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JEL Classification: G11, G32, J32

Keywords: Defined benefit pension plans, pension assumptions, EROA, underfunded

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Corporate Pension Plan Funding Levels and Pension Assumptions*

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1. Introduction

Recent failures of large corporate defined benefit (DB) pension plans have triggered elevated regulatory action to protect the income of future retirees. The 2006 Pension Protection Act (PPA) (effective in 2008), which focuses on the extent to which pension assets exceed liabilities (the funding ratio) of corporate DB plans, has been the most significant regulatory reform since 1974. We use the 2008 crisis as an exogenous shock to pension plans' funding ratios, in addition to the simultaneous implementation of the PPA, to investigate empirically whether corporate DB pension plan sponsors are more likely to make obligation-reducing assumptions when they are underfunded. In particular, we focus on the assumption made about the long-term expected return on pension assets (*EROA*): a higher expected return assumption can reduce the sponsor's payments to the pension plan.

We focus on the *EROA* assumption because corporate DB pension plan sponsors might have more flexibility than do state DB pension plan sponsors to experiment with this variable.[1] A large literature discusses state DB pension plan assumptions, in particular the liability discount rate (*LDR*) used to estimate the present value of future pension liabilities (i.e., the denominator of the funding ratio). Indeed, Andonov et al. (2017) find that state pension funds make less stringent liability discount rate assumptions to reduce reported underfunding. We argue that the regulatory environment gives state pension funds greater flexibility in choosing the *LDR* than do corporate pension plans.[2] Therefore, if corporate pension plans do not have as much flexibility in the choice of the *LDR*, they may reduce pension plan contributions by possibly experimenting with other

[1] See, for instance, the discussion in Gunz et al. (2009) and Cocco (2014) and the references therein.
[2] Cocco (2014) points out that the accounting rules up to 2006 require firms to use the yield on the U.S. 30-year Treasury bond as the raw discount rate for pension liabilities. This requirement was subsequently relaxed in September 2006, setting the discount rate equal to the yield of investment-grade corporate bonds.

assumptions (i.e., *EROA*). Hence, we focus our analysis on the *EROA* assumption and the change in *EROA* by the same plan sponsor over consecutive years ($\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$).

Our empirical analysis uses annual data from a U.S. single-employer corporate DB pension plan. We use the period 2003–2011, which covers several years before and after the 2008 exogenous shock on pension funding ratios, and it stops before other regulatory changes (in 2012) that could contaminate our analysis. We first conduct panel regressions over this time period and then test for causality between underfunding and the *EROA* assumption using a difference-in-differences approach around year 2008 by identifying the treatment and the control group of pension plans using the PPA definition of an underfunded plan.[3] The control group (fully funded plans) is considered the safest as their funding ratio is above the threshold set by the regulator. The treatment group (underfunded plans) which comprises the remaining pension plans in that year, is bound to be scrutinized by the regulator to improve their funding ratios over the following years.

In addition to the global financial crisis that directly affected pension funding ratios, in 2008, the PPA also came into effect and restricted the discretion of plan sponsors in choosing the *LDR* versus the larger range of discount rates used prior to 2008. Specifically, restricting the flexibility on *LDR* for plan sponsors tending to inflate *LDR* (i.e., reducing the present value of the pension liabilities) would immediately and positively affect the denominator of their funding ratio and hence worsen the funding ratio. One way to counteract the decrease in the funding ratio would be to increase the value of pension assets (i.e., the numerator of the funding ratio) by increasing the *EROA* assumption. Therefore, we expect that plans that were adversely affected by the onset of the 2008 crisis might increase the *EROA* assumption over the same period, which will have an obligation-reducing impact on the pension contributions of pension plan sponsors.

[3] Indicator variable set to 1 if the funding level is below 0.9 for the years preceding 2008, 0.92 for 2008, 0.94 for 2009, 0.96 for 2010, and 1 for 2011 or later.

Figure 1 provides some initial motivation for our analysis. In Panel A, although we observe a generally downward-sloping curve for the expected return on (pension) assets (*EROA*), the trend immediately after 2007 is striking. In 2008, plan sponsors seem to elevate their *EROA* assumption to levels as high as about 5 years earlier (2003), whereas the assumption also remains above the 2007 level for 2009. A dip below the 2007 number in 2010 coincides with the end of the financial crisis.

Under what circumstances would *EROA* increase? Equities are the riskiest securities in which DB pension funds invest. Hence, we would expect *EROA* to increase from either a higher percentage of pension assets invested in equity or historical increases in equity returns that would justify an increase in *EROA* (or both). From Panel A, we observe that the average percentage of pension plan assets invested in equities takes a sharp downturn in 2008 and subsequently increases by small amounts in 2009 and 2010 before declining in 2011. It thus seems unlikely that the increased *EROA* in 2008 is due to increased investment in equities.

The second potential explanation of a recent historical increase in equity returns also fails to explain the increase in *EROA* in 2008. In general, actuarial assumptions are based on historical data (e.g., ASOP 27) and the stock market experienced one of its worst declines in that period, so it is highly unlikely that *EROA* would account for a possible higher, forward-looking *EROA* that could have followed the 2008 decline. Even if we assume that plan sponsors exhaust the 7-month filing deadline after the end of the fiscal year (i.e., they can observe the performance of major asset classes for 7 of 12 months of the year they are supposed to forecast), it is surprising that the *EROA*

assumption only increases once over our time period, whereas the S&P 500 has a positive drift in 5 years of our sample period (Panel B).[4]

Figure 2 provides motivating evidence for our main identification strategy, namely that the 2008 global financial crisis can provide plausible exogenous variation in pension plan funding levels and that this variation might show up as differences in the *EROA* across funding categories. Specifically, Figure 2 shows the *EROA* assumption is conditional on the pension plans' funding status. The general trend is similar to that in Figure 1, but now we observe a higher increase in *EROA* coming from underfunded plans than from fully funded plans in 2008, where the biggest decrease in the funding ratio takes place.

To turn the motivation from Figures 1 and 2 into rigorously tested statistical models, we first conduct multivariate panel regressions. In our panel regression models, we explain the *EROA* assumed by plan sponsors at the end of the plan's fiscal year (t) for the following fiscal year (t+1), where plan sponsors have knowledge of the current year's (t) funding level, the other plan, and firm characteristics and financials. Our main explanatory variable is a Funding variable (pension assets over liabilities for the current fiscal year) and also the Transition variable, which identifies plans that have cascaded from fully funded to underfunded in the same fiscal year. We find a robust negative (positive) relationship between the funding level (transition) and *EROA* after controlling for factors such as firm size and asset allocation in equity and other factors affecting sponsors' pension contributions. The negative relationship is economically significant because a decrease in the funding level by 1 standard deviation (21%) is associated with an increase in *EROA* by 53 basis

[4] Based on the authors' calculations, 94% of the pension plans in our sample have a December 31st fiscal year-end date. Because firms have up to 7 months to file the accounts of each pension plan fiscal year, this means that they can file until July 31st of the following calendar year. As a result, plan sponsors have the benefit of grounding their *EROA* assumption after 7 of 12 months of the new fiscal year have passed."

points (bps), which translates to an average decrease in pension contributions of about 7 million USD. Results using *ΔEROA* as the dependent variable remain robust.

The panel regression results could potentially give indications of a causal negative relationship between funding levels and *EROA* assumptions, because the *EROA* assumption refers to the following fiscal year having knowledge of the current year's financials, so we also conduct a more direct causal test. Specifically, we conduct a difference-in-differences analysis, where we observe robust evidence that underfunded DB pension plans are associated with higher *EROA*s and *ΔEROA*s in the following year. We further find that when the funding level of DB plans drops sharply, then *EROA*s and *ΔEROA*s in the subsequent year are significantly larger, consistent with the interpretation of making obligation-reducing assumptions. Results are robust to a number of controls, including firm size, the percentage of pension assets invested in equities (following the results of Chuk (2013) that the *EROA* assumption is partly determined by pension asset allocation), and the financial constraints faced by the sponsoring firm.

Our findings suggest that corporate DB plan sponsors make obligation-reducing assumptions when DB pension plans experience deteriorating funding ratios. When DB pension plans are underfunded, their sponsors are obliged by law to improve their plans' financial condition. Such improvements imply additional pension contributions by sponsors into their plans. Our empirical findings show that plan sponsors purposely overstate *EROA*s to reduce fund contributions, especially in underfunded DB plans. The revisions in *EROA*s are economically significant and generate obligation-reducing outcomes: a plan making the transition from fully funded to underfunded assumes a higher *EROA* ranging from 44 to 79 bps and translates into an average annual decrease in the pension expense of about 6 to 11 million USD.

Evidence that actuarial assumptions might be strategically chosen is not new (Feldstein and Morck, 1983; Amir and Gordon, 1996). The literature can be naturally split into state DB pension plans and corporate DB pension plans, because these plans are governed by different pension regulations.[5] State (public sector – government) DB pension plans in the United States have been found to be severely underfunded (Novy-Marx and Rauh, 2009, 2011). [6] Underfunding seems to be driven by the pension assumptions made (also emphasized by Lucas and Zeldes, 2009). Corporate DB pension plan sponsors also face underfunding challenges and difficult choices about pension assumptions and other economic decisions similar to those faced by U.S. states.[7] In particular, Asthana (1999) finds evidence for a link between funding status and expected plan asset returns using a smaller sample (1990–1992), a different regulatory and economic environment, and without making the case for a causal link. In other instances, corporate sponsors of underfunded DB plans may engage in risk shifting by investing more in equities to improve their plans' financial condition (Bodie et al., 1985, 1987). In yet other instances, sponsors may engage in risk management by investing a greater proportion of their plan assets in bonds (Friedman, 1984; Rauh, 2009).[8] Sponsoring an underfunded corporate DB pension plan may also affect a firm's real

[5] It is perhaps important to emphasize that differences in accounting regulations might be affecting the potentially different assumptions made by state and corporate plan sponsors. Conditional on the state versus corporate DB plan distinction, the regulatory framework might influence whether the actuarial assumptions are mostly affecting the asset or the liability side of the DB balance sheet. DB pension plans offered by the U.S. government follow the Government Accounting Standard Board (GASB) regulations, offering the flexibility to base the discount rate of pension liabilities on the assumed, and thus more discretionary, expected rate of return of their assets (Brown and Wilcox, 2009). In contrast, corporate DB pension plans follow the regulations set by the Financial Accounting Standards Board (FASB). These regulations are more restrictive on this dimension, because they require DB pension plans from U.S corporations to base their pension liability discount rate on lower risk investments (Cocco, 2014). Specifically, SFAS 87 (1985) required corporate DB plan sponsors to use the 30-year U.S. Treasury-bond yield, a requirement that was subsequently relaxed in SFAS 158 (2006) allowing the use of the investment-grade corporate bond yield.

[6] As of December 2008, the U.S. governments had set aside approximately $1.94 trillion to cover public sector pension liabilities. By June 2009, the present value of liabilities was estimated at $3.20 trillion ($4.43 trillion) if the state general obligation debt rate (zero-coupon Treasury yield) were used for discounting.

[7] Cocco (2014) provides an excellent literature review studying the pension asset allocations of underfunded corporate DB pension plans.

[8] Rauh (2009) empirically examines the risk-shifting versus the risk management incentives of financially constrained corporations and finds that firms allocate pension funds to safer assets (debt and cash) when the plan is less funded and when sponsoring firms have a lower credit rating, a finding that supports the risk management hypothesis.

decisions. Rauh (2006), for example, finds that required pension contributions decrease available internal resources and lead to a reduction in plan sponsor capital expenditures, whereas Cocco and Volpin (2007) offer similar evidence from UK corporate plans. In addition, Anantharaman and Lee (2014) find that executives with risk-sensitive compensation packages tend to engage in risk shifting through corporate DB pension underfunding.

Next, we discuss in detail papers highly relevant to our research. For each paper, we provide a short summary. We describe how we control for each paper's contribution in our analysis and, finally, how we contribute to the literature.

Bergstresser et al. (2006) show that corporations increase their expected return on pension assets when they are preparing acquisitions, when their earnings are low, and when their CEOs are getting ready to exercise their stock options granted to them as part of their compensation package. In addition, the authors find that the *EROA* manipulation is not associated with the funding level of corporate pension plans over their sample period (1991–2002). Relative to Bergstresser et al. (2006), we make an explicit link between the *EROA* and funding status and control for their results using their pension sensitivity variable. That our results are robust when the pension sensitivity variable is added (which is also significant) lends support to the explanation that *EROA* manipulation over our sample period (2003–2011) is attributed to both explanations: underfunding concerns and earnings' concerns.

More recently, focusing on the liability side of corporate pension plan balance sheets, Anantharaman (2017) finds that economically important sponsors make higher (obligation-reducing) raw discount rate assumptions for their pension liabilities, especially when sponsors

intend to freeze their DB plan, consistent with the findings in Comprix and Muller (2011).[9] The spirit of our results is similar, but we focus on *EROA* rather than on liability discount rates and make the connection with plan funding levels rather than client value. More importantly, our results are more economically significant for the choice of pension asset expected returns than for liability discount rates, especially because the discretion on *LDR*s decreased with the introduction of the PPA. To address this literature, we control for *LDR* in the difference-in-differences model, and our conclusions remain unchanged.

Finally, in a recent paper, Bartram (2018) examines the link between corporate policies and the treatment of their defined pension plans. Bartram (2018) conducts an extensive empirical investigation over a long period of time (1992–2014) that includes not only several phases of the economic cycle (including the 2001 and 2008 crises) but also several changes in regulation and reporting that do not necessarily generate a homogeneous impact on pension plans as is also evident from the results. In this paper, we focus on the period immediately before and after 2008, a period during which data reporting is homogeneous. During this period, the major change in regulation (PPA) was implemented, while the recent global financial crisis in 2008 was also at a head (Campbell et al., 2010). In addition, we take our analysis a step further by controlling for both the *LDR* and the Sensitivity variable of Bergstresser et al. (2006), and our results remain qualitatively similar.

Relative to all these studies, we use the exogenous variation in funding status provided by the Great Recession (and the PPA implementation restricting flexibility on *LDR*) to justify a causal link between funding status and expected return assumptions. Furthermore, using both the *EROA*

[9] Comparing two different liability concepts, one regulated and one unregulated, Kisser et al. (2017) find that reported liabilities for corporate DB pension plans are understated by approximately 10% in the United States for years 1999–2007. Most of the bias can be attributed to higher assumed discount rates.

and the *ΔEROA* allows us to make a stronger causal link between funding status and pension plan *EROA* assumptions.

Our primary contribution is to show empirically that even though corporate pension plans, unlike state pension plans (Andonov et al. 2017), might not be directly affecting the liability discount rate, they might have an incentive to make obligation-reducing assumptions directly arising from the choice of the expected return on pension plan assets. The incentive to inflate the *EROA* becomes particularly strong when the pension funding level deteriorates, as evidenced over the recent financial crisis. Our paper focuses on a period that is clean from regulatory changes, which can contaminate our inferences, and uses not only the exogenous variation introduced by the 2008 global financial crisis but also the PPA implementation to show that deteriorating funding ratios causally increase the *EROA* assumption (i.e., an obligation-reducing for the sponsor's pension contribution). Furthermore, our paper presents results that are robust to the alternative potential explanation of making obligation-reducing assumptions by controlling for not only the sponsor's incentives to use pension contributions to manipulate corporate earnings but also the *LDR*, the other major channel by which to manipulate the pension funding ratio.

Our results have policy implications. The Pension Benefit Guarantee Corporation (PBGC) protects the benefits accumulated by DB plan beneficiaries. The literature finds that the presence of such an insurance is associated with maximizing returns by investing in risky assets (Sharpe, 1976; Treynor, 1977; Harrison and Sharpe, 1983). Some studies regard the PBGC insurance as a put option, because sponsors of DB plans need to pay a premium to participate, essentially buying the right to sell their underfunded DB pension plans to PBGC if needed, and attempt to estimate its value and the appropriate premiums that should come with it (see, for instance, Marcus, 1987; Hsieh et al., 1994; Pennacchi and Lewis, 1994; Boyce and Ippolito, 2002; among others). To the

extent that our results imply that plan sponsors paint a rosier picture of the underlying pension plan funding position, more attention needs to be paid on the relatively harmless-sounding choice of expected DB pension asset returns.

The rest of the paper is structured as follows. Section 2 provides the institutional background and develops the hypotheses to be tested. Section 3 describes the identification process and provides descriptive statistics. Section 4 describes the empirical setup using panel regressions. Section 5 demonstrates our difference-in-differences models and provides the results. Section 6 concludes.

2. Regulatory Framework and Hypothesis Development

2.1. Pension and Accounting Regulations and Changes

We first discuss the (U.S.) pension and accounting regulations and any associated changes in these regulations, in order of importance. We then discuss how we choose our sample period to reflect the major change in pension regulation (the Pension Protection Act that became effective in 2008) and avoid any other changes in regulation that may affect our analysis.

The Employee Retirement Income Security Act 1974 (ERISA) is a U.S. Federal law, enacted on September 2, 1974, that protects millions of plan beneficiaries in the United States. When originally introduced, it was seen as an attempt to safeguard the benefits that employees accumulate over their working lives and guarantee viable income to beneficiaries upon retirement. In subsequent decades, and following the default of a significant number of sizable DB pension plans and the deteriorating financial condition of the Pension Benefit Guaranty Corporation (PBGC),[10] further proposals for pension funding reforms were made. Their main aim was to

[10] PBGC is an independent U.S. government agency that takes over DB pension plans from bankrupt or insolvent firms and pays benefits to participants up to a stipulated maximum yearly amount.

elevate the funding level of DB pension plans and enhance the financial condition of the PBGC. The final proposal (the Pension Protection Act (PPA)) is considered the most comprehensive reform of pension laws since the enactment of the ERISA. It was voted into a law on August 17, 2006, but its provisions became effective in 2008 (Campbell et al., 2010).

The PPA established new funding requirements for defined benefit pensions and included reforms affecting cash balance pension plans, defined contribution plans, and deferred compensation plans for executives and highly compensated employees. One of its features is the classification of pension plans in categories of financial strength based on the level of funding of pension liabilities and a projected horizon for funding deficiency or insolvency.[11] We use this regulatory classification of fully funded versus underfunded plan status, as the main identification mechanism in our empirical analysis.[12] Specifically, we examine how the *EROA* assumption of pension plan sponsors differs across this regulatory funding category, in the period before and after the PPA came into force in 2008.

Another important change introduced by the PPA is the reduced flexibility in choosing the pension liability discount rates (*LDR*s). Specifically, after 2008, corporate pension plan sponsors were required to use the 2-year corporate bond rate to discount future pension obligations. This change in the regulation meant that the flexibility in adjusting assumptions around the choice of the liability discount rate was reduced for corporate pension plans.[13] For our purposes, this means both that pension plans might be affected by the reduced discretion over the *LDR* choice and that we need to control for the *LDR* in our analysis.

[11] For more details visit, https://www.gpo.gov/fdsys/pkg/PLAW-109publ280/pdf/PLAW-109publ280.pdf.
[12] Please refer to our definition of *Underfunded* (Table A1), which follows the definition in the PPA.
[13] It is possible that pension plan sponsors started preparing for the implementation of the PPA Act in the 2008 pension plan year to avoid finding themselves under regulatory scrutiny (i.e., being underfunded). For example, plan sponsors could slowly build their funding ratios before 2008 to minimize the need to make "stretched" obligation-reducing assumptions. However, precautionary behavior by plan sponsors would increase the probability of rejecting the hypotheses we test.

The impact of the PPA's implementation, especially with respect to the reduced discretion over the choice of the *LDR* and simultaneously the onset of the 2008 global financial crisis, resulted in a significant deterioration in corporate pension funding ratios. Hence, in 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) was introduced. Among other things, MAP-21 relaxed the strict guidelines on *LDR* and allowed the use of a 25-year rate of corporate bonds to discount future pension obligations.[14] Our analysis ends in 2011, that is, the year before the implementation of MAP-21 in 2012.

2.2. Hypothesis Development

Every pension plan-sponsoring firm needs the professional opinion of a pension actuary to undertake pension valuation work on their corporate DB pension plans, including making several pension plan assumptions. These assumptions are used to determine, among other things, the pension plan's funding status. The final word on these assumptions lies with the firm sponsoring the pension plan, but the complexity of the task means that, usually, the management of the plan-sponsoring firm relies on the recommendations of the actuary to make a decision (Gunz et al., 2009). The last step before all assumptions are eventually adopted involves getting past the auditors' screening.

Many studies examine the relationship and possible conflicts that may arise between firm management and the appointed actuaries. Some studies suggest that actuaries succumb to firm management pressure from fear of being replaced and occasionally agree to unreasonably optimistic (obligation-reducing) actuarial assumptions (Gunz et al., 2009; Crusap, 2006). On the other hand, professional standards through self-regulation, the threat of litigation, and reputational

[14] See https://www.irs.gov/retirement-plans/map-21-new-funding-rules-for-single-employer-defined-benefit-plans.

considerations may provide sufficiently strong incentives for actuaries to resist management pressure.[15] One recent change by the actuarial professional bodies is the implementation of the Actuarial Standard of Practice 41 (ASOP 41): the change encourages actuaries to state their disagreement in case they do not agree with the final assumption chosen by plan sponsors. Nevertheless, ASOP 41 came into effect in December 2010, that is, during the period of our analysis, so it is not possible to know whether pension actuaries agreed with the eventual *EROA* chosen by plan sponsors.

In this study, we focus on investigating the assumption on expected return on pension assets (*EROA*), because this assumption partly determines the pension expense (the minimum required pension contribution). The four major components of the annual pension expense are the service cost, the interest cost, the expected change in value on pension assets, and the amortization amounts (Equation (1)):

$$\begin{aligned} Pension\ Expense &= Service\ Cost + Interest\ Cost \\ &- Expected\ Change\ in\ Value\ of\ Pension\ Assets + Amortization\ amounts. \end{aligned} \tag{1}$$

The first component in Equation (1) is the service cost, which is the value of additional pension benefits that employees have earned over the current year. The service cost is a function of a predetermined pension benefit formula that accounts for elements such as employees' salary and years of service, among other factors. Service cost increases the pension expense.

The second component is the interest cost, which measures the impact of having employees age one year and thus being 1 year closer to receiving their retirement benefit, which has been accruing over the current year. This component is calculated by multiplying the *LDR* with the *PBO*'s

[15] A related study by Kamiya and Milidonis (2018) examines the case of actuarial independence and managerial discretion in the case of setting loss reserves in the property casualty insurance industry.

beginning year balance, and it is expected to increase the overall pension expense for the firm. Choosing the *LDR* comes with some discretion, but primarily in the period before the PPA came into force. Hence, we control for the choice of *LDR*.

The third component (our variable of interest) is the expected change in value of pension assets and is an assumption made by plan sponsors, which reflects the expected increase in pension assets over the following fiscal year. As previously discussed, discretion is needed in setting this assumption, which takes into account the historical performance of asset classes, projections of future individual asset classes returns (e.g., fixed income, equity), and other factors, such as macroeconomic developments, as described in the Actuarial Standard of Practice (ASOP) 27[16] and in the PPA.[17] Because the increase in pension assets will help pay pension liabilities in the future, the assumption of (a positive) expected return on pension plan assets, decreases the pension expense.

The fourth component relates to amortized amounts and consists of several items, such as the prior service cost, actuarial gains (or losses), and the pension funding deficit, if any. [18] Not much discretion is required in calculating the amortization amounts, as these (also) depend on the realization of the *EROA* assumption. If the *EROA* assumption in the previous year is overconservative[19] (i.e., the actual return on plan assets is larger than the expected return), then the (actuarial) gain needs to be amortized over the subsequent years.

[16] https://www.actuarialstandardsboard.org/wp-content/uploads/2014/02/asop027_172.pdf
[17] https://www.govtrack.us/congress/bills/109/hr4/summary
[18] Amortization amounts include, among other items, pension funding deficits (i.e., when the fair value of pension assets is smaller than the present value of pension liabilities). The pension plan sponsor is obliged by law to amortize these amounts over a number of years. For more details visit, https://www.actuary.org/pdf/pension/fundamentals_0704.pdf.
[19] If the difference between the expected and the actual value of assets is more than 10% of the MAX (PBO, Fair Value of plan assets), then it has to be amortized over the next several years.

The pension expense definition (Equation (1)) suggests that virtually no discretion is associated with the service cost, but some discretion comes with the interest cost (*LDR* assumption) and the expected return on pension assets (*EROA*) assumption. The last component (amortized amounts) indirectly decreases the degree of discretion on the *EROA* over previous years if it highly deviates from the realized return on pension assets. Our empirical setup is centered on the implementation of the PPA (in 2008), when the discretion on the *LDR* assumption largely decreased. Hence, the discretion in estimating the pension expense from 2008 to 2011 is virtually derived from the discretion in making the *EROA* assumption.

What constrains plan sponsors from minimizing pension expenses very aggressively, since they could use those funds for other positive net present value projects within their corporation? A pension plan's funding ratio, that is, the ratio of pension plan assets over *PBO*, is probably the strongest signal provided by a corporation with respect to the financial condition of its employees' pension plans. Since the implementation of the PPA and through the discussions that led to its enactment, it was obvious that much attention would be focused on pension plan funding ratios. Specifically, the PPA clearly defines a fully funded versus an underfunded pension plan.[20] According to the PPA, plan sponsors with underfunded pension plans are required to amortize the shortfall (i.e., underfunding) over a period of 7 years (this was previously much longer, up to 30 years). Typically, to emerge from underfunding, sponsors are required to make larger fund contributions to their pension plans (Campbell et al., 2010). The larger the gap separating the fair value of pension assets and the *PBO*, the larger the contributions needed to move the plan out of the underfunded status.

[20] This is an indicator variable equal to 1 if the funding level is below 0.9 for the years preceding 2008, 0.92 for 2008, 0.94 for 2009, 0.96 for 2010, and 1 for 2011 or later.

Therefore, corporate plan sponsors have strong incentives to avoid being classified as underfunded and also strong incentives to reverse the downward trend in funding ratios to avoid more regulatory scrutiny. However, the onset of the financial crisis, in combination with the simultaneous implementation of the provision of the PPA in 2008, must have had an adverse impact on already financially challenged firms, especially those struggling to keep their funding ratios over the regulatory funded threshold. Therefore, we expect corporate plan sponsors transitioning to an underfunded status because of the 2008 crisis to use the degrees of discretion offered by the pension *EROA* assumption (as the degrees of freedom to modify the *LDR* are simultaneously being limited by the PPA) to decrease their pension expenses. We formally state this as our first hypothesis.

Hypothesis 1: Corporate defined pension plan sponsors transitioning to an underfunded pension status as a result of the 2008 crisis are expected to assume a higher EROA than are those not making this transition.

Our second hypothesis is related to the first one but is not the same. To control in a flexible manner for different unobserved changes that are constant or smoothly varying from year to year, we construct a new measure, the first difference in expected returns from year to year ($\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$). Hence, in this second hypothesis, we focus on the slope of *EROA* from year to year rather than the level of *EROA.* Following the rationale of the first hypothesis, our second hypothesis states that managing the *EROA* assumption from year to year will be in line with more obligation-reducing assumptions, for those plans transitioning into the underfunded status as a result of the unexpected crisis. Therefore, our second hypothesis can be stated as follows.

Hypothesis 2: Corporate defined pension plan sponsors transitioning to an underfunded pension status as a result of the 2008 crisis are expected to assume a larger change in EROA than are those not making the transition.

Next, we will discuss the data and empirical methodology used to test these hypotheses.

3. Identification, Data, and Descriptive Statistics

We focus on U.S. corporate DB pension plans over the period 2003–2011. We choose this period to minimize contamination from unrelated regulatory changes and other events. We start in 2003 because this is the effective year of a new pension reporting standard (SFAS 132R), which requires corporate pension plans to disclose their pension asset allocation (Chuk, 2013). In addition, and as a potential consequence of SFAS 132R, this is the year when most of the corporate DB pension plan data are reported in a consistent manner through Compustat.[21]

The key identification strategy in our analysis is year 2008, when not only the PPA came into force but also the 2008 global financial crisis occurred. We consider both events (the PPA and the financial crisis) simultaneously occurring to be an exogenous shock to the corporate DB pension plans. The crisis generates a large decrease in pension asset values, thereby pushing many pension plans into an underfunded status territory. At the same time, the degrees of freedom that pension plan sponsors had in setting their pension expense assumptions were significantly reduced from the Pension Protection Act (PPA), due to the constraints imposed by the PPA on the choice of the *LDR* assumption. Therefore, 2008 offers an opportunity to examine how those plans that transitioned from fully funded to underfunded because of the crisis, used their discretionary ability in setting their *EROA* assumption. Therefore, we use a model of differences in differences around 2008 to compare fully funded versus underfunded pension plans to make a causal inference about

[21] A revision, which was introduced in 2009, to SFAS132R enhanced the reporting of pension asset allocation from the 2003 requirement. Specifically, in 2003, pension plans had to report the percentage of pension assets invested in equity, fixed income, and "other assets." In 2009, pension plans had to refine the category of "other assets." This modification is of minor importance to our analysis, as the riskiest asset category in our analysis (that also justifies the highest expected return) is the equity category.

the potential manipulation of the *EROA* by corporate pension plan sponsors to make obligation-reducing assumptions for their pension plans.

Our analysis covers up to 2011, shortly after the official end of the 2008 crisis and also before another significant regulatory change that partially reverses the PPA constraint on choosing the *LDR* assumption. Specifically, the implementation of the MAP-21 was introduced in 2012, which, among other things, relaxed the strict guidelines on *LDR* and allowed the use of a 25-year rate of corporate bonds to discount future pension obligations.[22]

Our sample combines data from three different databases. First, we collect single-employer pension-related data from Compustat Pensions Annual. These data include variables such as the fair value of pension assets (FVPA), projected benefit obligations (*PBO*), and pension valuation assumptions. Second, we select firm- and sponsor-related data from Compustat Fundamentals. In this instance, we use variables that can affect pension valuation assumptions, such as the firm capital structure and firm creditworthiness. Finally, we source variables related to corporate governance from MSCI (formerly KLM and GMI Ratings). All three databases are provided by Wharton Research Data Services (WRDS) and together form the final dataset (panel) we use for the empirical analysis. After deleting duplicates and entries from nondefined benefit pension plans, we are left with a panel that consists of 15,240 firm-year observations from 2,405 publicly traded U.S. firms and spans from 2003 to 2011. To remove the impact of outliers, we winsorize all variables at the 1% and the 99% level. Table A1 provides a detailed description of our variables.

3.1. Dependent Variables

Our main dependent variable is the expected return on pension plan assets *EROA*. We construct this variable using the assumption made by plan sponsors for the expected value of pension assets

[22] See https://www.irs.gov/retirement-plans/map-21-new-funding-rules-for-single-employer-defined-benefit-plans.

over the following fiscal year. Specifically, at the end of fiscal year *t*, plan sponsors assume their pension assets will have a specific value by the end of the following fiscal year *t*+1. *EROA* is the ratio of the assumed change in value of pension assets over the fiscal year *t*+1 over the actual value of pension assets reported at the end of fiscal year *t*:

$$EROA_{t+1} = \frac{Expected\ Change\ in\ Value\ of\ Plan\ Assets_{t+1}}{Actual\ Value\ of\ Plan\ Assets_{t}}. \quad (2)$$

In addition to $EROA$, we also calculate the change in $EROA$ between successive years, as another dependent variable for our analysis, by subtracting the previous fiscal year's assumption from the current fiscal year:

$$\Delta EROA_{t+1} = EROA_{t+1} - EROA_{t}. \quad (3)$$

$\Delta EROA$ is informative, because it allows us to compare changes in the same plan sponsor's assumption over successive years, thus directly controlling for unobserved plan heterogeneity. Moreover, $\Delta EROA$ has similarities with the loss reserve error[23] widely used in the insurance and economics literature to assess changes in assumptions conditional on incentives faced by property-liability insurance firms from year to year.

Table 1 reports aggregate descriptive statistics for the dependent variables over the period 2003–2011. We find that the average (median) *EROA* is 7.51% (7.78%), whereas the average (median) *ΔEROA* is -0.27% (-0.16%).

[23] Defined as the difference between an originally reported reserve estimate and a later revised one (Kazenski et al., 1992), this is an actuarial assumption that may differ based on whether the pension actuary is an officer (Kamiya and Milidonis, 2018).

3.2. Main Explanatory Variables

Table 1 also reports descriptive statistics for the main explanatory variables in our analysis. Because our main hypothesis relates to the funding status of pensions plans, we create a few versions of funding status, primarily to capture the regulatory thresholds imposed on single-employer pension plans over our sample period. *Funding Level* is defined as the ratio of pension assets over the value of *PBO* and has an average (median) value of 77.89% (77.90%). We then create the indicator variable called *Underfunded*, which depends on the institutional environment in each year, as detailed in Table A1. Overall, we observe that about 77.37% of plans are classified as underfunded, with a standard deviation of 41.85%. For our analysis, it becomes especially important to identify those plans that have made a transition from a fully funded to an underfunded status, using an indicator variable. Therefore, we create a *transition* variable to identify those plans and find that 7.47% of our plan-years make this transition over our sample period.

3.3. Plan Characteristics

We control for several plan characteristics in our analysis that might affect the *EROA* (and *ΔEROA*) assumption. The first one is plan size, which is determined by the present value of benefit obligations (*PBO*). We use *PBO*—instead of pension assets—which is the promise made to employees about their future benefits and tends to be more stable from year to year. On the other hand, pension plan assets are volatile and depend on economic conditions. The average (median) defined pension plan has *PBO* of $1,661 ($203) million with a standard deviation of $4,290 million. Similarly, the average (median) plan has an asset value of $1,358 ($152) million with a respective standard deviation of $3,581 million. The distribution of both variables suggests that the sample of pension plans includes a few very large plans generating mean values several times

over the median plan size. Hence, we control for the size of the plan (Plan Size), defined as the natural logarithm of the *PBO* (in millions). [24]

Pension asset allocation is a major determinant of the expected return on pension assets: more assets invested in equity will justify a higher *EROA*, all else being equal. We control for the percentage of pension assets invested in equity and find that, on average, pension plans invest 55.9% of their assets in equity and 36.8% in bonds, with the remainder invested in other securities. Another major pension plan assumption (with the largest impact on *PBO*) that we control for is the *LDR*. On average, the assumed *LDR* over our sample period is 5.64%, whereas the median *LDR* is 5.75%.

Auditors are expected to act as an external, independent monitor for corporate pension plans and the respective assumptions set forth by plan sponsors. The literature finds that bigger audit offices provide higher-quality audits, because of less dependency from clients, and tend to avoid questionable practices (e.g., overlooking earnings manipulation) that might contaminate their good name (Francis and Yu, 2009). Hence, we expect that controlling for large versus small auditors will capture the potential negative relationship between auditor size (and quality) and obligation-reducing assumptions. To control for the size (and indirectly quality) of auditing services, we create an indicator variable equal to 1 to identify auditing conducted by the Big 4 Auditors (PWC, Deloitte, KPMG, Ernst & Young) and 0 otherwise. On average, 94.5% of the plans in our sample are audited by the Big 4 auditors.

3.4. Corporate Characteristics

Current literature on corporate defined pension plan assumptions (Bergstresser et al., 2006; Bartram, 2018) discusses the likelihood that corporations may pierce the veil between the firm and

[24] Plan size and firm size (sponsor size) are correlated, so we use only one of the two (firm size). Results are robust when both variables are used.

the pension plan by adjusting their contributions to pension plans to serve corporate objectives, which are not necessarily aligned with the incentives of pension plan stakeholders (e.g., employees). Hence, we also control for several corporate characteristics.

First, we construct corporate leverage, defined as debt to assets. The average (median) leverage ratio is 26.5% (23.56%). Next we calculate debt maturity, as a proxy of the repayment horizon that firms face on their debt. We expect that the shorter the debt maturity, the higher the need to refinance or repay the debt, hence the stronger the need to make obligation reducing assumptions. Then we control for the firm's credit risk by including the firm's Z score, following Altman (1968). Firms in the distress zone might have stronger incentives to inflate the *EROA* assumption, thus reducing pension contributions. The amount of cash and short-term investments (*CASH and STI*) a company has could be a factor affecting the *EROA* assumption as well (Bartram, 2018). Hence, we replicate the variable used by Bartram (2018) to measure corporate liquidity and use it as a control variable in our analysis. Firm size and firm age are two demographic characteristics that could add pressure on corporate pension plans, since both characteristics could correlate with the age of employees who are expected to have significant levels of accumulated benefits in their corporate DB plans.

Next, we proxy for corporate governance quality by controlling for the independence of the board. We measure board independence by the ratio of board members who are not employees of the firm. We anticipate that more independent boards will be less likely to allow the manipulation of pension assumptions by the plan sponsor. The average (median) firm has 74.87% (77.78%) of its board members as outsiders, thus indicating relatively high-quality board oversight.

Our final control variable relates to the alternative hypothesis of *EROA* manipulation by corporate plan sponsors to manage corporate earnings in periods when they have to present an

optimistic snapshot of their firm. This might happen, for instance, in periods before potentially acquiring another firm, in periods when earnings are close to critical thresholds, or, even, in periods when executives are ready to exercise stock options on the firm's stock price granted to them as part of their compensation (Bergstresser et al., 2006). Hence, to control for the alternative hypothesis that pension plans alter their pension assumptions to serve other corporate objectives, we construct the *Pension sensitivity* variable (Bergstresser et al., 2006) as another explanatory variable. *Pension sensitivity* is defined as the log ratio of pension assets to corporate operating income.

3.5. How Does 2008 Change Corporate DB Pension Plans?

We set up our difference-in-differences model around year 2008, and, hence, we separately present descriptive statistics of our variables for the periods 2003–2007 and 2008–2011. Table 2, Panel A, shows results for the period 2003–2007, and Panel B shows results for the period 2008–2011. Focusing on the funding level, we observe a dramatic decrease in funding levels from the period before to after the crisis. This decrease is reflected in the mean difference of the *Funding* variable, the *Underfunded* indicator, and the *Transition* variable. Average (median) *Funding* before 2008 is 81% (81%) and 74% (74%) after 2008. The percentage of underfunded pension plans increases from 69% before 2008 to 88.7% after 2008, providing another signal that a mere 11.3% of plans remain in good funding status in the post-2008 era. Finally, as expected, the annual transition (from fully funded to underfunded) before 2008 was 2.6%, but this number jumps to 13.8% after 2008. This preliminary descriptive analysis illustrates that 2008 is associated with a major change in the funding status of pension plans, presumably arising from both the implementation of the PPA and the onset of the financial crisis.

Other notable characteristics over the two periods are that the largest part of the *EROA* distribution does not seem to have changed much up to the 75th percentile, but notable changes (positive values have been extended upward) take place above the 75th percentile in the latter period. Moreover, the distribution of *ΔEROA* has some notable changes outside the interquartile range. Observing the *LDR* values over the two periods, we observe little change, a trend likely driven by the PPA implementation, which restricted the discretion over the *LDR* assumption from 2008 onward. Also notable is the decrease in the allocation of pension assets into equity in the latter period.

4. Empirical Evidence: Correlations

Our main hypotheses imply that plan sponsors use a higher *EROA* assumption on plan assets when plans transition from a fully funded to an underfunded status because of the 2008 crisis. Before building the causal narrative, we investigate whether simpler statistics are consistent with this narrative.

4.1. Motivating Evidence

Figure 2 shows the $EROA$ for all pension plans in our sample from 2003 to 2011, conditional on their funding status (fully funded vs. underfunded). We observe that underfunded plan sponsors tend to assume a higher $EROA$ than fully funded plan sponsors, especially over the period 2008–2011. At the beginning of our sample period (2003 and 2004), we observe a decreasing trend in *EROA* for all plans and the average $EROA$ for unfunded plans stands slightly above the average *EROA* for fully funded plans. In 2008, both fully funded and underfunded plan sponsors revise their *EROA* assumptions upward, but, after 2008, the *EROA* assumptions trend downward. Given that we later perform a difference-in-differences regression between these two groups, it should

be noted that the parallel trends assumption before the actual implementation of PPA seems to be satisfied and that there seems to be an increase in *EROA* for underfunded plans after 2008.

Next, we test the statistical significance of the differences in *EROA* between the two types of pension plans. Table 3 presents the annual expected returns on pension assets (*EROA*) for corporate pension plans in the United States from 2003 to 2011. The average *EROA* for all pension plans is in column (2); the average *EROA* for the fully funded plans is given in column (3); and the average *EROA* for the underfunded plans is given in column (4). Column 5 reports whether the mean differences in *EROA* by funding category are statistically significant.

The difference between fully funded and underfunded plans in 2003 and 2004 is not statistically significant, whereas, in 2005, it is statistically different from zero at the 5% level. Underfunded plans make an *EROA* assumption that is, on average, 29 bps higher than the *EROA* assumption of fully funded pension plans. In 2007, the difference reverses signs, amounting to a 19-bp change (p-value < 0.05). Focusing next on the post-event period immediately after the exogenously introduced changes to pension assumptions and changes in the investing landscape, we observe several notable differences. First, both types of plans surprisingly increase their $EROA$ assumptions in 2008, which is the year with the largest declines in equity returns over the recent history.

The second major observation starting from 2008 is that underfunded plans consistently assume higher $EROA$ than do fully funded plans over the crisis years (2008–2010). The difference in ER is 55 bps for 2008 (p-value < 0.01), 35 bps for 2009 (p-value < 0.05), and 47 bps in 2011 (p-value < 0.05), whereas the implied difference for year 2010 (6 bps) is not statistically significant.

Figure 3 shows the change in expected pension asset returns (*ΔEROA*) for fully funded and underfunded corporate pension plans in our sample from 2003 to 2011. Overall, we observe that

in all years, *ΔEROA* is negative for both fully funded and underfunded plans, except for 2008, where a large positive value for both types of pension plans is observed. Interestingly, underfunded plans seem to assume higher (or less negative) *ΔEROA* than do fully funded plans. Again, it should be noted that the parallel trends assumption of the difference-in-differences model is satisfied and that, additionally, there seems to exist an increase in *ΔEROA* after 2008.

Table 4 tests the significance of the differences in *ΔEROA* of underfunded and fully funded plans. Specifically, we report the mean *ΔEROA* by year (2003–2011) for all plans (column 2), fully funded plans (column 3), and underfunded plans (column 4). The last column (5) shows the mean difference in *ΔEROA* between underfunded and fully funded plans and the respective statistical significance.

Results show that the difference between fully funded and underfunded plans is statistically significant for several years in the pre-event period. Specifically, this is the case in 2003 (*p*-value < 0.10) and 2005 (*p*-value < 0.05). Focusing next on the post-event period, we observe positive *ΔEROA* for both plans in 2008 and 2009. Interestingly, the difference between underfunded and fully funded plans is positive and statistically significant (*p*-value < 0.05) for 2008 and 2009, with a size of 36 and 32 bps, respectively.

The negative correlation between the pension plan funding level with both the *EROA* and *ΔEROA* is consistent with the idea that lower pension funding levels might lead management to revise expected pension asset returns. The transitions across funding categories during the crisis are also associated with larger *EROA* and are also consistent with this idea. We further analyze this relationship in the following section to move to a causal narrative, while controlling for various other plausible mitigating factors and theories.

4.2. Panel Regression Models

We start using ordinary least squares (OLS) panel regressions introducing fixed effects at the firm (plan sponsor) level to control for the unobserved time-invariant factors that may influence corporate pension plan assumptions. We estimate the regression model below with either the *EROA* or the *ΔEROA* as a dependent variable, where the assumption is made at time *t*, but it refers to the following fiscal year *t*+1:

$$y_{t+1} = a_0 + \alpha_1 * Funding_t + \alpha_2 * Transition_t + \beta * Plan\ Characteristics_t + \gamma * Firm\ Characteristics_t + \eta_t + \varepsilon_{t+1}. \quad (4)$$

The element a_0 represents the intercept, and *Funding* is the ratio of pension assets over pension liabilities at time *t*. The *Transition* variable is our main identification variable and takes the value of 1 if a plan becomes underfunded in the previous fiscal year (i.e., the plan is fully funded on year *t*-1 and underfunded on year *t*) and 0 otherwise. Next, we control for a series of pension plan characteristics and another set of corporate pension plan sponsor characteristics. The parameter η_t represents the year indicators, and ε_{t+1} are error terms.

4.2.1. Panel Regression Models: *EROA*

Table 5 reports the results from the panel regression model (Equation 4) with *EROA* as the dependent variable. Two major results are obvious. First, that the *EROA* assumption is negatively associated with the funding level implies that as funding ratios worsen, the *EROA* assumption increases, all else being equal. The results are statistically significant at the 1% level but also have a significant economic interpretation. For instance, a 1-standard-deviation decrease in the funding level of DB pension plans (i.e., decrease of 21% in the funding level) is expected to be associated with about a 53-bp increase in the next year's *EROA*. Given that the value of the pension assets

for DB plans in our sample average $1,358 million,[25] the associated expected change in the value of pension plans for the following year therefore would be about $7.1 million higher. This increase in expected value directly reduces the minimum required contributions by the same amounts.

The second result is that the *Transition* variable is also significant and negative. Across the different models presented in this table, the statistical significance of the coefficient ranges from 1% to 10%, depending on sample size and also the inclusion of the *Funding* variable. The size of the coefficient is also economically significant as a pension fund making the transition from the fully funded to the underfunded status is associated with an increase of 15 to 20 bps in the *EROA* for the following year. The magnitude in dollar terms ranges from about $1.7 to $2.3 million in the pension expense through the higher assumed expected return.

4.2.2. Panel Regression Models: *ΔEROA*

Estimating Equation (4) with *ΔEROA* as the dependent variable yields the results in Table 6. Overall, the results are consistent with those in Table 5. In short, we find a strong negative relation between *Funding* and the *ΔEROA* (p-value < 0.01) and a positive and significant relation between the *Transition* and *ΔEROA* (p-value < 0.05). Both results provide further evidence consistent with obligation-reducing assumptions when the plan is facing a decrease in funding levels or has transitioned from a fully funded to an underfunded status.

In all, the results suggest evidence of an association between the funding level of DB pension plans and obligation-reducing assumptions from pension plan sponsors with respect to *EROA*. Such behavior can significantly reduce the pension expense and hence the minimum amounts that sponsoring firms need to contribute in their plans.

[25] Table 1 provides more information on the distribution of the fair value of pension assets.

5. Empirical Evidence: Causal Setup

Although we find evidence of a correlation between funding levels and the *EROA* assumption, this does not necessarily imply causation. As previously discussed, the implementation of the PPA, in addition to the onset of the Great Recession in 2008, provides an exogenous shock to pension plan funding ratios. In addition, the PPA took effect in 2008. Therefore, to study the effect of pension plan funding deficiencies on assumed expected returns, we can use a difference-in-difference methodology where the exogenous crisis provides the first difference and then the variation between plans across different funding categories provides the second difference.

Hence, we employ a difference-in-differences approach in the two periods before 2008 (2003–2007) and after 2008 (2008–2011) to examine whether the large adverse impact on pension plans' funding ratios from the arrival of the global financial crisis has urged pension plans, especially those that switched funding category from fully funded to underfunded, to use their discretion in the *EROA* assumption in their favor (i.e., in an obligation-reducing manner).

The difference-in-differences (DD) research design is based on two mutually exclusive groups of observations (a treatment and a control) of which the dependent variables (*EROA* and *ΔEROA*) are assumed to have parallel trends over time in case no treatment takes place. It is further assumed that, in the presence of some kind of treatment, the dependent variable mean values do not have parallel trends in time.[26]

Our DD regression model follow the rationale of the panel regression model (Equation (4)). To test for the causal impact of year 2008 onward, we create the *Post-PPA* indicator, which takes the value of 1 for the period 2008–2011 and 0 otherwise. We interact this variable with the *Transition* variable, so that we can identify those firms that have switched funding status because of the

[26] Angrist and Pischke (2009) extensively discuss the details of this assumption.

changes in the economic environment over the latter period. All other variables used in the DD regression model (Equation (5)) remain the same as those in Equation (4):

$$y_{t+1} = a_0 + \alpha_1 * PostPPA + \alpha_2 * Transition_t + \alpha_3 * PostPPA * Transition_t + \alpha_4 * Funding_t + \beta * Plan\ Characteristics_t + \gamma * Firm\ Characteristics_t + \varepsilon_{t+1}. \quad (5)$$

5.1. Effect on *EROA*

We start by first estimating Equation (5) with *EROA* as a dependent variable and discuss the results in Section 5.1.1. Initially, we primarily control for plan characteristics, while we progressively add control variables related to the corporate plan sponsor. The three models we show correspond to the three respective models in Table 5, where evidence of an association between obligation-reducing assumptions and funding constraints was presented. We then present a series of robustness checks in Section 5.1.2 related to potential alternative hypotheses in the literature (i.e., Bergstresser et al., 2006; Anantharaman, 2017).

5.1.1. Main Evidence of Obligation-Reducing Treatment of *EROA*

The first result that we document in Table 7, is that during the period 2008–2011 (*Post-PPA* variable), evidence suggests that *EROA* has decreased in a significantly detectable manner (*p*-value < 0.01) across all corporate pension plans. The economic significance of this variable is also sizable: it ranges from about 101–110 bps over this period.

The main result that we observe, however, from all three models in Table 7 is a strong positive relation on our causal variable, that is, the interaction term between the *Post-PPA* and the *Transition* variable. We interpret this as evidence that plans whose funding level was adversely affected after 2008 choose to increase their *EROA* in a statistically significant manner. In conjunction with the negative coefficient on the *Post-PPA* variable, this result implies that although *EROA* decreases overall in the period 2008–2011, those plans transitioning to an

underfunded status have decreased their *EROA* by a significantly smaller amount compared with those that did not switch to an underfunded status. The size of this coefficient is economically significant as well because it ranges from about 44 bps (in the most relaxed model) to about 79 bps (in the third model that controls for most variables).

In short, focusing on the last column, it seems that although, on average, pension plans decrease their *EROA* assumption over the period 2008–2011 by about 101 bps, if a pension plan has made the transition from fully funded to underfunded over the same period, the decrease in *EROA* is much smaller: it only amounts to about 22 bps (101 – 79), thus gaining from an obligation-reducing assumption of about 79 bps.

Again, taking the value of the average pension plan as benchmark, transitioning to a lower funding category during the crisis years brings an expected increase in the value of plan assets of about 10.66 million USD.[27] This amount translates into a substantial decrease in the pension expense and the minimum required contributions from the corporate plan sponsor.

Next, we focus on the remaining control variables from the DD model. That the *Funding* variable obtains a negative coefficient (in 2 of the 3 models) implies that, as the funding level decreases (deteriorates), the *EROA* assumption increases (i.e., in an obligation-reducing manner). Next, we observe that the *Equity* variable (i.e., the proportion of pension assets invested in equity) is positive and significant (p-value < 0.01), as expected. In other words, higher *EROA* are justified by higher pension assets, allocated to the riskiest investments that carry the higher expected return.

A pension plan can be fully funded well, but the plan sponsor may be short on cash or face financial difficulties. To capture this dimension that can potentially affect the *EROA* assumption, we use the *Cash and STI* (short-term investment) variable. That the coefficient of this variable is

[27] This is calculated as follows: 0.00785*1,358 million, which is the average pension asset value size.

negative and significant (p-value < 0.01) can be interpreted as further evidence of an association between plan sponsors with liquidity issues making obligation-reducing assumptions through an elevated *EROA*.

5.1.2. Robustness to Alternative Hypotheses: *EROA*

Two key alternative explanations to the potential manipulation of *EROA* are those presented by Bergstresser et al. (2006) relating to earnings manipulation and those presented by Anantharaman (2017) and Kisser et al. (2017) discussing the potential manipulation of the *LDR* assumption.

Bergstresser et al. (2006) find that corporate pension plan sponsors tend to manipulate the *EROA* assumption when the corporate plan sponsor needs to show elevated corporate earnings. As an example, they focus on firms getting ready to acquire potential investment targets, firms challenged by the level of their earnings, or firms whose executives intend to exercise their stock options on the firm's stock price. Hence, using a dataset from 1991 to 2002, they devise a measure of pension sensitivity to earnings that captures the *EROA* manipulation. As a robustness check to our results, we replicate this measure (*Sensitivity*) and include it as a control variable in our DD regressions.

Anantharaman (2017) uses pension plan data over the period 2000–2007 to show that plan sponsors manipulate their *LDR* so that the present value of future liabilities decreases (by using an increased *LDR*). As previously discussed, the implementation of the PPA in 2008 made it more difficult for corporate pension plan sponsors to manipulate the *LDR*. Therefore, we do not anticipate that it will influence our results in the *Post-PPA* period. Still though, we use the *LDR* assumption as an additional control in our DD setup, in addition to the pension *Sensitivity* variable by Bergstresser et al. (2006).

Table 8 presents the results of these robustness checks. Our results are robust to these specifications (at various levels of statistical significance) and, consequently, the potential alternative hypotheses that could be driving the results. Specifically, in all models (columns) we observe that the variable *Transition*Post-PPA* to be positive and significant and with an economic magnitude similar to that of Table 7 (ranges from 41 to 79 bps). Interestingly the *Post-PPA* variable is still negative in all regressions but is only significant in some regressions.

Our results remain significant when the pension *Sensitivity* variable is included (the second model in Table 8). Specifically, that the pension sensitivity variable obtains a positive and significant coefficient is consistent with Bergstresser et al. (2006). On the other hand, the *Transition*Post-PPA* remains robust. Next, we control for the *LDR* variable as shown in the third model in Table 8. That the *LDR* variable gains a positive and significant coefficient (*p*-value < 0.01) is consistent with the extant literature (Bartram, 2018). This result shows that our evidence of *EROA* manipulation is over and above any manipulation conducted on the *LDR*. Finally, we create a model that includes both the *Sensitivity* and *LDR* variables as control variables (the last model in Table 8). Results on our main variable remain qualitatively similar.

5.2. Effect on *ΔEROA*

EROA measures the level of assumption across different plans, but *ΔEROA* allows us to focus on short-term annual changes in pension assumptions. Table 9 shows the results. We observe a positive, statistically significant coefficient on the *Transition*Post-PPA* variable ranging from 52 (first model) to 80 bps (third model), which is consistent with the results in Table 7. Furthermore, we observe that changes in the post-PPA period are positive and significant, and the coefficient of the *Funding* variable is negative and significant, providing additional evidence that asset allocations to equity investment are associated with a higher *ΔEROA* assumption.

Following the rationale from Table 8, we next control for the two alternative hypotheses that could be driving *ΔEROA*, and we report the results in Table 10. We first control for the *Sensitivity* variable (the second model in Table 10), then for the *LDR* variable (third column), and, finally, for both *Sensitivity* and *LDR* variables together (fourth column). Our results remain robust to all specifications. However, we note that only the *LDR* variable is statistically significant, and the *Sensitivity* variable is not.

Overall, our findings provide support not only for a causal relationship between the funding level and the assumed *EROA* but also for *ΔEROA* on plan assets. Plans with lower funding levels tend to consistently use higher expected returns, which tend to produce decreases in plan sponsors' pension obligations, a finding that echoes the extant literature that finds manipulation of assumptions in an obligation-reducing manner for the corporation (e.g., Kisser et al., 2017; Novy-Marx and Rauh, 2009, 2011; Andonov, 2017). Our results are robust to the alternative hypotheses offered by the literature (Bergstresser et al., 2006; Anantharaman, 2017) and are of economic significance and should be of concern to regulators, especially when pension plans are much closer to tapping into the PBGC.

6. Conclusions

We find evidence consistent with the manipulation of pension assumptions in corporate DB pension plans in the US, especially by those pension plans that have a funding ratio lower than the ratio dictated by legislation. Specifically, we find that corporate plan sponsors inflate their assumption related to the long-term investment return of their pension assets, therefore directly reducing the pension contributions to their DB pension plans. The impact of the obligation-reducing assumption is sizable as it amounts to about 40 (to 80) basis points or $6 (to $11) million, on average. Such practices are likely to have long-term implications for retirees depending on these

DB pension plans for their retirement and therefore need to be a source of active concern for both regulators and analysts interested in potential manipulation of corporate financial statements.

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Tables and Figures

Table 1: Descriptive statistics

This table presents descriptive statistics of the main dependent and independent variables used in our analysis. Dependent variables are the expected return on pension assets (*EROA*) and change in *EROA* ($\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$) for corporate pension plans in the United States from 2003 to 2011. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Table A1 defines the independent variables. All reported statistics are based on variables winsorized at the 1% and the 99% level. Descriptive statistics include the number of observations (Obs.), mean, standard deviation (SD), minimum (min), maximum (max), and several percentiles of the distribution (p5, p10, p25, p50, p75, p90, and p95).

Variable	Obs.	Mean	SD	Min	p5	p10	p25	p50	p75	p90	p95	Max
Dependent variables												
EROA	15,240	0.0751	0.0204	0	0.0349	0.0516	0.068	0.0778	0.0844	0.0933	0.1028	0.1435
ΔEROA	14,315	-0.0027	0.0182	-0.0864	-0.0255	-0.0164	-0.0073	-0.0016	0.0016	0.0101	0.0237	0.0733
Independent variables												
Liability Discount Rate (*LDR*)	14,804	0.0564	0.0097	0.0205	0.04	0.045	0.0531	0.0575	0.061	0.0645	0.0675	0.09
Fair Value of Pension Assets	15,240	1,357.6	3,580.7	0.568	3.010	6.254	26.878	151.576	771.896	3,235.4	7,476.16	23,542
Fair Value of Pension Liabilities	15,240	1,660.6	4,290.6	1.028	4.5925	9.518	38.7695	202.62	971.99	3,947.3	9,254.26	27,885.6
Funding Level	15,240	0.7789	0.2124	0.1524	0.4321	0.5351	0.6560	0.7790	0.9019	1.0227	1.1191	1.4314
Underfunded	15,240	0.7737	0.4185	0	0	0	1	1	1	1	1	1
Transition to Underfunded	14,357	0.0747	0.2630	0	0	0	0	0	0	0	1	1
Pension Assets in Equity	12,915	0.5589	0.1791	0	0.175	0.306	0.49	0.6	0.67	0.73	0.777	0.94
Pension Assets in Debt	12,809	0.3679	0.1682	0	0.142	0.2	0.27	0.345	0.43	0.56	0.698	1
Pension Sensitivity	13,853	-0.2597	1.5193	-4.4558	-2.9982	-2.2961	-1.1612	-0.1266	0.7030	1.5262	2.0928	3.5464
Pension Expense	15,016	70.55	175.60	-24	0.119	0.522	2.52	11.64	47	170.31	379	1,162.39
Plan Size	15,240	5.3129	2.2204	0.7071	1.7214	2.3531	3.6831	5.3163	6.8804	8.2810	9.1329	10.2359
Firm Size	10,986	7.9071	2.0221	2.6205	4.3720	5.2738	6.6112	7.9458	9.3302	10.4754	11.1723	12.2775
Firm Age	15,240	3.0367	0.8283	0.6931	1.6094	1.9459	2.4849	3.0910	3.8067	4.0431	4.0943	4.1271
Leverage (Debt / Assets)	15,198	0.2650	0.2002	0	0.0024	0.0316	0.1186	0.2356	0.3647	0.5266	0.6435	0.9923
Debt Maturity	11,375	0.8794	0.1937	0	0.4815	0.6791	0.8454	0.9579	0.9962	1	1	1
Book-to-Market Ratio	11,235	0.494	1.020	-7.551	0.000	0.149	0.317	0.515	0.760	1.128	1.496	2.854
Cash and STI	15,146	-2.9066	1.4334	-7.2895	-5.6092	-4.7894	-3.7275	-2.7770	-1.8980	-1.2036	-0.7874	0.0380
Z-Score	10,252	19.395	86.159	-1.302	0.669	1.188	2.062	3.682	6.680	15.303	40.126	728.383
Board Independence	6,878	0.7487	0.1435	0.3	0.4545	0.55	0.6667	0.7778	0.875	0.9	0.9167	0.9286
Big 4 Auditor	6,912	0.9453	0.2274	0	0	1	1	1	1	1	1	1

Table 2: Descriptive statistics before and after year 2008

This table presents descriptive statistics of several pension and firm (plan-sponsor) related variables for the periods 2003–2007 and 2008–2011. The expected return on pension assets (*EROA*) is the expected change in the value of plan assets over a fiscal year normalized by the fair value of plan assets at the end of the previous fiscal year. The change in expected returns (*ΔEROA*) is defined as the difference in *EROA* for 2 consecutive fiscal years ($\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$). Table A1 defines the remaining variables. All reported statistics are based on variables winsorized at the 1% and the 99% level.

A. Pre-PPA years (2003–2007)

Main variables	Obs.	Mean	SD	Min	p5	p10	p25	p50	p75	p90	p95	Max
EROA	8,794	0.0762	0.0195	0	0.0370	0.0552	0.0702	0.0789	0.0849	0.0919	0.0996	0.1435
ΔEROA	8,101	-0.0038	0.0186	-0.0864	-0.0295	-0.0178	-0.0076	-0.0019	0.0009	0.0065	0.0158	0.0733
Funding level	8,794	0.8075	0.2163	0.1524	0.4457	0.5577	0.6841	0.8136	0.9323	1.0511	1.1522	1.4314
Underfunded	8,794	0.6907	0.4622	0	0	0	0	1	1	1	1	1
Transition to underfunded	8,125	0.0260	0.1591	0	0	0	0	0	0	0	0	1
Pension assets in equity	7,179	0.6014	0.1610	0	0.2682	0.404	0.55	0.63	0.7	0.75	0.792	0.94

B. Post-PPA Years (2008–2011)

Main variables	Obs.	Mean	SD	Min	p5	p10	p25	p50	p75	p90	p95	Max
EROA	6,446	0.0737	0.0215	0	0.0324	0.0485	0.0649	0.0756	0.0836	0.0962	0.1065	0.1435
ΔEROA	6,214	-0.0012	0.0176	-0.0864	-0.0229	-0.0150	-0.0069	-0.0012	0.0025	0.0158	0.0283	0.0733
Funding level	6,446	0.7399	0.2006	0.1524	0.4072	0.5168	0.6282	0.7384	0.8527	0.9656	1.0578	1.4314
Underfunded	6,446	0.8869	0.3167	0	0	0	1	1	1	1	1	1
Transition to underfunded	6,232	0.1383	0.3453	0	0	0	0	0	0	1	1	1
Pension assets in equity	5,736	0.5058	0.1864	0	0.11	0.23	0.41	0.55	0.63	0.7	0.74	0.94

Table 3: Expected returns on pension assets

This table presents the annual expected returns on pension assets (*EROA*) for corporate pension plans in the United States, from 2003 to 2011, averaged across different categories (all (2), fully funded (3), and underfunded (4)). *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Fully funded (underfunded) plans are defined as plans with a ratio of pension assets over projected benefit obligations higher (lower) than 0.9 for years preceding 2008, 0.92 for 2008, 0.94 for 2009, 0.96 for 2010, and 1 for 2011 or later (more information is in Table A1). The statistical significance of the mean differences in *EROA* between fully funded and underfunded plans is reported in column (5).

Fiscal year	All plans		Fully funded		Underfunded		Underfunded -Fully funded	
	Number	Mean	Number	Mean	Number	Mean	(U-F)	*p* Value
2003	1,831	8.15%	432	8.13%	1,399	8.15%	0.02%	0.874
2004	1,801	7.72%	425	7.63%	1,376	7.75%	0.12%	0.266
2005	1,776	7.64%	394	7.42%	1,382	7.71%	0.29%	0.008
2006	1,710	7.38%	603	7.39%	1,107	7.38%	-0.01%	0.927
2007	1,676	7.14%	866	7.24%	810	7.05%	-0.19%	0.037
2008	1,655	8.03%	219	7.56%	1,436	8.10%	0.55%	0.001
2009	1,611	7.47%	202	7.17%	1,409	7.52%	0.35%	0.039
2010	1,590	7.11%	201	7.06%	1,389	7.12%	0.06%	0.640
2011	1,590	6.82%	107	6.38%	1,483	6.85%	0.47%	0.047

Table 4: Change in expected returns on pension assets (*ΔEROA*)

This table presents the annual change in expected returns on pension (i.e., $\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$) for corporate pension plans in the United States, from 2003 to 2011, averaged across different categories (all (2), fully funded (3), and underfunded (4)). *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Fully funded (underfunded) plans are defined as plans with a ratio of pension assets over projected benefit obligations higher (lower) than 0.9 for years preceding 2008, 0.92 for 2008, 0.94 for 2009, 0.96 for 2010, and 1 for 2011 or later (more information is in Table A1). The statistical significance of the mean differences in *ΔEROA* between fully funded and underfunded plans is reported in column (5).

Fiscal	All plans		Fully funded		Underfunded		Underfunded - Fully funded	
year	Number	Mean	Number	Mean	Number	Mean	U-F	*p* Value
2003	1,482	-0.82%	375	-0.98%	1,107	-0.77%	0.21%	0.094
2004	1,712	-0.47%	412	-0.58%	1,300	-0.43%	0.15%	0.154
2005	1,681	-0.07%	379	-0.23%	1,302	-0.02%	0.21%	0.0293
2006	1,617	-0.24%	566	-0.28%	1,051	-0.21%	0.07%	0.406
2007	1,609	-0.35%	842	-0.37%	767	-0.31%	0.06%	0.475
2008	1,591	0.84%	208	0.53%	1,383	0.88%	0.36%	0.018
2009	1,570	-0.64%	193	-0.93%	1,377	-0.60%	0.32%	0.018
2010	1,535	-0.40%	194	-0.51%	1,341	-0.38%	0.13%	0.176
2011	1,518	-0.29%	105	-0.35%	1,413	-0.29%	0.06%	0.704

Table 5: Panel regression results (*EROA*: 2003–2011)

This table presents panel regression results of the expected return on pension assets (*EROA* - dependent variable) on the transition (from fully funded to underfunded status) variable and the control variables described in Table A1. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Fixed effects (at the company-sponsor level), year indicators, and clustered robust standard errors are used in all models. All variables are winsorized at the 1% and the 99% level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors are provided in parentheses.

	Dependent variable: Expected return on pension assets		
Transition	0.00203***	0.00165**	0.00146*
	(0.000737)	(0.000743)	(0.000819)
Funding	-0.0224***	-0.0230***	-0.0277***
	(0.00234)	(0.00245)	(0.00294)
Equity	0.0180***	0.0183***	0.0179***
	(0.00227)	(0.00248)	(0.00308)
Leverage	0.00163	0.00226	-0.000571
	(0.00220)	(0.00232)	(0.00324)
Firm Size	-0.000587	-0.000370	0.0000651
	(0.000478)	(0.000459)	(0.000740)
Firm Age	-0.00253	-0.00242	-0.00396
	(0.00222)	(0.00233)	(0.00373)
Debt Maturity	0.00125	0.00155	0.00172
	(0.00106)	(0.00111)	(0.00130)
Book to Market	0.000636***	0.000653***	-0.000442
	(0.000204)	(0.000209)	(0.000407)
Cash and STI	0.000535***	0.000447**	0.000525*
	(0.000187)	(0.000190)	(0.000274)
Z-Score		0.00000274	0.00000205
		(0.00000263)	(0.00000378)
Board Independence			0.000327
			(0.00232)
Big 4 Auditor			0.00159
			(0.00240)
Constant	0.103***	0.1000***	0.106***
	(0.00791)	(0.00813)	(0.0139)
Observations	7364	6883	4350
Adj. *R*-squared	0.168	0.168	0.195
Fixed effects	Firm (sponsor)	Firm (sponsor)	Firm (sponsor)
Year indicators	Yes	Yes	Yes

Table 6: Panel regression results (*ΔEROA*: 2003–2011)

This table presents panel regression results of the change in expected returns (*ΔEROA* - the dependent variable) on the transition (from fully funded to underfunded status) variable and the control variables described in Table A1. *ΔEROA* is the difference in the expected return on pension assets (*EROA*) for 2 consecutive years (i.e., $\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$). *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Fixed effects (at the company-sponsor level), year indicators, and clustered robust standard errors are used in all models. All variables are winsorized at the 1% and the 99% level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors are provided in parentheses.

	Dependent variable: Change in expected return on pension assets		
Transition	0.00401***	0.00330***	0.00338***
	(0.00115)	(0.00117)	(0.00123)
Funding	-0.0183***	-0.0186***	-0.0241***
	(0.00281)	(0.00294)	(0.00356)
Equity	0.00969***	0.0102***	0.0127***
	(0.00264)	(0.00288)	(0.00358)
Leverage	-0.00190	-0.00176	-0.00241
	(0.00288)	(0.00285)	(0.00368)
Firm Size	-0.00274***	-0.00236***	-0.00311***
	(0.000639)	(0.000606)	(0.00101)
Firm Age	0.00367*	0.00384*	0.00514
	(0.00209)	(0.00220)	(0.00356)
Debt Maturity	-0.000101	0.000550	0.000106
	(0.00142)	(0.00149)	(0.00166)
Book to Market	0.000474*	0.000449	-0.000818
	(0.000275)	(0.000282)	(0.000599)
Cash and STI	0.000980***	0.000885***	0.00126***
	(0.000276)	(0.000280)	(0.000416)
Z-Score		0.00000619	0.00000316
		(0.00000482)	(0.00000574)
Board Independence			0.00166
			(0.00303)
Big 4 Auditor			0.000347
			(0.00292)
Constant	0.0125	0.00763	0.0125
	(0.00823)	(0.00832)	(0.0141)
Observations	7352	6872	4342
Adj. R-squared	0.0928	0.0921	0.134
Fixed effects	Firm (Sponsor)	Firm (Sponsor)	Firm (Sponsor)
Year indicators	Yes	Yes	Yes

Table 7: Difference-in-differences (*EROA*: 2003–2011)

This table presents the results of the difference-in-differences regressions of the expected return on pension assets (*EROA* - dependent variable) on the transition (from fully funded to underfunded status) variable in the period before 2008 and the period of 2008 onward. The Post-PPA indicator (1 for 2008–2011; 0 otherwise) captures the exogenous change imposed from the 2008 crisis and also the implementation of the Pension Protection Act (PPA) regulation. The impact of the difference-in-differences model is captured through the interaction term of the transition and Post-PPA indicators. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Table A1 defines the remaining variables. Heteroscedasticity-robust standard errors are used. All variables are winsorized at the 1% and the 99% level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors are provided in parentheses.

	Dependent variable: Expected return on pension assets		
Post-PPA	-0.0110***	-0.0108***	-0.0101***
	(0.000790)	(0.000818)	(0.00105)
Transition	0.00111	-0.000587	-0.00264
	(0.00175)	(0.00157)	(0.00197)
Transition * Post-PPA	0.00444**	0.00607***	0.00789***
	(0.00203)	(0.00191)	(0.00234)
Funding	-0.00322**	-0.00226*	-0.000275
	(0.00132)	(0.00136)	(0.00164)
Equity	0.0308***	0.0320***	0.0335***
	(0.00157)	(0.00165)	(0.00207)
Leverage	0.00214**	0.00303**	0.00419***
	(0.00107)	(0.00121)	(0.00154)
Firm Size	0.000348***	0.000423***	0.000522***
	(0.0000996)	(0.000105)	(0.000153)
Firm Age	0.00186***	0.00172***	0.00123***
	(0.000256)	(0.000271)	(0.000360)
Debt Maturity	0.00155	0.00147	0.00146
	(0.00106)	(0.00114)	(0.00151)
Book to Market	0.0000260	0.0000665	-0.000678
	(0.000209)	(0.000214)	(0.000465)
Cash and STI	-0.000860***	-0.000849***	-0.000775***
	(0.000137)	(0.000139)	(0.000176)
Z-Score		0.00000189	0.000000911
		(0.00000244)	(0.00000345)
Board Independence			0.000762
			(0.00163)
Big 4 Auditor			0.00152
			(0.00105)
Constant	0.0552***	0.0534***	0.0501***
	(0.00225)	(0.00237)	(0.00324)
Observations	7364	6883	4350
Adj. *R*-squared	0.183	0.186	0.206

Table 8: Robustness of difference-in-differences regressions (*EROA*: 2003–2011)

This table presents robustness results of difference-in-differences regressions of the expected return on pension assets (*EROA* - dependent variable) on the transition (from fully funded to underfunded status) variable in the period before 2008 and the period of 2008 onward. The crisis indicator (1 for 2008–2011; 0 otherwise) captures the exogenous change imposed from the 2008 crisis and also the implementation of the Pension Protection Act (PPA) regulation. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. The impact of the difference-in-differences model is captured through the interaction term of the transition and crisis indicators. The robustness of results reported in Table 7 are tested against additional control variables, such as, the liability discount rate (*LDR*) assumption employed by previous studies (e.g., Anantharaman, 2017; Kisser et al., 2017) and the sensitivity variable employed by Bergstresser et al. (2006). The remaining control variables are the same as those used in Table 7 and are described in Table A1. Heteroscedasticity-robust standard errors are used. All variables are winsorized at the 1% and the 99% level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors are provided in parentheses.

	Dependent variable: Expected return on pension assets			
Post-PPA	-0.0101***	-0.0106***	-0.000477	-0.00108
	(0.00105)	(0.00104)	(0.00126)	(0.00126)
Transition	-0.00264	-0.00104	-0.00140	0.0000846
	(0.00197)	(0.00184)	(0.00195)	(0.00184)
Transition * Post-PPA	0.00789***	0.00605***	0.00574**	0.00406*
	(0.00234)	(0.00225)	(0.00230)	(0.00221)
Funding	-0.000275	-0.00438***	-0.00354**	-0.00743***
	(0.00164)	(0.00168)	(0.00154)	(0.00161)
Equity	0.0335***	0.0321***	0.0295***	0.0285***
	(0.00207)	(0.00210)	(0.00195)	(0.00200)
Leverage	0.00419***	0.00340**	0.00444***	0.00383**
	(0.00154)	(0.00154)	(0.00150)	(0.00150)
Firm Size	0.000522***	0.000940***	0.000561***	0.000957***
	(0.000153)	(0.000164)	(0.000150)	(0.000160)
Firm Age	0.00123***	0.000521	0.00126***	0.000627*
	(0.000360)	(0.000380)	(0.000350)	(0.000367)
Debt Maturity	0.00146	0.000870	0.00201	0.00156
	(0.00151)	(0.00151)	(0.00145)	(0.00143)
Book to Market	-0.000678	0.0000996	-0.000696	0.0000608
	(0.000465)	(0.000505)	(0.000468)	(0.000506)
Cash and STI	-0.000775***	-0.000880***	-0.000534***	-0.000656***
	(0.000176)	(0.000177)	(0.000173)	(0.000175)
Z-Score	0.000000911	0.00000154	0.00000403	0.00000517
	(0.00000345)	(0.00000353)	(0.00000318)	(0.00000331)
Board Independence	0.000762	-0.000576	0.00198	0.000750
	(0.00163)	(0.00166)	(0.00156)	(0.00159)
Big 4 Auditor	0.00152	-0.000280	0.000424	-0.000579
	(0.00105)	(0.00108)	(0.00101)	(0.00105)
Sensitivity		0.00175***		0.00158***
		(0.000200)		(0.000196)
LDR			0.715***	0.701***
			(0.0587)	(0.0616)
Constant	0.0501***	0.0562***	0.0112***	0.0165***
	(0.00324)	(0.00325)	(0.00419)	(0.00436)
Observations	4350	4170	4326	4148
Adj. *R*-squared	0.206	0.228	0.255	0.275

Table 9: Difference-in-differences (*ΔEROA*: 2003–2011)

This table presents the results of the difference-in-differences regressions of the change in expected returns (*ΔEROA* - the dependent variable) on the transition (from fully funded to underfunded status) variable in the period before 2008 and the period of 2008 onward. The crisis indicator (1 for 2008–2011; 0 otherwise) captures the exogenous change imposed from the 2008 crisis and also the implementation of the Pension Protection Act (PPA) regulation. The impact of the difference-in-differences model is captured through the interaction term of the transition and crisis indicators. *ΔEROA* is the difference in the expected return on pension assets (*EROA*) for 2 consecutive years (i.e., $\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$). *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. Table A1 defines the remaining variables. Heteroscedasticity-robust standard errors are used. All variables are winsorized at the 1% and the 99% level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors are provided in parentheses.

	Dependent variable: Change in expected return on pension assets		
Post-PPA	0.00438***	0.00470***	0.00600***
	(0.000887)	(0.000921)	(0.00120)
Transition	0.000761	-0.00195	-0.00242
	(0.00287)	(0.00284)	(0.00235)
Transition * Post-PPA	0.00520*	0.00785***	0.00802***
	(0.00302)	(0.00301)	(0.00262)
Funding	-0.00607***	-0.00576***	-0.00578***
	(0.00128)	(0.00132)	(0.00157)
Equity	0.00448***	0.00436***	0.00571***
	(0.00150)	(0.00159)	(0.00204)
Leverage	-0.000429	-0.000280	-0.000461
	(0.00114)	(0.00130)	(0.00163)
Firm Size	-0.000166	-0.000190*	-0.0000322
	(0.000105)	(0.000113)	(0.000165)
Firm Age	0.000534*	0.000615**	0.000296
	(0.000284)	(0.000305)	(0.000382)
Debt Maturity	-0.000579	-0.00000847	-0.000443
	(0.00107)	(0.00117)	(0.00152)
Book to Market	0.0000604	0.0000186	-0.000735
	(0.000227)	(0.000234)	(0.000453)
Cash and STI	0.000200	0.0000799	0.0000924
	(0.000158)	(0.000162)	(0.000196)
Z-Score		0.00000459*	0.00000177
		(0.00000235)	(0.00000264)
Board Independence			0.000546
			(0.00179)
Big 4 Auditor			-0.00118
			(0.00123)
Constant	-0.00508**	-0.00653***	-0.00701**
	(0.00210)	(0.00226)	(0.00324)
Observations	7352	6872	4342
Adj. R-squared	0.0753	0.0770	0.108

Table 10: Difference-in-differences model 2 (*ΔEROA*: 2003–2011)

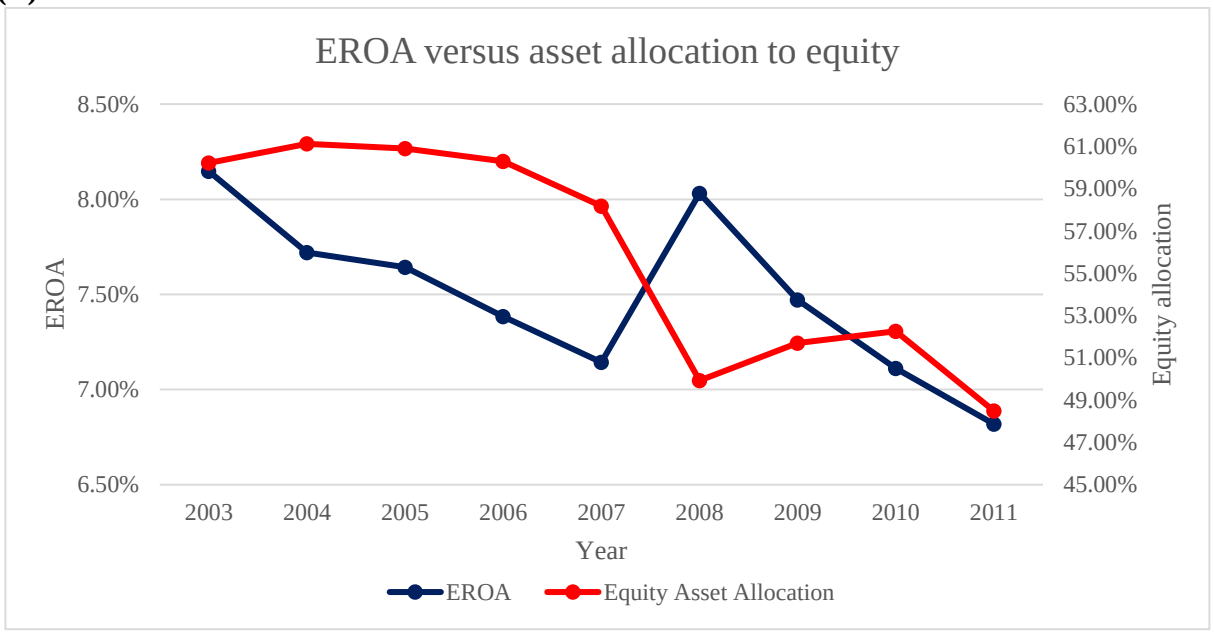
This table presents the robustness results of difference-in-differences regressions of the change in expected return on pension assets (*ΔEROA* - dependent variable) on the transition (from fully funded to underfunded status) variable in the period before 2008 and the period of 2008 onward. The crisis indicator (1 for 2008–2011; 0 otherwise) captures the exogenous change imposed from the 2008 crisis and also the implementation of the Pension Protection Act (PPA) regulation. ΔER is the difference in the expected return on pension assets (*EROA*) for 2 consecutive years (i.e., $\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$). *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. The impact of the difference-in-differences model is captured through the interaction term of the transition and crisis indicators. The robustness of results reported in Table 9 are tested against additional control variables, such as the liability discount rate (*LDR*) assumption employed by previous studies (e.g., Anantharaman, 2017; Kisser et al., 2017) and the sensitivity variable employed by Bergstresser et al. (2006). The remaining control variables are the same as those used in Table 9 and are described in Table A1. Heteroscedasticity-robust standard errors are used. All variables are winsorized at the 1% and the 99% level. $*p < 0.1$; $**p < 0.05$; $***p < 0.01$. Standard errors are provided in parentheses.

	Dependent variable: Change in expected return on pension assets			
Post-PPA	0.00600***	0.00612***	0.00779***	0.00827***
	(0.00120)	(0.00121)	(0.00145)	(0.00149)
Transition	-0.00242	-0.00258	-0.00217	-0.00228
	(0.00235)	(0.00241)	(0.00236)	(0.00242)
Transition * Post-PPA	0.00802***	0.00829***	0.00760***	0.00778***
	(0.00262)	(0.00269)	(0.00263)	(0.00270)
Funding	-0.00578***	-0.00526***	-0.00588***	-0.00553***
	(0.00157)	(0.00162)	(0.00158)	(0.00165)
Equity	0.00571***	0.00610***	0.00572***	0.00604***
	(0.00204)	(0.00214)	(0.00207)	(0.00217)
Leverage	-0.000461	-0.00111	-0.000274	-0.000892
	(0.00163)	(0.00164)	(0.00163)	(0.00164)
Firm Size	-0.0000322	-0.00000438	-0.0000230	0.0000113
	(0.000165)	(0.000183)	(0.000165)	(0.000183)
Firm Age	0.000296	0.000386	0.000255	0.000345
	(0.000382)	(0.000398)	(0.000383)	(0.000397)
Debt Maturity	-0.000443	-0.000317	-0.000379	-0.000219
	(0.00152)	(0.00153)	(0.00152)	(0.00153)
Book to Market	-0.000735	-0.000164	-0.000709	-0.000119
	(0.000453)	(0.000427)	(0.000454)	(0.000425)
Cash and STI	0.0000924	0.0000569	0.000140	0.000108
	(0.000196)	(0.000200)	(0.000198)	(0.000201)
Z-Score	0.00000177	0.00000153	0.00000234	0.00000238
	(0.00000264)	(0.00000279)	(0.00000265)	(0.00000282)
Board Independence	0.000546	0.000684	0.000787	0.000964
	(0.00179)	(0.00186)	(0.00179)	(0.00186)
Big 4 Auditor	-0.00118	-0.000668	-0.00140	-0.000789
	(0.00123)	(0.00119)	(0.00124)	(0.00119)
Sensitivity		-0.000194		-0.000193
		(0.000228)		(0.000226)
LDR			0.118*	0.143**
			(0.0613)	(0.0647)
Constant	-0.00701**	-0.00914***	-0.0142***	-0.0179***
	(0.00324)	(0.00314)	(0.00449)	(0.00451)
Observations	4342	4162	4320	4142
Adj. R-squared	0.108	0.110	0.110	0.113

Figure 1. EROA and pension equity allocation

Panel A shows the annual average (across all pension plans) of the expected return on pension assets (*EROA*) and pension asset allocation to equity from 2003 to 2011. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. The pension asset allocation in equity is the proportion of pension assets allocated to equity. Both variables are winsorized at the 1% and the 99% level, and the plots are given in percentage terms. Panel B shows the annual average (across all pension plans) of the expected return on pension assets (*EROA*) and the daily level of the S&P 500 index from 2003 to 2011. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. *EROA* is winsorized at the 1% and the 99% level.

(A)



(B)

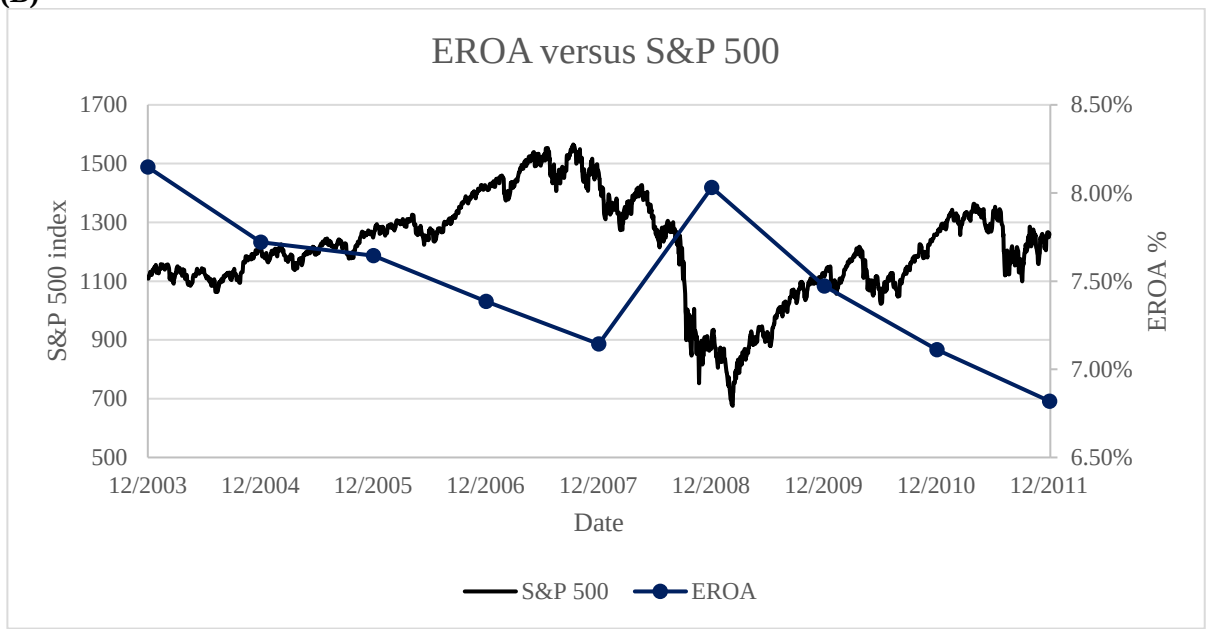


Figure 2. EROA by pension funding status

This figure shows the annual average (across all pension plans) of the expected return on pension assets (*EROA*) and pension asset allocation to equity from 2003 to 2011. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. *EROA* is winsorized at the 1% and the 99% level and, in this graph, is given in percentage terms. Pension plans are classified to fully funded and underfunded. Underfunded refers to plans with a funding level below 90% for years 2003–2007 and a funding level below 92%, 94%, 96%, and 100% for years 2008, 2009, 2010, and 2011 or later, respectively.

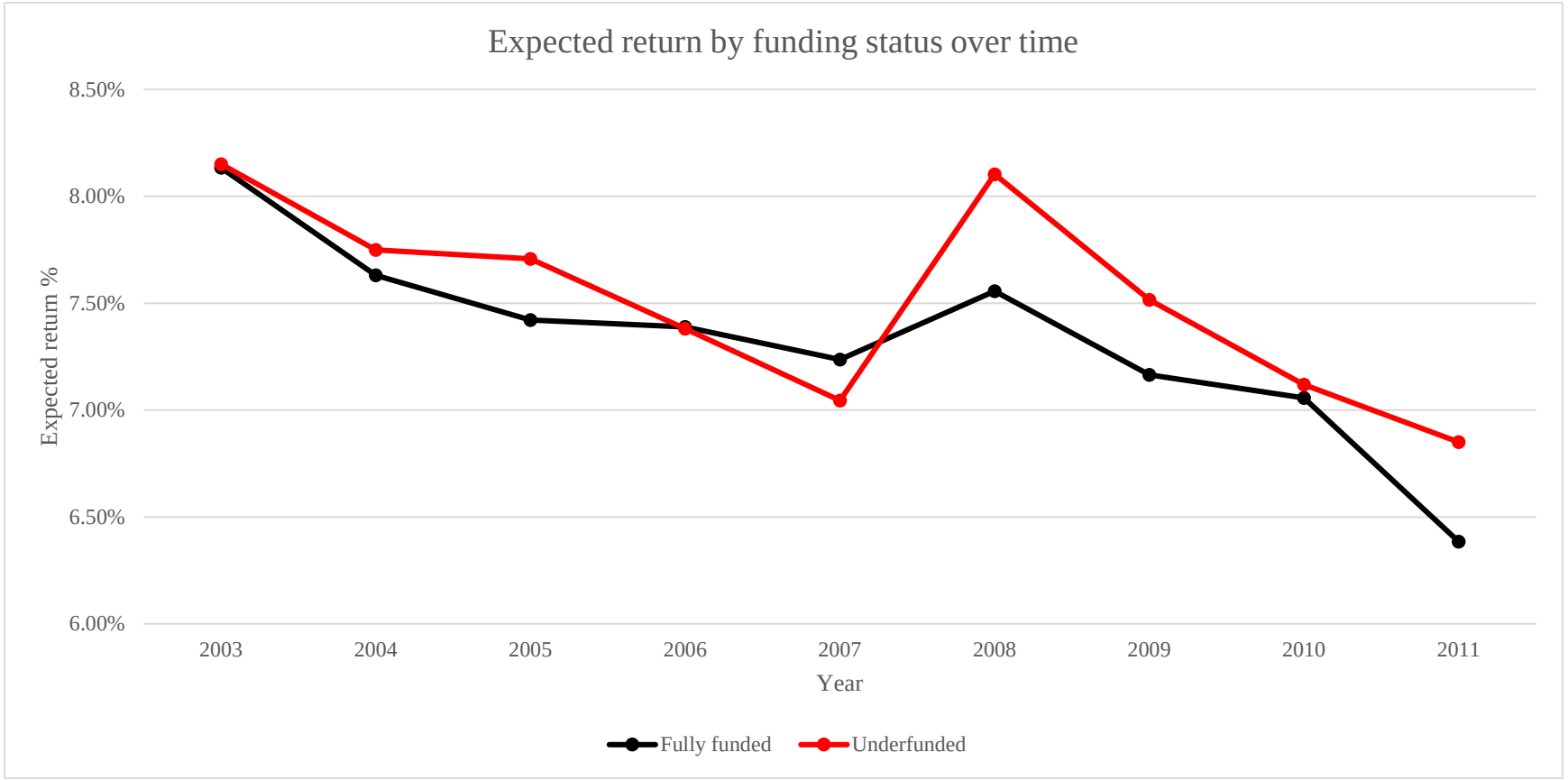
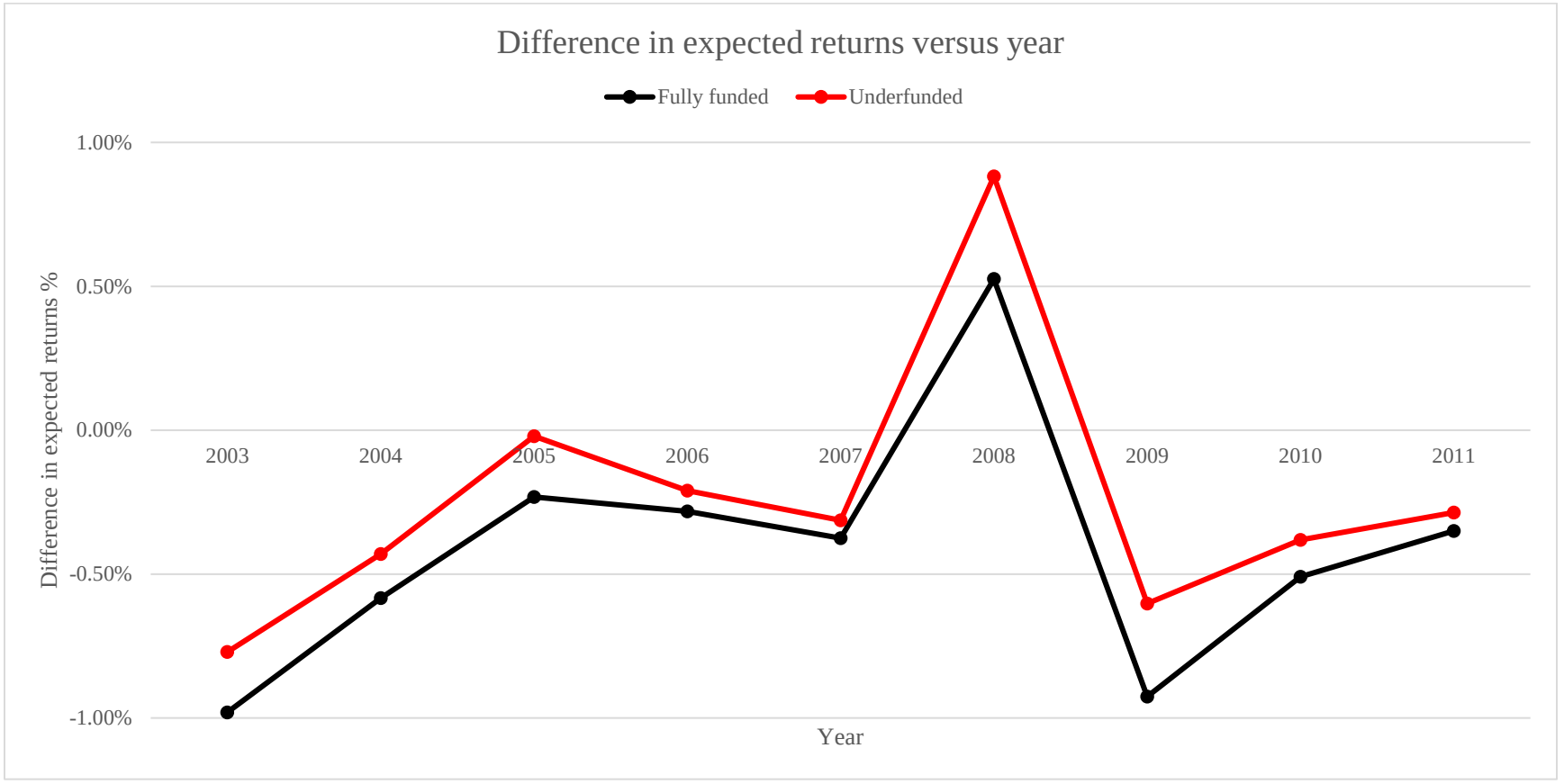


Figure 3. Change in plan's EROA by funding status

This figure shows the annual average (across all pension plans) of the change in expected returns (*ΔEROA*) conditional on the plan funding status from 2003 to 2011. *ΔEROA* is the difference between the expected return on pension assets (*EROA*) for 2 consecutive years (for instance, $\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$). *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year. *EROA* is winsorized at the 1% and the 99% level and, in this graph, is given in percentage terms. Pension plans are classified to fully funded and underfunded. Underfunded refers to plans with a funding level below 90% for years 2003–2007 and a funding level below 92%, 94%, 96%, and 100% for years 2008, 2009, 2010, and 2011 or later, respectively.



Appendix

Table A1. Variable definitions and sources of data

Variable description	Symbol	Definition and source
Valuation assumptions		
Expected Return of Pension Assets	*EROA*	Estimated by normalizing the Expected Change in Pension Assets Value (Compustat item PPRPA) with the Total Pension Assets (Compustat Item PPLAO) at the end of the previous fiscal year. *EROA* is an assumption made at the end of the fiscal year that corresponds to the expected return on pension assets for the following fiscal year.
Change in Expected Returns	$\Delta EROA$	The difference between the expected return on pension assets for 2 consecutive years (i.e., $\Delta EROA_{t+1} = EROA_{t+1} - EROA_t$).
Pension Liabilities Discount Rate	*LDR*	The discount rate that firms use to find the present value of pension liabilities (Compustat item PBARR, divided by 100).
Plan-Related		
Funding level	Funding	The funding level of pension plans is estimated from the ratio of pension plan assets (Compustat item PPLAO) over projected benefit obligations (Compustat item PBPRO)
Underfunding Status	Underfunded	Indicator variable set to 1 if funding level is below 0.9 for years preceding 2008, 0.92 for 2008, 0.94 for 2009, 0.96 for 2010 and 1 for 2011.
Transition	Transition	Transitions is an indicator variable set to 1 when a pension plan drops to underfunding, in the current fiscal year, when it was classified as non-underfunded in the previous fiscal year. Set to 0 otherwise.
Pension Assets in Equity	Equity	The proportion of pension assets invested in equity (Compustat item PNATE, divided by 100).
Ratio of Pension Assets to Operating Income	Sensitivity	The natural logarithm of the ratio of Pension Assets (Compustat item PPLAO) by firm operating income (Compustat item OANCF).

Firm Related		
Ratio of Leverage	Leverage	Long-term debt (Compustat item DLTT) + Debt in current liabilities (Compustat item DLC) / Total Firm Assets (Compustat item AT).
Size of Firm	Firm Size	The natural logarithm of size of market value ([Compustat item (CSHO)* Compustat item (PRCC_F) + Compustat item (DT) + Compustat item (PSTK)]).
Age of Firm	Firm Age	The natural logarithm of unity added to the total number of years a firm is listed with Compustat, until the year of observation.
Debt Maturity	Debt Maturity	The ratio of long-term debt (Compustat item DLTT) over total debt (Compustat item DT).
Book to Market	Book to Market	The ratio of total book value of equity (given by the product of Compustat item (CSHO) and Compustat item (BKVLPS)) over the total market value of equity (Compustat item MKVALT) of a firm.
Cash and Short-Term Investments	Cash and STI	The natural logarithm of the ratio of Cash and Short-Term Investments (Compustat item CHE) over the difference of Total Firm Assets (Compustat item AT) and Cash and Short-Term Investments (Compustat item CHE).
Altman Z-Score	Z-score	Estimated by 1.2 * [Current Firm Assets (Compustat item ACT) - Current Firm Liabilities (Compustat item LCT)] / Total Firms Assets (Compustat item AT) + 1.4 * Retained Earnings (Compustat item RE) / Total Firm Assets (Compustat item AT) + 3.3 * Operating Income After Depreciation (Compustat item OIADP) / Total Firm Assets (Compustat item AT) + 0.6 * [Firm Stock Price (Compustat item PRCC_F) * Number of Shares Outstanding (Compustat item CSHO)] / [Debt in Current Liabilities (Compustat item DLC) + Long-Term Debt (Compustat item DLTT)] + 0.99 * Total Sales (Compustat item SALE) / Total Firm Assets (Compustat item AT).
Board Independence	Board Independence	Number of Board of Directors that are not firm employees (MSCI item DIRECTORSOUTSIDE) / Total Number of members in Board of Directors (MSCI item DIRECTORSTOTAL).
Big 4 Auditor Indicator	Big 4 Auditor	Indicator variable set to 1 if the plan sponsor is audited by one of the Big 4 audit firms (Deloitte, KPMG, PWC, Ernst & Young, given by MSCI item AUDITOR). Set to 0 otherwise.