Do pension plans strategically use regulatory freedom?*

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November 2016

Abstract

We use a historical experiment to test whether U.S. corporate defined benefit pension plans strategically use regulatory freedom to lower the reported value of pension liabilities, and hence required cash contributions. For some years, pension plans were required to estimate two liabilities - one with mandated discount rates and mortality assumptions, and another where these could be chosen freely. Using a sample of 11,963 plans, we find that the regulated liability exceeds the unregulated measure by 10 percent and the difference further increases for underfunded pension plans. Moreover, underfunded plans tend to assume lower life expectancy and substantially higher discount rates. The effect persists both in the cross-section of plans and over time and it serves to reduce cash contributions. Finally, we show that credit risk is unlikely to explain the finding. Instead, it seems that plans use regulatory leeway as a simple cash management tool.

JEL Classification: G23; G39; J32; M40

*The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management. We thank Stephen Boyce, Benedict Clements, Frank Eich, Daniel Folkinshteyn, David Gustafson, Gregorio Impavido, Laura Kodres, Olivia Mitchell, Theo Nijman, S. Erik Oppers, Konrad Raff, Rina Ray, Francisco Santos, Irina Stefanescu, Ian Tonks and Amy Viener for invaluable feedback. Finally, we are grateful to seminar participants at the Eastern Finance Association, the Netspar International Pension Workshop, the American Economic Association, European Finance Association, Southern Finance Association, the Swiss Finance Institute, the Vienna Graduate School of Finance, Norwegian School of Economics, and the 8th Longevity Risk Conference. Please address all correspondence to michael.kisser@nhh.no.

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1 Introduction

The Employee Retirement Income Security Act of 1974 (ERISA) established minimum sponsor contribution standards for private industry defined benefit (DB) pension plans. Despite subsequent rounds of legislation aimed at further ensuring adequate plan funding, plan sponsors still kept considerable leeway in calculating contributions. Presumably to expedite passage through Congress, it contains provisions that allow DB pension plan sponsors to use less stringent actuarial assumptions and thereby reduce funding gaps and required sponsor contributions.

Giving more freedom to plan sponsors involves a difficult trade-off. While a temporary funding relief for underfunded pension plans provides breathing room that might restore the long-term viability of plan sponsors, it may undermine the interests of their employees and retirees. By allowing for lower pension contributions, both credit risk and longevity risk (the risk of retirees outliving their financial resources) is shifted from shareholders to pension plan participants and ultimately to the Pension Benefit Guaranty Corporation (PBGC) and the taxpayer. For well funded and financially healthy pension plans, this risk may be negligible. However, it may become more relevant if underfunded pension plans are more likely to opt for such a temporary funding relief.

The objective of this paper is to investigate whether U.S. corporate DB pension plans strategically use regulatory freedom to their own benefit. We tackle this question by exploiting historical particularities of pension funding law, which we detail below. Regulation surrounding pension funding law is preoccupied with the level of plan funding and required cash contributions and, as such, our results complement the findings by Bergstresser et al. (2006) who document manipulation of pension expenses in audited financial statements.

We focus on a large sample of pension plans provided by the U.S. Department of Labor (DOL), which contains detailed information on various actuarial assumptions, including the mortality tables and/or discount rates used to estimate pension plan liabilities. Our main analysis is based on a sample of 11,963 U.S. corporate DB pension plans over the period from 1999 to 2007. In addition, we provide a further robustness check of the MAP-21 episode in 2012 focusing on another sample of 5,452 plans.

During the 1999 to 2007 period, the Internal Revenue Service (IRS) required plan sponsors to employ two different liability concepts for calculating required sponsor contributions: a current and an accrued

liability measure.[1] Discount rates and mortality tables used for the current liability calculation were imposed by legislation, whereas for accrued liabilities plan sponsors were given more discretion. Both liability measures co-existed over the sample period and they affected pension contributions differently. Accrued liabilities were used to compute the normal level of contributions to the pension fund (commonly referred to as the normal cost) and the minimum funding contribution which additionally amortizes the amount of any underfunding into the current year required contribution. The current liability measure was the basis for additional top-up contributions for significantly underfunded plans.

This historical experiment allows us to investigate the difference between the two liability concepts, which is both interesting and useful. First, we are able to simply describe whether and by how much the two liability measures differ. Second, because we also have data on the underlying discount rate and mortality assumptions, we are able to investigate why the two measures differ and, more importantly, explore the difference in the underlying actuarial assumptions. Finally, because the analysis focuses on comparing two different measures (liabilities or actuarial assumptions) from the same pension plan at the same point in time, we are able to control for many plan specific factors that otherwise would be unobservable.

We find that, on average, accrued pension liabilities would have to be increased by 10 percent in order to keep up with the regulated current liability measure. Most of the difference stems from using higher discount rates. Unsurprisingly, when given the choice, sponsors often use a higher rate than the one mandated for the current liability estimation. On average, corporate DB pension plans employed discount rates for the accrued pension liability concept that exceeded the regulated measure by approximately 170 basis points. In addition, we also find that a subset of pension plans made substantially lower and outdated life expectancy assumptions.

More importantly, our analysis reveals that the funding status of a pension plan has a strong impact on actuarial assumptions. Underfunded plans are more likely to assume lower life expectancy (relative to the regulated mortality table) and they employ substantially higher discount rates (relative to the mandated rate). Moreover, we document a similar time-series effect as changes in funding levels are negatively correlated with changes in relative discount rates. Taken together, underfunded plans seem to stretch actuarial assumptions in order to reduce the report value of pension liabilities.

[1] Pension liabilities are calculated in several ways, depending on the purpose: funding, accounting or settlement. In this paper we focus on funding. The current liability corresponds to the accumulated benefit obligation (accounting) and termination liability (settlement), and the accrued liability to the projected benefit obligation (accounting).

Crucially, this appears contrary to the regulations under which actuarial assumptions should not be related to the funding status of the pension plan. In blunt words, life expectancy and discount rate assumptions are not supposed to relate to the plan's funding status. The results suggest a degree of opportunistic behavior of pension plans, as the lower reported value of pension liabilities translates into a substantial reduction in cash contributions. Specifically, we find that the decision to exploit regulatory leeway and report lower value of pension liabilities typically reduces cash contributions by 6 to 8 percent of plan assets.

We then explore an alternative explanation for the negative relation between discount rates and funding levels. Specifically, we use firm level data from Compustat to test the extent to which credit risk of the plan sponsor "explains" the use of higher discount rates. While economically reasonable, it is important to note that such an implicit discount rate adjustment is not intended by law. This is because the actuarial liability is not supposed to measure the market value of the pension promise to the plan participant.[2]

To address this issue, we employ a two-stage regression framework. In the first step, we estimate the implied deviation from the regulated discount rate based on plan specific information as well as various firm characteristics controlling for the sponsor's credit risk. We then take the residual from the first stage regression (i.e. the part of the deviation that is left unexplained by credit risk and other plan controls) and regress it on the funding level of the plan sponsor. The results continue to suggest that underfunded plans employ substantially higher discount rates. Moreover, we show that this result robustly holds even among plan sponsors with low measures of credit risk. These findings suggest that plans strategically use regulatory leeway and manage actuarial assumptions as a cash management tool that seems to smooth cash contributions to the pension plan. This "tool" is used independently of the credit risk of the plan sponsor.

The Pension Protection Act (PPA) of 2006 stopped the dual use of the two competing liability definitions and required that, as of 2008, firms only employ one regulated liability measure. However, our results continue to be highly relevant. To illustrate, we relate our findings to the recently introduced MAP-21 bill, which provided relief to DB pension plan sponsors by allowing the use of historical discount rates (which are higher than current rates) when computing pension liabilities. Focusing on another

[2]Instead, it is a regulated actuarial funding target concept that should not reflect the credit risk of the plan sponsor. We discuss this issue in detail in Section ??.

sample of 5,452 corporate DB pension plans that filed with the IRS in 2012, we find that underfunded plans were substantially more likely to be early adopters of the new legislation. The benefit of the adoption followed immediately: mandatory pension contributions decreased by 37 percent for pension plans that switched to the new rule, whereas they increased by 33 percent for those plans that postponed adoption of MAP-21 until 2013.

The paper proceeds as follows. Section (2) clarifies the contribution of this paper relative to the extant literature, Section (3) describes the basics of pension funding law, Section (4) introduces the historical experiment, Section (5) investigates the role of sponsor characteristics and Section (6) discusses policy implications in light of the MAP-21 bill. Section (7) concludes.

2 Contribution relative to the extant literature

Management of corporate DB pension plans needs to compute and report values for pension assets and liabilities following two different sets of rules. Pension funding rules are governed by law described in the Internal Revenue Code (IRC) and deal with cash contributions to the pension plan. Pension accounting rules are set by the Financial Accounting Standards Board (FASB) and are used to determine pension expenses in audited financial statements. Actuarial assumptions underlying the two concepts typically differ (Bodie, Light, and Morck, 1987; Pension Committee of the American Academy of Actuaries, 2004).

Academic research covers both the funding situation of pension plans and corresponding cash contributions, as well as financial reporting issues surrounding the recognition of pension expenses in audited financial statements. Below, we attempt to classify papers according to their main contribution (funding versus accounting) and then conclude with a summary of our main contribution.

Pension funding decisions

A potential friction that affects both pension funding policy and corporate financial decisions are taxes. A tax benefit exists because cash contributions generate tax deductions and further because income earned within the pension fund is tax exempt. The (so-called) tax arbitrage view suggests that all plans should be overfunded to the maximum allowable amount, tilt their asset allocation to bonds and increase leverage at

the corporate level (Black, 1980; Tepper, 1981).[3] Using a sample of 102 U.S. DB plan sponsors, Thomas (1988) shows that a reduction in the tax status of the plan sponsor significantly reduces contributions to pension plans. The paper provides further cross-sectional evidence that firms with a low tax status are less likely to be overfunded and that they choose less conservative actuarial methods and assumptions. Clinch and Shibao (1996) investigate pension plan reversions between 1980 and 1985 and show that tax considerations also help explain pension plan terminations.[4] Turning to the second implication of the tax arbitrage argument, Frank (2002) provides evidence that firms with higher tax rates invest a larger fraction of their pension assets into bonds.

Taxes aside, pension funding decisions can be influenced by other considerations such as the availability of internal funds (Myers and Majluf, 1984; Niehaus, 1985), a free-riding problem arising from the fact that the pension plan is insured by the PBGC (Sharpe, 1976) or the desire of management to avoid putting the firm into the spotlight of regulators, financial media or investors (Watts and Zimmerman, 1978; Mittelstaedt, 1989). Francis and Reiter (1987) investigate the drivers of funding decisions for a sample of 224 DB pension plans. Their findings confirm the positive impact of taxes and further suggest that the availability of capital or the desire to reduce political costs increase pension funding. Perhaps surprisingly, the pension put effect can not be identified.[5] Investigating the degree to which pension decisions reflect the overall financial situation of the plan sponsor, Bodie, Light, and Morck (1987) show that more profitable plan sponsors use lower discount rates and are on average better funded.[6]

Using a sample of 45 firms in 1983, Ghicas (1990) shows that plan sponsors which switch to a less conservative actuarial method to compute pension liabilities are on average better funded, they already employ higher discount rates and they have lower working capital. Ashtana (1999) further investigates the determinants of actuarial choices for U.S. corporate DB pension plans. Contrary to Ghicas (1990), the paper shows that overfunded pension plans make more conservative actuarial choices. For instance,

[3]The tax arbitrage view assumes no legal separation between the firm (plan sponsor) and the pension plan. However, firms can not withdraw excess assets at will (Ippolito, 1986) and regulatory rules limit the amount that can be withdrawn (e.g. excise tax).

[4]Alternative explanations for pension plan terminations include cash needs, a reduction in labor costs or corporate control benefits (Ippolito, 1986; Thomas, 1989; Mittelstaedt, 1989; Pontiff, Shleifer, and Weisbach, 1990; Rauh, Stefanescu, and Zeldes, 2016).

[5]More recent empirical evidence produces conflicting results. Coronado and Liang (2005) show that cash contributions decrease for firms that are closer to bankruptcy. However, when focusing instead on the asset allocation of pension plans, Rauh (2009) finds that firms with underfunded pension plans invest a larger fraction into bonds (as opposed to equities in case plans tried to maximize the value of the pension put option).

[6]The latter finding differs from Feldstein and Morck (1983) who find a negative correlation between profitability and funding.

they employ lower discount rates, more conservative actuarial cost methods and assume higher rates of future salary growth when computing expected benefit payments.

The more recent literature has further investigated the link between corporate finance and pension funding decisions. For instance, mandatory pension contributions negatively affect investment policy (Rauh, 2006; Bakke and Whited, 2012) and they reduce stock prices, specifically for financially constrained firms (Franzoni, 2009; Campbell, Dhaliwal, and Schwartz, 2010). Firms with DB pension plans further trade-off tax savings from interest payments and pension contributions with overall bankruptcy costs (Shivdasani and Stefanescu, 2010) and they are less likely to be taken over or to engage in a seasoned equity offering (Cocco and Volpin, 2013). There is further some evidence that investors consider the overall consolidated leverage of a DB plan sponsor when estimating the cost of equity (Jin, Merton, and Bodie, 2006). However, other studies suggest that the adjustment to new pension related information is slow as security prices do not immediately reflect all publicly available information on pension plans (Franzoni and Marin, 2006; Picconi, 2006).

Pension accounting decisions

Existing research has broadly focused on two topics. First, it investigates whether pension accounting is a potential playground for earnings management. Second, it assesses the degree to which reported information on pension plans is reflected in security prices.

While disentangling earnings management from reasonable judgment when preparing financial statements is difficult (Dechow and Skinner, 2000), empirical evidence is indicative of its presence.[7] The decision to manage earnings can arise because of a link to managerial compensation or to significant corporate events.[8] Pension accounting may be a potential playground for such manipulative activities given that it affects earnings while - at the same time - regulation and disclosure are highly complex (McGill, Brown, Haley, and Schieber, 2004).

[7] For example, small reported profits are substantially more likely than small reported losses (Hayn, 1995; Burgstahler and Dichev, 1997; Degeorge, Patel, and Zeckhauser, 1999) and there is an unusual frequency of zero or slightly positive earnings surprises (Degeorge, Patel, and Zeckhauser, 1999; Brown, 2001; Burgstahler and Eames, 2006). See also Healy and Wahlen (1999) for a review of the literature.

[8] Managerial compensation can be directly linked to earnings or indirectly to stock price performance (Healy, 1985). Empirical evidence shows that stock prices drop in response to negative earnings surprises, with a disproportionally large negative effect for growth stocks (Skinner and Sloan, 2002) and that firms with continuous earnings growth are priced at a premium (Barth, Elliott, and Finn, 1999). Also, Rangan (1998) and Teoh, Welch, and Wong (1998) show that the inferior performance of stocks following seasoned equity offerings can be explained by earnings management prior to the equity offering.

For example, pension expenses can be influenced by the choice of the discount rate used to compute the present value of pension liabilities, the assumed salary growth of employees or the assumed expected return on the plan's investment portfolio (SFAS No. 87).[9] Using a sample of approximately 300 DB pension plans from 1987 to 1993, Blankley and Swanson (1995) find some evidence that pension plans change discount rates less frequently than would be expected if they were fully compliant with the SFAS No. 87 requirement. However, the authors also conclude that expected return assumptions of pension investments as well as salary growth estimates seem reasonable.[10] This result is somewhat surprising given that the discount rate used to compute the present value of pension liabilities is more tightly regulated than expected return on asset assumptions which allow for more judgment. Consistent with this point, Goodwin, Goldberg, and Duchac (1996) show that firms are more likely to increase expected return on asset assumptions in case earnings have decreased or due to high (excessive) leverage.

Using data collected from the *Pensions and Investments* asset allocation survey, Amir and Benartzi (1998) investigate the accuracy of financial reporting data by combining it with information on the asset allocation of pension plans. Testing whether a higher expected return on plan assets on average corresponds to a larger fraction of plan assets invested into equities, they find that the empirical correlation is rather weak and, in addition, the expected return on pension assets does a poor job predicting future (actual) returns.[11] Chuk (2012) uses a mandatory change in financial disclosure requirements which - coming effective for fiscal years ending in 2003 – required firms to disclose the percentage asset allocation of pension plans in the financial statements (SFAS No. 132R). The study provides indirect evidence of earnings management as it shows that firms with previously upward biased expected return assumptions respond to the new disclosure requirements by decreasing return assumptions and/or increasing the allocation to more risky assets.

Using data from 1991 to 2002, Bergstresser, Desai, and Rauh (2006) provide further systematic evidence that sponsors of DB pension plans opportunistically change expected return assumptions of plan assets. The changes occur when their impact is potentially large such as in periods leading up to acquisitions, seasoned equity offerings or before managers exercise stock options. Bartram (2015)

[9]To be precise, the annual pension expense consists of the service cost and the interest cost, net of the expected return on the pension assets. The first two components capture the present value of the promised pension benefits whereas the third component reflects managerial expectations of the expected return on the plan's investments.

[10]Amir and Gordon (1996) investigate assumptions underlying postretirement benefits other than pensions (SFAS No. 106) and find that plans with more leverage make more aggressive assumptions to reduce the associated liability.

[11]Amir and Benartzi (1999) show that asset allocation decisions are also driven by the desire to avoid recognition of the additional minimum funding liability (SFAS No. 87), which reflects the riskiness of plan assets.

provides complementary recent evidence showing that financially distressed plan sponsors and/or sponsors of underfunded plans make more aggressive return on asset assumptions, which in turn help to decrease pension expenses.

Turning to the value implications of pension reporting data, Daley (1984) relates the market value of the plan sponsor's equity to accounting earnings and different measures of pension cost. The paper finds that pension expenses are reflected in the market value of equity and that they outperform other measures such as unfunded vested benefits or unfunded prior service cost. Barth, Beaver, and Landsman (1992) show that pension expenses have a higher implicit value than non-pension expenses which may be explained by the debt-like character of those costs. The study further decomposes pension expenses into its main components and finds that larger service costs are associated with higher (instead of lower) equity values of the sponsoring firm.[12] This positive relation may arise because service costs act as a proxy for the human capital of a firm which correlates positively with equity value (Subramanyam and Zhang, 2001; Hann, Heflin, and Subramanyam, 2007).

Barth, Beaver, and Landsman (1993) add information on pension assets and liabilities to the the existing valuation framework. They find that controlling for pension balance sheet information makes pension earnings become redundant. However, the robustness of this finding is not clear. Subsequent studies suggest instead that pension assets (and not pensions earnings) are redundant when explaining the market value of the sponsor's equity (Coronado and Sharpe, 2003; Coronado, Mitchell, Sharpe, and Nesbitt, 2008).

Contribution of this paper

This paper contributes to the literature by providing novel evidence on how U.S. corporate DB pension opportunistically manage their pension funding policy. We show that underfunded plans are more likely to use any wiggle room that is provided by pension legislation in order to report lower pension liabilities. These results complement the documented opportunistic behaviour relating to pension expenses and earnings management (Blankley and Swanson, 1995; Amir and Benartzi, 1998; Bergstresser et al., 2006; Chuk, 2012), and we also show that attempts to take advantage of the leeway to set discount rates are not only prevalent among public U.S. pension funds (Brown and Wilcox, 2009; Novy-Marx and Rauh, 2011).

[12] The other components behave as expected: equity value correlates negatively with interest costs but positively with the return on pension assets.

In fact, and to the best of our knowledge, we are the first to provide large sample evidence investigating the relation between funding levels, actuarial assumptions and pension liabilities.[13]

Second, our novel research design exploits the difference between regulated and unregulated pension liabilities or actuarial assumptions. This measure contributes to the literature as it benchmarks a plan-specific actuarial assumption relative to its regulated counterpart and thereby helps to interpret whether an assumption is unusually high or low. Moreover, it allows us to control for many unobservable plan- and time-specific factors. As a consequence, we are the first to provide evidence showing that the funding status also distorts life expectancy assumptions.

Third, we show that stretching actuarial assumptions directly benefits the pension plan as cash contributions are reduced. The finding contributes to the literature both by directly illustrating how pension plans could opportunistically mitigate the impact of mandatory cash contributions and by indirectly relating our findings to a literature that investigates the impact of cash contributions to corporate financial decisions (Rauh, 2006; Bakke and Whited, 2012). Moreover, we show that the negative relation between discount rates and funding levels is unlikely to be explained by the credit risk of the plan sponsor.

Finally, our results are highly policy relevant as we document that pension plans strategically employ regulatory leeway to their own benefit. Because pension plan participants and retirees do not take part in setting actuarial assumptions, our findings raise the possibility of a wealth transfer from retirees and workers to shareholders.

3 A primer on pension funding law

Pension funding rules are governed by law and deal with cash contributions to pension plans. Up until 2008, U.S. pension funding law required sponsors to estimate two different concepts of pension liabilities for purposes of calculating required sponsor contributions (Pension Committee of the American Academy of Actuaries, 2004; Munnell and Soto, 2007). The minimum funding contribution (MFC) is based on the accrued pension liability (AL), whereas additional funding requirements for significantly underfunded plans are derived from the current liability (CL) measure.

[13]Our main analysis covers 11,963 pension plans (48,880 plan-years) over the period from 1999 to 2007. Feldstein and Morck (1983) investigate 132 plans in 1979, Thomas (1988) covers 102 pension plans in 1984, Bodie et al. (1987) analyses 515 plans in 1980, Ghicas (1990) includes 47 plans in 1983 and Ashtana (1999) investigates 2,419 plans over the period 1990 to 1992. The analysis in Bartram (2015) covers approximately 5,000 observations on U.S. pension plans – however, contrary to our paper, his analysis focuses on pension accounting (not pension funding) and he finds a positive relation between funding and discount rates.

Unless referenced differently, the summary below and the corresponding nomenclature is based on U.S. funding law and the corresponding textbook by McGill et al. (2004).

3.1 Pension liability definitions

The AL is an estimate of the benefits that workers earned from their past service but adjusted for future expected salary increases, calculated under assumptions set by the plan sponsor and the actuary. For example, following ERISA in 1974, plan sponsors were permitted to select a "reasonable" mortality table for determining actuarial accrued liabilities used to calculate required contributions. In addition, plan sponsors also retained substantial flexibility with regards to the underlying discount rate, as they were basically allowed to discount future liabilities using the expected return on pension assets.[14]

The CL is a measure of the benefits accrued to date (without any adjustments for future expected salary increases) using discount rates and mortality tables prescribed by law. The CL was used to calculate a special deficit reduction contribution (DRC) for significantly underfunded plans following the Omnibus Budget Reconciliation Act of 1987.[15] Unlike for the AL calculation, the mortality table and discount rate assumptions for CL were prescribed by legislation. For example, the Retirement Protection Act of 1994 (RPA 1994) mandated the use of the GAM-83 mortality table in determining current liability and it also required the Treasury to review the mortality tables every five years and update them as necessary to reflect changes and trends in pension plan experience.[16] The RPA 1994 legislation initially required that the discount rate must be based on a weighted average of 30-year constant-maturity Treasury bond yields, but then changed the requirement for plan years beginning in 2004 to a weighted average of long-term investment grade corporate bond yields.

[14]The instructions for the Form 5500 (page 26, line 6(e) in IRS (2007)) define the valuation liability interest rate as follows: "Enter the assumption as to the expected interest rate (investment return) used to determine all the calculated values except for current liability...". Under ERISA, this assumption should be selected "on the basis of actuarial assumptions and methods, which, in the aggregate, are reasonable (taking into account the experience of the plan and reasonable expectations), and which, in combination, offer the actuary's best estimate of anticipated experience under the plan", see page 871 of ERISA (1974).

[15]Small plans (those with fewer than 100 employees) and multi-employer plans were not subject to the deficit reduction contribution rules but instead to the ERISA minimum funding rules, on which actuarial discretion was maintained, as it was for actuarial accrued liability calculations.

[16]The Treasury first updated the tables to the RP-2000 table plus the AA projection scale in 2005 for plan years beginning in 2007.

3.2 Cash contributions: regulation and relation to pension expenses

The difference between AL and CL matters because it impacted cash contributions to pension plans. Underfunded plans are subject to rules governing minimum funding requirements, whereas overfunded plans are subject to rules governing full funding limits.

Minimum funding requirements

Absent severe underfunding, cash contributions are solely based on the AL measure and were referred to as the minimum funding contribution (MFC). The MFC reflects the present value of newly accrued benefits (called the normal cost) and an amortization payment due to unfunded past service liabilities as well as *so-called* experience gains and losses.[17]

$$MFC = \text{normal cost} + \text{amortization} \tag{1}$$

However, for significantly underfunded plans pension funding law requires additional funding requirements (AFR) that were based on the current liability measure. Specifically, the AFR is based on the difference between the minimum funding contribution and the so-called deficit reduction contribution (DRC)

$$AFR = \max\left[DRC - MFC, 0\right] \tag{2}$$

The DRC is based on CL and is constructed such that cash contributions increase significantly with plan underfunding.[18] However, not all plans were immediately subject to the DRC as there were several exceptions. For example, if underfunding was lower than 10% then the DRC did not apply. Additional funding is also not required in case the plan is at least 80% funded and has been at least 90% funded for two consecutive years over the past three years.

The total amount of mandatory pension contributions was given by the sum of MFC and AFR:

[17] Unfunded past service liabilities are liabilities from the initial plan adoption and retroactive plan amendments. Experience gains and and losses represent difference between actuarial assumptions and actual gains and losses, as well as gains and losses arising from changes in actuarial assumptions. For more details, see **?**

[18] The value of DRC is based on the following non-linear equation for plan years following 1995: $DRC = \min 0.30, \left[0.30 - 0.40\left(\frac{PA}{CL} - 0.60\right)\right] \times (CL - PA)$ where PA denotes the value of plan assets. Rauh (2006) uses this formula when estimating the impact of mandatory cash contributions on plan's investment policy.

$$MPC = MFC + AFR \tag{3}$$

However, pension funding law contained yet another provision which allowed pension plans to reduce the MPC in case historical cash contributions exceed required contributions.[19]

Full funding limits

Overfunded plans are not required to make cash contributions and, moreover, those contributions are only tax-deductible as long as the level of (over-)funding does not exceed a certain threshold (called the full funding limit, FFL). Originally, the FFL was the excess of 100% of AL over the value of plan assets. Congress subsequently tightened full funding limitations and set it equal to the lesser of 100% AL and a time-varying threshold for CL. For example, in 1999 the threshold was 155% of CL such that the full funding limit was given by[20]

$$FFL = \min\left[AL, 1.55 \times CL\right] - PA \tag{4}$$

Pension expenses

Pension expenses are governed by the Financial Accounting Standards Board (FASB) and are typically less volatile than cash contributions. SFAS No. 87 decomposes the annual pension expense into the service cost, the interest cost, an adjustment for the expected return on the pension assets and an amortization item.[21] The first two components capture the present value of the promised pension benefits and are conceptually similar to the normal cost (see above). The third component reflects managerial expectations of the expected return on the plan's investments and is unique to pension accounting. Finally, the last item reflects historical differences between actual and realized returns. The discount rate for the interest cost is tightly regulated (similar to the CL concept) but the expected return on pension assets makes pension expenses less volatile than cash contributions.

[19] The difference between historical cash contributions and historically required contributions is measured by the so-called funding standard account, FSA.

[20] The CL funding limit was 155% in 2000, 160% in 2001, 165% in 2002, 170% in 2003 and repealed in 2004. In 2005, it was set to 180% (Munnell and Soto, 2007).

[21] For exact details, see SFAS No. 87; Barth, Beaver, and Landsman (1992) or Pension Committee of the American Academy of Actuaries (2004).

3.3 Subsequent legislation

The passage of the Pension Protection Act of 2006 (PPA 2006) removed some of the wiggle room in setting actuarial assumptions starting in 2008. Since then the Treasury prescribes by regulation both the interest rate and the mortality table to be used for all liability determinations. For mortality tables, the Treasury has imposed the RP-2000 table plus the AA projection scale whereas for discount rates plan sponsors can choose between using the full (current) yield curve or a segmented yield curve concept. The segmented yield curve is based on a 24-month average of high quality corporate bonds of varying maturities. In general, the two concepts yield similar discount rates. Finally, the PPA has decreased the period for amortizing a plan's funding shortfall from 30 to 7 years.

However, in 2012 Congress provided pension contribution relief by signing into law the MAP-21 Act. MAP-21 provides that the segmented yield curve (which is again based on a 24-month average of yields for various maturities) has to be adjusted in case those yields deviate from their long-term historical average. To be precise, MAP-21 sets a corridor of permissible interest rates using a long-term average of 25 years. When the 24-month average falls outside the corridor, it allows the plan sponsor to use the closest point of the corridor to the 24-month average – essentially introducing a floor and a ceiling to the discount rates.[22] Because historical corporate bond yields, especially the yields in the late 80s and early 90s, were significantly higher than current yields, this adjustment increases current discount rates, which lowers the value of liabilities, thus lowering mandatory contributions. Although MAP-21 provided that the corridor first applies to plan years beginning in 2012, it gave plans that used the segmented yield curve concept the option of waiting until 2013. Pension plans using the full yield curve do not have to apply the new measures introduced in MAP-21.

4 Regulatory leeway and pension liability management

4.1 Data source and proxy for pension liability management

This study uses the Form 5500 pension plan data filed with the U.S. Department of Labor (DOL).[23] The information submitted to the DOL is partitioned into separate schedules and includes general information

[22]The corridor started at 10 percent for 2012. In other words, for 2012, yields were subject to a floor of 90 percent of the 25-year long-term average. MAP-21 called for the corridor to increase five percentage points a year starting with 2013 until reaching 30 percent in 2016 where it was scheduled to remain indefinitely. However, recently enacted legislation in 2014 delayed the start of the increase until 2018, so the phase-in will not be complete (i.e. reach 30 percent) until 2021.

[23]We use data provided by the Centre of Retirement Research at Boston College.

on the plan (Form 5500), actuarial information (Schedule B), financial information (Schedule H), and others.[24] Any administrator or sponsor of a plan must file this information once a year.

As summarized in detail in Appendix Table 1, the main analysis focuses on single-employer DB pension plans with at least 100 plan participants. The sample period covers the years 1999 to 2007. The starting point is motivated by the fact that as of 1999 information on important actuarial assumptions (retirement age, number of plan participants and the underlying mortality tables used in actuarial computations) are jointly available. The study ends in 2007 as this is the last year before the changes imposed by the PPA of 2006 come into effect. The final sample consists of 48,880 observations (11,963 pension plans). The average number of observations for each plan is four (median also equals 4) and, on average, 5,959 plans are included in the sample each year. All variables used below are exactly defined in Appendix Table 2.

Table 1 presents summary statistics for the main variables used in this paper. Columns (2) and (3) compare average dollar values of current and accrued pension liabilities for our sample of 11,963 pension plans over the period from 1999 to 2007. Current liabilities hover around $90 million and exceed accrued liabilities in each single year of the sample period. Plan assets, on the other hand, exceed current liabilities substantially in the early years of the sample but average funding levels decrease at the beginning of the millennium.

Column (4) displays the percentage difference between current and accrued liabilities for each pension plan at each point in time. We refer to this difference as the liability gap measure $G_{i,t}$,

$$G_{i,t} = \frac{CL_{i,t} - AL_{i,t}}{AL_{i,t}} \tag{5}$$

where CL (AL) denotes current (accrued) pension liabilities and $G_{i,t}$ is the percentage difference between them.

A value of G exceeding zero implies that accrued pension liabilities would increase by G percentage points if more conservative actuarial assumptions were employed. Put differently, in such a case reported pension liabilities are low relative to the regulated pension liability concept. The table shows that accrued liabilities would need to be increased by 10 percent (median 11 percent) in order to keep up with the regulated current liability measure. Figure 1 further displays the distribution of this gap measure for our sample and shows that in 71 percent of the cases, current liabilities exceed the accrued liability measure.

[24]For more information on other type of information, please see IRS (2007) page 8.

Theoretically, the two measures do not need to be equal. For example, as explained in Section 3, AL should account for future expected salary increases. Ceteris paribus, this would result in a higher liability value than under the CL concept - an assumption typically made by the literature (Munnell and Soto, 2003) that is also implicitly reflected in the regulation of the full funding limit.[25] The empirically observed lower (average) values of AL suggest that plan sponsors deviate in other assumptions which mitigate this effect. From a regulatory perspective, it would be worrying if such other assumptions were correlated with the funding status of the pension plan.

Below, we present detailed evidence on the existence of such a channel and show that the funding status of a pension plan impacts actuarial choices and, in turn, cash contributions. In Section 4.2, we relate the pension liability gap to the funding status of pension plans. Using the pension liability gap measure (G) as a dependent variable in this exercise, allows us control for many plan-specific factors that otherwise would be unobservable.[26] In Section 4.3, we further explore the impact of funding on the underlying actuarial assumptions. We start by benchmarking the AL discount rate with the rate underlying CL. This is useful for several reasons. First, it automatically controls for variation in the general level of interest rates. Second, both discount rates have cash flow implications which makes the difference also economically relevant. Third, AL has not been designed to reflect the funding status or credit risk of the plan sponsor.[27] Finding a systematic impact of the funding status therefore allows us to specifically investigate whether the result is explained by the credit risk of the plan sponsor or other considerations.[28] Relatedly, we also investigate differences in life expectancy assumptions where it is particularly hard to give an economic argument for the impact of plan funding. Finally, in Section 4.4 we investigate whether the use of regulatory freeway in reporting AL translates into a reduction of cash contributions to pension plans.

[25]As detailed in Section 3, the full funding limit was set to be the lesser value of AL and a scaled-up version of CL. If regulators had known that $AL < CL$, the scaling would not have been necessary.

[26]For example, the existing literature typically regresses a plan-specific value (such as pension liabilities or assets) on control variables. Focusing on the difference in two plan-specific values allows us to go beyond the typical control variables as any potential omitted variable will to a large degree be netted out in our dependent variable G. For example, while we don't have information on the exact workforce composition or individual benefit structure they would affect both AL and CL. As a consequence, the impact of such omitted variables will be limited to the degree they affect the two variables asymmetrically.

[27]The AL measure has not been designed to measure the market value of promised pension benefits to plan participants, but instead it is a regulated funding target concept. In other words, the AL should not reflect credit risk of the plan sponsor because regulation aims to precisely avoid a mechanical reduction in pension contributions for underfunded plans (Pension Committee of the American Academy of Actuaries, 2004; Munnell and Soto, 2007).

[28]We take up this issue in detail in Section 5.

4.2 How does funding impact the pension liability gap?

Figure 2 displays the non-parametric relation between the funding status (F) of a pension plan and the pension liability gap measure (G) where

$$F_{i,t} = \frac{PA_{i,t} - CL_{i,t}}{CL_{i,t}} \tag{6}$$

PA is the current market value of plan assets and F is measured in percentage points (pp). A funding status of zero implies that pension assets match pension liabilities and that the plan is fully funded. The figure suggests that the level of plan funding is negatively correlated with the liability gap measure.[29] For example, for plans that are underfunded by 25 percent the gap between accrued and current liabilities is about 18 percent, whereas accrued and current liabilities are virtually identical for plans that are overfunded by 25 percent.

The negative impact of funding is robust to the inclusion of several control variables, as shown by estimating the following reduced-form model

$$G_{i,t} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t} \tag{7}$$

where X denotes a vector of additional control variables (to be introduced in the next paragraph), γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = i$) and η_t are time-fixed effects.[30] Throughout the paper, standard errors under fixed effect estimation are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms (Petersen, 2009).

The estimation of a linear reduced-form model requires that we control for additional factors that may also impact the difference between the two liability measures. For example, we control for plan size as smaller pension plans might not have the necessary degree of sophistication when choosing actuarial assumptions. Similarly, the duration of pension payouts might differ considerably from the one implied by

[29]Note that the funding status exceeds 0.65 in only 3.6 percent of all cases, thereby suggesting that the right tail of Figure 2 happens rarely.

[30]To be precise, the Form 5500 contains a six-digit industry classification (North American Industry Classification, NAICS) and we classify plans into 19 different industries, based on the broad classification suggested by the Form 5500.

using long-term yields under the current liability measure.[31] Finally, we control for the plan's investment into risky assets using the limited information that is provided on asset allocation in Schedule H of the Form 5500.[32]

We argue that employing G as the dependent variable comes with the additional benefit of controlling for potentially missing additional information that is required to compute the value of pension liabilities. For example, we don't have information on the exact workforce composition or individual benefit structure. However, they would affect both the computation of AL and CL and, as a consequence, be netted out in the computation of G. In general, the impact of such omitted variables would be limited to the degree they affect AL and CL asymmetrically.

Table 2 provides estimates under OLS and plan-fixed effect estimation. Column (1) is based on OLS estimation and shows that a 10 percentage point increase in plan funding decreases the pension liability gap by 20 basis points. The effect is statistically significant at the 1% level and its magnitude is robust to the inclusion of plan-specific control variables (size, duration and investment in risky assets), industry-, year- and firm-fixed effects. Contrary to what would be expected under a visibility cost argument (Watts and Zimmerman, 1978; Mittelstaedt, 1989), we can see that the size of the pension plan has a positive impact on the liability gap. In other words, ceteris paribus larger plans report lower values of AL than smaller plans.

4.3 How does funding impact actuarial assumptions?

The evidence above suggests that higher funding levels are associated with more conservative values of accrued pension liabilities. We now investigate how actuarial assumptions underlying the computation of G respond to plan funding.

4.3.1 Funding status and discount rates

We quantify the magnitude of different discount rate assumptions by computing an excess discount rate ($r^{\Delta}_{i,t}$), defined as the difference between the freely chosen discount rate ($r^{AL}_{i,t}$) and the government imposed

[31] We define duration as one minus the ratio of retirees to all plan participants, see Appendix Table 2.

[32] However, note that the proxy based on the Form 5500 is rather crude: Schedule H includes preliminary information on the asset allocation of pension plans. The categorization distinguishes between cash and accounts receivables, fixed-income investments (e.g. Treasuries and corporate bonds), direct equity investments, real estate and indirect investments (e.g. trusts, funds, insurance investments). The control variable is defined as the fraction of assets that are not invested into cash, accounts receivables or fixed income investments, see Appendix Table 2.

rate ($r_{i,t}^{CL}$):

$$r_{i,t}^{\Delta} = r_{i,t}^{AL} - r_{i,t}^{CL} \tag{8}$$

Benchmarking the accrued liability discount rate with the government imposed rate is useful for several reasons. First, it controls for variation in the general level of interest rates. Second, both discount rates have cash flow implications. As detailed in Section 3, cash contributions are typically based on the AL measure, but for significantly underfunded plans they are derived from the current liability. Since the CL discount rate implicitly reflects the law's assessment of the corresponding required contributions, it is interesting to test whether (and by how much) the AL discount rate deviates from this assumption.

In addition, it allows us to investigate whether differences in discount rate assumptions relate to the funding status of the pension plan. This is relevant from a regulatory point of view because the AL measure has not been designed to measure the market value of promised pension benefits to plan participants, but instead it is a regulated funding target concept. In other words, the AL should not reflect credit risk of the plan sponsor because regulation aims to precisely avoid a mechanical reduction in pension contributions for underfunded plans (Pension Committee of the American Academy of Actuaries, 2004; Munnell and Soto, 2007).[33]

Panel A of Figure 3 illustrates the distribution of excess discount rate assumptions ($r_{i,t}^{\Delta}$). The graph shows that pension plans consistently employ higher discount rates when left with the choice: the average (median) difference is 172 (172) basis points. The heterogeneity in actuarial assumptions does not only reflect differences across firms but also within-firms over time. Panel A in Table 3 contains information on the change in excess discount rates and the number of plans modifying its assumptions. For example, in 2005, 3,615 pension plans increased excess rates, 33 left them unchanged whereas 468 plans decreased rates, leading to an average increase in excess discount rates by 36 basis points.[34]

[33] From the perspective of a plan participant credit risk of the plan sponsor will still matter for his/her valuation of the pension promises. However, the complexities of such a valuation are typically large. First, DB pension plans are often set up as separate legal entities from the plan sponsor. From the perspective of a plan participant, only the underfunded component of accrued pension liabilities would be subject to the credit risk of the plan sponsor. Moreover, the risk is further reduced by the fact that in case of corporate bankruptcy, pension promises are insured by the Pension Benefit Guaranty Corporation (PBGC). Technically speaking, the plan sponsor owns a put option (to sell the pension promises to the PBGC), for which it pays a periodic premium (Sharpe, 1976). However, plan participants would also not view the pension promises as fully risk-less as, for example, the PBGC only covers benefit payments up to a statutory limit (Rauh, 2009).

[34] Note that the number of yearly increases, decreases and no-changes do not add up to the number of yearly observations because not all plans were also included in the sample in the previous year. In 2005, 847 plans were included for the first time (i.e. the difference between the total yearly observations and the number of increases, decreases and no-changes: 4963 - (3615 + 33 + 468) = 847.

As stated above, pension funding law also does not give a role to financial risk measures when setting rates but instead requires that the assumption should be reasonable. We first test whether funding levels affect differences in discount rates by estimating

$$r^{\Delta}_{i,t} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t} \tag{9}$$

Table 4 displays corresponding results. Irrespective of whether one employs OLS estimation (column 1) or accounts for plan-fixed effects (column 3), we find that the funding level has a strong negative impact on the choice of the excess discount rate. Moreover, when splitting funding into a positive and a negative component we find that most of the power comes from underfunded plans: a 10 percentage point increase in the level of underfunding increases the difference between current and accrued liability discount rates by approximately 13 basis points.[35]

Variation in excess discount rates can arise due to changes in both actuarial and current liability discount rates. As a robustness check, we also test whether the funding status directly impacts actuarial discount rate assumptions only (i.e. the variable r^{AL}). Appendix Table 3 displays corresponding results and reinforces earlier findings. Funding levels have a strong negative impact on actuarial discount rate assumptions and the effect is again strongest for underfunded pension plans.

Comparing cross-sectional and time-series effects

Coefficient estimates obtained from a pooled regression analysis reflect both cross-sectional and time-series variation in the underlying variables. From a practical perspective, it is interesting to know whether our results implicitly identify a set of plans that consistently exploit regulatory leeway in setting actuarial assumptions, or - whether more generally - any plan is more likely to cherry pick assumptions in case funding levels deteriorate. To answer this question, we perform both cross-sectional (i.e. year-by-year) regressions as well as traditional time-series analysis (Fama and MacBeth, 1973).

Table 5 displays results of Fama-MacBeth regressions and reveals a strong cross-sectional relation between funding levels and discount rate assumptions. Focusing on the coefficient of funding in column (1), the impact is similar to the pooled regression analysis: a 10 percentage point increase in funding decreases excess discount rate assumptions by 5 basis points. Column (2) further shows that the effect

[35]To ease interpretation of coefficients, negative funding levels are recorded with a positive sign (thus implying that a positive coefficient means that more underfunded plans have a higher corresponding probability)

is strongest for underfunded plans. Here, a 10 percentage point increase in the level of underfunding triggers a corresponding 12 basis points increase in excess discount rates. For completeness, the table also displays the cross-sectional sensitivity of actuarial discount rate assumptions to funding levels in columns (3) and (4). The results are quantitatively similar.

Table 6 presents results of an additional regression testing whether changes in funding lead to changes in discount rate assumptions. Specifically, columns (1) and (2) investigate the impact of changes in funding on changes in excess discount rate assumptions (i.e. changes in $r^{\Delta}_{i,t}$) and reveal a strong time-series effect that is consistent with the substantial amount of time-series variation that was descriptively documented in Table 3. The results complement the cross-sectional evidence and show that changes in funding levels are negatively correlated with changes in excess discount rate assumptions. The finding is again driven by underfunded pension plans: if underfunding gets worse, excess discount rates are reduced substantially.

Finally, columns (3) and (4) investigate changes in actuarial discount rates. The findings are interesting and warrant further explanation. Column (4) shows that increases in overfunding lead to increases in actuarial discount rate assumptions, whereas as no such effect is present in case underfunding deteriorates. The statistical explanation of the missing significance is due to the fact that changes in actuarial discount rates are not as frequent as changes in excess discount rate assumptions. In other words, most of the time series variability in excess discount rates (r^{Δ}) is driven by changes in the current liability discount rate (r^{CL}).

What is the practical implication of these findings? Cross-sectionally, there is ample evidence that more underfunded plans use higher discount rates. The results are robust and obtain for both the excess discount rate and the actuarial discount rate. In the time-series dimension, there is significant evidence that increases in plan underfunding are strongly correlated with decreases in excess discount rate assumptions. The fact that the same relation is missing for changes in actuarial discount rates suggests that plans *passively exploit* regulatory leeway over time.

In other words, the decrease in regulated discount rates that occurred during the sample period reflects to a large degree the reduction in risk-free rates. This reduction (in risk-free rates) should be equally relevant for the actuarial discount rate and therefore lead to an equivalent downward adjustment. However, most pension plans ignore this new information and opt to leave actuarial discount rates unchanged most of the time. The missing adjustment keeps accrued pension liabilities artificially low as interest rates do not reflect the new economic environment.

4.3.2 Funding status and life expectancy assumptions

Another source of potential differences are life expectancy assumptions. We first compute life expectancy under the state imposed GAM-83 mortality table (relevant for CL) and then compare it to the life expectancy under the mortality table chosen by the plan sponsor for the accrued liability measure.[36] Because mortality tables only contain information on expected death rates at a given age, we convert them into life expectancy assumptions by computing and summing up all successive multi-period survival rates (Coughlan et al., 2007). We then define a corresponding excess life expectancy assumption ($LE^{\Delta}_{i,t}$) by computing the difference between life expectancy under the accrued pension liability measure ($LE^{AL}_{i,t}$) and the current liability measure ($LE^{CL}_{i,t}$) at the average retirement age:

$$LE^{\Delta}_{i,t} = LE^{AL}_{i,t} - LE^{CL}_{i,t} \tag{10}$$

Panel B of Figure 3 shows a frequency plot of excess life expectancy assumptions ($LE^{\Delta}_{i,t}$). Contrary to Panel A which showed significant heterogeneity in excess discount rates, we can see that plans employ the 1983 GAM mortality table, implying that the average difference in life expectancy assumptions is likely to be small. However, the graph also illustrates that there are a few cases where pension plans employ significantly lower life expectancy assumptions. In general, life expectancy forecasts are either based on historical mortality data (Lee and Carter, 1992), expert opinion or a combination of the two. Mortality tables employ such official mortality forecasts and they form the basis of corporate life expectancy assumptions.

Irrespective of how life expectancy is modeled, funding considerations do not play any role. To test whether funding levels impact life expectancy assumptions, we estimate the following logit model

$$y_{i,t} \quad = \quad \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t} \tag{11}$$

where $y_{i,t}$ is a dummy variable equal to one in case the freely chosen life expectancy assumption is

[36] For our sample, pension plans have based their calculations on the (1) 1951 Group Annuity Mortality Table, (2) 1971 Group Annuity Mortality Table, (3) 1971 Individual Annuity Mortality Table, (4) the 1984 Unisex Pension Table, (5) the 1983 Individual Annuity Mortality Table, (6) the 1983 Group Annuity Mortality Table, (7) the 1994 Uninsured Pensioner Table and (8) the 2007 Mortality Table.

below the one mandated by the government (i.e. $LE^{\Delta}_{i,t} < 0$), $F_{i,t}$ is the funding status of plan i at time t (as defined in equation 6), the vector X includes the same set of control variables as used in the previous section, γ_k is an industry-fixed effect and η_t are time-fixed effects.

Table 7 displays corresponding results and shows that the funding status has a statistically and economically significant impact on life expectancy assumptions: a 10 percentage point increase in the funding status decreases the probability of using a less stringent mortality table by 5 to 8 percentage points. This effect is robust and pertains when the funding status is the only regressor (column 1) or equally when the full set of control variables, industry and time dummies are included (column 4).

Column 5 further splits the funding level into a positive and a negative component and tests whether the probability of using less stringent mortality tables responds asymmetrically to positive and negative funding levels.[37] The coefficients on both variables are statistically significant and have the expected sign. We can see that most of the power comes from underfunded plans: a 10 percentage point increase in the level of underfunding increases the probability of using less conservative life expectancy assumptions by 12 percentage points.[38]

Regulation prescribed the use of the 1983-GAM mortality table for all sample years until (but excluding) 2007, when the more stringent 2007 mortality table was imposed. The new mortality table increases regulated life expectancy assumptions which - ceteris paribus - raises the likelihood of using less conservative life expectancy assumptions under the accrued liability measure. Put differently, unless plans also incorporate the more conservative (and up-to-date) life expectancy assumptions into the accrued liability measure, the probability of using an outdated mortality table increases in this year.

As an additional robustness check to including time dummies, Appendix Table 4 re-estimates the logit model and focuses only on the subsample from 1999 to 2006. For this period, the regulated life expectancy assumptions are constant implying that differences in excess life expectancy assumptions only relate to active decisions in pension liability management surrounding the accrued liability measure. Columns (1) to (5) show that results are quantitatively similar: a 10 percentage point increase in the level of underfunding raises the probability of using less conservative life expectancy assumptions by 11 percentage points.

[37] Again, to ease interpretation of coefficients, negative funding levels are recorded with a positive sign (thus implying that a positive coefficient means that more underfunded plans have a higher corresponding probability).

[38] We have also estimated equation 11 using a dummy variable for being underfunded. This simpler model suggests that the probability of using less stringent mortality tables increases by 60 to 80% in case the plan is underfunded.

4.4 Pension liability management and cash contributions

Table 8 contains descriptive information on the interaction between the use of regulatory leeway to decrease pension liabilities, funding levels and cash contributions to the pension plan. Column (1) shows the cumulative number of times a pension plan has reported a lower value of AL than CL over the total periods T the plan is included in the dataset. Columns (2) and (3) display the corresponding number of plan years and pension plans.

For example, Panel A shows that 2,011 pension plans (out of the total pool of 11,963 pension plans) have never employed actuarial assumptions such that $AL < CL$. Those plans are on average overfunded by 16 percent, they contribute 12 percent of plan assets to the plan which, in turn, coincides with the mandatory funding contribution (MFC).[39] On the other hand, 1,106 pension plans report $AL < CL$ for a total of 5 years. While those plans are on average underfunded by 6 percent, corresponding cash contributions are lower and only equal 8 percent of plan assets (offsetting the reduced MFC of 7 percent and an AFR of 1 percent).

The reduction in cash contributions becomes even more apparent when focusing only on years of plan underfunding (Panel B). In this case, plans that never use regulatory leeway to their advantage are on average underfunded by 13 percent and they contribute 20 percent of pension assets to the pension plan. Increasing the number of times plans have reported such that $AL < CL$, cash contributions decrease significantly to as little as 6 percent of assets even though funding levels also deteriorate. Moreover, the reduction in cash contributions is mirrored by a decrease in the MFC, thereby providing strong empirical evidence that the use of regulatory leeway leads to a direct and significant reduction in cash contributions for pension plans.[40]

The strong negative relation between the use of regulatory leeway and cash contributions also holds in a multivariate context. Focusing again on years of plan underfunding, Table 9 provides corresponding evidence and is based on estimating

[39] Note that, as long as plans are overfunded, those contributions are voluntary.

[40] In untabulated results, we further investigate the role of the funding standard account. Interestingly, all plans (irrespective of funding and use of regulatory leeway) report a value of FSA of around 6 to 8 percent of pension assets. For plans that use regulatory leeway to their advantage, the FSA actually increases over the sample period which, of course, also reflects the downward biased values of the MFC. We interpret these additional findings to be consistent with the argument of Watts and Zimmerman (1978) and Mittelstaedt(1989) who argue that plans try to avoid becoming the focus of regulators and financial media. In other words, reducing cash contributions through a reduction in the MFC (while leaving the FSA unchanged) is likely to generate less attention from Congress and financial media than a corresponding reduction in cash contributions by drawing down the transparent FSA account. In addition, plans preserve the option value of doing so at a later point in time.

$$Contrib_{i,t} = \alpha + \beta_1 F + \beta_2 I_{(G>0)i,t} + \gamma_k + \eta_t + \epsilon_{i,t} \tag{12}$$

where $Contrib$ equals total cash contributions (CC) in Panel A and the minimum funding contribution (MFC) in Panel B, both expressed in percent of plan assets. The dummy variable $I_{(G>0)}$ is equal to one in case reporting is such that $AL < CL$, γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = i$) and η_t are time-fixed effects. Irrespective of the exact regression model, results strongly suggest that the decision to report $AL < CL$ leads to a reduction in cash contributions (Panel A), which is driven by a decrease in the MFC of approximately 6 to 8 percent of pension assets.

To further disentangle time-series and cross-sectional effects, we re-estimate equation (12) by conditioning on the overall frequency a plan employs regulatory leeway (i.e. the cumulative number of times it reports $AL < CL$). Corresponding findings are shown in Table 10 for total cash contributions (Panel A) and the minimum funding contribution (Panel B).

For example, column 1 in Panel B shows that for the 1,672 plans that employ regulatory leeway once, the MFC on average decreases by 6 percent of plan assets. This effect is estimated using 2,652 plan-years out of which $AL < CL$ in 60 percent of these observations. For each column, we then update the estimation by conditioning on a more frequent cumulative use of reporting $AL < CL$. As can be seen, the effect is highly statistically significant for all but the last column (where the statistical significance drops to 10 percent). This is particularly interesting given that - with a higher cumulative use of reporting $AL < CL$ - the indicator variable $I_{(G>0)}$ loses statistical power as most observations will reflect the use of regulatory leeway (e.g. in column 8, the fraction 98 percent of the 1,280 plan-years correspond to $AL < CL$).

Taken together, the findings in this section strongly point towards a strategic role of cash considerations in the setting of actuarial assumptions. We turn to this issue next.

5 Sponsor characteristics

Above findings suggest that a desire to reduce cash contributions to the pension fund may explain the relation between plan funding and actuarial discount rate assumptions. One related question is whether this observed behavior is related to the credit risk of the plan sponsor - are firms facing financial distress more likely to use favorable assumptions when calculating pension liabilities?

If this is the case, reported actuarial liabilities would be implicitly adjusted for the riskiness of the expected cash flows, which is contrary to regulation.[41] The actuarial liability measure has not been designed to measure the market value of promised pension benefits to plan participants, but instead it is a regulated funding target concept. In other words, the AL should not reflect credit risk because regulation aims to precisely avoid a mechanical reduction in pension contributions for underfunded plans (Pension Committee of the American Academy of Actuaries, 2004; Munnell and Soto, 2007).[42]

To test whether credit risk has any impact on actuarial assumptions, we merge our sample of pension funds with firm-level data on U.S. public industrial corporations from Compustat. The match is performed using information on a firm's employment number (EIN) and the fiscal year and results in a total of 6,401 matched observations (corresponding to 952 pension plans).[43] In a given year, a firm can sponsor multiple pension funds (the average number of pension plans per firm is two). We therefore need to adjust our pension plan variables: for each sponsor and year, we compute aggregate values of pension assets, current and accrued liabilities, retired and total plan participants and total investment into risky assets. Using the implied weights of each plan (relative to all plans of a plan sponsor), allows us to further derive weighted-average values of life expectancy and discount rate assumptions. Keeping one observation per plan sponsor in a given year and requiring the availability of accounting information on a few selected variables (to be introduced below) reduces the total number of observations to 2,797 firm years (670 plan sponsors). Appendix Table 5 provides more details on the sample selection procedure.

Table 11 presents summary statistics on the main actuarial variables, this time measured at the level of the plan sponsor. Pension plan assets and liabilities are substantially larger than for the full sample of plans displayed in Table 1: accrued liabilities are equal to $479 million and, on average, would need to be increased by 16 percent in order to keep up with the regulated current liability measure. As in the full

[41] Such an implicit channel would be conceptually different from the risk adjustment argument made by Brown and Wilcox (2009) and Novy-Marx and Rauh (2011). These papers investigate the value of public pension liabilities for the taxpayer and argue that future pension obligations should be valued at a rate that reflects the riskiness of the liabilities. Because public pension promises are typically protected by constitutional, statutory or common law guarantees, the corresponding discount rate should be (close to) the risk-free rate.

[42] From the perspective of a plan participant credit risk of the plan sponsor will still matter for his/her valuation of the pension promises. However, the complexities of such a valuation are typically large. First, DB pension plans are often set up as separate legal entities from the plan sponsor. From the perspective of a plan participant, only the underfunded component of accrued pension liabilities would be subject to the credit risk of the plan sponsor. Moreover, the risk is further reduced by the fact that in case of corporate bankruptcy, pension promises are insured by the Pension Benefit Guaranty Corporation (PBGC). Technically speaking, the plan sponsor owns a put option (to sell the pension promises to the PBGC), for which it pays a periodic premium (Sharpe, 1976). However, plan participants would also not view the pension promises as fully risk-less as, for example, the PBGC only covers benefit payments up to a statutory limit (Rauh, 2009).

[43] For general information regarding matching Form 5500 data to firms in Compustat, see Gron and Madrian (2004).

sample, plan sponsors are well funded in the early years of the sample but then become underfunded in the years surrounding the burst of the dot-com bubble. Interestingly, the spread between actuarial and current liability discount rates is wider ($r^{\Delta} = 198bp$) whereas the difference in life expectancy assumptions is close to zero.

The aim of this section is to investigate whether credit risk explains the impact of funding levels on the difference in discount rate assumptions. We address the issue employing a two-stage regression approach. In the first stage, we estimate the implied deviation of accrued liability discount rates from the current liability measure (i.e. the fitted variable $\hat{r}^{\Delta}$) using the entire set of previously introduced control variables as well as proxies for the plan sponsor's credit risk and firm characteristics

$$r^{\Delta}_{j,t} = \alpha + \delta X_{j,t} + \lambda Y_{j,t} + \gamma_k + \eta_t + \epsilon_{j,t} \tag{13}$$

where the subscript j indicates that the variables are now measured at the level of the plan sponsor. The additional variable $Y_{j,t}$ is a vector of sponsor characteristics including Altman's z-score (Altman and La Fleur, 1981), the firm's consolidated leverage ratio (Shivdasani and Stefanescu, 2010), the relative size of the pension plan(s) to the size of the plan sponsor and other firm characteristics such as Tobin's q or the sponsor's dividend yield. A formal definition of all variables is provided in Appendix Table 2.[44]

Table 12 presents results of the first stage regression with OLS estimates displayed in Panel A and firm fixed-effect estimates displayed in Panel B. Focusing first on the plan specific variables displayed in Panel A, we can see that the impact of plan specific factors is qualitatively similar to the results shown in Table 4 for the full sample of plans: large plans, plans with a higher duration of liabilities and/or more risky investments make higher discount rate assumptions (relative to the regulated discount rate). Turning to sponsor characteristics, results are slightly ambiguous. While credit risk proxies based on z-scores have a negative impact (high z-score values mean low credit risk) and consolidated leverage ratios do not matter statistically, only the relative size the pension plan (relative to the plan sponsor) affects discount rates positively. Panel B further shows that the effects of z-scores and relative plan size continue to be statistically significant when accounting for sponsor fixed effects.

[44] In unreported analysis, we also investigate whether firms that engage in earnings management are more likely to employ favourable actuarial assumptions in the valuation of pension liabilities. Accounting accruals reflect discretionary decisions by management in order to separate the recognition of revenues and expenses from actual cash flows. Excessive use of such accounting accruals is typically associated with firms that engage in earnings management (Sloan, 1996). However, when using such an accrual measure we do not find any relation to the opportunistic choice of actuarial assumptions.

In the second stage, we regress the part of the discount rate deviation that is left unexplained (i.e. the fitted regression residual $\hat{\epsilon}_{j,t}$ from the first stage regression) on the funding level of the pension plan, i.e.

$$\hat{\epsilon}_{j,t} = \kappa + \theta \mathrm{F}_{j,t} + \nu_{j,t} \tag{14}$$

The regression coefficient θ thus captures the remaining impact of the funding level on the difference in discount rates that can not be explained by the factors used in the first stage regression. In other words, if the marginal effect of the funding level on discount rates is captured by the set of variables used in the first stage regression, then the coefficient estimate θ should be indistinguishable from zero in the second stage regression. However, Table 13 confirms the previous evidence. The funding status continues to be significant (both for OLS and firm fixed effect estimation), also when it is split into a positive a negative component. Columns 2 and 3 show that a 10 percentage point increase in the level of underfunding increases the difference between accrued and current liability discount rates by 7 to 9 basis points.[45]

The missing impact of consolidated leverage in the first stage regression is surprising. To better understand the result, we sort plan sponsors into two groups using the median consolidated leverage as the threshold. The sort generates substantial variation in leverage ratios: leverage equals 18 (55) percent for the low (high) group. We repeat the exercise using also z-score measures and find again that z-scores differ substantially across the two groups.[46] Because both sorts univariately identify high (low) credit risk sponsors, we are able to test whether non-linearities in those variables drive their missing impact in the first stage regression (and thereby the significance of the funding variable in the second stage regression).

We therefore re-estimate the first stage regression separately for each group and use the residuals again in the second stage. Table 14 displays the corresponding results and confirms that funding is negatively correlated with the difference in discount rate assumptions. The effect is again driven by underfunded pension plans and, most importantly, it is statistically significant in each of the four groups.

Overall, our findings suggest that the impact of funding on actuarial assumptions is unlikely to be driven by credit risk - as perhaps mostly emphasized by the fact that the relation robustly holds even

[45]We also estimate the effect of funding and the firm specific variables Y jointly in one multivariate regression. In this case, the partial impact of funding is stronger than using the two-step approach. Results are available upon request.

[46]For the low (high) z-score group, the z-score value is 2.4 (10.5).

among plan sponsors with low level of perceived credit risk. Instead, the residual statistically significant impact of the funding status is consistent with the previous explanation that simple cash management considerations drive excess discount rate assumptions.

6 Policy implications and the MAP-21 bill

While the PPA of 2006 has eliminated the difference between accrued and current pension liabilities, the above findings are still highly policy relevant. At a general level, the results suggest that pension plans are likely to use any wiggle room that is offered by the respective pension legislation in order to keep the reported value of pension liabilities as low as possible. From a pension policy perspective, this might not be desirable if such a downward bias of reported pension liabilities increases the risk of employees and retirees that the pension promises will not be met.

In 2012, Congress signed into law the MAP-21 Act. This bill essentially gave sponsors of corporate DB pension plans that use the segmented yield curve concept a funding relief. The reason is that under MAP-21, segment yield curves are computed over a longer period than before. Because historically yields are higher than current rates, this change effectively increases discount rates and decreases pension liabilities.[47].

To illustrate the importance of our findings in the context of MAP-21, we use again Form 5500 data on corporate DB pension plans for plan-years ending in 2011 and 2012. Focusing on single-employer DB pension plans with at least 100 plan participants, this sample includes 8,105 pension plans (13,638 observations) for which information on pension liabilities, assets and contributions is available. Out of those, only 0.8 percent use the full yield curve in order to determine the discount rate underlying the computation of pension liabilities. Put differently, more than 99 percent of all plans use the segmented yield curve approach.

We then focus on the 5,218 pension plans that are available in 2012 and identify the subset of plans that switched to the MAP-21 rule in the same year. We find that 81 percent of all plans (4,239 pension plans) applied the new discount rate rules. The economic impact of the switch to the new rules is substantial as discount rates, on average, increased by 213 basis points. Consistent with our earlier findings that underfunded plans are more likely to bias the reported value of pension liabilities downward, we find that

[47]See Section **??** for full details

the funding status differs systematically for switching and non-switching plans. Plans that switched rules were underfunded by 8 percent in 2011 whereas non-switching plans were overfunded by 6 percent.

To more formally estimate the impact of the plan's funding status on the decision to adopt the MAP-21 legislation early, we estimate the following prediction model

$$update_{i,t} = \alpha + \theta^P F^+_{i,t-1} + \theta^N F^-_{i,t-1} + \delta X_{i,t-1} + \gamma_k + \eta_t + \epsilon_{i,t} \tag{15}$$

where t is the year of the adoption of the MAP-21 legislation, $update_{i,t}$ is a dummy variable equal to one in case the plan adopted MAP-21, X is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets) and γ_k is an industry-fixed effect. The funding variables are the degrees of overfunding or underfunding ($F^+_{i,t-1} = max(F, 0)$ and $F^-_{i,t-1} = max(-F, 0)$). Hence, a positive coefficient on the $F^-_{i,t-1}$ underfunding variable means that more underfunded plans are more likely to be early adopters of the new legislation.

Table 15 shows that the funding level in the year preceding the earliest possible adoption has a significant impact on the switching decision: plans that are more underfunded are significantly more likely to adopt the MAP-21 legislation already in 2012. For example, plans that switched were underfunded by an average of 8 percent, while plans that did not switch were overfunded by 6 percent. These results are consistent with our earlier findings and highlight the policy relevance of our results: pension funds – when in need and left with the choice – are more likely to use the wiggle room granted by pension legislation in order to keep the reported value of pension liabilities low.

The effect on mandatory pension contributions followed immediately: mandatory pension contributions decreased by 37 percent for switching pension plans, whereas they increased by 33 percent for those plans that postponed adoption of MAP-21 until 2013.

7 Conclusion

The analysis presented in this paper suggests that pension funds – when left with the choice – use regulatory leeway to their own benefit. The finding is based on a historical experiment of 11,963 U.S. corporate DB pension plans over the period from 1999 to 2007. During the sample period, the IRS distinguished between two alternative pension liability concepts: a current liability measure, which is based on state imposed discount rates and mortality tables, and an accrued liability measure. For the latter, the actuary

and plan sponsor could choose the appropriate discount rate and mortality assumptions. Our analysis reveals that the reported value of accrued pension liabilities would need to be increased by 10 percent in order to keep up with the government mandated pension liability measure.

The difference between the two liability measures is due to deviations in discount rate and life expectancy assumptions. We show that the funding status of a pension plan has a direct impact on both of them: underfunded plans are substantially more likely to employ lower life expectancy assumptions (relative to the regulated measure) and also to use higher discount rate assumptions. The effect persists both in the cross-section of plans and over time and it serves to reduce cash contributions to the pension plan. Finally, we show that the opportunistic behavior is not alternatively explained by the credit risk of the plan sponsor as the relation exists even among plans with low consolidated leverage ratios. Instead, it seems that plans use regulatory leeway as a simple cash management tool.

While the PPA eliminated the co-existence of the two liability measures in 2008, our results continue to be highly relevant. In 2012, the U.S. government signed into law the MAP-21 Act. The bill gives sponsors of DB pension plans the option of using higher discount rates when computing the present value of pension liabilities. Plans had the option of implementing the legislation immediately in 2012 and we show that underfunded plans were substantially more likely to make use of it. The benefit of the adoption followed immediately: mandatory pension contributions decreased by 37 percent for pension plans that switched to the new rule, whereas they increased by 33 percent for those plans that postponed adoption of MAP-21 until 2013.

References

Altman, Edward I., and James K. La Fleur, 1981, Managing a return to financial health, *Journal of Business Strategies* 10–31.

Amir, Eli, and Shlomo Benartzi, 1998, The expected rate of return on pension funds and asset allocation as predictors of portfolio performance, *The Accounting Review* 73, 335–352.

Amir, Eli, and Shlomo Benartzi, 1999, Accounting recognition and the determinants of pension asset allocation, *Journal of Accounting, Auditing and Finance* 14, 321–343.

Amir, Eli, and Elizabeth A. Gordon, 1996, Firms' choice of estimation parameters: empirical evidence from sfas no. 106, *Journal of Accounting, Auditing and Finance* 11, 427–448.

Ashtana, Sharad, 1999, Determinants of funding strategies and actuarial choices for defined-benefit pension plans, *Contemporary Accounting Research* 16, 39–74.

Bakke, Tor-Erik, and Toni Whited, 2012, Threshold events and identification: a study of cash shortfalls, *Journal of Finance* 25, 1286–1329.

Barth, Mary E., William H. Beaver, and Wayne R. Landsman, 1992, The market valuation implications of net periodic pension cost components, *Journal of Accounting and Economics* 15, 0–62.

Barth, Mary E., William H. Beaver, and Wayne R. Landsman, 1993, A structural analysis of pension disclosures under sfas 87 and their relation to share prices, *Financial Analysts Journal* 49.

Barth, Mary E., John A. Elliott, and Mark W. Finn, 1999, Market rewards associated with patterns of increasing earnings, *Journal of Accounting Research* 37.

Bartram, Soehnke M., 2015, In good times and in bad: defined benefit pensions and corporate financial policy, Working Paper.

Bergstresser, Daniel, Mihir Desai, and Joshua Rauh, 2006, Earnings manipulation, pension assumptions and managerial investment decisions, *Quarterly Journal of Economics* 121, 157–195.

Black, Fischer, 1980, The tax consequences of long-run pension policy, *Financial Analyst Journal* 36, 21–28.

Blankley, Alana I., and Edward P. Swanson, 1995, A longitudinal study of sfas 87 pension rate assumptions, *Accounting Horizons* 9, 1–21.

Bodie, Zvi, Jay O. Light, and Randall Morck, 1987, Funding and asset allocation in corporate pension plans: an empirical investigation, in Zvi Bodie, John B. Shoven, and David A. Wise, eds., *Issues in Pension Economics* (University of Chicago Press).

Brown, J.R., and D.W. Wilcox, 2009, Discounting state and local pension liabilities, *American Economic Review* 99, 538–542.

Brown, Lawrence D., 2001, A temporal analysis of earnings surprises: profits versus losses, *Journal of Accounting Research* 39, 221–241.

Burgstahler, David, and Ilia Dichev, 1997, Earnings management to avoid earnings decreases and losses, *Journal of Accounting and Economics* 24, 99–126.

Burgstahler, David, and Michael Eames, 2006, Management of earnings and analysts' forecasts to achieve zero and small positive earnings surprises, *Journal of Business Finance and Accounting* 33, 633–652.

Campbell, John L., Dan S. Dhaliwal, and William C. Schwartz, 2010, Equity valuation effects of the pension protection act of 2006, *Contemporary Accounting Research* 27, 469–536.

Chuk, Elizabeth C., 2012, Economic consequences of mandated accounting disclosures: evidence from pension accounting standards, *The Accounting Review* 88, 395–427.

Clinch, Greg, and Toshi Shibao, 1996, Differential tax benefits and the pension reversion decision, *Journal of Accounting and Economics* 21, 69–106.

Cocco, Joao, and Paolo Volpin, 2013, Corporate pension plans as takeover deterrents, *Journal of Financial and Quantitative Analysis* 48, 1119–1144.

Coronado, Julia, and Nellie Liang, 2005, The influence of pbgc insurance on pension fund finances, Working Paper.

Coronado, Julia Y., Olivia S. Mitchell, Steven A. Sharpe, and Blake S. Nesbitt, 2008, Footnotes aren't enough: the impact of pension accounting on stock values, *Journal of Pension Economics and Finance* 3, 257–276.

Coronado, Julia Y., and Steven A. Sharpe, 2003, Did pension plan accounting contribute to a stock market bubble?, *Brookings Papers on Economic Activity* 16, 323–371.

Coughlan, Guy, David Epstein, Alen Ong, Amit Sinha, Javier Hevia-Portocarrero, Emily Gingrich, Marwa Khalaf-Allah, and Praveen Joseph, 2007, LifeMetrics - A toolkit for measuring and managing longevity and mortality risks, Technical report, JP Morgan.

Daley, Lane A., 1984, The valuation of reported pension measures for firms sponsoring defined benefit plans, *The Accounting Review* 59, 177–198.

Dechow, Patricia M, and Douglas J. Skinner, 2000, Earnings management: Reconciling the views of accounting academics, practitioners, and regulators, *Accounting Horizons* 14.

Degeorge, Francois, Jayendu Patel, and Irchard Zeckhauser, 1999, Earnings management to exceed thresholds, *Journal of Business* 72, 1–33.

Discroll, J.C., and A.C. Kraay, 1998, Consistent covariance matrix estimation with spatially dependent panel data, *Review of Economics and Statistics* 80, 549–560.

ERISA, Employee Retirement Income Security Act of 1974, Pub. L. No. 93-406, 88 Stat. 829 (codified as amended in scattered sections of 5 U.S.C., 18 U.S.C., 26 U.S.C., 29 U.S.C., and 42 U.S.C.)), 1974.

Fama, Eugene, and James MacBeth, 1973, Risk, return, and equilibrium: empirical tests, *Journal of Political Economy* 81, 607–636.

Feldstein, Martin, and Randall Morck, 1983, Pension funding decisions, interest rate assumptions, and share prices, in Zvi Bodie, and John B Shoven, eds., *Financial aspects of the United States pension system* (University of Chicago Press).

Financial Accounting Standards Board (FASB), 1985, Employers' accounting for pensions, Statement of Financial Accounting Standards No. 87.

Financial Accounting Standards Board (FASB), 1990, Employers' accounting for postretirement benefits other than pensions, Statement of Financial Accounting Standards No. 106.

Financial Accounting Standards Board (FASB), 2003, Employers' disclosures about pensions and other postretirement benefits, Statement of Financial Accounting Standards No. 132R.

Francis, Jere R., and Sara A. Reiter, 1987, Determinans of corporate pension funding strategy, *Journal of Accounting and Economics* 9, 35–59.

Frank, Mary M., 2002, The impact of taxes on corporate defined benefit plan asset allocation, *Journal of Accounting Research* 40, 1163–1190.

Franzoni, Francesco, 2009, Underinvestment vs overinvestment: Evidence from price reactions to pension contributions, *Journal of Financial Economics* 92, 491–518.

Franzoni, Francesco, and Jose M. Marin, 2006, Pension plan funding and stock market efficiency, *Journal of Finance* 61, 921–956.

Ghicas, Dimitrios C., 1990, Determinants of actuarial cost method changes for pension accounting and funding, *The Accounting Review* 65, 384–405.

Goodwin, Joseph H., Stephen R. Goldberg, and Jon E. Duchac, 1996, An empirical analysis of factors associated with changes in pension-plan interest-rate assumptions, *Journal of Accounting, Auditing and Finance* 11, 305–322.

Gron, Anne, and Brigitte C. Madrian, 2004, Matching form 500 filings with Compustat and Crsp, Working Paper.

Hann, Rebecca N., Frank Heflin, and KR Subramanyam, 2007, Fair-value pension accounting, *Journal of Accounting and Economics* 44, 328–358.

Hayn, Carla, 1995, The information content of losses, *Journal of Accounting and Economics* 20, 125–153.

Healy, Paul M., 1985, The effect of bonus schemes on accounting decisions, *Journal of Accounting and Economics* 7, 85–107.

Healy, Paul M., and James M. Wahlen, 1999, A review of the earnings management literature and its implications for standard setting, *Accounting Horizons* 13, 365–383.

Ippolito, Richard A, 1986, *Pensions, economics, and public policy* (University of Pennsylvania Press).

IRS, Internal Revenue Service, 2007, Instructions for form 5500, Department of the Treasury.

Jin, Li, Robert C. Merton, and Zvi Bodie, 2006, Do a firm's equity returns reflect the risk of its pension plan?, *Journal of Financial Economics* 81, 1–26.

Lee, Ronald D., and Lawrence R. Carter, 1992, Modeling and forecasting U.S. mortality, *Journal of the American Statistical Association* 87, 659–671.

McGill, Dan M., Kyle N. Brown, John J. Haley, and Sylvester J. Schieber, 2004, *Fundamentals of Private Pensions*, 8th edition (Oxford University Press).

Mittelstaedt, Fred H., 1989, An empirical analysis of the factors underlying the decision to remove excess assets from overfunded pension plans, *Journal of Accounting and Economics* 11, 399–418.

Munnell, Alicia H., and Mauricio Soto, 2003, The outlook for pension contributions and profits in the U.S., Working Paper No. CRR WP 2003-13.

Munnell, Alicia H., and Mauricio Soto, 2007, Why are companies freezing their pensions?, Working Paper No. CRR WP 2007-22.

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

Niehaus, Greg, 1985, Comments on pension plan terminations, Unpublished manuscript.

Novy-Marx, Robert, and Joshua Rauh, 2011, Public pension promises: How big are they and what are they worth?, *Journal of Finance* 66, 1207–1245.

Pension Committee of the American Academy of Actuaries, 2004, Fundamentals of current pension funding and accounting for private sector pension plans.

Petersen, Mitchell, 2009, Estimating standard errors in finance panel data sets: Comparing approaches, *Review of Financial Studies* 22, 435–480.

Picconi, Marc, 2006, The perils of pensions: does pension accounting lead investors and analysts astray?, *Accounting Review* 81, 925–955.

Pontiff, Jeffrey, Andrei Shleifer, and Michael S. Weisbach, 1990, Reversion of pension assets after takeovers, *Journal of Finance* 61, 600–613.

Rangan, Srinivasan, 1998, Earnings management and the performance of seasoned equity offerings, *Journal of Financial Economics* 50, 101–122.

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

Rauh, Joshua D., 2009, Risk shifting versus risk management: investment policy in corporate pension plans, *Review of Financial Studies* 22, 2687–2733.

Rauh, Joshua D., Irina Stefanescu, and Stephen. Zeldes, 2016, Cost saving and the freezing of corporate pension plans, Working Paper.

Sharpe, William F., 1976, Corporate pension funding policy, *Journal of Financial Economics* 3, 183–193.

Shivdasani, Anil, and Irina Stefanescu, 2010, How do pensions affect corporate capital structure decisions?, *Review of Financial Studies* 23, 1287–1323.

Skinner, Douglas J., and Richard G. Sloan, 2002, Earnings surprises, growth expectations, and stock returns or don't let an earnings torpedo sink your portfolio, *Review of Accounting Studies* 7, 289–312.

Sloan, Richard G., 1996, Do stock prices fully reflect information in accruals and cash flows about future earnings?, *The Accounting Review* 71, 289–315.

Subramanyam, KR, and Yuan Zhang, 2001, Does stock price reflect future service effects not included in the projected benefit obligation as defined in sfas 87 and sfas 32?, University of Southern California.

Teoh, Siew H., Ivo Welch, and TJ Wong, 1998, Earnings management and the underperformance of seasoned equity offerings, *Journal of Financial Economics* 50, 63–99.

Tepper, Irwin, 1981, Taxation and corporate pension policy, *Journal of Finance* 36, 1–13.

Thomas, Jacob K., 1988, Corporate taxes and defined benefit pension plans, *Journal of Accounting and Economics* 10, 199–237.

Thomas, Jacob K., 1989, Why do firms terminate overfunded pension plans?, *Journal of Accounting and Economics* 11, 361–398.

Watts, Ross L., and Jerold L. Zimmerman, 1978, Towards a positive theory of the determinants of accounting standards, *The Accounting Review* 53, 112–134.

Figure 1: **Distribution of the pension liability gap meausre**

The figure plots the distribution of the pension liability gap measure G, where

$$G_{i,t} = \frac{CL_{i,t} - AL_{i,t}}{AL_{i,t}}$$

and CL (AL) denotes the value of current (accrued) pension liabilities. Variables are defined in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

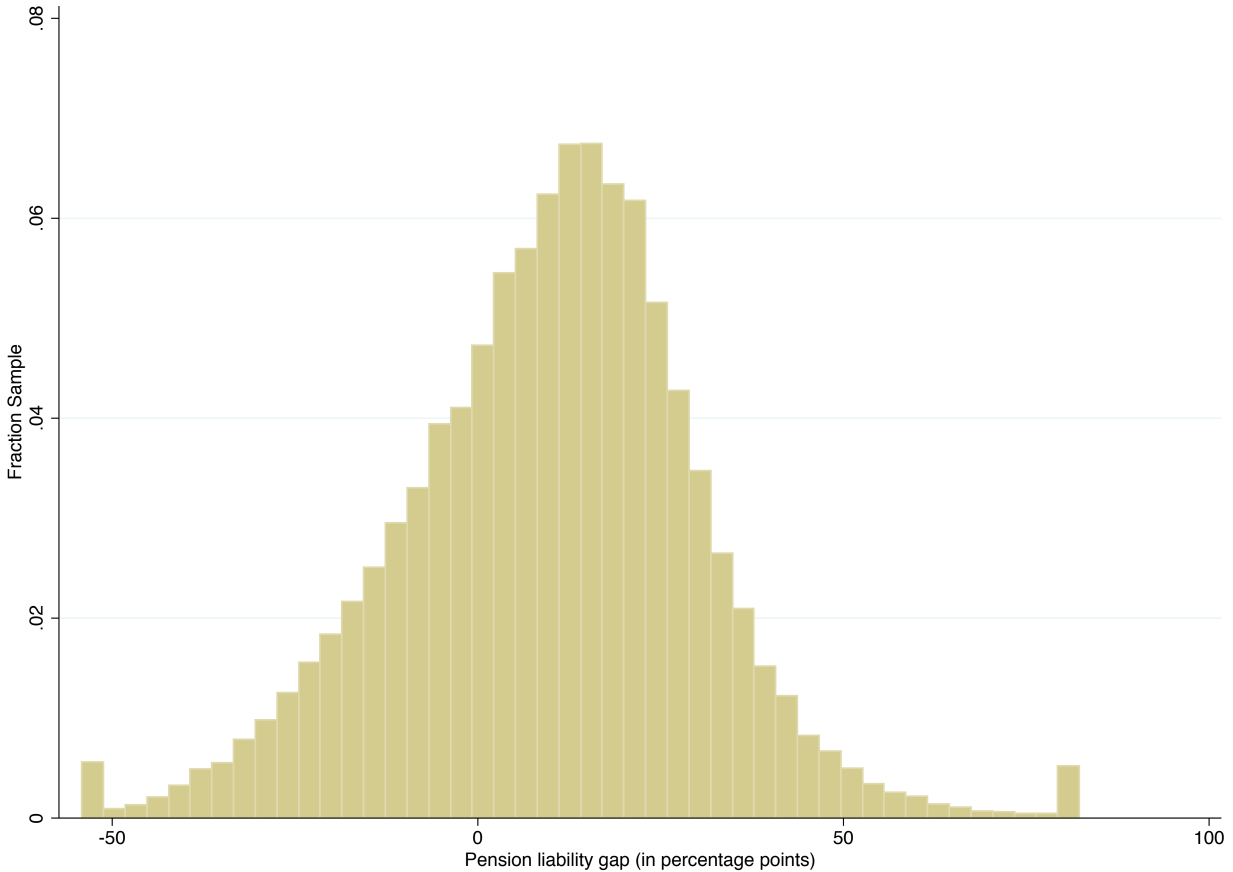


Figure 2: **Univariate relation between the funding status and the pension liability gap**

The figure plots the univariate relation between the funding status F of the pension plan (horizontal axis) and the corresponding pension liability gap measure G. The funding status F is defined as the difference between pension assets and pension liabilities, measured relative to pension liabilities. The pension liability gap G is defined as the percentage difference between current (CL) and accrued liabilities (AL). The kernel regression estimation is performed using an Epanechnikov kernel, with a bandwith of 10. A 95% confidence interval is included in the shaded region. The relation is displayed for funding levels within the 1 and 99 percentile values. Variables are defined in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

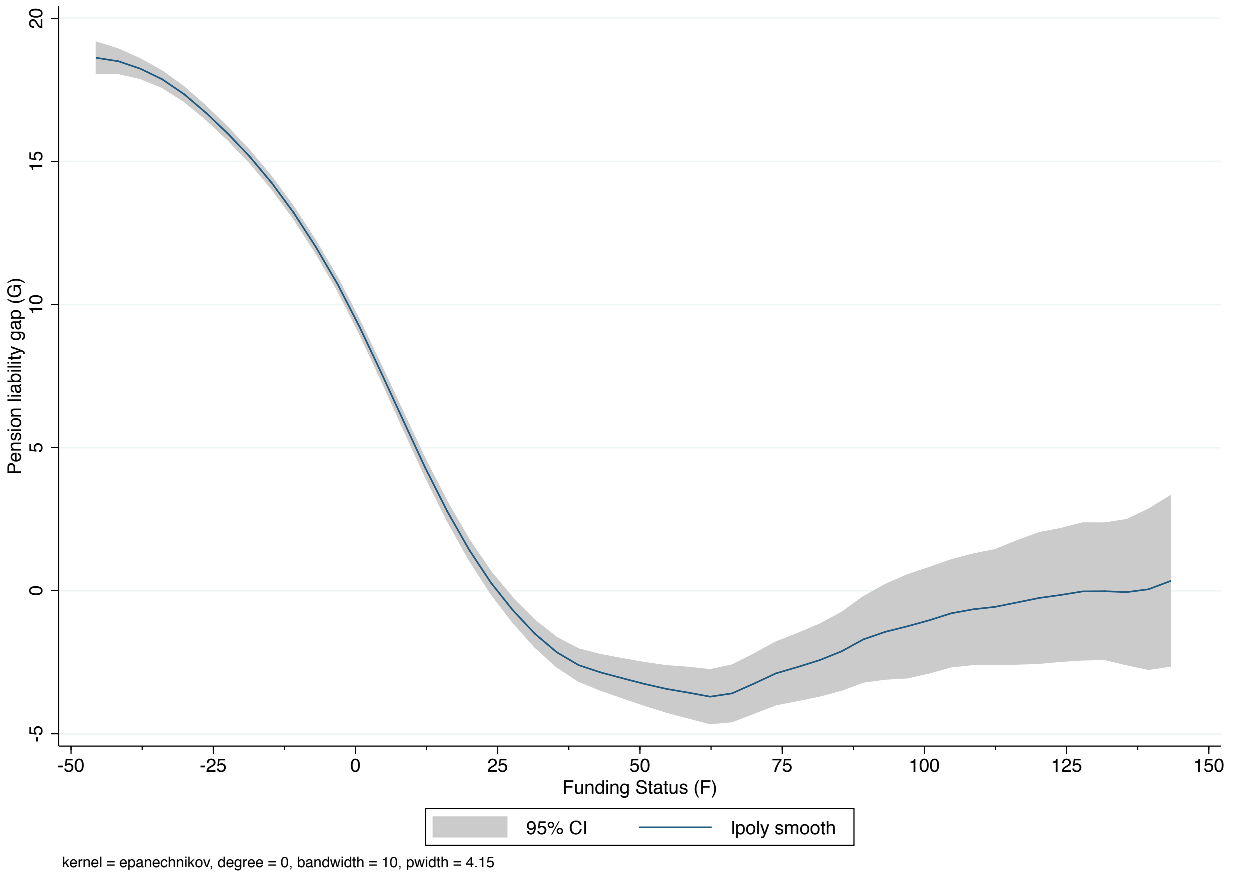
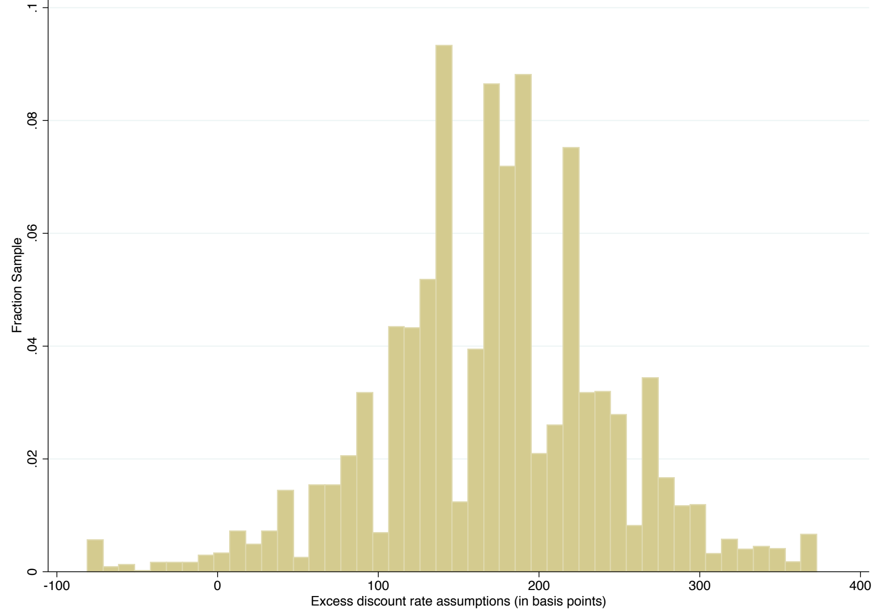


Figure 3: **Excess actuarial assumptions**

The figure contains a frequency distribution of excess actuarial assumptions, which are defined as the difference in actuarial assumptions used under the accrued liability (AL) and the current liability (CL) measure. Panel A displays excess discount rate assumptions ($r_{i,t}^{\Delta} = r_{i,t}^{AL} - r_{i,t}^{CL}$ where $r_{i,t}^{AL}$ ($r_{i,t}^{CL}$) is the discount rate assumptions under the AL (CL) measure). Panel B shows excess life expectancy assumptions ($LE_{i,t}^{\Delta} = LE_{i,t}^{AL} - LE_{i,t}^{CL}$ where $LE_{i,t}^{AL}$ ($LE_{i,t}^{CL}$) is the life expectancy assumption under the AL (CL) measure). Variables are defined in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

Panel A: Excess discount rate assumptions



Panel B: Excess life expectancy assumptions

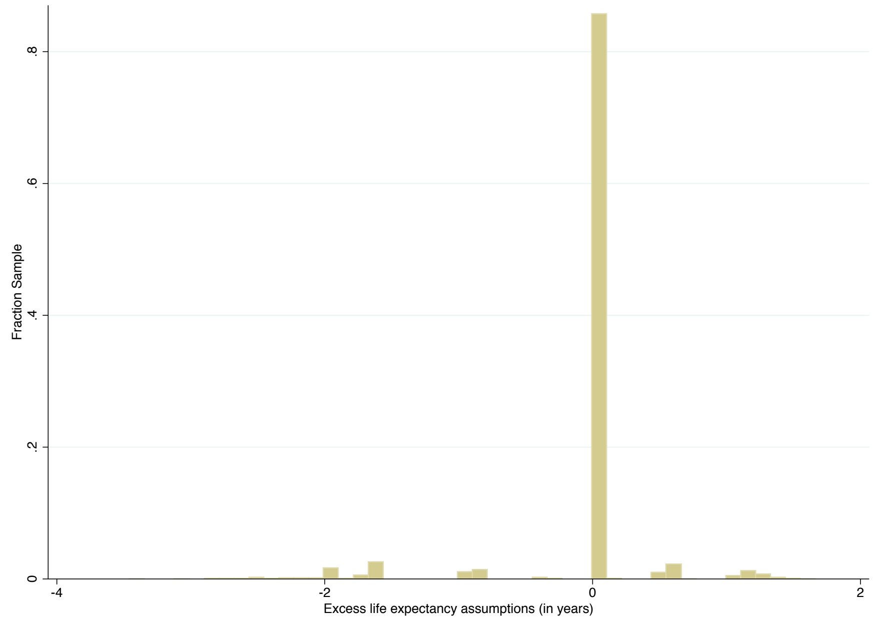


Table 1: **Summary statistics of main variables (Form 5500 Sample)**

This table displays average (Panel A) and median (Panel B) values of the main variables used in this paper. Actuarial liabilities (AL), current liabilities (CL) and pension assets (PA) are stated in million U.S. dollars, discount rates (r^{AL}, r^{CL} and r^{Δ}) are measured in basis points, life expectancy variables (LE^{AL}, LE^{CL} and LE^{Δ}) are computed at the average retirement age of the pension plan and are measured in years and $Size$ is the natural logarithm of pension assets. All other variables including the pension liability gap (G), the funding status (F), the ratio of retired to all plan participants (Dur) and the fraction invested in risky assets ($Risky$) are measured in percentage points. Exact variable definitions are given in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

$Year$	$Plans$ (1)	AL (2)	CL (3)	G (4)	PA (5)	F (6)	r^{AL} (7)	r^{CL} (8)	r^{Δ} (9)	LE^{AL} (10)	LE^{CL} (11)	LE^{Δ} (12)	$Size$ (13)	Dur (14)	$Risky$ (15)
Panel A: Average Values															
1999	5736	67	74	7	91	16	806	642	163	17.17	17.32	-0.15	2.48	81	85
2000	5918	60	68	10	88	14	806	623	182	17.25	17.37	-0.12	2.47	81	84
2001	7349	74	85	12	96	2	806	611	195	17.29	17.39	-0.09	2.54	81	84
2002	7290	82	94	6	93	-3	803	653	150	17.36	17.43	-0.07	2.54	80	83
2003	6799	92	107	9	91	-15	796	634	162	17.39	17.45	-0.06	2.51	79	85
2004	5651	102	113	7	114	-4	794	644	149	17.43	17.47	-0.04	2.72	79	86
2005	4963	100	114	12	117	-5	787	603	183	17.33	17.37	-0.03	2.69	78	86
2006	2624	59	69	16	68	-8	778	574	204	17.15	17.19	-0.05	2.48	78	85
2007	2550	91	109	18	115	-4	773	578	194	18.12	18.15	-0.03	2.67	78	85
Avg.	5959	81	93	10	97	0	797	625	172	17.35	17.43	-0.08	2.56	80	85
Panel B: Median Values															
1999	5736	9	9	8	10	7	800	655	152	16.95	16.95	0.00	2.30	85	97
2000	5918	9	9	11	10	5	800	631	169	16.95	16.95	0.00	2.33	84	97
2001	7349	10	11	13	11	-6	800	621	181	16.95	16.95	0.00	2.36	84	96
2002	7290	11	11	7	10	-10	800	685	130	16.95	16.95	0.00	2.35	83	94
2003	6799	11	12	10	10	-20	800	665	148	16.95	16.95	0.00	2.31	83	93
2004	5651	13	13	9	12	-8	800	655	145	17.26	16.95	0.00	2.50	82	95
2005	4963	12	13	14	12	-10	800	610	190	16.95	16.95	0.00	2.47	81	95
2006	2624	10	11	17	10	-12	800	577	223	16.19	16.19	0.00	2.29	81	94
2007	2550	11	12	20	11	-9	800	578	219	18.23	17.07	-0.88	2.44	80	95
Avg.	5918	10	11	11	11	-8	800	631	172	16.95	16.95	0.00	2.37	83	95

Table 2: **Funding status and the pension liability gap**

This table displays results when estimating the effect of of plan funding on the gap variable $G_{i,t}$, which is defined as the relative difference between current pension liabilities (CL) and accrued pension liabilities (AL):

$$G_{i,t} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $F_{i,t}$ is the funding status of plan i at time t,, $X_{i,t}$ denotes a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share of risky assets), γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = i$) and η_t are time-fixed effects. The estimation is done using both OLS-estimation (columns 1 to 3) and by accounting for plan-fixed effects (columns 4 to 6). Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^{+}$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

	OLS			Fixed effects		
	(1)	(2)	(3)	(4)	(5)	(6)
$Funding_{i,t}$ (F)	-0.20**	-0.22**	-0.23**	-0.18**	-0.22**	-0.25**
	(0.00)	(0.00)	(0.00)	(0.02)	(0.02)	(0.02)
Size		1.37**	1.67**		9.07**	5.89**
		(0.06)	(0.06)		(2.71)	(1.29)
Duration		-0.22**	-0.18**		-0.06	-0.03**
		(0.00)	(0.01)		(0.05)	(0.01)
Risky		0.08**	0.06**		0.02*	0.02**
		(0.00)	(0.00)		(0.01)	(0.00)
Time dummies	no	no	yes	no	no	yes
Industry dummies	no	no	yes	no	no	yes
N	48880	48880	48880	48880	48880	48880
R^2	0.10	0.17	0.23	0.09	0.15	0.27

Table 3: **Changes in excess actuarial assumptions**

This table shows the mean change in excess actuarial assumptions and the number of increases, nonchanges and decreases for all firms in the sample. Panel A displays the change in excess discount rate assumptions ($r^{\Delta}_{i,t} - r^{\Delta}_{i,t-1}$), Panel B the change in excess life expectancy assumptions ($LE^{\Delta}_{i,t} - LE^{\Delta}_{i,t-1}$). Detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

Year	Change (1)	Number of increases (2)	Number no change (3)	Number of decreases (4)	Total count (5)	% of firms increasing (6)	% of firms decreasing (7)
Panel A: Change in excess discount rates							
2000	21.74	3201	40	184	5918	0.54	0.03
2001	13.20	4474	34	271	7349	0.61	0.04
2002	-45.26	1118	64	4916	7290	0.15	0.67
2003	11.33	4639	86	1322	6799	0.68	0.19
2004	-10.94	3757	38	1272	5651	0.66	0.23
2005	34.69	3615	33	468	4963	0.73	0.09
2006	26.30	2253	15	153	2624	0.86	0.06
2007	-5.98	23	71	1683	2550	0.01	0.66
Avg.	2.09	2796	44	1271	5959	0.47	0.21
Panel B: Change in excess life expectancy assumptions							
2000	0.02	55	3363	7	5918	0.01	0.00
2001	0.02	66	4705	8	7349	0.01	0.00
2002	0.02	76	6007	15	7290	0.01	0.00
2003	0.01	95	5936	16	6799	0.01	0.00
2004	0.01	59	5002	6	5651	0.01	0.00
2005	0.01	74	4030	12	4963	0.01	0.00
2006	0.01	33	2380	8	2624	0.01	0.00
2007	-0.36	456	0	1321	2550	0.18	0.52
Avg.	-0.01	81	3951	78	5959	0.02	0.03

Table 4: **Plan funding and excess discount rate assumptions**

This table displays results when estimating the impact of the funding status on excess discount rate assumptions. The regression is given by

$$r_{i,t}^{\Delta} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $r_{i,t}^{\Delta}$ denotes excess discount rate assumptions ($r_{i,t}^{\Delta} = r_{i,t}^{AL} - r_{i,t}^{CL}$), $F_{i,t}$ is the funding status of plan i at time t, $X_{i,t}$ is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets), γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = i$) and η_t are time-fixed effects. In columns (2 and 4), the funding level is split into a positive (overfunded) and negative (underfunded) component (which records negative funding levels with a positive sign). The estimation is done using both OLS-estimation (Panel A) and by accounting for plan-fixed effects (Panel B). Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 1, detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

	OLS		Fixed effect	
Control Variables	(1)	(2)	(3)	(4)
$Funding_{i,t}$ (F)	-0.47**		-0.56**	
	(0.01)		(0.17)	
$Size_{i,t}$	14.53**	15.41**	15.86**	22.14**
	(0.20)	(0.20)	(4.72)	(6.77)
$Duration_{i,t}$	0.07**	0.11**	-0.06	-0.02
	(0.02)	(0.02)	(0.04)	(0.04)
$Risky_{i,t}$	0.30**	0.33**	0.03	0.07**
	(0.02)	(0.02)	(0.02)	(0.01)
$Overfunding_{i,t}$ (F^+)		-0.24**		-0.36**
		(0.01)		(0.09)
$Underfunding_{i,t}$ (F^-)		1.34**		1.32**
		(0.03)		(0.35)
Time dummies	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes
N	48880	48880	48880	48880
R^2	0.21	0.23	0.27	0.29

Table 5: **Plan funding and discount rate assumptions: cross-sectional evidence**

This table displays results when estimating the impact of the funding status on excess discount rate assumptions. The regression is given by

$$y_{i,t} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \epsilon_{i,t}$$

where $F_{i,t}$ is the funding status of plan i at time t, $X_{i,t}$ is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets) and γ_k is an industry-fixed effect. In columns (1) and (2), the dependent variable y is $r^{\Delta}_{i,t}$ (denoting the difference in discount rate assumptions: $r^{\Delta}_{i,t} = r^{AL}_{i,t} - r^{CL}_{i,t}$). In columns (3) and (4), y is the discount rate under the AL measure ($r^{AL}_{i,t}$). In columns (2) and (4), the funding level is split into a positive (overfunded) and negative (underfunded) component (which records negative funding levels with a positive sign). The estimation is done using Fama-Macbeth regressions. Values in parentheses denote standard errors which are adjusted for heteroskedasticity. $^{+}$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 1, detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

	$y = r^{\Delta}_{i,t}$		$y = r^{AL}_{i,t}$	
Control Variables	(1)	(2)	(3)	(4)
$Funding_{i,t}$ (F)	-0.48**		-0.38**	
	(0.06)		*(0.03)*	
$Size_{i,t}$	13.71**	14.40**	11.50**	12.17**
	(0.97)	(0.95)	(0.23)	(0.23)
$Duration_{i,t}$	0.04	0.08+	-0.06*	-0.03
	(0.04)	(0.04)	(0.02)	(0.02)
$Risky_{i,t}$	0.31**	0.32**	0.32**	0.34**
	(0.01)	(0.01)	(0.02)	(0.02)
$Overfunding_{i,t}$ (F^{+})		-0.22**		-0.16**
		(0.02)		(0.02)
$Underfunding_{i,t}$ (F^{-})		1.18**		0.99**
		(0.18)		(4.09)
Industry dummies	yes	yes	yes	yes
N	48880	48880	48880	48880
R^2	0.13	0.14	0.13	0.14

Table 6: **Plan funding and discount rate assumptions: time-series evidence**

This table displays results when estimating the impact of changes in the funding status on changes in discount rate assumptions. The regression is given by

$$\Delta y_{i,t} = \alpha + \theta\left(\Delta F_{i,t}\right) + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $\Delta F_{i,t} = F_{i,t} - F_{i,t-1}$ is changes in the funding status of plan i at time t, $X_{i,t}$ is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets), γ_k is an industry-fixed effect and η_t are time-fixed effects. In columns (1) and (2), the dependent variable $\Delta y_{i,t}$ is the change in excess discount rate assumptions ($r^{\Delta}_{i,t} - r^{\Delta}_{i,t-1}$). In columns (3) and (4), $\Delta y_{i,t}$ is the change in the discount rate under the AL measure ($r^{AL}_{i,t} - r^{AL}_{i,t-1}$). In columns (2) and (4), funding changes are split into changes for overfunded and underfunded plans (note that negative funding levels are recorded with a positive sign). The estimation is done using Fama-Macbeth regressions. Values in parentheses denote standard errors which are adjusted for heteroskedasticity. $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 1, detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

	$\Delta y_{i,t} = \Delta r^{\Delta}_{i,t}$		$\Delta y_{i,t} = \Delta r^{AL}_{i,t}$	
Control Variables	(1)	(2)	(3)	(4)
Change in Funding$_{i,t}$ (ΔF)	-0.62**		-0.03+	
	(0.03)		*(0.02)*	
$Size_{i,t}$	-0.52**	-0.33+	-0.15	-0.16
	(0.18)	(0.18)	(0.10)	(0.10)
$Duration_{i,t}$	0.01	0.02	0.02+	0.02+
	(0.02)	(0.02)	(0.01)	(0.01)
$Risky_{i,t}$	0.01	0.02	0.03**	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)
Change in $Overfunding_{i,t}$ (ΔF^+)		-0.30**		-0.04*
		(0.03)		(0.02)
Change in $Underfunding_{i,t}$ (ΔF^-)		1.53**		-0.02
		(0.05)		(0.02)
Industry dummies	yes	yes	yes	yes
N	33730	33730	33730	33730
R^2	0.29	0.31	0.01	0.01

Table 7: **Plan funding and excess life expectancy assumptions**

This table displays results when estimating the impact of the funding status on excess life expectancy assumptions. The estimation is based on a logit model where

$$y_{i,t} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $y_{i,t}$ is a dummy variable equal to one in case the freely chosen life expectancy assumption is below the one mandated by the government (i.e. $LE^{\Delta}_{i,t} < 0$), $F_{i,t}$ is the funding status of plan i at time t, the vector $X_{i,t}$ denotes of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share of risky assets), γ_k is an industry-fixed effect and η_t are time-fixed effects. In column (5), the funding level is split into a positive (overfunded) and negative (underfunded) component (which records negative funding levels with a positive sign). $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 1, detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

	Logit Regression				
Control Variables	(1)	(2)	(3)	(4)	(5)
$Funding_{i,t}$ (F)	-0.008**	-0.005**	-0.007**	-0.007**	
	(0.001)	(0.001)	(0.001)	(0.001)	
$Size_{i,t}$		-0.213**	-0.269**	-0.263**	-0.254**
		(0.011)	(0.012)	(0.013)	(0.013)
$Duration_{i,t}$		-0.007**	-0.007**	-0.007**	-0.007**
		(0.001)	(0.001)	(0.001)	(0.001)
$Risky_{i,t}$		-0.012**	-0.014**	-0.014**	-0.014**
		(0.001)	(0.001)	(0.001)	(0.001)
$Overfunding_{i,t}$ (F^+)					-0.004**
					(0.001)
$Underfunding_{i,t}$ (F^-)					0.012**
					(0.002)
Time dummies	no	no	yes	yes	yes
Industry dummies	no	no	no	yes	yes
N	48880	48880	48880	48880	48880

Table 8: **Use of regulatory leeway, funding ratios and cash contributions**

This table displays information summarizing the impact of using regulatory leeway to manage pension liabilities on actual cash contributions. Results are displayed separately for all plan years (Panel A) and underfunded plan-years (Panel B). Column 1 displays the cumulative number of times a plan has reported a lower value of AL than CL over the total observations T per plan ($\sum_0^T I_{G>0}$). Column 2 shows the total number of corresponding plan years (N) and column 3 the number of underlying pension plans. Columns (4) to (8) display financing information on the pension plan including funding levels (F), actual cash contributions (CC), the minimum funding contribution (MFC), the additional funding requirement (AFR) and the excess cash contribution ($EC = CC - MFC - AFR$). All variables in columns (3) to (9) are standardized by the value of plan assets. Detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

$\sum_0^T I_{G>0}$ (1)	N (2)	$Plans$ (3)	F (4)	CC (5)	MFC (6)	AFR (7)	EC (8)
A: All plan years							
0	6922	2011	16	12	12	0	1
1	4982	2599	5	9	9	1	0
2	4841	1550	4	8	8	1	0
3	5438	1360	0	8	8	1	0
4	5634	1209	-4	8	7	1	0
5	6042	1106	-6	8	7	1	0
6	6049	963	-6	8	7	1	0
7	4730	660	-8	7	7	2	0
8	2667	330	-11	7	7	2	-1
9	1575	175	-11	7	7	2	-1
Avg.	5371	1337	0	9	8	1	0
B: Underfunded plan years							
0	2356	1030	-13	20	17	1	1
1	2652	1673	-16	14	12	2	0
2	2845	1181	-16	13	11	2	0
3	3494	1156	-17	11	9	2	0
4	3894	1085	-18	11	9	2	0
5	4365	1026	-18	10	8	2	0
6	4429	905	-17	10	8	2	0
7	3506	631	-18	9	8	2	0
8	2139	320	-18	9	8	2	-1
9	1270	168	-18	8	7	2	-1
Avg.	3399	972	-17	11	9	2	0

Table 9: **Regulatory leeway and reduction in cash contributions**

This table displays results when estimating the effect of using regulatory leeway on cash contributions to the pension plan $cost_{i,t}$ to the pension fund:

$$_{i,t} = \alpha + \beta_1 F + \beta_2 I_{(G>0)i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where *Contrib* equals total cash contributions (CC) in Panel A and the minimum funding contribution (MFC) in Panel B, both expressed in percent of plan assets. The dummy variable $I_{(G>0)}$ is equal to one in case reporting is such that $AL < CL$, γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = i$) and η_t are time-fixed effects. Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 30,905 plan-years with underfunding, 1999-2007.

	(1)	(2)	(3)	(4)	(5)
Panel A: *Contrib* = **Total cash contributions** (CC)					
$I_{G>0}$	-6.745**	-8.685**	-8.931**	-8.532**	-4.099**
	(0.263)	(0.243)	(0.250)	(0.246)	(0.224)
F		-0.614**	-0.646**	-0.660**	-0.733**
		(0.012)	(0.013)	(0.013)	(0.015)
Year fixed effects	no	no	yes	yes	yes
Industry fixed effects	no	no	no	yes	no
Plan fixed effects	no	no	no	no	yes
N	30950	30950	30950	30950	30950
R^2	0.03	0.23	0.23	0.25	0.29
Panel B: *Contrib* = **Mandatory funding contribution** (MFC)					
$I_{G>0}$	-6.688**	-7.806**	-7.955**	-7.889**	-3.857**
	(0.178)	(0.167)	(0.171)	(0.172)	(0.360)
F		-0.354**	-0.371**	-0.374**	-0.254**
		(0.008)	(0.008)	(0.009)	(0.023)
Year fixed effects	no	no	yes	yes	yes
Industry fixed effects	no	no	no	yes	no
Plan fixed effects	no	no	no	no	yes
N	30950	30950	30950	30950	30950
R^2	0.07	0.22	0.23	0.23	0.20

Table 10: **Does the reduction in contributions depend on the frequency of using regulatory leeway?**

This table displays results when estimating the effect of using regulatory leeway on cash contributions to the pension plan $cost_{i,t}$ to the pension fund:

$$_{i,t} = \alpha + \beta_1 F + \beta_2 I_{(G>0)i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where *Contrib* equals total cash contributions (CC) in Panel A and the minimum funding contribution (MFC) in Panel B, both expressed in percent of plan assets. The dummy variable $I_{(G>0)}$ is equal to one in case reporting is such that $AL < CL$, γ_k is an industry-fixed and η_t are time-fixed effects. Column 1 presents results for plans that have reported $AL < CL$ once in the sample period ($\sum_0^T I_{G>0} = 1$), ..., column 8 for plans that have reported $AL < CL$ for eight years ($\sum_0^T I_{G>0} = 8$). Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 30,905 plan-years with underfunding, 1999-2007.

	$\sum_0^T I_{G>0}$ is equal to							
	1	2	3	4	5	6	7	8
Panel A: *Contrib* = **Total cash contributions** (CC)								
$I_{G>0}$	-4.738**	-4.640**	-4.937**	-4.177**	-6.779**	-1.961**	-1.784+	-0.01
	(0.794)	(0.702)	(0.629)	(0.737)	(0.947)	(0.579)	(1.024)	(1.455)
F	-0.801**	-0.787**	-0.653**	-0.621**	-0.614**	-0.553**	-0.526**	-0.513**
	(0.049)	(0.048)	(0.036)	(0.036)	(0.030)	(0.028)	(0.032)	(0.037)
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Plan fixed effects	no	no	no	no	no	no	no	no
% $I_{G>0} = 1$	0.60	0.72	0.82	0.90	0.94	0.97	0.98	0.99
N	2652	2845	3494	3894	4365	4429	3506	2139
R^2	0.26	0.26	0.25	0.21	0.26	0.19	0.22	0.24
Panel B: *Contrib* = **Mandatory funding contribution** (MFC)								
$I_{G>0}$	-5.880**	-5.900**	-5.337**	-4.822**	-6.965**	-2.907**	-3.802**	-1.755+
	(0.549)	(0.496)	(0.444)	(0.556)	(0.731)	(0.435)	(0.859)	(0.993)
F	-0.518**	-0.447**	-0.391**	-0.345**	-0.290**	-0.289**	-0.282**	-0.278**
	(0.033)	(0.031)	(0.023)	(0.023)	(0.017)	(0.019)	(0.021)	(0.021)
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Plan fixed effects	no	no	no	no	no	no	no	no
% $I_{G>0} = 1$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N	2652	2845	3494	3894	4365	4429	3506	2139
R^2	0.25	0.23	0.24	0.18	0.20	0.16	0.18	0.23

Table 11: **Summary statistics of main variables (Compustat subsample)**

This table displays average (Panel A) and median (Panel B) values of the main actuarial variables. Detailed variable definitions and an explanation of the aggregation procedure are in Appendix Table 2. Actuarial liabilities (AL), current liabilities (CL) and pension assets (PA) are stated in million U.S. dollars, discount rates (r^{AL}, r^{CL} and r^{Δ}) are measured in basis points, life expectancy variables (LE^{AL}, LE^{CL} and LE^{Δ}) are computed at the average retirement age of the pension plan and are measured in years and size is the natural logarithm of pension assets. All other variables including the pension liability gap (G), the funding status (funding), the ratio of retired to all plan participants (duration) and the fraction invested in risky assets (risky) are fractions. Sample of 707 U.S. single employer DB plan sponsors and 2,797 plan-years, 1999-2007.

$Year$	$Plans$	AL	CL	G	PA	F	r^{AL}	r^{CL}	r^{Δ}	LE^{AL}	LE^{CL}	LE^{Δ}	$Size$	Dur	$Risky$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Panel A: Average Values															
1999	373	270	308	13	369	19	828	641	188	17.63	17.77	-0.14	4.11	78	89
2000	365	294	341	17	455	17	828	622	206	17.71	17.81	-0.09	4.07	79	87
2001	419	542	625	17	715	3	828	607	221	17.80	17.88	-0.07	4.40	77	87
2002	420	473	556	14	546	-6	822	633	189	17.83	17.87	-0.04	4.32	78	86
2003	406	533	633	16	561	-15	816	615	201	17.95	17.97	-0.02	4.39	76	88
2004	323	495	565	11	571	0	809	642	167	18.01	18.04	-0.02	4.54	75	89
2005	287	603	706	17	713	-3	809	605	204	17.98	17.96	0.03	4.62	75	91
2006	98	564	664	21	695	-8	799	574	225	17.86	17.83	0.04	4.09	72	89
2007	106	961	1170	23	1288	0	793	577	216	18.95	18.74	0.24	4.66	73	91
Avg.	356	479	560	16	592	2	819	620	199	17.88	17.93	-0.04	4.34	77	88
Panel B: Median Values															
1999	373	50	54	13	65	8	825	655	195	17.73	17.73	0.00	4.18	81	99
2000	365	44	50	17	61	8	825	631	217	17.73	17.73	0.00	4.10	83	98
2001	419	67	82	18	78	-5	825	621	229	17.73	17.73	0.00	4.35	79	96
2002	420	70	80	14	72	-14	825	675	175	17.73	17.73	0.00	4.28	79	95
2003	406	81	96	16	76	-20	800	665	185	17.73	17.73	0.00	4.33	78	94
2004	323	81	87	13	89	-4	800	655	168	17.73	17.73	0.00	4.48	78	96
2005	287	80	95	18	90	-6	800	610	190	17.73	17.73	0.00	4.50	76	96
2006	98	42	53	22	47	-8	800	577	223	17.73	17.73	0.00	3.84	74	96
2007	106	62	84	25	77	-3	800	578	222	18.79	18.65	1.16	4.34	74	97
Avg.	373	65	76	16	73	-6	800	629	195	17.73	17.73	0.00	4.29	79	96

Table 12: **Credit risk, firm characteristics and excess discount rates**

This table displays results when estimating the effect of credit risk variables and firm characteristics on excess discount rate assumptions

$$r^{\Delta}_{j,t} = \alpha + \delta X_{j,t} + \lambda Y_{j,t} + \gamma_k + \eta_t + \epsilon_{j,t}$$

where $r^{\Delta}_{j,t}$ denotes excess discount rate assumptions ($r^{\Delta}_{j,t} = r^{AL}_{j,t} - r^{CL}_{j,t}$), $X_{j,t}$ is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets), γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = j$), η_t are time-fixed effects and the variable $Y_{j,t}$ contains proxies for the firm's credit risk. All regressions include time dummies, Panel A also includes industry dummies. Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^{+}$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions and an explanation of the aggregation procedure are in Appendix Table 2. Sample of 707 U.S. single employer DB plan sponsors and 2,797 plan-years, 1999-2007.

Control Variables	(1)	(2)	(3)	(4)	(5)
Panel A: OLS Estimation					
$\text{Size}_{j,t}$	14.40**	14.41**	13.68**	13.45**	13.46**
	(0.64)	(0.64)	(0.69)	(0.70)	(0.70)
$\text{Dur}_{j,t}$	0.34**	0.35**	0.39**	0.38**	0.38**
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
$\text{Risky}_{j,t}$	0.17*	0.17*	0.18**	0.18**	0.19**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
$\text{Z-score}_{j,t}$	0.90**	1.00**	0.85**	0.75**	0.75**
	(0.18)	(0.22)	(0.23)	(0.24)	(0.24)
$\text{Lev}_{j,t}$		5.08	-2.53	2.83	2.97
		(6.44)	(7.02)	(7.45)	(7.45)
$\text{Rel. Size}_{j,t}$			24.83**	24.43**	24.45**
			(8.40)	(8.43)	(8.45)
$Q_{j,t}$				3.40*	3.38*
				(1.62)	(1.62)
$\text{Div}_{j,t}$					-15.06
					(48.13)
N	2797	2797	2797	2797	2797
R^2	0.24	0.24	0.24	0.24	0.24
Panel B: Fixed Effect Estimation					
$\text{Size}_{j,t}$	8.53**	8.26**	6.11**	6.00**	6.02**
	(1.82)	(1.75)	(1.60)	(1.54)	(1.54)
$\text{Dur}_{j,t}$	0.03	0.02	0.02	0.02	0.02
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
$\text{Risky}_{j,t}$	0.04	0.05	0.05	0.05	0.05
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
$\text{Z-score}_{j,t}$	0.39*	0.60**	0.43*	0.60**	0.60**
	(0.17)	(0.20)	(0.18)	(0.13)	(0.13)
$\text{Lev}_{j,t}$		18.58**	6.65	-3.86	-4.20
		(6.89)	(5.60)	(5.46)	(5.34)
$\text{Rel. Size}_{j,t}$			57.10**	62.27**	62.24**
			(15.15)	(15.56)	(15.52)
$Q_{j,t}$				-7.04**	-6.99**
				(1.99)	(2.04)
$\text{Div}_{j,t}$					14.45
					(21.50)
N	2797	2797	2797	2797	2797
R^2	0.17	0.17	0.18	0.18	0.18

Table 13: **Plan funding und excess discount rates: Compustat subsample**

This table displays results when estimating the impact of funding on the deviation from the implied excess discount rate $\hat{\epsilon}_{j,t}$:

$$\hat{\epsilon}_{j,t} = \kappa + \theta F_{j,t} + \nu_{j,t}$$

where $\hat{\epsilon}_{j,t}$ is the residual from the first stage regression estimated in column (5) of Table 12 and F is the funding status of the pension plan. Columns (2) and (4) split the funding variable into a positive (overfunded) and negative (underfunded) component (which records negative funding levels with a positive sign). Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^{+}$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions and an explanation of the aggregation procedure are in Appendix Table 2. Sample of 707 U.S. single employer DB plan sponsors and 2,797 plan-years, 1999-2007.

	OLS		Fixed effects	
Control variables	(1)	(2)	(3)	(4)
$Funding_{i,t}$ (F)	-0.42**		-0.33**	0
	(0.04)		(0.13)	
$Overfunding_{i,t}$ (F^{+})		-0.33**		-0.17**
		(0.06)		(0.04)
$Underfunding_{i,t}$ (F^{-})		0.74**		0.91**
		(0.12)		(0.28)
N	2797	2797	2797	2797
R^2	0.05	0.06	0.03	0.05

Table 14: **Plan funding, z-scores and consolidated leverage**

This table displays results when estimating the impact of funding on the deviation from the implied excess discount rate $\hat{\epsilon}_{j,t}$:

$$\hat{\epsilon}_{j,t} = \kappa + \theta \text{funding}_{j,t} + \nu_{j,t}$$

where $\hat{\epsilon}_{j,t}$ is the residual from the first stage regression estimated in column (5) of Table 12 and F is the funding status of the pension plan. Results are grouped by the z-score measure (low versus high) and the consolidated leverage ratio (low versus high). Regressions are performed separately for each group. Panel A employs a joint funding variable, Panel B splits the funding variable into a positive and a negative component (which records negative funding levels with a positive sign). Results are based on OLS estimation. Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^{+}$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions and an explanation of the aggregation procedure are in Appendix Table 2. Sample of 707 U.S. single employer DB plan sponsors and 2,797 plan-years, 1999-2007.

	Z-Score		Leverage	
	Low	High	Low	High
Panel A: Joint funding variable				
$Funding_{i,t}$ (F)	-0.33**	-0.50**	-0.40**	-0.46**
	(0.05)	(0.07)	(0.06)	(0.06)
N	1399	1398	1399	1398
R^2	0.04	0.07	0.05	0.06
Panel B: Split funding variable				
$Overfunding_{i,t}$ (F^{+})	-0.29**	-0.36**	-0.26**	-0.44**
	(0.07)	(0.08)	(0.07)	(0.08)
$Underfunding_{i,t}$ (F^{-})	0.49**	1.02**	0.99**	0.50**
	(0.15)	(0.19)	(0.19)	(0.16)
N	1399	1398	1399	1398
R^2	0.04	0.07	0.06	0.06

Table 15: **The impact of funding levels to adapt the MAP-21 bill**

This table displays results when estimating the following prediction model

$$update_{i,t} = \alpha + \theta^P F^+_{i,t-1} + \theta^N F^-_{i,t-1} + \delta X_{i,t-1} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $update_{i,t}$ is a dummy variable equal to one in case the plan adopted the MAP-21 legislation in 2012, $F^+_{i,t-1}$ ($F^-_{i,t-1}$) is the positive (negative) component of the plan's funding status (which records negative funding levels with a positive sign), X is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets) and γ_k is either an industry-fixed effect. Values in parentheses denote standard errors which are adjusted for heteroskedasticity, the third line for each coefficient variable are odds ratios. $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 6, detailed variable definitions are in Appendix Table 7. Sample of 5,405 U.S. single employer defined benefit pension plans, 2012.

	Logit	
	(1)	(2)
$Overfunding_{i,t}$ (F^+)	-2.72**	-2.31**
	(0.32)	(0.30)
	0.07	0.10
$Underfunding_{i,t}$ (F^-)	3.28**	3.88**
	(0.48)	(0.51)
	26.63	48.52
Size$_{i,t}$		0.23**
		(0.02)
		1.26
Duration$_{i,t}$		0.56*
		(0.24)
		1.75
Risky$_{i,t}$		0.57**
		(0.15)
		1.77
Time dummies	no	no
Industry dummies	no	no
N	5218	5218

Appendix Table 1: Sample selection procedure, Form 5500, 1999-2007

	Number of Observations	
	Plan-years	Plans
Form 5500: DB Pension Plans	**101747**	**19511**
Additional sample restrictions		
- non single-employer plans	-15734	-2332
- plans with < 100 participants	-1385	-498
- missing & erroneous information assets and liabilities[a]	-2927	-731
- missing & erroneous information on interest rate[b]	-362	-19
- missing & erroneous information on mortality tables[c]	-30532	-3545
- missing & erroneous information on asset allocation[d]	-1927	-423
= Final Sample	**48880**	**11963**

[a] We drop observations with missing, zero or negative values for current pension liabilities (eliminates 2,290 obs.), in case plans employ more than one actuarial liability method (eliminates 487 obs.), if information on actuarial liabilities is missing, zero or negative (eliminates 7 obs.) and if values for pension assets are missing, zero or negative (eliminates 143 obs.)

[b] We drop observations with missing values for either the current or the accrued pension liability discount rate (eliminates 362 obs.)

[c] We drop observations in case information on mortality tables for male workers are missing (eliminates 133 obs.), in case different mortality tables are used for pre- and post-retirement (eliminates 3,755 obs.), if the mortality tables is specified as "Other" (eliminates 18,406 obs.), in case no mortality tables is specified (eliminates 9 obs.), if a hybrid version of a mortality tables is specified (eliminates 7,452 obs.), if information on the retirement age is missing or the retirement age specified is less (greater) than 56 (65) years (eliminates 777 obs.)

[d] We eliminate observations in case individual pension investments, specified in Schedule H of the Form 5500, are negative (eliminates 643 obs.) or are missing (eliminates 1,284 obs.)

Appendix Table 2: Variable Definitions, 1999 - 2007

Variable	Description
I: Form 5550, Main Section (General Information)	
participants (all)	TOT_PARTCP_BOY_CNT
participants (retired)	RTD_SEP_PARTCP_RCVG_CNT + BENEF_RCVG_BNFT_CNT
industry	BUSINESS_CODE
II: Form 5500, Schedule B (Actuarial Information)	
current liability (CL)	ACTRL_RPA94_INFO_CURR_LIAB_AMT
accrued liability (AL)	max[ACTRL_ACCR_LIAB_GAIN_MTHD_AMT, ACTRL_ACCR_LIAB_AGE_MTHD_AMT]
pension assets (PA)	ACTRL_CURR_VALUE_AST_01_AMT
CL interest rate (r^{CL})	ACTRL_CURR_LIAB_RPA_PRCNT
AL interest rate (r^{AL})	ACTRL_VALUATION_INT_PRE_PRCNT
mortality table	ACTRL_MORTALITY_MALE_PRE_CODE
retirement age	ACTRL_WEIGHTED_RTM_AGE
III: Form 5500, Schedule H (Financial Information)	
cash	NON_INT_BEAR_CASH_EOY_AMT + INT_BEAR_CASH_EOY_AMT
accounts receivable (AR)	EMPLR_CONTRIB_EOY_AMT + PARTCP_CONTRIB_EOY_AMT + OTHER_RECEIVABLE_EOY_AMT
US treasuries (rf)	GOVG_SEC_EOY_AMT
corporate debt (rd)	CORP_DEBT_PREFERRED_EOY_AMT + CORP_DEBT_OTHER_EOY_AMT
equities	PREF_STOCK_EOY_AMT + COMMON_STOCK_EOY_AMT
joint ventures	JOINT_VENTURE_EOY_AMT
real estate	REAL_ESTATE_EOY_AMT
loans	OTHER_LOANS_EOY_AMT + PARTCP_LOANS_EOY_AMT
trusts	INT_COMMON_TR_EOY_AMT + INT_POOL_SEP_ACCT_EOY_AMT + INT_MASTER_TR_EOY_AMT
funds	INT_103_12_INVST_EOY_AMT + INT_REG_INVST_CO_EOY_AMT
insurance	INS_CO_GEN_ACCT_EOY_AMT
other	OTH_INVST_EOY_AMT
employer	EMPLR_SEC_EOY_AMT + EMPLR_PROP_EOY_AMT
buildings	BLDGS_USED_EOY_AMT
total investment	cash + AR + rf +rd + equities + JV + RE + loans + trusts + funds + insurance + other + employer + buildings
IV: Computed plan-specific variables[b]	
G	(CL - AL)/AL
funding	(PA - CL)/CL
r^{Δ}	r^{AL} - r^{CL}
death rate (q)	taken from respective mortality table[a]
t-period survival rate ($_tp_x$)	$\Pi_{i=0}^{t-1}(1-q_{x+i})$
life expectancy (LE)	$\sum_{t=1}^{\infty} {}_tp_x$
LE^{Δ}	$LE^{AL} - LE^{CL}$
size	log(PA)
duration	1 - retired/all
risky	1 - (cash - AR - rf - rd)/(total investment)
V: Computed firm-specific variables (based partly on Compustat mnemonics[C]**)**	
rel. size[d]	CL_j/at
leverage	$(CL_j + dlc + dltt)/(CA_j + prcc_f \times csho + dlc + dltt)$
Z-score[e]	$1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + X_5$
Q	$(prcc_f \times csho + dlc + dltt - invt)/at$
dividend	$(dvc + dvp)/(prcc_f \times csho)$

[a] Over the sample period, mortality tables employed by pension plans include (1) the 1951 Group Annuity Table, (2) the 1971 Group Annuity Table, (3) the 1971 Individual Annuity Mortality, (4) the Unisex Pensioner 1984 Table, (5) the 1983 Individual Annuity Table, (6) the 1983 Group Annuity Table, (7) the 1983 Group Annuity Table (Rev. Rule 95-28), (8) the Uninsured Pensioner Table 1994 and (9) the 2007 Mortality Table for 1.412(I)(7)-1 of the Income Tax Regulation.

[b] The plan-specific variables B, funding, r^{Δ}, size and duration are winsorized at the 0.5 (99.5) percent level.

[c] The sponsor-specific variables B, funding, r^{Δ}, size, duration, relative size, leverage, all components of the Z-score, Q and dividend payments are winsorized at the 0.5 (99.5) percent level.

[d] Aggregate firm specific variables (generically called W_j) that are based on pension plan data are computed as follows $W_j = \sum_{i=1}^{N} w_i$ where N is the number of pension plans per plan sponsor in a given year. Average firm specific variables (generically called U_j) that are based on pension plan data are computed as value weighted averages using the weights (generically called $u_{j,i}$)of each pension plan relative to plan sponsor (where $u_{j,i} = CL_i/CL_j$).

[e] Using Compustat mnemonics, X_1 is $(act - lct)/at$, X_2 is re/at, X_3 is $oiadp/at$, X_4 is $(prcc_f \times csho)/(dlc + dltt)$ and X_5 is $sale/at$.

Appendix Table 3: Plan funding and actuarial discount rate assumptions

This table displays results when estimating the impact of the funding status on excess discount rate assumptions. The regression is given by

$$r_{i,t}^{AL} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $r_{i,t}^{AL}$ denotes the discount rate assumption under the AL measure, $F_{i,t}$ is the funding status of plan i at time t, $X_{i,t}$ is a vector of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share invested in risky assets), γ_k is either an industry-fixed or a plan-fixed effect (in which case $k = i$) and η_t are time-fixed effects. In columns (2 and 4), the funding level is split into a positive (overfunded) and negative (underfunded) component (which records negative funding levels with a positive sign). The estimation is done using both OLS-estimation (Panel A) and by accounting for plan-fixed effects (Panel B). Values in parentheses denote standard errors which are adjusted for heteroskedasticity and, under fixed effect estimation, are computed according to Discroll and Kraay (1998) to account for possible cross-sectional and temporal interdependence among the error terms. $^{+}$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 1, detailed variable definitions are in Appendix Table 2. Sample of 11,963 U.S. single employer defined benefit pension plans and 48,880 plan-years, 1999-2007.

	OLS		Fixed effect	
Control Variables	(1)	(2)	(3)	(4)
$Funding_{i,t}$ (F)	-0.34**		-0.11**	
	(0.01)		(0.01)	
$Size_{i,t}$	11.58**	12.23**	2.82**	2.52**
	(0.18)	(0.18)	(0.74)	(0.78)
$Duration_{i,t}$	-0.05**	-0.02	0.01	0.00
	(0.02)	(0.02)	(0.02)	(0.02)
$Risky_{i,t}$	0.33**	0.34**	0.05**	0.05**
	(0.01)	(0.01)	(0.01)	(0.01)
$Overfunding_{i,t}$ (F^{+})		-0.17**		-0.12**
		(0.01)		(0.01)
$Underfunding_{i,t}$ (F^{-})		0.98**		0.07**
		(0.03)		(0.02)
Time dummies	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes
N	48880	48880	48880	48880
R^2	0.17	0.18	0.07	0.07

Appendix Table 4: **Plan funding and excess life expectancy assumptions (1999 to 2006)**

This table displays results when estimating the impact of the funding status on excess life expectancy assumptions. The estimation is based on a logit model where

$$y_{i,t} = \alpha + \theta F_{i,t} + \delta X_{i,t} + \gamma_k + \eta_t + \epsilon_{i,t}$$

where $y_{i,t}$ is a dummy variable equal to one in case the freely chosen life expectancy assumption is below the one mandated by the government (i.e. $LE^{\Delta}_{i,t} < 0$), $F_{i,t}$ is the funding status of plan i at time t, the vector $X_{i,t}$ denotes of additional control variables (size of pension plan, a proxy for the duration of pension liabilities and the share of risky assets), γ_k is an industry-fixed effect and η_t are time-fixed effects. In column (5), the funding level is split into a positive (overfunded) and negative (underfunded) component (which records negative funding levels with a positive sign). $^+$, *, ** indicate significance at the 10%, 5% and 1% level, respectively. Details on sample selection criteria are in Appendix Table 1, detailed variable definitions are in Appendix Table 2. Sample of 11,700 U.S. single employer defined benefit pension plans and 46,330 plan-years, 1999-2006.

	Logit Regression				
Control Variables	(1)	(2)	(3)	(4)	(5)
$Funding_{i,t}$ (F)	-0.008**	-0.003**	-0.006**	-0.006**	
	(0.001)	(0.001)	(0.001)	(0.001)	
$Size_{i,t}$		-0.325**	-0.299**	-0.295**	-0.286**
		(0.013)	(0.014)	(0.014)	(0.014)
$Duration_{i,t}$		-0.006**	-0.007**	-0.007**	-0.007**
		(0.001)	(0.001)	(0.001)	(0.001)
$Risky_{i,t}$		-0.015**	-0.015**	-0.015**	-0.015**
		(0.001)	(0.001)	(0.001)	(0.001)
$Overfunding_{i,t}$ (F^+)					-0.004**
					(0.001)
$Underfunding_{i,t}$ (F^-)					0.011**
					(0.002)
Time dummies	no	no	yes	yes	yes
Industry dummies	no	no	no	yes	yes
N	46330	46330	46330	46330	46330

Appendix Table 5: Sample selection procedure, Compustat, 1999-2007

	Number of Observations	
	Firm-years	Firms
Compustat	**110686**	**15284**
Additional sample restrictions		
- missing EIN	-17108	-2378
- change reporting date	-2147	-69
= Merged Compustat/Form5500 Sample	**6401**	**952**
- financial firms or utilities	-1125	-242
- more than one observation per year	-2223	0
- missing information on financial variables	-256	-40
= Final Sample	**2797**	**670**

[a] We drop observations in case either the EIN or a firm's gvkey appears twice in a fiscal year

[b] We drop observations financial firms (eliminates 692 obs.) or utilities (eliminates 433 obs.)

[c] We drop observations with missing values of book assets (eliminates 2 obs.), market value of the firm (eliminates 3 observations), dividend payments (eliminates 5 observations) and Tobin's q (eliminates 6 obs.) In addition, we drop observation in case there are missing values for Altman's z-score (eliminates 240 obs.)

Appendix Table 6: Sample selection procedure, Form 5500, 2011-2012

	Number of Observations	
	Plan-years	Plans
Form 5500: DB Pension Plans	**22729**	**13754**
Additional sample restrictions		
- non single-employer plans	-407	-229
- plans with < 100 participants	-8206	-5244
- missing & erroneous information assets and liabilities[a]	-32	-14
- missing & erroneous information on contributions[b]	-444	-161
- missing & erroneous information on asset allocation[c]	-533	-296
- missing & erroneous information in interest rates	-128	-60
- missing & erroneous information in 2011[d]	-419	-408
= Intermediate Sample	12560	7342
- observations in 2011	-7342	-2124
= Final Sample in 2012	**5218**	**5218**

[a] We drop observations with missing, zero or negative values for pension liabilities (eliminates 27 obs.) and if values for pension assets are missing, zero or negative (eliminates 5 obs.)

[b] We drop observations with missing values for mandatory pension contributions (eliminates 159 obs.) and if values for pension contributions are missing (eliminates 285 obs.)

[c] We eliminate observations in case individual pension investments, specified in Schedule H of the Form 5500, are negative (eliminates 137 obs.) or are missing (eliminates 396 obs.)

[d] Plan sponsors are allowed to use interest rates that precede or follow the true valuation date. For example, if the employed interest rates precede (follow) the valuation date by 5 months it is said that the plan uses a look back (forward) period of 5 months. Because the number of look back (forward) months is not stated, we identify the number of look back (forward) months employed by the pension plan by comparing the stated segment interest rates in the Form 5500 to the officially published segment interest rates over a 24 months interval ($+/-$ 12 months) around valuation date. Once the difference between these rates is sufficiently close to zero (we use $+/-$ 2 basis points to allow for typos), this identifies the appropriate number of look back (forward) months to be used in 2012. Observations for which we are unable to identify the appropriate number of look back (forward) rates are dropped.

Appendix Table 7: Variable Definitions, 2011-2012

Variable	Description
I: Form 5550, Main Section (General Information)	
participants (all)	tot_partcp_boy_cnt
participants (retired)	rtd_sep_partcp_rcvg_cnt + benef_rcvg_bnft_cnt
industry	business_code
II: Form 5500, Schedule B (Actuarial Information)	
liability	sb_tot_fndng_tgt_amt
assets	sb_curr_value_ast_01_amt
contributions (mandatory)	sb_fndng_rqmt_tot_amt
contributions	sb_contr_alloc_curr_yr_02_amt
yield curve	sb_yield_curve_ind
interest	sb_eff_int_rate_prcnt
interest (segment t)a	interest_segt
interest (segment 2)	interest_seg2
interest (segment 3)	interest_seg3
III: Form 5500, Schedule H (Financial Information)	
cash	non_int_bear_cash_eoy_amt + int_bear_cash_eoy_amt
accounts receivable (AR)	emplr_contrib_eoy_amt + partcp_contrib_eoy_amt + other_receivables_eoy_amt
US treasuries (rf)	govt_sec_eoy_amt
corporate debt (rd)	corp_debt_preferred_eoy_amt + corp_debt_other_eoy_amt
equities	pref_stock_eoy_amt + common_stock_eoy_amt
joint ventures	joint_venture_eoy_amt
real estate	real_estate_eoy_amt
loans	other_loans_eoy_amt + partcp_loans_eoy_amt
trusts	int_common_tr_eoy_amt + int_pool_sep_acct_eoy_amt + int_master_tr_eoy_amt
funds	int_103_12_invst_eoy_amt + int_reg_invst_co_eoy_amt
insurance	ins_co_gen_acct_eoy_amt
other	oth_invst_eoy_amt
employer	emplr_sec_eoy_amt + emplr_prop_eoy_amt
buildings	bldgs_used_eoy_amt
all	cash + AR + rf +rd + equities + JV + RE + loans + trusts + funds + insurance + other + employer + buildings
IV: Computed plan-specific variables[b]	
funding	(assets - liability)/liability
Δ interest (segment t)	interest (segment t) - published segment interest rate[c]
Δ interest	$\sum_{t=1}^{3}$ Δ interest (segment t)
update	1 if Δ interest > -2 bp & Δ interest < 2bp
size	log(PA)
duration	1 - retired/all
risky	1 - (cash - AR - rf - rd)/all

[a] The segmented yield curve concept distinguishes between three different segment rates, implying that i = (1, 2, or 3).

[b] The plan-specific variables funding, r^{Δ}, size and duration are winsorized at the 0.5 (99.5) percent level.

[c] The published segment interest rate is taken from the Internal Revenue Service and is applied over a 24 months interval around the valuation date. See Appendix Table 6 for more details.