]		0.178	[6.41]	***	-0.416	[2.13]	**
Log (Investment Horizon) * DotCom	0.263	[0.93]		-0.004	[0.26]		0.027	[0.66]		0.054	[1.83]	*	0.068	[0.25]	
Employer Contributions/PBO				0.000	[0.42]								0.027	[1.51]	
Employer Contributions/PBO * Crisis				0.002	[1.64]								0.070	[2.60]	***
Employer Contributions/PBO * DotCom				-0.011	[4.94]	***							-0.040	[1.10]	
Participant Contributions/PBO	-0.548	[3.12]	***	0.015	[1.61]								-0.153	[0.54]	
Participant Contributions/PBO * Crisis	0.449	[2.07]	**	0.044	[4.16]	***							-0.203	[0.57]	
Participant Contributions/PBO * DotCom	0.423	[1.63]		-0.003	[0.17]								0.616	[1.66]	*
Crisis	1.277	[0.87]		0.086	[1.34]		0.111	[0.38]		0.759	[3.41]	***	-3.095	[2.22]	**
DotCom	2.245	[1.07]		0.032	[0.25]		0.962	[1.63]		2.011	[6.00]	***	4.324	[1.80]	*
Intercept	9.256	[6.43]	***	-0.226	[1.47]		0.274	[0.62]		2.657	[9.45]	***	4.092	[2.07]	**
Industry fixed effects	yes			yes			yes			yes			yes		
Adj. R-Squared	0.19			0.21			0.60			0.60			0.14		
Observations	11,644			11,644			11,644			11,644			11,644		

Appendix A: Variable Definitions

The table shows the variables used in the paper and their definitions.

Variable	Definition
Panel A: PostRetirement Plans	
Discount Rate	Weighted average assumed discount rate. It is an estimated rate used to determine the present value at which the projected benefit obligation could be effectively settled.
LT Expected Return on Plan Assets	Anticipated Long-Term Rate of Return on Plan Assets
Actual Return on Plan Assets	Actual Return on Plan Assets /Lagged Fair Value of Plan Assets
Volatility of Return on Plan Assets	Prior 5-year standard deviation of Actual Return on Plan Assets
Log (PBO)	Natural logarithm of projected benefit pension obligation
PBO/Total Assets	Projected Plan Obligations / TotalAssets
Funding Level/PBO	(Fair Value of Plan Assets - Projected Benefit Obligation) / Projected Benefit Obligation
Employer Contributions/PBO	Employer Contributions/Projected Benefit Obligations
Participant Contributions/PBO	Participant Contributions/Projected Benefit Obligations
Investment Horizon	Pension Projected Benefit Obligation/Pension Service Cost
Log (Investment Horizon)	Natural logarithm of Investment Horizon
Pension Asset Allocation Equity	Percentage of pension plan assets invested in equity (stock) securities as of the end of the period.
Pension Asset Allocation Debt	Percentage of pension plan assets invested in debt (fixed income) securities as of the end of the period.
Pension Asset Allocation Real Estate	Percentage of pension plan assets invested in real estate as of the end of the period
Pension Asset Allocation Other	Percentage of pension plan assets not invested in equity, debt, or real estate.
Pension Asset Beta	1 * Pension Asset Allocation Equity + 0.175 * Pension Asset Allocation Debt + 0.150 * Pension Asset Allocation Real Estate + 1.2 * Pension Asset Allocation Other
Panel B: General Firm Characteristics	
Log (Age)	Natural logarithm of age of firm (one plus difference between observation year and year of first observation on Compustat)
Capital Expenditures/Total Assets	Capital Expenditures/Total Assets with missing values set to zero
R&D Expense/Total Assets	ResearchDevelopment / TotalAssets with missing values set to zero
Log (CashAndSTInvestment/Total Assets)	Natural logarithm of Cash&STInvestments / (TotalAssets - Cash&STInvestments)
Debt Maturity	Long-Term Debt (due more than 1 year) / Total Debt
Log(Size Market Value)	Natural Logarithm of SizeMarketValue (Market Capitalization + Total Debt + Preferred Stock)
Tangible Assets/Total Assets	(TotalAssets - Total Intangible Assets) / TotalAssets
Net PPE/Total Assets	Net PPE / TotalAssets
Tax Rate	Marginal tax rate
Gross ProfitMargin (3-year average)	Average of up to 3 years of GrossProfitMargin, i.e. Operating Income (before Depreciation) / Sales
Log (Volatility of GrossProfitMargin)	Natural Logarithm of prior 5-year standard deviation of Gross Profit Margin
Return On Assets	Net Income / Total Assets
Log (Volatility of ROA)	Natural Logarithm of prior 5-year standard deviation of Return on Assets
Quick Ratio	(Cash&STInvestments + Total Receivables)/Current Liabilities
Book/Market	Equity Book Value/Market Capitalization
Leverage (Market Value)	Total Debt / (Market Capitalization + Total Debt)
Z-Score	Altman(2000) Z-Score = 6.56*(Working Capital/Total Assets) + 3.26*(Retained Earnings/Total Assets) + 6.72*(EBIT/Total Assets) + 1.05*((Total Common Equity + Preferred Stock)/Total Debt)
Rating	S&P domestic long-term issuer rating
Net FX-Exposure	Difference between Foreign Sales/Total Sales and Foreign Assets/Total Assets (with missing values set to zero)
Dividend (dummy)	Dummy variable with value 1 if a dividend was paid; 0 otherwise
Negative Book Equity	Dummy variable with value 1 if Common Equity or Book Value Per Share are negative; 0 otherwise

Appendix B: Summary Statistics

The table shows summary statistics of the main variables used in the analysis.

	Observations	Mean	Std. Dev.	Skewness	Kurtosis	Minimum	Percentiles 1st	5th	25th	Median	75th	95th	99th	Maximum
Defined Benefit Plans														
Discount Rate	34,663	0.06	0.02	-0.46	0.14	0.00	0.02	0.04	0.05	0.06	0.08	0.09	0.09	0.10
LT Expected Return on Plan Assets	32,282	0.08	0.02	-1.51	3.48	0.00	0.02	0.05	0.07	0.08	0.09	0.10	0.11	0.11
Actual Return on Plan Assets	21,083	0.06	0.11	-0.84	1.07	-0.28	-0.28	-0.16	0.01	0.08	0.13	0.21	0.31	0.31
Volatility of Return on Plan Assets	18,823	0.10	0.06	0.38	0.03	0.00	0.00	0.01	0.06	0.10	0.14	0.20	0.24	0.42
Log (PBO)	42,509	4.44	2.42	0.09	-0.45	-0.99	-0.93	0.49	2.72	4.37	6.10	8.61	10.00	10.00
PBO/Total Assets	42,508	0.16	0.18	2.17	5.34	0.00	0.00	0.01	0.03	0.10	0.21	0.53	0.93	0.93
Funding Level/PBO	42,145	-0.17	0.34	-0.06	1.08	-1.00	-1.00	-0.87	-0.35	-0.17	0.01	0.37	0.83	0.88
Employer Contributions/PBO	22,839	0.05	0.05	2.33	7.25	0.00	0.00	0.00	0.01	0.03	0.06	0.15	0.31	0.31
Participant Contributions/PBO	22,263	0.00	0.01	4.07	18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03
Investment Horizon	37,091	0.04	0.04	2.81	10.53	0.00	0.00	0.00	0.02	0.03	0.05	0.11	0.25	0.25
Log (Investment Horizon)	34,636	-3.55	0.91	-0.69	1.49	-6.69	-6.68	-5.26	-3.98	-3.47	-3.01	-2.20	-1.35	-1.35
Pension Asset Beta	14,040	0.68	0.15	-0.84	1.93	0.17	0.18	0.37	0.62	0.70	0.76	0.89	1.04	1.17
Pension Asset Allocation Equity	14,040	53.7	17.9	-1.03	0.90	0.00	0.00	17.0	45.0	58.0	66.0	76.0	85.0	90.0
Pension Asset Allocation Debt	14,040	39.0	17.5	1.13	2.22	0.00	0.00	16.0	29.0	36.0	46.0	75.0	100	100
Pension Asset Allocation Real Estate	14,040	1.37	2.99	2.46	5.79	0.00	0.00	0.00	0.00	0.00	0.00	8.35	14.0	15.0
Pension Asset Allocation Other	14,040	5.89	10.78	2.98	10.5	0.00	0.00	0.00	0.00	1.00	7.00	29.0	55.0	84.0
General Firm Characteristics														
Capital Expenditures/Total Assets	42,509	0.06	0.05	2.62	11.40	0.00	0.00	0.01	0.02	0.04	0.07	0.15	0.24	0.46
R&D Expense/Total Assets	42,509	0.02	0.04	5.71	55.83	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.18	0.71
Log (CashAndSTInvestment/Total Assets)	41,465	-3.05	1.56	-0.66	1.14	-14.1	-7.39	-5.71	-4.02	-2.90	-1.94	-0.73	0.00	0.00
Debt Maturity	40,459	0.78	0.27	-1.61	1.74	0.00	0.00	0.08	0.70	0.89	0.98	1.00	1.00	1.00
Log(Size Market Value)	36,569	7.06	2.09	-0.24	-0.42	-0.3	2.1	3.48	5.63	7.12	8.59	10.61	10.6	10.6
Log (Age)	42,509	2.9	0.9	-0.8	0.2	0.0	0.0	1.1	2.3	3.0	3.6	4.0	4.1	4.2
Tangible Assets/Total Assets	38,913	0.85	0.18	-1.30	0.93	0.30	0.30	0.47	0.76	0.92	0.99	1.00	1.00	1.00
Net PPE/Total Assets	42,324	0.33	0.21	0.70	-0.29	0.00	0.02	0.06	0.17	0.29	0.47	0.75	0.88	0.94
Tax Rate	28,171	0.28	0.10	-1.48	0.99	0.00	0.01	0.05	0.25	0.33	0.34	0.35	0.36	0.46
Gross ProfitMargin (3-year average)	40,994	0.14	0.14	-0.85	12.64	-1.00	-0.26	0.01	0.07	0.12	0.19	0.40	0.56	0.80
Return On Assets	42,469	0.02	0.12	-3.30	22.35	-1.00	-0.50	-0.15	0.00	0.04	0.07	0.15	0.28	0.46
Log (Volatility of ROA)	39,515	-3.42	1.09	-0.27	1.36	-11.67	-6.22	-5.15	-4.09	-3.43	-2.74	-1.58	-0.86	0.00
Log (Volatility of GrossProfitMargin)	40,983	-3.82	1.03	0.04	1.14	-11.6	-6.39	-5.46	-4.45	-3.84	-3.21	-2.10	-0.98	0.00
Quick Ratio	41,213	1.19	1.03	4.04	24.67	0.01	0.10	0.30	0.66	0.94	1.38	2.8	5.6	10.0
Book/Market	36,569	0.69	1.05	-0.53	12.74	-5.00	-5.00	0.02	0.31	0.55	0.93	2.18	5.00	5.00
Leverage (Market Value)	36,567	0.29	0.24	0.87	-0.02	0.00	0.00	0.00	0.10	0.24	0.44	0.80	0.95	0.95
Z-Score	40,003	2.46	2.55	-1.20	5.70	-17.6	-5.7	-1.6	1.23	2.53	3.99	6.26	7.77	10.2
Rating	19,276	9.96	3.77	0.06	-0.15	1.00	1.00	4.00	7.00	10.00	13.00	16.00	19.00	22.0
Net FX-Exposure	42,509	0.14	0.29	0.85	2.60	-1.00	-0.73	-0.08	0.00	0.00	0.22	0.76	1.00	1.00
Dividend (dummy)	42,509	0.62	0.49	-0.50	-1.75	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Negative Book Equity	42,509	0.08	0.27	3.11	7.68	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00

Appendix C: Pension Plan Asset Allocation

The table shows results from regressions of the percentage of assets of U.S. defined-benefit pension plans invested in equity securities and debt securities, and the plan asset beta as dependent variable. In particular, it shows the coefficients and associated *p*-values of independent variables capturing a firm's asset risk, financial risk, and pension plan characteristics. Measures of asset risk are the the natural logarithm of the ratio of CashAndSTInvestment/Total Assets, the natural logarithm of the Volatility of GrossProfitMargin, the three-year average of GrossProfitMargin, Book/Market, Net PPE/Total Assets, R&D Expense/Total Assets (with missing values set to zero), Dividend (dummy), Net FX-Exposure, and the natural logarithm of Age. Measures of financial risk are leverage using market values, debt maturity, Z-Score, and an indicator for negative book equity. Pension plan characteristics are the funding level (scaled by PBO), the natural logarithm of PBO, PBO/Total Assets, the long-term expected return on plan assets, the actual return on plan assets, the natural logarithm of the investment horizon, Employer Contributions/PBO, and Participant Contributions/PBO. The table also shows the Adjusted R-Squared and the number of observations. Regressions include year and industry fixed effects as indicated. Standard errors are clustered by firm. All explanatory variables are lagged by one period. All variables are defined in Appendix A.

(continued)

Appendix C: Pension Plan Asset Allocation (continued)

	Fraction of Plan Assets Invested in Equity Securities						Fraction of Plan Assets Invested in Debt Securities						Plan Asset Beta					
	(1)			(2)			(1)			(2)			(1)			(2)		
	MarEff	t-stat		MarEff	t-stat		MarEff	t-stat		MarEff	t-stat		MarEff	t-stat		MarEff	t-stat	
Asset Risk																		
Log (CashAndSTInvestment/Total Assets)	-0.444	[1.13]		-0.708	[1.66]	*	0.237	[0.60]		0.446	[1.10]		-0.002	[0.46]		-0.003	[0.86]	
Log (Volatility of GrossProfitMargin)	-1.073	[2.61]	***	-0.971	[2.32]	**	1.147	[2.53]	**	1.010	[2.11]	**	-0.010	[2.48]	**	-0.009	[2.10]	**
Gross ProfitMargin (3-year average)				-0.488	[0.92]					0.902	[1.54]					-0.007	[1.35]	
Book/Market	0.180	[0.63]					-0.361	[0.98]					0.003	[0.88]				
Net PPE/Total Assets	0.868	[1.60]		1.114	[2.02]	**	0.117	[0.20]		-0.172	[0.28]		-0.003	[0.62]		-0.001	[0.21]	
R&D Expense/Total Assets	1.349	[2.24]	**	1.335	[2.30]	**	-0.980	[1.59]		-0.939	[1.54]		0.008	[1.40]		0.007	[1.35]	
Dividend (dummy)	-0.379	[0.92]		-0.462	[1.13]		0.345	[0.74]		0.354	[0.77]		-0.004	[0.94]		-0.004	[0.97]	
Net FX-Exposure	-0.415	[0.81]		-0.442	[0.87]		-0.060	[0.12]		-0.084	[0.17]		0.002	[0.47]		0.002	[0.53]	
Log (Age)	0.109	[0.25]		-0.024	[0.06]		-0.180	[0.37]		-0.122	[0.24]		0.003	[0.66]		0.003	[0.57]	
Financial Risk																		
Leverage (Market Value)	-0.629	[1.47]					0.009	[0.02]					0.000	[0.07]				
Debt Maturity	-0.345	[1.42]		-0.479	[1.90]	*	0.411	[1.56]		0.435	[1.65]		-0.004	[1.69]	*	-0.004	[1.74]	*
Z-Score				1.326	[2.28]	**				-0.596	[1.02]					0.004	[0.72]	
Negative Book Equity				0.081	[0.19]					0.036	[0.08]					-0.001	[0.29]	
Pension Plan																		
Funding Level/PBO	-0.579	[1.15]		-0.591	[1.16]		-0.263	[0.54]		-0.310	[0.63]		0.002	[0.51]		0.003	[0.60]	
PBO/Total Assets	-0.840	[1.24]		-0.841	[1.23]		0.897	[1.63]		1.017	[1.80]	*	-0.007	[1.49]		-0.008	[1.61]	
Log (PBO)	-1.701	[2.74]	***	-1.470	[2.38]	**	0.040	[0.06]		-0.061	[0.09]		-0.003	[0.59]		-0.003	[0.47]	
LT Expected Return on Plan Assets	5.416	[10.06]	***	5.333	[9.97]	***	-4.749	[7.31]	***	-4.701	[7.32]	***	0.036	[6.21]	***	0.036	[6.20]	***
Actual Return on Plan Assets	0.493	[1.99]	**	0.525	[2.13]	**	-0.286	[1.16]		-0.293	[1.19]		0.002	[0.82]		0.002	[0.83]	
Log (Investment Horizon)	0.998	[2.26]	**	0.950	[2.17]	**	-0.693	[1.43]		-0.656	[1.36]		0.005	[1.16]		0.005	[1.12]	
Employer Contributions/PBO	-0.497	[1.75]	*	-0.487	[1.75]	*	1.076	[3.68]	***	1.069	[3.79]	***	-0.009	[3.58]	***	-0.009	[3.70]	***
Participant Contributions/PBO	-0.045	[0.12]		-0.068	[0.19]		-0.271	[0.57]		-0.275	[0.59]		0.001	[0.33]		0.001	[0.34]	
Intercept	20.2	[2.77]	***	19.4	[2.59]	***	71.7	[8.56]	***	70.1	[8.04]	***	0.431	[5.69]	***	0.445	[5.63]	***
Industry fixed effects	yes			yes			yes			yes			yes			yes		
Year fixed effects	yes			yes			yes			yes			yes			yes		
Adj. R-Squared	0.30			0.30			0.21			0.21			0.16			0.16		
Observations	4,024			4,024			4,024			4,024			4,024			4,024		