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The unique regulation of U.S. public pension funds links their liability discount rate to the expected return on assets, which gives them incentives to invest more in risky assets in order to report a better funding status. Comparing public and private pension funds in the United States, Canada, and Europe, we find that U.S. public pension funds act on their regulatory incentives. U.S. public pension funds with a higher level of underfunding per participant, as well as funds with more politicians and elected plan participants serving on the board, take more risk and use higher discount rates. The increased risk-taking by U.S. public funds is negatively related to their performance. (*JEL* G11, G18, G23, H55)

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Defined benefit (DB) pension funds promise retirement benefits that depend on the employee's earnings history, tenure of service, and age. DB retirement systems typically pool the assets of multiple generations and allow for intergenerational as well as intragenerational risk-sharing (Merton 1983;

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Shiller 1999). The risk-sharing can create a conflict of interest between the different stakeholders or across generations, particularly when a DB pension fund is underfunded—that is, when the value of its assets is lower than the value of its liabilities representing the promised pension benefits (Brown 2008; Novy-Marx and Rauh 2011b). The reported funding shortfall in pension fund accounting statements depends crucially on the liability discount rate that is used to value the stream of promised benefits. In general, the higher the discount rate that is used, the lower the reported present value of the liabilities and the stronger the pension plan's funding position as reported in the accounting statements. In this paper, we consider the incentives of current pension fund stakeholders to use a higher liability discount rate in order to reduce the probability that a low reported funding level triggers regulatory increases in the contribution payments and public discussions on reductions in future (or even already accrued) pension benefits.[1]

The regulation of U.S. public pension funds allows considerably more discretion in setting the liability discount rate compared with the regulation of other pension funds. U.S. public pension funds follow the Government Accounting Standards Board (GASB) guidelines for discounting liabilities, which allow them to base their liability discount rates on the (assumed and thus more discretionary) expected rate of return on their assets (Brown and Wilcox 2009). In contrast, the regulations pertaining to the discount rates of U.S. private pension funds, as well as Canadian and European public and private pension funds, require that their liability discount rates are based on high credit quality interest rates and thus their discount rates cannot be managed by modifying the allocation to risky assets. For instance, Canadian public and private pension plans discount their liabilities using market yields of high-quality corporate debt instruments (Canadian Institute of Actuaries 2011), while U.S. corporate pension plans use a discount rate that is a combination of upper-medium and high-grade long-term corporate bonds (Rauh 2006). In this paper, we consider how this difference in regulation is associated with pension fund asset allocation and investment performance.

The GASB regulations for U.S. public pension funds have two important consequences, the first of which has been studied extensively in the literature and the second of which is new and the main empirical contribution of our paper. The first consequence is that GASB guidelines allow U.S. public funds to severely understate their liabilities. The accrued pension benefits of U.S. public plans appear legally well protected, such that using the expected return on assets will generally imply a discount rate that is too high. Brown and Wilcox (2009) and Novy-Marx and Rauh (2011b) suggest that promised pensions should be discounted at a rate that reflects the time value of money and the uncertainty

[1] For instance, among U.S. public pension funds, the employer (i.e., the state, county, or city) needs to pay an additional catch-up contribution to cover the already accrued, but unfunded liabilities over the next thirty years (GASB 1994). The size of these amortization payments depends on the dollar value of the funding deficit.

of these liabilities. Brown and Pennacchi (2015) further argue that for funding purposes, pension funds should always use default-free discount rates.

The second consequence of GASB regulations is that the link between the discount rate and the expected return on their assets affords U.S. public pension funds considerable discretion to manage their liability discount rate by changing their allocation across asset classes and by choosing an expected return for individual asset classes. The main "regulatory incentives hypothesis" we posit is that the regulatory link between the liability discount rate and the expected rate of return on assets gives U.S. public funds an incentive to increase their allocation to risky assets. A larger allocation to risky assets allows these funds to employ higher expected returns and thus to justify a higher discount rate and, as a consequence, lower the reported value of the liabilities. Further, as GASB regulations serve only as guidelines, the extent to which U.S. public plans respond to these incentives may depend on their current and prospective funding status, as well as their board composition. Specifically, differences in how various stakeholder groups are represented on the board could be associated with funds' decisions on the allocation to risky assets, which in turn could have consequences for their investment performance.

We define the percentage allocated to risky assets as investments in public equity, alternative assets, and high-yield bonds. We relate the percentage allocated to risky assets to the percentage of retired pension plan members, which we refer to as the "fund maturity." Funds with more retired members are generally more likely to face worsening future funding status prospects, such that our regulatory incentives hypothesis implies that more mature U.S. public funds are expected to face increased incentives to maintain a high liability discount rate.[2] Alternatively, if the regulation does not affect the asset allocation, then the relation between fund maturity and risky asset allocation should be similar for all groups of pension funds. However, we document that a 10% increase in the percentage of retired members of U.S. public pension funds is associated with a 5.93% increase in their allocation to risky assets, while for all other pension funds, a 10% increase in the percentage of retired members is associated with a 1.67% lower allocation to risky assets. This increased risk-taking enables more mature U.S. public funds to use higher discount rates, as a 10% increase in their percentage of retired members is associated with a 75-basis-point increase in their discount rate.[3]

In contrast, the asset allocation of our control group, consisting of U.S. corporate pension funds as well as Canadian and European pension funds, becomes more conservative as the funds mature. This result is in line with Rauh (2009) and suggests that these pension funds take less investment risk when

[2] Below, we examine in more detail the various pension fund characteristics that provide explanatory power for the percentage of retired pension plan members across funds.

[3] Similarly, Mohan and Zhang (2014) examine financial constraints at the state level and document that public DB pension funds from states with lower credit ratings invest more in equity.

their promised benefits need to be met sooner and become less uncertain due to increased retirements. In line with this intuition, we also find that more mature pension funds in the control group use lower discount rates that better reflect the shorter duration of their cash outflows and the corresponding generally upward-sloping yield curve.

In our regulatory incentives hypothesis, we further posit that U.S. public pension funds increase allocations to risky assets when expected asset returns decline. Our empirical proxy for the level of expected asset returns is the nominal level of interest rates, which is exogenous to individual pension plans. During our sample period, the ten-year U.S. Treasury yield fell from 7% in 1994 to less than 2% in 2012. As interest rates decline, the expected rates of return on both risky and non-risky assets fall, although U.S. public pension funds can refrain from lowering their liability discount rate by increasing their allocation to risky assets. Consistent with our regulatory incentives hypothesis, U.S. public funds significantly increase their allocation to risky assets when interest rates are declining, while the funds in the control groups do not. Economically, the approximately five-percentage-point decline in the yield on ten-year Treasury notes is associated with a fifteen-percentage-point increase in their allocation to risky assets.

Taking more risk may affect the pension fund performance. The regulatory incentives hypothesis implies that U.S. public pension funds change their asset allocation in order to manage their liability discount rate and the reported funding level, rather than to respond to the available investment opportunities or asset-liability considerations. However, if asset allocation decisions are in part driven by regulatory incentives, U.S. public pension funds may be looking for additional investments in risky assets during periods when there are fewer attractive investment opportunities or when they have limited capacity to select and monitor additional risky investments. In this case, we would expect them to underperform.

We evaluate investment performance by adjusting the gross pension fund returns for both their investment costs and the benchmark performance within various asset classes, thus taking asset allocation decisions as given. We find that U.S. public plans underperform the benchmarks by about 51 basis points a year, and that their underperformance is substantially worse if the fund is more mature. A 10% increase in the maturity of U.S. public pension funds is associated with 38–58 basis points lower returns (depending on the specification). The underperformance of mature U.S. public plans is primarily due to lower returns in equities and alternative assets—that is, those risky assets in which they particularly increased their allocation in order to maintain higher liability discount rates. None of the other groups of pension funds underperform on average.

Overall, we document that U.S. public pension funds with a higher percentage of retired members invest more in risky assets, maintain higher liability discount rates, and obtain lower returns. Next, we focus on the subsample of U.S. public pension funds for which more detailed data is available on the funding status and board of trustees. This allows us to examine in more detail how fund maturity is related to the level of underfunding, board composition, and local economic circumstances.

First, we estimate the level of underfunding per plan participant, which determines the level of required contribution payments (i.e., the additional cash payments needed to reduce underfunding). More mature pension funds have larger accrued liabilities for a given number of participants, since on average these participants have accrued liabilities for a longer period of time. If a pension fund is underfunded, it is required to pay additional catch-up contributions to amortize the unfunded accrued liability (Governmental Accounting Standards Board 1994, Novy-Marx and Rauh 2014).[4] The size of these catch-up contributions depends on the dollar amount of the funding deficit, rather than on the funding ratio itself (as long as the pension fund is underfunded). Since mature pension funds have larger accrued liabilities per participant, any reduction in the discount rate results in a larger increase in the dollar amount of their reported liabilities and thus in their funding deficit, which translates into higher required contribution payments.[5] As a result, the regulatory incentives hypothesis implies that U.S. public pension funds with a higher underfunding per participant have stronger incentives to invest more in risky assets and maintain a higher liability discount rate, because it enables them to reduce the required contributions today and transfer more of the economic cost of underfunding to the future.

Second, we hand-collect data on the board composition of U.S. public pension funds from their Comprehensive Annual Financial Reports (CAFRs). Pension fund trustees can represent three stakeholder groups: the plan participants, the state (employer), and taxpayers (citizens). Board members differ also in the procedure through which they join the board. They can be elected by plan participants, be appointed by government officials, or serve as ex officio members by virtue of holding a political position. Fund maturity is positively related to the percentage of state-political trustees and participant-elected trustees, and we hypothesize that these board members are more likely to act on the regulatory incentives.

[4] Online Appendix Figure E.1 shows that essentially all U.S. public pension funds are underfunded during our sample period.

[5] The following example illustrates the economic consequences of lowering the liability discount rate in the case of underfunding. In 2012, the actuary of CalPERS recommended lowering the discount rate from 7.75% to 7.25% (see "CalPERS Should Cut Assumed Return to 7.25%, Actuary Says," *Bloomberg*, March 7, 2012). The article states: "Lowering the return would boost the state's pension costs, as a percent of payroll, as much as 4.2 percent in the year beginning July 1, according to a CalPERS staff report. Local governments could see an increase of as much as 4.5 percent. The costs for some public safety agencies could jump as much as 6.5 percent. ... The board rejected a similar proposal ... last year. Board members at the time expressed concern that lowering the rate to 7.5 percent would burden local governments when they were already facing financial strains." One week later, the CalPERS board decided to indeed lower the discount rate, but by only half as much as recommended by its actuary (see "CalPERS Lowers Investment Target to 7.5%," *Wall Street Journal*, March 14, 2012).

State-political board members are politicians like treasurers, comptrollers, or state senators working for the public entity sponsoring the pension fund. We expect that these trustees are more susceptible to regulatory incentives because they have a relatively short-term focus that is influenced by their fairly short political cycle. Thus, we hypothesize that they prefer to postpone required contribution increases, pension restructuring, and other fiscally costly decisions during the current cycle. Based on GASB regulations, the employer (not the plan members) has the obligation to entirely cover the additional catch-up contributions, whereas politicians have strong incentives to minimize these contribution payments and use the resources for other purposes.[6]

Participant-elected trustees represent the currently employed and retired pension plan members. As older plan participants have a shorter horizon, their representatives may be more willing to transfer the economic costs of underfunding to the future. Older participants have incentives to increase risk-taking and maintain a higher discount rate because, in the short term, they are not obliged to pay higher contributions if increased risk-taking results in low returns and more underfunded liabilities, but they could benefit from increased pensions if risk-taking yields good returns. It is only after reported underfunding persists for a prolonged period that plan members may be exposed to reductions in pension benefits (as has happened, for example, in Rhode Island and New Jersey).[7] In addition, as any reductions are arguably unlikely to apply retroactively to accrued benefits, older pension participants may be less concerned about the long-term viability of the fund and more concerned about any short-term contribution increases, and thus more likely to elect board members who are more susceptible to the regulatory incentives.

Our results confirm the hypothesis considered in the full sample, namely that U.S. public pension funds with a higher percentage of retired members are more susceptible to regulatory incentives. In the subsample of U.S. public pension funds, fund maturity is strongly related to the level of underfunding per participant and board composition. We find that U.S. public pension funds with a higher level of underfunding per participant invest more in risky assets and use higher liability discount rates, consistent with our intuition that these pension funds have stronger incentives to report a lower funding deficit and reduce the required contribution payments today. We also find that pension funds with

[6] Mitchell and Smith (1994) discuss how several states have reduced budget deficits in the short run by altering the actuarial assumptions used to compute their pension obligations. For example, in 1989, the New York State Common Retirement Fund raised the assumed rate of return on pension fund assets from 8% to 8.75%, which lowered pension contributions by $325 million annually and helped balance a state budget deficit (see "States Are Finding Pension Funds Can Be a Bonanza Hard to Resist," *New York Times*, April 22, 1990). Interestingly, the New York State Common Retirement Fund is governed only by politicians, because the New York State Comptroller is the sole trustee directly accountable for the performance, oversight, and management of the fund.

[7] The Rhode Island Retirement Security Act of 2011 was implemented on July 1, 2012, and it tied the cost-of-living adjustments (COLAs) to the funding level and actual investment returns. This act suspended any COLAs until the funding level exceeds 80%. In New Jersey, Chapter 78, P.L. 2011 of the Pension and Health Benefit Reform Law, suspended future COLAs for all participants as of August 1, 2011. The retirement committees have the authority to reactivate the COLA on pensions when a target funded ratio of 75–80% is achieved.

a higher percentage of state-political and participant-elected trustees allocate more to risky assets and use higher discount rates, confirming our hypothesis that these trustees are more susceptible to regulatory incentives. For instance, a pension fund whose board consists only of state-political members invests 10 percentage points more in risky assets than a pension fund without state-political trustees. Pension fund performance is primarily negatively related to the composition of the board and not to the level of underfunding per member. We find that U.S. public pension funds governed by more state-political and participant-elected board members underperform.

Brown and Wilcox (2009), Novy-Marx and Rauh (2009), Pennacchi and Rastad (2011), and Mohan and Zhang (2014) suggest that GASB regulations provide pension sponsors with incentives to invest in riskier portfolios in order to justify a higher discount rate and report a lower funding gap. Our main contribution is to empirically test this prediction, and document that U.S. public pension funds indeed seem to act on these incentives. By comparing U.S. public funds with public Canadian and European public funds, we show that fund type (public vs. private) is not the key determinant of the differences in strategic asset allocation and liability discount rates. By comparing U.S. public funds with U.S. private funds, we show that differences in regulations, not country effects, explain the allocation and discount rate choices of funds.

With regard to pension fund performance, Goyal and Wahal (2008) and Hochberg and Rauh (2013) find that U.S. public pension funds underperform in public and private equity. Our contribution to this literature is to show that differences in regulations are associated with pension fund investment performance. One potential explanation for the underperformance of U.S. public funds in equity and alternative assets is their excessive risk-taking due to regulatory incentives, but we cannot rule out alternative explanations unrelated to regulatory incentives, like lower skills and political incentives.

Our paper also contributes to the literature on pension fund governance. Cocco and Volpin (2007) document agency conflicts among the corporate executives acting as trustees of U.K. private pension funds. Among U.S. public pension funds, prior research finds that pension funds whose boards have a high fraction of members who are politically affiliated or represent plan participants take more risk (Pennacchi and Rastad 2011; Bradley, Pantzalis, and Yuan 2016). We find that asset allocation decisions and performance are related to stakeholder representation and the procedure through which trustees join the board.

1. Regulatory Background and Empirical Design

In this paper, we examine whether the asset allocation and performance of U.S. public pension funds are related to the distinct regulation concerning their liability discount rates. In this context, it is important to note that U.S., Canadian, and European pension funds generally face no limits on the proportion of investments they can make in risky assets.[8]

U.S. public pension funds follow the GASB guidelines, which allow them to base their liability discount rates on the expected return on their assets.[9] Our regulatory incentives hypothesis posits that since U.S. public pension funds are unconstrained in the proportion of their assets that can be invested in risky asset classes, they can use the GASB regulations strategically. They can invest more in risky assets in order to justify a higher discount rate and present a better funding position, which in turn may reduce required contribution payments or postpone potential pension reforms. One concern is that, in addition to regulation, other economic determinants could also influence the asset allocation of U.S. public funds. We test the regulatory incentives hypothesis by comparing the asset allocation, discount rates, and performance of U.S. public pension funds with two control groups of pension funds that face different regulatory standards.

The first group consists of U.S. corporate DB pension funds, which we argue face similar investment opportunities as U.S. public DB pension funds. For example, both private and public U.S. pension funds overweight domestic assets (Goyal and Wahal 2008) that expose them to correlated performance shocks. By comparing U.S. public funds with U.S. private funds, we test whether differences in regulation, not country effects, explain the asset allocation and performance of funds. The second control group comprises Canadian and European public and private DB pension funds. Private and public pension funds may be subject to differences in career risk and life-cycle patterns among their participants. In addition, public and private funds face different implicit guarantees by the government for support in case of funding problems (Brown 2008). We show that there are no significant differences in the regulation of public and private pension funds in Canada and Europe. In our analysis, we find that public funds in Europe and Canada make similar allocation decisions as their private counterparts, while U.S. public funds make distinct investment decisions from U.S. private funds, such that we can attribute the differences in asset allocation to the distinct regulation, and not to the plan type.

Most importantly for our empirical identification, the discount rates of U.S. private pension funds as well as Canadian and European public and private pension funds do not depend on the expected rate of return on their investments and hence cannot be managed by modifying the allocation to risky assets.

[8] See the Organisation for Economic Co-operation and Development (OECD) (2011) Survey of Investment Regulation of Pension Funds.

[9] The first GASB statement was issued in 1987, in which U.S. public plans were advised to discount their liabilities using the expected return on assets regardless of their funding status. The only major revision of GASB discounting guidelines occurred in June 2012 and does not affect our sample period. According to GASB Statement No. 67, Paragraph 44, published in 2012, the discount rate should be conditional on the funding status: "If the amount of pension plan assets is projected to be greater than the liabilities, then the actuarial present value of benefit payments should be determined using the expected rate of return on those investments. The actuarial present value of unfunded benefit payments should be calculated using a municipal bond rate" (GASB 2012).

For instance, until 2004, U.S. corporate plans were required to discount their liabilities using the thirty-year Treasury rate, both for funding purposes and when estimating their deficit reduction (i.e., catch-up) contributions. Since 2006, firms have been allowed to discount their liabilities using a rate that is a blend of long-term corporate bonds, including both upper-medium and high-grade securities (Rauh 2006).[10] In our analysis, we are only making relative comparisons and are not arguing that U.S. corporate pension funds had or have no regulatory latitude at all (prior literature has documented that pension valuations can be manipulated for the benefit of firm managers or shareholders).[11]

In Canada, public and private pension funds are regulated in the same way. The accounting standards developed by the Canadian Institute of Actuaries require their liability discount rate to be based on the market yields of high-quality corporate debt instruments that match the timing of the expected benefit payments. These standards leave limited room for discretion, only allowing latitude in defining "high-quality" debt instruments and addressing the lack of suitable debt instruments at very long-term maturities (Canadian Institute of Actuaries 2011).[12] Funding deficits must be covered over five to ten years, and the burden can be shared between employees and employer.

Our small sample of European pension funds consists mostly of Dutch funds and a few U.K. funds. In the Netherlands, pension funds have almost no discretion in choosing their liability discount rate. Until 2004, Dutch pension funds were obliged to use a discount rate of 4%. Thereafter, the Financial Assessment Framework set the requirements for discounting the liabilities by using the term structure of nominal risk-free interest rates. In this regime, if the funding ratio is less than 105%, the fund must submit a recovery plan that involves both higher contributions and lower inflation protection of benefits.[13] The U.K. pension regulator prescribes private and public plans to discount their liabilities using the yields on U.K. government securities of appropriate

[10] The Pension Protection Act of 2006 was the latest regulatory change that affected corporate DB plans in our sample period. Title 3 of The Pension Protection Act of 2006 states the amendments to ERISA affecting interest rate assumptions. These amendments became part of the 29 U.S. Code §1083—Minimum funding standards for DB pension plans. Thus, since 2008, U.S corporate pension funds determine the present value of liabilities using a segmented yield curve based on a twenty-four-month average of investment-grade corporate bonds of varying maturities. The IRS publishes these segment interest rates monthly. Alternatively, a plan sponsor may determine the present value of liabilities by using either the entire yield curve (also published monthly by the IRS) or the published rates from any of the four months prior to the valuation year.

[11] The relation between pension accounting standards and corporate decisions has been extensively studied; see, for example, Pontiff, Shleifer, and Weisbach (1990), Bergstresser, Desai, and Rauh (2006), Rauh (2006), Brown (2008), Rauh (2009), Campbell, Dhaliwal, and Schwartz (2012), Love, Smith, and Wilcox (2011), and An, Huang, and Zhang (2013).

[12] Further, in Canada, only the province of Ontario has established pension benefit insurance. Crossley and Jametti (2013) find that insured plans in Canada invest 5% more in equities than do similar plans without benefit guarantees. Our data does not include the province in which Canadian funds are registered, but we control for fund fixed effects, which should absorb the differences in asset allocation due to such cross-jurisdiction variation.

[13] See the Pension Act 2007 (Pensioenwet)—Financial Assessment Framework technical provisions.

terms. These discount rates can be adjusted for broader economic factors, such as economic growth and wage inflation. The additional contributions to cover funding deficit are typically paid by the employer.[14]

Taken together, their regulation leaves U.S. public pension funds with considerably more discretion to choose liability discount rates than U.S. private funds or (public and private) pension funds in Canada and Europe. If U.S. public pension funds act in line with the regulatory incentives hypothesis, then we would expect to observe differences in their asset allocation, discount rates, and performance. In our analysis, we explore whether regulation is a separate channel providing such incentives, without assuming that a proper valuation of the liabilities removes all incentives for more risk-taking.

2. Data

To study the effect of different regulatory standards on pension fund asset allocation and performance, we use data from CEM Benchmarking Inc. The dataset comprises more than 850 DB pension funds for the 1990–2012 period. The data covers three regions (United States, Canada, and Europe) and enables us to look at both cross-sectional and time-series variation.[15]

On the liabilities side, CEM provides information on the number of active and retired plan members, inflation protection policies, and liability discount rates. The data on the number of active and retired plan members enables us to estimate the percentage of retired members as a proxy for fund maturity. Even though the dataset does not contain precise information on participants' age and life expectancy, the increasing longevity of participants will be reflected in the higher number of retired members over time.

On the assets side, CEM provides detailed data on the strategic asset allocations of pension funds. Annually, pension funds submit their strategic (target) and their actual (realized) asset allocation policy to CEM. The actual asset allocation policy can be affected by market movements due to the expected transaction costs of rebalancing or due to inertia. For example, relatively large positive returns in the equity market would tend to increase the share of this asset class in a pension fund's actual asset allocation. Hence, to capture more precisely the asset allocation decisions made by pension fund boards, we use strategic asset allocation weights when calculating the riskiness of the investment policy. We define the percentage allocated to risky assets as a sum of the strategic allocation weights to equity, alternative asset classes, and risky fixed income investments. Alternative assets include investments in real estate, private equity, hedge funds, commodities, natural resources, and infrastructure. We classify allocations to high-yield, emerging market debt, and mortgages as

[14] See the U.K. Pensions Act 2004—Code of practice no. 3.

[15] CEM data has been used previously by French (2008) to study the cost of active investing, and by Andonov, Bauer, and Cremers (2012) to examine the asset management skills of pension funds.

risky fixed income investments.[16] The non-risky assets include investments in cash and investment-grade fixed income assets.

In our analysis, we split the sample into public and private pension funds. Our sample of U.S. public DB pension funds includes both state and local plans. The private subsample captures the pension funds classified as "corporate" and "other" in the CEM database. In the United States and Canada, the "other" category is mainly composed of multi-employer or Taft-Hartley funds, often referred to as "union" funds. In Europe, the "other" category covers mainly industry-wide funds, which are common in the Netherlands. We combine the category "other" with "corporate" and label this group "private" funds, because these pension funds are established by private-sector employers and are subject to the same regulation. For example, all U.S. private DB pension plans are regulated by the Employee Retirement Income Security Act (ERISA) and have an insurance program within the Pension Benefit Guarantee Corporation (PBGC).[17]

Table 1 presents the summary statistics. Panel A shows that the majority of observations are U.S. pension funds, followed by Canadian funds and a smaller number of European funds.[18] The pension funds had more than $4.54 trillion in assets under management in 2012 and covered around 29% of global DB pension fund assets (more than 16% of total global pension fund assets).[19] U.S. pension funds included in the CEM dataset controlled more than 40% of total assets under management by the U.S. DB pension sector. Canadian pension funds in the sample held approximately 80–90% of the total assets under management by Canadian pension funds. To our knowledge, this is the broadest global database on pension fund asset allocation and performance available for academic research.

In Panels B and C of Table 1, we document different trends in the allocation to risky assets between public and private pension plans. The strategic allocation to risky assets of public pension funds increased from 56.1% in 1993 to 72.4% in 2012, mainly due to increased risk-taking among U.S. public pension funds.[20] Private pension plans decreased their allocation to risky assets from 63.0% in

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16 All of our results are robust to calculating the percentage allocated to risky assets in two different ways: (i) removing the risky fixed income assets from the risky assets; and (ii) calculating the percentage allocated to risky assets based on the actual asset allocation instead of the strategic asset allocation weights. We provide details in Online Appendix B.

17 PBGC insurance programs were created as part of ERISA in 1974 to protect pension benefits. In 1980, the U.S. Congress enacted the Multiemployer Pension Plan Amendments Act of 1980 to strengthen the protection for multiemployer plans.

18 The summary statistics in Table 1 start in 1993, because in the 1990–1992 period we have an insufficient number of cross-sectional observations for the liability discount rates.

19 The comparison is based on the Global Pension Assets Study 2012 conducted by Towers Watson. A comparison based on the "Pensions&Investments/Towers Watson World 300: Largest retirement funds" yields even stronger conclusions about the relevance of CEM data.

20 European public pension funds also seem to increase their allocation to risky assets over time, but this subsample is small and the averages are volatile over time.

Table 1
Summary statistics

	All funds		U.S.		Canada		Europe	
	Public	Private	Public	Private	Public	Private	Public	Private
Panel A: Total number of pension funds and observations								
Funds	229	634	164	363	56	181	9	90
Obs. [fund × year]	1,894	3,616	1,365	2,017	487	1,283	42	316
Panel B: Summary statistics in 1993								
Funds	41	147	36	83	5	64		
%Risky	0.561	0.630	0.565	0.665	0.531	0.585		
	(0.170)	(0.126)	(0.179)	(0.135)	(0.101)	(0.097)		
%Retired	0.273	0.311	0.282	0.323	0.205	0.296		
	(0.102)	(0.160)	(0.099)	(0.167)	(0.112)	(0.151)		
LDR	8.116	7.986	8.070	8.214	8.400	7.695		
	(0.663)	(0.884)	(0.677)	(0.787)	(0.548)	(0.922)		
Fund size	9.904	2.259	10.262	3.380	7.323	0.804		
	(15.411)	(5.841)	(16.110)	(7.530)	(9.727)	(1.203)		
Inflation protection	0.610	0.153	0.583	0.013	0.800	0.328		
	(0.494)	(0.361)	(0.500)	(0.112)	(0.447)	(0.473)		
Returns	1.363	0.828	1.293	2.031	1.868	−0.731		
	(2.032)	(2.732)	(2.018)	(2.247)	(2.300)	(2.520)		
Panel C: Summary statistics in 2012								
Funds	87	214	63	127	20	53	4	34
%Risky	0.724	0.602	0.745	0.617	0.651	0.592	0.749	0.560
	(0.087)	(0.152)	(0.072)	(0.160)	(0.085)	(0.108)	(0.141)	(0.174)
%Retired	0.421	0.567	0.407	0.618	0.465	0.505	0.417	0.474
	(0.121)	(0.252)	(0.076)	(0.250)	(0.212)	(0.241)	(0.028)	(0.233)
LDR	7.215	4.642	7.708	4.360	6.075	5.415	4.467	4.023
	(0.974)	(1.024)	(0.361)	(0.866)	(0.447)	(0.931)	(1.557)	(1.371)
Fund size	31.790	8.318	32.543	8.085	15.749	2.734	100.131	17.896
	(52.502)	(15.178)	(44.430)	(11.073)	(27.964)	(3.498)	(159.103)	(29.234)
Inflation protection	0.598	0.228	0.556	0.083	0.700	0.521	0.750	0.324
	(0.493)	(0.420)	(0.501)	(0.278)	(0.470)	(0.505)	(0.500)	(0.475)
Returns	0.033	0.674	−0.192	0.539	0.598	1.218	0.737	0.344
	(1.462)	(1.436)	(1.526)	(1.522)	(1.192)	(1.221)	(0.542)	(1.206)

This table provides descriptive statistics for pension fund asset allocation, maturity, liability discount rates, fund size, inflation protection policy, and performance. In Panel A, rows *Funds* and *Obs.* present the total number of funds and observations during the entire sample period. In Panels B and C, we show the means and standard deviations (in parentheses) of variables separately in 1993 and 2012. *%Risky* shows the average percentage allocation to risky assets based on the strategic asset allocation policy. The risky assets include allocations to equity, alternative asset classes (i.e., hedge funds, private equity, and real estate), and risky fixed income (i.e., high-yield bonds, emerging markets debt, and mortgages). *%Retired* presents the average percentage of retired members from total plan members. *LDR* presents the average liability discount rates used by the pension funds. The *Fund size* row reports the average total assets under management (in US $billion) of the pension funds. *Inflation protection* is a dummy variable taking a value of one if a pension fund provides a contractual inflation protection. The *Returns* row presents the average net benchmark-adjusted returns in percentage points. We show the statistics for all funds and separately by region. We also report the statistics separately for public and private (corporate) pension funds.

1993 to 60.2% in 2012. Additionally, we observe significant regional effects: compared with Canadian and European funds, U.S. pension funds on average allocate a greater percentage of their assets to risky investments.

Pension funds have been maturing over time, and private plans are generally more mature than public plans. The percentage of retired members among private funds increased from 31.1% in 1993 to 56.7% in 2012, while among public funds it increased from 27.3% in 1993 to 42.1% in 2012. The difference in maturity between public and private funds is the result of a growing number of U.S. corporations having chosen to freeze their DB pension plans and replace them with defined contribution (DC) plans for new employees (Rauh, Stefanescu, and Zeldes 2012). Some U.S. public retirement systems have also introduced DC plans, but the private sector is shifting more rapidly toward DC plans. In Canada and Europe, the differences in the percentage of retired members between public and private funds are smaller.

Table 1 indicates that U.S. pension funds, on average, use higher discount rates than Canadian and European funds. Among U.S. funds, public plans maintain steady discount rates around 7.5–8.0% during the entire period. In sharp contrast, the liability discount rates of U.S. private pension funds decrease from 8.2% in 1993 to 4.4% in 2012, closely following the trend in interest rates. The discount rates of Canadian plans also decrease over time. Most European funds use discount rates of 4% before 2000, following strict (Dutch) regulatory guidelines. Afterwards, their liability discount rates move together with government bond yields, consistent with the revised regulation. In both Europe and Canada, there is no significant difference between the discount rates used by public and private pension funds.

We also present summary statistics for fund size, returns, and inflation protection policy in Table 1. To control for differences in inflation protection policy across funds, we create a dummy variable equal to one if a pension fund provides contractual inflation protection, and zero if the fund provides ad hoc inflation protection or no protection at all to the plan members. On average, public pension funds are larger and more likely to provide inflation protection than private plans. We measure pension fund performance as the weighted average of the net benchmark-adjusted returns for each asset class held by the pension fund. We calculate these returns by subtracting the investment costs and benchmark returns from the gross returns in different asset classes, and then aggregating these up across asset classes.[21]

We extend the analysis of U.S. public (state and local) pension funds by hand-collecting data on their board composition and funding status from the Comprehensive Annual Financial Reports (CAFRs). The board composition is reported in the CAFR's Introduction section, and the exact regulation is clarified in the Financial section (Notes to the Basic Financial Statements—Plan Description). We also look at the state or municipal codes and statutes to verify the board composition and to understand the election and appointment

[21] The investment costs include the costs of all internal and external money managers hired by the pension fund. Internal investment costs include not only the cost of compensation and benefits of employees managing internal portfolios, but also expenses for support staff, consulting, research, legal, trading services, and overhead costs. External investment costs capture the management fees paid to investment consultants and external asset managers, while the performance fees are directly subtracted from the returns. Importantly, the net benchmark-adjusted returns remove all investment fees from the returns.

Table 2
Summary statistics: Board composition and funding status of U.S. public funds

	Funds	Obs.	Mean	Median	StDev
Panel A: Board composition data					
Board size	113	1,117	9.317	9.000	2.817
InvBoard	12	122	0.109	0.000	0.312
%State	100	947	0.241	0.200	0.208
%State-elected	4	42	0.017	0.000	0.086
%State-appointed	47	392	0.068	0.000	0.126
%State–ex officio	78	749	0.156	0.111	0.198
%GenPublic	82	822	0.278	0.286	0.225
%GenPublic-elected	1	13	0.003	0.000	0.024
%GenPublic-appointed	81	809	0.276	0.286	0.227
%Participant	106	1,059	0.480	0.444	0.202
%Participant-elected	77	766	0.346	0.429	0.269
%Participant-appointed	43	384	0.130	0.000	0.223
%Participant–ex officio	2	15	0.004	0.000	0.032
Panel A: Funding status data					
Actuarial assets ($mil.)	113	1,117	19,933	7,307	33,357
Actuarial liabilities ($mil.)	113	1,117	23,585	9,317	38,096
Funding ratio	113	1,117	0.845	0.853	0.169
Underfunding per participant ($mil.)	113	1,117	0.154	0.108	0.164

The summary statistics in this table are only for the subsample of U.S. public pension funds. Panel A presents statistics for the pension fund board composition. In this panel, columns *Funds* and *Obs.* show the number of funds and observations that have at least one board member belonging to that category. *Board size* reports the total number of pension fund board members. *InvBoard* is an indicator equal to one if a pension fund has a separate investment board. We split the board members in three categories. *%State* measures the percentage of board members representing the employer— that is, state, county, city, or other public entity. State trustees can be elected to the board by plan members (*%State-elected*), be appointed by government executives (*%State-appointed*) or serve as ex officio members by the virtue of holding another government position (*%State–ex officio*). *%GenPublic* measures the percentage of trustees who represent the citizens (taxpayers) and do not work for the state or participate in the pension plan. General public board members can be either elected to the board by plan members (*%GenPublic-elected*), or appointed to the board (*%GenPublic-appointed*). *%Participant* measures the percentage of board trustees who are currently employed and retired plan participants. Board members representing plan participants can be elected by plan members (*%Participant-elected*), be appointed to the board (*%Participant-appointed*), or serve as ex officio members, because they are union leaders (*%Participant–ex officio*). Panel B presents summary statistics for the funding status of U.S. public funds. We report the actuarial value of assets and liabilities in $million, estimated using GASB valuation methods, and the corresponding funding ratio. Underfunding per participant is an estimation of the average underfunding per plan participant in $million. For this estimation, we recalculate the value of the liabilities using the ten-year Treasury rates.

procedures.[22] The funding status data—that is, the actuarial value of assets, liabilities, and funding ratio—is presented in the CAFR's Actuarial section (Schedule of Funding Progress).

Table 2 reports the descriptive statistics. We are able to collect board and funding data for 113 out of the 164 U.S. public funds in our sample, for a total of 1,117 observations. Pension funds have on average nine board members with a significant cross-sectional variation. The time-series variation of board variables is limited, as only 19 pension funds experience a change in board composition during our sample period, while 94 funds maintain the same

[22] For example, the board composition of Texas state pension funds (Texas ERS, Texas Teachers RS, Texas County and District RS, etc.) is defined in the Texas Government Code Title 8: Public Retirement Systems.

board structure over time. Additionally, regulations pertaining to the board composition of most plans were adopted long ago. For instance, the board composition of county retirement systems in California (Orange County ERS, San Diego County ERS, etc.) is defined by the County Employees Retirement Law of 1937 and has not changed since then. As a result, it seems unlikely that board compositions themselves are endogenous to the current funding levels or market conditions.

Only 12 pension plans have a separate board that makes asset allocation and investment decisions, but is not directly responsible for the actuarial assumptions and liability discount rate choice. We capture this separation of responsibilities by creating a dummy variable (*InvBoard*) that is equal to one if a pension fund has a separate investment board.[23]

We categorize board members into three groups based on whom they represent, and we calculate the percentage of board members in that category. First, state trustees represent the state, county, or city as an employer. Second, plan participant trustees represent the currently employed and retired plan members. Third, general public trustees represent the citizens (taxpayers), and do not work for the state or participate in the pension plan. Board members also differ in the appointment procedure: trustees can be elected by plan members, be appointed by a governmental executive, or serve as ex officio members by the virtue of their function.

Most state board members are either appointed by a governmental executive or serve as ex officio members. Typical examples of state–ex officio board members are: state treasurer, comptroller, personnel director, director of finance, superintendent of public instruction, and so on. State-appointed trustees are usually appointed by the governor, mayor, speaker of the state house of representatives, or president of the state senate, and frequent examples are senators, representatives, local government officials, school board representatives, and so on. In our analysis, we combine the state-appointed and state–ex officio board members, and label this variable *state-political* board members, because these two groups of trustees are either elected politicians or appointed by elected politicians. On average, state-appointed and state–ex officio trustees together represent 22.4% (15.6+6.8) of the board members.

State-elected board members participate in the boards of only four pension funds. They are also governmental officers, but the main characteristic is that they are elected by plan participants. Thus, we do not combine them with the state-appointed and state–ex officio trustees. For example, in Michigan Municipal RS, three officers of a municipality or court are elected as employer (state) trustees by the plan participants at the annual meeting.

[23] For example, Los Angeles County Employees Retirement Association has a retirement board and an investment board. The Board of Retirement is responsible for the overall management of the retirement system, while the Board of Investments is responsible for establishing investment policy and objectives, as well as exercising authority and control over the investment management.

Board members from the general public hold, on average, 27.8% of the pension fund board seats. These board members typically work in the local financial industry and are appointed by governmental officials.[24] For example, CalSTRS has three general public representatives on the board appointed by the governor and confirmed by the senate and, in 2014, these trustees worked at a brokerage and investment banking firm, venture capital firm, and insurance company.[25]

Trustees representing plan participants are present on the board of 106 out of 113 U.S. public pension funds. The majority of these trustees are elected by plan participants. Two pension plans have ex officio plan board members who are all union representatives. For example, the heads of the three unions with the largest number of participating employees sit on the board of New York City ERS.[26] In our analysis, we combine the participant-elected and participant–ex officio board members, and label the variable as *PlanMem-elected* board members. Jointly these two categories represent 35.0% of the board members.

Approximately 13% of the board trustees are plan members appointed to the board. The appointment procedure involves two groups of stakeholders: typically, plan participants nominate several candidates, and a government official appoints one of them to the pension fund board. For instance, in the Texas Teachers RS, two trustees are appointed by the governor from the three public school active member candidates who have been nominated by employees of public school districts, while one trustee is appointed by the governor from the three higher education active member candidates nominated by employees of higher education institutions.

Panel B of Table 2 presents data on the funding status of U.S. public pension funds. The funding ratio is measured as the actuarial value of assets divided by the actuarial value of liabilities. The average self-reported funding ratio is 84.5% and decreases over time. The actuarial value of liabilities is estimated using the discount rates reported in Table 1 and reflects the chosen discount rate. Thus, to estimate the level of underfunding per plan member, we recalculate the value of the liabilities using the ten-year Treasury rates. For this recalculation, we collect data on the average annual pension benefit paid by the pension funds (reported in the Actuarial section, Schedule of retirees and beneficiaries added to and removed from rolls) and make several assumptions about the demographic characteristics of plan members based on Novy-Marx and Rauh (2011b).[27] Our estimation indicates that the average underfunding per plan member is

[24] In our sample, only one pension fund, Kentucky Teachers RS, has two board members from the general public elected by plan participants. In all other funds, these trustees are appointed to the board.

[25] The information has been retrieved from the biographies of the board members posted on CalSTRS website.

[26] The plan Participant–ex officio trustees are not always union representatives, but in our case this holds for both plans—New York City ERS and Massachusetts Bay Transportation Authority Retirement Fund.

[27] Based on Novy-Marx and Rauh (2011b), we make the following assumptions about the active and retired members. For active members, we assume that their average age is 43.53 years, they have worked an average of 11.34 years, and their retirement age is 60. For retired members, we assume that their average age is

around $154,000. Importantly, the underfunding per member displays a positive correlation of 0.43 with the percentage of retired members. Thus, mature U.S. public pension funds have a greater funding deficit per participant in dollar terms.[28]

As a robustness check, we perform an alternative estimation of the level of underfunding that requires only two assumptions. First, instead of making assumptions about the age and working career of retired and active participants, we assume that every pension fund has a duration of ten years, which is implied by the recent GASB 2012 disclosures and follows Rauh (2016). Second, instead of relying on the Entry Age Normal (EAN) actuarial method, we estimate the value of Accumulated Benefits Only (ABO) liabilities. The EAN method recognizes some benefits that have not yet been formally earned, while ABO reflects only pension benefits that employees would be entitled to receive under their current salaries and years worked. Based on Novy-Marx and Rauh (2011b), the typical ratio of ABO liabilities to EAN liabilities is 0.85, which we use to reduce the liabilities to get our estimated value for the ABO liabilities.[29]

When analyzing the U.S. public pension funds, we include the following economic and demographic variables at the U.S. state level: public employee unionization rates, GDP per capita, GDP growth, population growth, and state and local government expenditures per capita. The summary statistics for these variables are in the Online Appendix Table E.2.[30]

3. Pension Fund Maturity and Allocation to Risky Assets

In this section, we begin by documenting the trend in asset allocation and discount rates among U.S. public pension funds, because this relation is central to the regulatory incentives hypothesis. Figure 1 plots the average percentage allocation to risky assets, the liability discount rate of these funds, as well as the ten-year U.S. Treasury yield through time. The plot shows an almost completely flat line for the discount rate used by U.S. public pension funds. These plans can justify maintaining a discount rate of around 8% by offsetting the declines in the risk-free rate (and overall expected assets return) with an

69.27 years. Additionally, we use data from the World Bank to estimate the life expectancy for U.S. citizens, and we assume that the pension funds use the Entry Age Normal (EAN) actuarial valuation method.

28 We measure the underfunding per participant, but one could also measure underfunding per taxpayer or relative to the budget. We think that scaling by pension fund participants is more natural or intuitive. If one wants to scale by the number of taxpayers or budget resources, the distinction between local and state pension funds is difficult, but necessary in order to determine the appropriate scaling factor.

29 We are grateful to Joshua Rauh for suggesting this alternative measure of underfunding.

30 The public employee unionization rates data originally comes from the Bureau of Labor Statistics (BLS), was constructed by Barry Hirsch and David Macpherson, and is available at http://unionstats.gsu.edu. The Bureau of Economic Analysis (BEA) provides the GDP per capita and GDP growth data. Population growth is reported by the Census Bureau. The data on state and local government expenditures per capita comes from the Census Bureau's Annual Survey of Local Government Finance. The government expenditures data are not available for 2001 and 2003, reducing our sample.

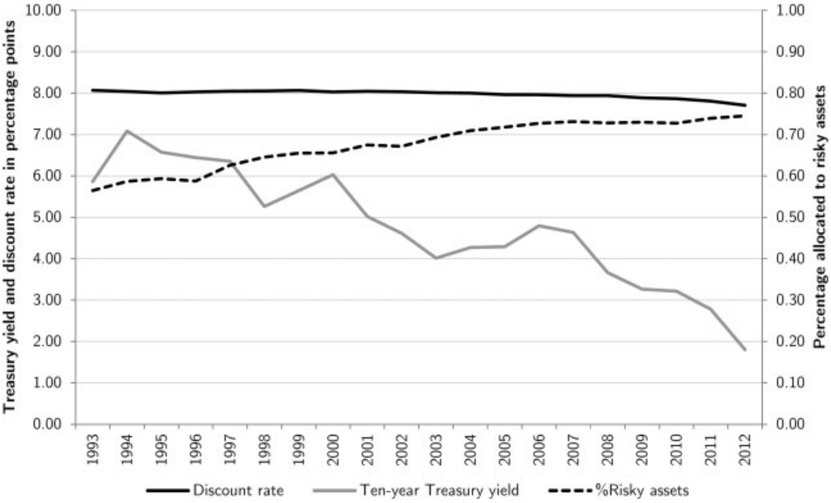

Figure 1
Asset allocation and liability discount rates of U.S. public pension funds

increased allocation to risky assets. The accrued benefits of U.S. public pension funds appear well protected during our sample period, as they are backed by constitutional non-impairment clauses and common law (Brown and Wilcox 2009).[31] As a result, the average liability discount rate of 8% at the end of our sample period does not reflect the uncertainty of these liabilities, and keeping their discount rates so high enables U.S. public funds to understate the promised value of pension benefits.

To test our regulatory incentives hypothesis, we examine the relation between the allocation to risky assets and fund maturity. Rauh (2009) finds a negative correlation between risk-taking and fund maturity among U.S. corporate pension funds, which suggests that as the cash flows resulting from promised benefits become less uncertain, private pension funds take less investment risk. This result is consistent with Black (1989), Bodie, Merton, and Samuelson (1992), Sundaresan and Zapatero (1997), and Lucas and Zeldes (2009), who argue that investing in risky assets can help younger pension funds hedge

[31] For example, in response to the Orange County bankruptcy filing in 1994, the county executive proposed a 40% budget reduction and layoffs of 1,000 people. Despite these financial difficulties, retirement obligations were met in full (Brown and Wilcox 2009). The Orange County ERS is part of our sample during the entire period, including the most problematic years (1994–1996) for the county. However, recent events have increased the uncertainty surrounding the accrued and future DB pension benefits. The city of Detroit filed for bankruptcy in July 2013, which is after the end of our sample period. If the bankruptcy judges rule to impair the pensions, despite Michigan state constitutional protection, Detroit pension plan members will be the first ones to experience a haircut on their pension promises. However, in Illinois, the non-impairment constitutional provision was interpreted broadly and Illinois Supreme Court decision No.2014 MR1 declared the pension reform unconstitutional. The court ruled that "membership in any pension system shall be an enforceable contractual relationship, the benefits of which shall not be diminished or impaired. (Illinois Constitution, Article XIII, §5.) This constitutional language is unambiguous and the Pension Protection Clause is given effect without resort to other aids for construction."

against increases in future pension benefits, especially if the promised benefits are tied to real wages.

We relate the percentage allocated to risky assets ($\%Risky_{i,t}$) by pension fund i in year t to the percentage of retired members ($\%Retired_{i,t}$) using pooled panel regressions with year (YFE_t) and fund fixed effects (FFE_i):

$$\%Risky_{i,t} = \beta_0 + \beta_1 \%Retired_{i,t} + \beta_2 X_{i,t} + \beta_3 YFE_t + \beta_4 FFE_i + u_{i,t} \tag{1}$$

where $X_{i,t}$ refers to the control variables and $u_{i,t}$ is the idiosyncratic error. We independently double-cluster the robust standard errors in all regressions by pension fund and by year. In the regressions, we include interaction terms to capture the distinct regulation of U.S. public funds.

As controls, we include fund size, inflation protection policy, and plan type. Log of pension fund assets captures any effect of scale on allocation decisions. We control for inflation protection policy following the Campbell and Viceira (2005) argument that pension fund asset allocation should depend on the indexation policy. We also include an indicator variable that equals one for public pension plans to control for differences in allocation to risky assets between public and private plans, because their participants could face different career risks and life-cycle patterns.

The results in Table 3 show that pension funds that have a higher proportion of retired members invest less in risky assets, which is consistent with Rauh (2009). Based on column (1), a 10% increase in the percentage of retired members is associated with a 1.61% reduction in the allocation to risky assets. This amounts to about 14% of the standard deviation in the allocation to risky assets and thus seems economically meaningful. In contrast to other funds, U.S. public pension funds that are more mature invest more in risky assets, and this positive relation is consistent with our regulatory incentives hypothesis. Based on column (2), for all funds except U.S. public pension funds, a 10% increase in the percentage of retired members is associated with a 1.67% lower allocation to risky assets. However, for U.S. public funds, a 10% increase in the percentage of retired members is associated with a 5.93% increase in the allocation to risky assets [$0.1 \times (-0.167) + 0.1 \times 0.760 = 0.0593$]. The interaction term *%Retired × Public × U.S.* is economically and statistically significant in all estimations.

Additionally, we replace the fund fixed effects with a dummy variable for U.S. pension funds and document significant regional differences. Based on column (4), U.S. pension funds invest more in risky assets than Canadian and European funds.[32]

However, contrary to the life-cycle theory that is generally followed in practice, Lustig and Van Nieuwerburgh (2008) and Pennacchi and Rastad

[32] The regression for the results in Table 3, column (4), includes interaction terms, which can influence the region dummy variable. In Online Appendix Table B.9, we estimate a regression without any interaction terms and without the public-type dummy variable, and find that U.S. pension funds allocate around 7% more to risky assets than Canadian funds and 12% more than European funds.

Table 3
Regressions: Percentage allocated to risky assets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Percentage allocated to risky assets						
%Retired	−0.161***	−0.167***	−0.099**	−0.084**	−0.123***	−0.107***	−0.092***
	[0.035]	[0.034]	[0.046]	[0.034]	[0.032]	[0.030]	[0.021]
%Retired × Public × U.S.		0.760***	0.772***	0.479***			
		[0.161]	[0.175]	[0.127]			
%Retired × Public			0.018	−0.006			
			[0.067]	[0.063]			
%Retired × U.S.			−0.095*	−0.075*			
			[0.057]	[0.040]			
Yield_{t-1}	−0.000	−0.005	−0.002	−0.001	−0.007	0.001	0.005
	[0.006]	[0.006]	[0.005]	[0.008]	[0.006]	[0.005]	[0.006]
Yield_{t-1} × Public × U.S.					−0.035***	−0.034***	−0.022***
					[0.006]	[0.008]	[0.008]
Yield_{t-1} × Public						−0.010*	−0.024***
						[0.005]	[0.005]
Yield_{t-1} × U.S.						0.014**	0.010**
						[0.006]	[0.005]
Fund size	0.014	0.014	0.012	0.007***	0.022	0.012	0.005**
	[0.015]	[0.015]	[0.014]	[0.002]	[0.015]	[0.014]	[0.002]
Inflation protection				0.015**			0.017**
				[0.007]			[0.007]
Public × U.S.				−0.191***			0.086**
				[0.050]			[0.041]
Public				−0.007			0.117***
				[0.030]			[0.029]
U.S.				0.121***			0.042
				[0.018]			[0.027]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE	Yes	Yes	Yes	No	Yes	Yes	No
Double-clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,510	5,510	5,510	5,463	5,510	5,510	5,463
R^2	0.733	0.746	0.747	0.210	0.750	0.755	0.226

In this table, we estimate a panel model. The dependent variable is the percentage allocated to risky assets based on the strategic asset allocation of pension funds. The risky assets include allocations to equity, alternative asset classes, and risky fixed income. As independent variables, we include *%Retired*, the percentage of retired members from total pension fund members; *%Retired* × *Public*, an interaction term capturing the percentage of retired members among public funds; *%Retired* × *U.S.*, an interaction term capturing the percentage of retired members among U.S. pension funds; *%Retired* × *Public* × *U.S.*, an interaction term capturing the percentage of retired members among U.S. public pension funds; $\textit{Yield}_{t-1}$, the Treasury yield in the previous year; $\textit{Yield}_{t-1}$ × *Public*, an interaction term capturing the effect of the previous year's Treasury yield on public funds; $\textit{Yield}_{t-1}$ × *U.S.*, an interaction term capturing the effect of the previous year's Treasury yield on U.S. funds; and $\textit{Yield}_{t-1}$ × *Public* × *U.S.*, an interaction term capturing the effect of the previous year's Treasury yield on U.S. public funds; *Fund size*, the logarithm of total pension fund assets; *Inflation protection*, a dummy variable taking a value of one if a fund provides a contractual inflation protection; *Public*, a dummy variable taking a value of one if a pension fund is public; *Public* × *U.S.*, a dummy variable for U.S. public funds; and *U.S.*, a regional dummy variable. Where indicated, we include year dummies and fund fixed effects. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

(2011) argue that wage growth is negatively correlated with returns on risky assets. A full-scale analysis of the relation between human capital and returns on risky assets is beyond the scope of our paper, but our results suggest that it is difficult to rationalize the decisions of U.S. public pension funds also using the Lustig and Van Nieuwerburgh (2008) theory. First, unlike our regulatory incentives hypothesis, this theory does not imply that U.S. public pension funds that are more mature will use higher discount rates, which we document in the next section. Second, it also does not imply that pension funds modify their asset allocation policy when interest rates decline, as we show below.

The substantial decline in yields on government bonds during our sample period is exogenous to individual pension plans. For example, the yield on ten-year U.S. Treasury notes decreased from 7.09% in 1994 to 1.80% in 2012. This decline in yields reduces the expected return on both risky and non-risky assets (because the risk-free rate declines, even if risk premiums remain the same), and puts pressure on U.S. public pension funds to reduce their discount rates. As explained previously, their regulations allow U.S. public plans to maintain the same expected return and liability discount rate by increasing the proportion allocated to risky assets.

To test whether the declining trend in interest rates is associated with pension fund asset allocation, we add interaction terms with the ten-year Treasury yield in the previous year to the regression model.[33] Our results in Table 3, columns (5)–(7), indicate that, as Treasury yields declined, especially U.S. public pension funds increased their allocation to risky assets. Based on column (6), the approximately four-percentage-point decline in the yield on ten-year U.S. Treasuries over this period is associated with a twelve-percentage-point increase in the allocation to risky assets of U.S. public pension funds $[-4\times(0.014-0.010-0.034)=0.120]$.

We perform two robustness checks and present the results in Online Appendix B. First, we disaggregate the risky assets into equity, alternative assets, and risky fixed income assets. Alternative assets, like private equity, real estate, and hedge funds, are generally considered to be riskier and less liquid than public equity and fixed income (Sadka 2010; Fung, Hsieh, Naik, and Ramadorai 2008; Phalippou and Gottschalg 2009). Hence, by increasing the allocation to alternative assets, U.S. public pension funds could declare ex ante higher expected return on assets. We document that U.S. public pension funds that are more mature invest more in all three groups of risky assets, but the percentage increases in their allocation to alternative assets are economically larger than the increases in equity and risky fixed income.

Second, we reduce the number of interaction terms by analyzing the relation between fund maturity and risk-taking in two subsamples. The results within the subsample of only U.S. pension funds increase in magnitude and indicate that our conclusions are not determined by differences across countries. Moreover, the relation between the Treasury yields and the allocation to risky assets is significant only for U.S. public funds, not U.S. corporate funds. Examining the subsample of only public pension funds (thus excluding all private funds) indicates that the positive relation between fund maturity and risk-taking is

[33] For Europe, we use the eurozone countries' ten-year government bond yields (changing composition over time and weighted average) provided by Eurostat.

present only among U.S. public pension funds—that is, cross-type differences do not determine the allocation to risky assets.[34]

4. Pension Fund Liabilities Valuation

Based on financial theory, a discount rate should reflect the timing and riskiness of the promised value of future cash flows. Thus, pension funds that are more mature, whose liabilities have shorter duration and are more likely to be paid, should use lower discount rates than younger funds because the yield curve is generally upward-sloping. Another reason why mature funds should use lower discount rates is because their projected liabilities are more akin to those of a (shorter-duration) bond rather than of equity (Lucas and Zeldes 2006; Benzoni, Collin-Dufresne, and Goldstein 2007). However, in our regulatory incentives hypothesis, we posit that U.S. public pension funds can present a more favorable funding position by investing more in risky assets, declaring a higher expected rate of return, and using it as a discount rate. Since U.S. public funds that are more mature invest relatively more in risky assets, we expect that they will use higher (instead of lower) discount rates.

To test the relation between fund maturity, allocation to risky assets, and discount rates, we estimate the following pooled panel regression model with year and fund fixed effects:

$$LDR_{i,t} = \gamma_0 + \gamma_1 \%Risky_{i,t} + \gamma_2 \%Retired_{i,t} + \gamma_3 X_{i,t} + \gamma_4 YFE_t + \gamma_5 FFE_i + \varepsilon_{i,t} \quad (2)$$

where $LDR_{i,t}$ represents the liability discount rate of fund i in year t, $X_{i,t}$ captures the control variables, and $\varepsilon_{i,t}$ is the idiosyncratic error. In all regressions, we independently double-cluster the standard errors by pension fund and by year.

Table 4 shows that the allocation to risky assets is positively related to liability discount rates. The magnitude of this relation is reduced by half once we separate the allocation to risky assets of U.S. public pension funds from the other pension funds. Based on column (2), the interaction term capturing the allocation to risky assets of U.S. public funds is positive and significant.

In general, pension funds that are more mature use lower liability discount rates. However, fund maturity is strongly positively related to the discount rates of U.S. public funds, which is in line with our regulatory incentives hypothesis. In particular, the interaction term *%Retired* × *Public* × *U.S.* in column(3) is positive and significant. This interaction term indicates that, for U.S. public pension funds, a 10% increase in the percentage of retired members is associated with an increase in the discount rate of 75 basis points [0.1 × (8.794 – 1.310)].

[34] We also construct a matched subsample of pension funds, matching each U.S. public fund with a non-U.S. public fund, separately for each year, based on two variables: fund size and the percentage of retired members. The results in Appendix B confirm that U.S. public funds that are more mature invest more in risky assets.

Table 4
Regressions: Liability discount rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Dependent variable: Liability discount rate				
%Risky	1.873***	0.948**	1.284***	−0.024	0.640	1.154***	0.961***	−0.197	0.584
	[0.412]	[0.471]	[0.310]	[0.528]	[0.779]	[0.339]	[0.280]	[0.447]	[0.745]
%Risky × Public × U.S.		3.132***		1.315	1.126			−0.172	−0.466
		[0.800]		[1.015]	[1.506]			[0.754]	[1.439]
%Risky × Public				0.071	1.278			0.177	1.112
				[0.750]	[1.280]			[0.468]	[1.347]
%Risky × U.S.				1.210*	0.026			1.187*	0.077
				[0.638]	[0.873]			[0.643]	[0.820]
%Retired	−1.155***	−1.164***	−1.310***	−0.160	0.206	−1.408***	−0.734***	−0.549***	−0.074
	[0.297]	[0.297]	[0.322]	[0.345]	[0.376]	[0.266]	[0.241]	[0.183]	[0.175]
%Retired × Public × U.S.			8.794***	8.108***	3.002***				
			[2.433]	[2.510]	[0.861]				
%Retired × Public				0.246	−0.258				
				[0.716]	[0.497]				
%Retired × U.S.				−1.547***	−0.946**				
				[0.457]	[0.383]				
Yield	0.079	0.025	0.018	0.031	0.096	0.386***	0.011	0.075	0.128
	[0.082]	[0.072]	[0.078]	[0.076]	[0.252]	[0.051]	[0.078]	[0.081]	[0.238]
Yield × Public × U.S.						−0.378***	−0.465***	−0.601***	−0.512***
						[0.034]	[0.035]	[0.060]	[0.066]
Yield × Public								0.001	−0.090
								[0.047]	[0.070]
Yield × U.S.								0.285***	0.126
								[0.078]	[0.101]
Fund size	0.080	0.110	0.082	0.068	−0.093***	−0.213*	0.196*	0.027	−0.109***
	[0.116]	[0.107]	[0.127]	[0.115]	[0.034]	[0.118]	[0.107]	[0.092]	[0.032]
Inflation protection					0.158**				0.184**
					[0.080]				[0.075]
Public × U.S.					−1.227				3.358***
					[1.049]				[1.056]
Public					−0.350				0.097
					[0.876]				[1.040]
U.S.					1.221**				0.235
					[0.607]				[0.784]
Year FE	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Fund FE	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Double-clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,328	5,328	5,328	5,328	5,289	5,328	5,328	5,328	5,289
R^2	0.817	0.822	0.830	0.834	0.552	0.821	0.842	0.850	0.590

In this table, we estimate a panel model. The dependent variable is the liability discount rate used by the pension funds. Independent variables include *%Risky*, the percentage allocated to risky assets based on strategic asset allocation policy; *%Risky × Public*, an interaction term capturing the percentage allocated to risky assets of public funds; *%Risky × U.S.*, an interaction term capturing the percentage allocated to risky assets of U.S. pension funds; *%Risky × Public × U.S.*, an interaction term capturing the allocation to risky assets of U.S. public funds; *%Retired*, the percentage of retired members from total pension fund members; *%Retired × Public*, an interaction term capturing the percentage of retired members among public funds; *%Retired × U.S.*, an interaction term capturing the percentage of retired members among U.S. pension funds; *%Retired × Public × U.S.*, an interaction term capturing the percentage of retired members among U.S. public funds; *Yield*, the ten-year Treasury yield; *Yield × Public*, an interaction term capturing the effect of the Treasury yield on public funds; *Yield × U.S.*, an interaction term capturing the effect of the Treasury yield on U.S. funds; and *Yield × Public × U.S.*, an interaction terms capturing the effect of the Treasury yield on U.S. public funds. *Fund size*, the logarithm of total pension fund assets; *Inflation protection*, a dummy variable taking a value of one if a fund provides contractual inflation protection; *Public*, a dummy variable taking a value of one if a pension fund is public; *Public × U.S.*, a dummy variable capturing U.S. public funds; and *U.S.*, a regional dummy variable. Where indicated, we include year dummies and fund fixed effects. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

As a comparison, a 10% increase in fund maturity is associated with a reduction of 13 basis points in the discount rates of all other funds.

We extend our analysis by examining the relation between interest rates and liability discount rates, and add interaction terms with the ten-year government bond yields to the panel regressions.[35] Based on their regulation, government bond yields would be expected to be positively associated with the discount rates used by U.S. private funds, Canadian funds, and European funds. According to financial theory, the Treasury yield (as a proxy for the risk-free rate of return) should also be positively related with the expected return on both risky and non-risky assets, and consequently to the discount rate of U.S. public pension funds. However, U.S. public plans could avoid incorporating the decline in interest rates in their discount rates by strategically using the flexibility in GASB regulation—that is, by investing more in risky assets and managing the expected return of their assets.

Consistent with the observed pension fund regulation, in column (6) in Table 4, we find that in general, discount rates are positively associated with yields: a 100-basis-point decrease in the government bond yield is associated with a decrease in the liability discount rate of 39 basis points for U.S. private pension funds and both public and private pension fund types in Canada and Europe. The relation is less than proportional because private pension funds base their discount rates mainly on high-quality corporate (not government) yields, and their regulatory standards allow some smoothing of the changes in interest rates over time. For example, prior to the Pension Protection Act of 2006, U.S. private pension funds were permitted to smooth interest rates over four years when determining the discount rate (Brown 2008), while Dutch pension funds used a flat discount rate of 4% until 2004.

In sharp contrast, Treasury yield changes have no discernible relation to the liability discount rates of U.S. public pension funds. The interaction term *Yield* $\times$ *Public* $\times$ *U.S.* is negative and significant, completely outweighing the unconditional relation of Treasury yields with discount rates. Based on column (6), a 100-basis-point decrease in the Treasury yield is associated with a reduction in the discount rate of only 0.8 basis points (0.386 – 0.378), which is not significantly different from zero.

In columns (7)–(9) in Table 4, we include year fixed effects. The *Yield* variable is identified by cross-country differences in these regressions, while the year fixed effects absorb the declining trend over time—that is, the annual

[35] Novy-Marx and Rauh (2011b) find that the effective average duration of U.S. public pension funds is around thirteen years. We use the ten-year Treasury rate, because the fifteen-year rate is not available in all regions covered by our study and because in our estimations we focus on the trend in Treasury yield, which is highly correlated across Treasury yields of different maturities. We do not have sufficient data to more precisely estimate the maturity and distribution of cash flows over time for each pension fund. However, we focus on the general trend in interest rates, and the ten-year and twenty-year yields exhibit similar trends over time, such that the potential duration mismatch should not be a significant problem. For instance, the U.S. ten-year Treasury yield declined from 7.09% in 1994 to 1.80% in 2012, while the twenty-year yield declined from 7.49% in 1994 to 2.54% in 2012.

government bond yields in Europe, Canada, and the United States are highly positively correlated. In these models, the interaction term *Yield* × *Public* × *U.S.* remains negative and significant, indicating that the discount rates of U.S. public pension funds do not reflect the trend in interest rates, even though the expected return on assets depends on them.

As a robustness check, we reduce the number of interaction terms and analyze the association between liability discount rates and pension fund characteristics separately in two subsamples. First, we analyze the subsample of only U.S. pension funds, and next we examine the subsample of only public pension funds. The results presented in Online Appendix C confirm that mature U.S. public funds use higher rates to discount their liabilities, and that their discount rates are not related to the dynamics in government bond yields.

5. Pension Fund Performance

In this section, we examine whether the performance of U.S. public pension funds is related to their preference for a riskier asset allocation. According to our regulatory incentives hypothesis, U.S. public plans increased their allocation to risky assets in order to maintain a high liability discount rate and report a better funding status. This implies that part of their asset allocation may not be due to the availability of attractive investment opportunities or the funds' ability to select and monitor additional risky investments. As a result, we hypothesize that U.S. public funds may underperform compared with other pension funds. The underperformance may be greater among U.S. public pension funds that are more mature, as we find that they respond relatively more strongly to the GASB regulatory incentives. An alternative hypothesis is that U.S. public funds invest more in risky assets because they have become more successful in selecting and monitoring investments in equity, alternative assets, and high-yield bonds. If this is the case, U.S. public funds would deliver similar or even higher returns than other pension funds.

We disentangle these two alternative explanations by analyzing pension fund net benchmark-adjusted returns. We first calculate returns of pension fund i in year t separately for each asset class by subtracting the investment costs and the self-reported benchmark return in that asset class from the gross returns, and then aggregate across all asset classes held by the fund. The CEM data include the self-declared benchmarks, which are usually market indexes against which performance is measured. The advantage of using net benchmark-adjusted returns instead of directly analyzing the net returns is that the benchmarks reflect the geographical allocation and exposure to different asset classes. For example, if a fund invests internationally in equity, then the equity benchmark returns are a weighted average of indexes in multiple countries.[36]

[36] A potential worry is that, even though the CEM database is anonymous, pension funds may strategically choose their benchmark in order to report an outperformance, or only participate in years when they achieve a better

The net benchmark-adjusted returns capture the security selection skills of the pension funds. Even if pension funds increase their allocations to risky assets, as long as they invest passively and buy the index, their net benchmark-adjusted returns would be equal to zero. However, in Online Appendix Figure D.1, we observe that pension funds actively manage around 80% of their assets and only 20% passively. In Online Appendix Table D.1, we also examine the possibility that pension funds with a higher percentage invested in risky assets allocate more to passive mandates. If a pension fund has a limited active management capacity and expertise, but it wants to invest more in risky assets, the fund could simply increase the allocation to passive mandates within risky assets. In this case, we should observe a positive association between the percentage invested in passive mandates and the percentage invested in risky assets. However, we document no significant association between the percentage invested in passive mandates and the percentage invested in risky assets. The interaction term capturing the allocation to risky assets of U.S. public pension funds is also close to zero and insignificant. Thus, we conclude that all pension funds engage primarily in active asset management and their performance can differ from the benchmark returns.

We relate the net benchmark-adjusted returns ($NTR-BM_{i,t}$) of fund i in year t to the percentage of retired members and to the percentage allocated to risky assets, using panel regressions with year and fund (or regional) fixed effects:

$$\begin{aligned} NTR-BM_{i,t} = \rho_0 + \rho_1 \%Risky_{i,t} + \rho_2 \%Retired_{i,t} + \rho_3 X_{i,t} \\ + \rho_4 YFE_t + \rho_5 FFE_i + \upsilon_{i,t} \qquad (3) \end{aligned}$$

We include interaction terms to capture the different regulation of U.S. public funds and control for fund size, plan type, and inflation protection policy. Two new control variables capture the asset management style: the percentage allocated to actively managed mandates and the percentage of assets delegated to external asset managers. We also add controls for the previous year's net benchmark-adjusted performance and for the lagged changes in allocation to risky assets. The previous year's net benchmark-adjusted performance captures the persistence in returns and potentially investment skills. The lagged changes in allocation to risky assets control for pension funds implementing large changes in their investment policy over time, which could expose them to implementation costs—that is, illiquidity, transaction costs, and so on.

performance. We examine the benchmarks reported by pension funds in Online Appendix Table D.1. In equity, fixed income, and alternative assets, pension funds select well-established market indexes (e.g., Russell 3000, S&P 500, TSE 300, MSCI World, Barclays U.S. Aggregate, FTSE/NAREIT Index, HFRI Index) as their benchmarks. We verify that the reported return values for these benchmarks correspond to the values that we could calculate using other major financial databases. Moreover, we do not observe a difference in the benchmark returns reported by U.S. public pension funds and other pension funds in our sample. Online Appendix D gives further details on our performance measures and additional self-reporting tests conducted on the CEM database. All tests indicate that the performance of pension funds is not related to their presence in the CEM dataset.

The results in columns (1)–(4) in Table 5 show that U.S. public pension funds underperform other pension funds by 36 to 61 basis points annually, while there is no significant underperformance or outperformance of Canadian and European public versus private pension funds. The lower net benchmark-adjusted returns of U.S. public funds are related to two main factors: the allocation to risky assets and fund maturity. Based on column (5), a 10% increase in the strategic allocation to risky assets of U.S. public pension funds is associated with an increase in underperformance of 14.0 basis points annually. In column (9), we also find that more mature U.S. public funds underperform: a 10% increase in the percentage of retired members of U.S. public funds is associated with returns that are 9.4 basis points lower.

In Table 6, we further explore the underperformance of U.S. public pension funds by controlling for fund fixed effects in the regressions. We document that the underperformance is greater among U.S. public pension funds that are more mature. Our results indicate that a 10% increase in the percentage of retired members of U.S. public pension funds is associated with performance that is 38–58 basis points lower.

Table 7 analyzes the performance of U.S. pension funds by asset class. We examine the performance separately in equity, alternative assets, risky fixed income assets, and non-risky assets (cash and investment-grade bonds). Pension fund returns in equity and fixed income are based on market prices, while returns in alternative assets are based not only on transaction prices, but also on appraisal values, and thus partly on potentially stale prices. At the same time, our sample period includes 23 years, and the average holding period of a property or private equity fund is typically around 10 years. Many private deals have been completed during our sample period, such that their total average performance should be reflected in the database.[37]

We find that U.S. public pension funds have annual returns in equity that are 24 basis points lower and returns in alternative assets that are 241 basis points lower. These results are in line with our regulatory incentives hypothesis, as the underperformance of U.S. public funds is concentrated in the asset classes that experienced the highest increases in allocations. Moreover, in Table 7, columns (2) and (4), we document that U.S. public pension funds that are more mature are the ones underperforming in equity and alternative assets. A 10% increase in the percentage of retired members of U.S. public funds is associated with a decrease in their annual returns in alternative assets of 137 basis points. In risky fixed income assets, the performance of U.S. public funds is lower, but not statistically significant, possibly due to the lower number of observations.

In non-risky assets, we do not find a difference in the performance between private and public pension funds. The public dummy variable is close to zero,

[37] In Online Appendix D.III, we further discuss the pension fund performance in alternative assets. Importantly, we use annual data, and real estate and private equity investments are typically appraised at least once a year. In addition, pension funds, on average, underperform their self-reported benchmarks in alternative assets.

Table 5
Regressions: Performance of pension funds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Dependent variable: Net benchmark-adjusted returns									
Public × U.S.	−0.363***	−0.510***	−0.598***	−0.606***	0.450	0.581	0.553	−0.322	−0.197	−0.217
	[0.138]	[0.175]	[0.188]	[0.191]	[0.426]	[0.675]	[0.667]	[0.319]	[0.416]	[0.417]
Public		0.051	0.176	0.164	0.105	−0.339	−0.383	0.218	0.557*	0.546*
		[0.159]	[0.184]	[0.185]	[0.339]	[0.577]	[0.608]	[0.262]	[0.312]	[0.308]
U.S.		0.206	0.042	0.055	0.170	0.024	0.040	0.195	0.009	0.023
		[0.270]	[0.211]	[0.215]	[0.269]	[0.213]	[0.218]	[0.271]	[0.210]	[0.213]
%Risky	0.164	−0.031	−0.345	0.774	0.354	−0.182	0.872	0.031	−0.190	0.892
	[0.722]	[0.643]	[0.706]	[0.937]	[0.850]	[0.835]	[0.831]	[0.645]	[0.680]	[0.928]
%Risky × Public					−0.089	0.843	0.896			
					[0.616]	[0.833]	[0.878]			
%Risky × Public × U.S.					−1.395***	−1.792**	−1.768**			
					[0.477]	[0.888]	[0.877]			
%Retired	0.213	0.154	0.121	0.120	0.193	0.158	0.156	0.265	0.396*	0.394*
	[0.258]	[0.247]	[0.196]	[0.193]	[0.241]	[0.181]	[0.178]	[0.245]	[0.210]	[0.205]
%Retired × Public								−0.574	−1.216	−1.178
								[0.806]	[1.008]	[1.001]
%Retired × Public × U.S.								−0.411	−0.938**	−0.942**
								[0.345]	[0.385]	[0.389]
Fund size	0.047	0.034	0.076	0.076	0.036	0.075	0.075	0.031	0.069	0.069
	[0.058]	[0.052]	[0.057]	[0.057]	[0.053]	[0.059]	[0.059]	[0.053]	[0.059]	[0.058]
Inflation protection	0.043	0.096	−0.005	−0.004	0.101	−0.007	−0.007	0.094	−0.011	−0.010
	[0.143]	[0.114]	[0.130]	[0.130]	[0.117]	[0.132]	[0.133]	[0.114]	[0.130]	[0.130]
%External	−0.111	−0.164	−0.093	−0.085	−0.145	−0.082	−0.075	−0.149	−0.057	−0.050
	[0.287]	[0.222]	[0.203]	[0.201]	[0.224]	[0.204]	[0.202]	[0.221]	[0.198]	[0.196]
%Active	0.194	0.199	0.125	0.116	0.206	0.134	0.124	0.210	0.141	0.132
	[0.358]	[0.360]	[0.348]	[0.344]	[0.358]	[0.347]	[0.343]	[0.361]	[0.349]	[0.345]
$\Delta\%Risky_{t-1}$			−1.150			−1.203			−1.176	
			[0.956]			[0.998]			[0.966]	
%Risky$_{t-1}$				−2.276			−2.285			−2.266
				[1.515]			[1.523]			[1.510]
%Risky$_{t-2}$				1.044			1.096			1.072
				[0.969]			[1.016]			[0.978]
Return$_{t-1}$			−0.003	−0.003		−0.003	−0.003		−0.004	−0.004
			[0.099]	[0.099]		[0.099]	[0.099]		[0.099]	[0.099]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,425	5,425	3,694	3,694	5,425	3,694	3,694	5,425	3,694	3,694
R^2	0.121	0.122	0.133	0.134	0.122	0.134	0.134	0.122	0.135	0.135

We estimate a panel model. The dependent variable is pension fund net benchmark-adjusted performance. Independent variables include *Public*, a dummy variable taking a value of one if a pension fund is public; *Public × U.S.*, a dummy variable capturing U.S. public funds; *%Risky*, the percentage allocated to risky assets based on strategic asset allocation policy; $\Delta\%Risky_{t-1}$, the lagged change in the percentage allocation to risky assets; $\%Risky_{t-1}$ and $\%Risky_{t-2}$, the percentage allocated to risky assets in years *t–1* and *t–2*; *%Retired*, the percentage of retired members from total pension fund members; *%Risky × Public*, an interaction term capturing the percentage allocated to risky assets of public funds; *%Risky × Public × U.S.*, an interaction term capturing the allocation to risky assets of U.S. public funds, *%Retired × Public*, an interaction term capturing the percentage of retired members among public funds; *%Retired × Public × U.S.*, an interaction term capturing the percentage of retired members among U.S. public funds; *Fund size*, the logarithm of total pension fund assets; *Inflation protection*, a dummy variable taking a value of one if a fund provides contractual inflation protection; *%External*, percentage of assets delegated to external managers; *%Active*, percentage of assets managed actively; and $Return_{t-1}$, the net benchmark-adjusted return of pension funds in the previous year. In all models we include year dummies and the U.S. region dummy variable. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

Table 6
Regressions: Performance of U.S. pension funds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Net benchmark-adjusted returns of U.S. funds							
%Risky	−0.118	−0.002	0.219	−0.202	0.649	0.336	0.358	1.000
	[0.756]	[1.062]	[1.474]	[1.506]	[1.803]	[1.020]	[1.051]	[1.594]
%Risky × Public			−0.548	−0.028	0.069			
			[1.864]	[2.260]	[2.261]			
%Retired	0.129	0.551	0.556	0.930	0.865	0.631	1.070	1.019
	[0.282]	[0.676]	[0.676]	[0.639]	[0.622]	[0.675]	[0.699]	[0.692]
%Retired × Public						−3.764***	−5.833**	−5.663**
						[1.343]	[2.530]	[2.456]
Public	−0.421**							
	[0.178]							
Fund size	0.070	0.222	0.227	0.464	0.463	0.301	0.619	0.615
	[0.055]	[0.407]	[0.405]	[0.585]	[0.586]	[0.407]	[0.596]	[0.595]
%External	−0.028	−0.732	−0.687	−0.538	−0.531	−0.624	−0.356	−0.351
	[0.267]	[0.686]	[0.745]	[0.942]	[0.936]	[0.703]	[0.856]	[0.852]
%Active	0.209	−0.703	−0.711	−0.680	−0.737	−0.687	−0.607	−0.652
	[0.427]	[0.902]	[0.896]	[0.927]	[0.934]	[0.905]	[0.922]	[0.927]
Inflation protection	0.052							
	[0.180]							
$\Delta \%Risky_{t-1}$				−1.575*			−1.769**	
				[0.838]			[0.815]	
$\%\text{Risky}_{t-1}$					−2.501***			−2.446***
					[0.945]			[0.932]
$\%\text{Risky}_{t-2}$					1.242			1.519
					[1.167]			[1.116]
Return_{t-1}				−0.146	−0.146		−0.149	−0.149
				[0.118]	[0.118]		[0.119]	[0.118]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,338	3,365	3,365	2,225	2,225	3,365	2,225	2,225
R^2	0.141	0.329	0.329	0.280	0.281	0.330	0.282	0.282

We estimate a panel model and the dependent variable is the net benchmark-adjusted performance only of U.S. pension funds. Independent variables include *%Risky*, the percentage allocated to risky assets based on strategic asset allocation policy; $\Delta \%Risky_{t-1}$, the lagged change in the percentage allocation to risky assets; $\%Risky_{t-1}$ and $\%Risky_{t-2}$, the percentage allocated to risky assets in years *t–1* and *t–2*; *%Retired*, the percentage of retired members from total pension fund members; *%Risky × Public*, an interaction term capturing the percentage allocated to risky assets of public funds; *%Retired × Public*, an interaction term capturing the percentage of retired members among public funds; *Fund size*, the logarithm of total pension fund assets; *Inflation protection*, a dummy variable taking a value of one if a fund provides contractual inflation protection; *%External*, percentage of assets delegated to external managers; *%Active*, percentage of assets managed actively; and $Return_{t-1}$, the net benchmark-adjusted return of pension funds in the previous year. In all models except model (1), we include year dummies and fund fixed effects. Model (1) includes the *Public* dummy variable, which takes a value of one if a pension fund is public. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

and the interaction term *%Retired × Public* is not significant. This result shows that the investments of U.S. public pension funds do not perform differently from the investments of other pension funds when their percentage allocation is not inflated by regulatory incentives.

An alternative explanation for why U.S. public pension funds underperform is that they just have lower skills than other pension funds, regardless of their regulatory differences. However, the low skills hypothesis seems insufficient

Table 7
Regressions: Performance of U.S. pension funds by asset class

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Equity		*Alternative assets*		*Risky fixed income*		*Non-risky assets*	
%Risky	1.110*	1.401	5.673	7.957	3.940	6.266	0.232	0.401
	[0.578]	[1.241]	[3.720]	[6.521]	[2.751]	[6.492]	[0.562]	[0.698]
%Retired	0.135	0.544	−0.292	0.047	−1.219	−2.761	0.513**	0.803**
	[0.274]	[0.649]	[1.422]	[3.341]	[1.115]	[2.702]	[0.206]	[0.335]
%Retired × Public		−4.732*		−13.661*		−6.108		0.211
		[2.462]		[8.150]		[9.560]		[1.436]
Public	−0.237**		−2.410**		−0.858		0.044	
	[0.110]		[1.048]		[0.703]		[0.173]	
Fund size	0.035	0.108	0.510**	2.244	0.500***	−0.552	0.045	−0.134
	[0.063]	[0.379]	[0.206]	[1.875]	[0.179]	[2.577]	[0.051]	[0.169]
Inflation protection	0.120		0.498		−0.398		−0.004	
	[0.167]		[0.572]		[0.427]		[0.130]	
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE	No	Yes	No	Yes	No	Yes	No	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,307	3,332	2,533	2,553	624	627	3,309	3,334
R^2	0.166	0.306	0.100	0.348	0.159	0.358	0.275	0.399

We estimate a panel model. The dependent variable is the net benchmark-adjusted performance of U.S. pension funds. In columns (1) and (2), the dependent variable measures the performance in equity; in columns (3) and (4), performance in alternative assets; in columns(5) and (6), performance in risky fixed income assets; and in columns (7) and (8), performance in non-risky assets, such as cash and investment-grade bonds. Independent variables include *%Risky*, the percentage allocated to risky assets based on strategic asset allocation policy; *%Retired*, the percentage of retired members from total pension fund members; *%Retired × Public*, an interaction term capturing the percentage of retired members among public funds; *Fund size*, the logarithm of total pension fund assets; and *Inflation protection*, an indicator taking a value of one if a fund provides contractual inflation protection. Columns with odd numbers include the *Public* dummy variable, which takes a value of one if a pension fund is public. In columns with odd numbers, we include only year fixed effects, whereas in columns with even numbers, we include both year and fund fixed effects. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

to fully explain the underperformance of U.S. public plans, because it does not predict that pension fund maturity is related to investment skills and performance, while it is posited in our regulatory incentives hypothesis that U.S. public pension funds that are more mature will be susceptible to the GASB regulatory incentives and perform worse. Still, excessive risk-taking due to regulatory incentives is only one potential explanation of the underperformance by U.S. public pension funds, and it does not provide an explanation as to why these pension funds opt for active asset management.

6. The Level of Underfunding per Participant and Governance

For the subset of U.S. public pension funds, the greater level of publicly available disclosures allows us to consider the role of underfunding per member and pension fund governance. Our results using the full sample of pension funds focus on fund maturity as a proxy for the importance of the regulatory incentives hypothesis, because fund maturity data is available for the full sample. For U.S. public pension funds, we use more detailed data and confirm that fund maturity is significantly related to funding status and board composition. After that, we consider how the level of underfunding per participant and the board composition relate to the allocation to risky assets, liability discount rates, and performance of U.S. public funds.

Table 8 examines only U.S. public pension funds, and relates the percentage of retired members to the level of underfunding per pension fund participant and board composition. The goal of this analysis is not to discover causal relationships, but to explore whether fund maturity proxies for these variables as suggested by the regulatory incentives hypothesis. We cannot use pension fund fixed effects in the regressions after including the governance variables, because 94 out of 113 U.S. public funds have a constant board composition over time. However, we use pension fund state fixed effects, control for board size, include an indicator variable equal to one for pension funds that have two separate boards that make the investment and actuarial decisions, and control for the economic and demographic conditions in the state.

First, we find that the percentage of retired participants is positively related to the level of underfunding per participant, and confirm that fund maturity proxies for worse funding situation and higher required contribution payments. This positive relation shows that mature U.S. public funds have a stronger incentive to use a higher liability discount rate because it enables them to transfer a larger economic cost of underfunding to the future. This argument is based on the regulatory requirement that underfunded pension funds (i.e., essentially all of the U.S. public funds in our sample) need to pay catch-up contributions to amortize the unfunded accrued liability. The size of these amortization contributions depends on the dollar value of the funding deficit (GASB 1994). Pension funds that are more mature have larger accrued liabilities per participant, since on average their participants have accrued liabilities for a longer period of time. For these pension funds, any reduction in the liability discount rate results in a larger increase in the (dollar) amount of their reported liabilities and thus in their reported funding deficit. This increase in the reported funding deficit translates into higher required contribution payments today. Thus, U.S. public pension funds that are more mature have a stronger incentive to invest more in risky assets and justify a higher liability discount rate in order to report lower underfunding and transfer more of the economic cost of underfunding to the future.[38]

[38] In Online Appendix A, we use different stylized scenarios to examine how the liability discount rate changes affect the required contribution payments and pension funding status depending on pension fund maturity. In addition to the basic scenario with required catch-up contributions, we also analyze two alternative scenarios. First, we consider what happens if a pension fund does not receive the entire amount of annual required contributions from the public sponsor (employer). According to Novy-Marx and Rauh (2014), 45% of U.S. public pension funds received less than the full required amount of contributions in 2009 from their public sponsor. If a pension fund does not receive the entire amount of annual required contributions from the sponsor, it faces a prolonged negative trend in its funding status in the years after the discount rate reduction, in addition to the initial reduction. This negative trend is steeper among pension funds that are more mature, because their cash outflows for pension payments are larger than the inflows from normal contributions. In effect, these pension funds continue to pay the entire promised amount of pensions to retirees, even if they are not fully funded. Second, we study the impact of

Table 8
Regressions: Percentage of retired members of U.S. public pension funds

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Percentage retired members				
Underfunding per participant	0.122***		0.090***	0.096***	0.095***
	[0.036]		[0.027]	[0.029]	[0.028]
%State-political		0.101**	0.095***	0.095***	0.094**
		[0.040]	[0.036]	[0.037]	[0.037]
%PlanMem-elected		0.165***	0.151***	0.151***	0.150***
		[0.032]	[0.034]	[0.034]	[0.033]
%GenPublic-appointed		0.048	0.046*	0.043	0.042
		[0.031]	[0.027]	[0.027]	[0.028]
Fund size	−0.019***	−0.015***	−0.013***	−0.013***	−0.013***
	[0.005]	[0.004]	[0.004]	[0.003]	[0.004]
Board size			0.001	0.001	0.001
			[0.002]	[0.002]	[0.002]
InvBoard			−0.012	−0.013	−0.013
			[0.025]	[0.025]	[0.025]
Unionization				−0.159***	−0.167***
				[0.041]	[0.042]
Population growth				0.002	0.003
				[0.002]	[0.002]
GDP per capita				−0.014	−0.016
				[0.014]	[0.015]
GDP growth				0.000	−0.000
				[0.001]	[0.001]
Government expenditures					0.002
					[0.004]
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes
Observations	1,117	1,117	1,117	1,117	975
R^2	0.616	0.670	0.688	0.692	0.690

The dependent variable is the percentage of retired participants of U.S. public pension funds. *Underfunding per participant* is estimated by dividing the total underfunding in $million (difference between the liabilities discounted with the ten-year Treasury rates and the actuarial assets) with the total number of active and retired plan members. We include the following board composition variables in the models. *%State-political* captures the percentage of board members representing the employer (state, country, city, or other public entity), who are either appointed by a government executive or serve as ex officio members by the virtue of holding another government position. *%PlanMem-elected* measures the percentage of board members representing the plan participants, who are either elected by the plan members or serve on the board as union leaders. *%GenPublic-appointed* measures the percentage of board members appointed from the general public. We also control for *Board size*, the total number of pension fund board members, and *InvBoard*, an indicator equal to one if a pension fund has a separate investment board. *Fund size* measures the logarithm of total pension fund assets. We control for the following economic variables on a state level: public employee unionization rates, GDP per capita, GDP growth, population growth, and state and local government expenditures per capita. The government expenditures data on a state level is not available in 2001 and 2003, and this reduces the number of observations in column (5). Every regression includes year fixed effects and state fixed effects. We also independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

Second, fund maturity is related to the pension fund board composition. Among U.S. public pension funds, the board of trustees has the power to decide on the fund's asset allocation policy and actuarial assumptions. Table 8 shows

lower investment returns on required contribution payments. Lower returns negatively affect all pension funds, but again the effects are more pronounced among pension funds that are more mature. See also Novy-Marx and Rauh (2011a) for a broader discussion on the policy options available to U.S. public pension funds.

that the percentage of retired members is positively related to the percentage of state-political trustees and participant-elected trustees. We interpret this as evidence that pension funds that are more mature tend to be governed by trustees who are arguably more susceptible to regulatory incentives.

The first group, state-political board members, is more susceptible to regulatory incentives because these members are generally politicians, and thus have stronger short-term incentives to minimize the contribution payments from the public sponsor (employer) to the pension fund during the current political cycle and use the budget resources for other purposes. As noted earlier, the employer contribution payments depend on the reported funding deficit. If the pension plan is underfunded, the sponsor (not the employees) has the obligation to pay catch-up contributions to amortize the unfunded accrued liability. By investing more in risky assets and using a higher discount rate, the public sponsor of the pension fund faces lower required contribution payments today (although higher costs in the future).

The second group, board members elected by plan participants, is more susceptible to regulatory incentives because plan participants bear little downside risk from higher risk-taking by pension funds in the short run. If increased risk-taking results in low returns and underfunded liabilities, plan participants are not obliged to pay catch-up contributions to cover the funding deficit. However, they could benefit from higher pensions if risk-taking yields good returns. This argument holds mainly for the short term, because in the long term (i.e., after a prolonged period of funding problems), the normal contribution rates for plan participants can be increased and promised (non-accrued) benefits can be reduced. Thus, older active workers and retired participants have stronger incentives to respond to the regulatory incentives relative to younger workers because any changes in contributions or benefits generally cannot be implemented retroactively. Importantly, the positive relation between fund maturity and the percentage of elected plan participants on the board presented in Table 8 implies that for pension funds with a higher percentage of older and retired participants, these participants tend to be better represented on the fund's board. Basically, the board of trustees of mature funds has more trustees with a stronger incentive to transfer the economic costs of underfunding to the future.

Additionally, fund maturity remains significantly related to the level of underfunding per plan participant and pension fund board composition when we control for state fixed effects, economic conditions, and population growth in the state. These controls are important because some states, like Michigan, New York, and Oregon, have more public pension funds that are more mature, but our results are not due to the geographical distribution of these pension funds. Next, we test our hypothesis that the percentage of retired members is positively associated with the risk-taking and discount rate choice among U.S. public pension funds because it proxies for the level of underfunding per participant (and thus the prospect of increasing required contributions) and board composition.

In Table 9, we directly relate the percentage allocated to risky assets by U.S. public funds to the level of underfunding per participant, board composition, fund maturity, and other controls. We find that the level of underfunding per participant is positively related to the allocation to risky assets, while fund maturity becomes insignificant after these new variables are added. The economic significance of underfunding is meaningful, as an increase of one standard deviation in the level of underfunding per participant (0.164) is associated with a 1.18% higher allocation to risky assets ($=0.164\times0.072$). Boards with a higher percentage of state-political and participant-elected board members also invest more in risky assets. Based on column (4), an increase of one standard deviation in the percentage of state-political trustees (0.208) is associated with a 2.02% higher allocation to risky assets ($=0.208\times0.097$).

Table 10 relates the level of underfunding per participant and board composition to the liability discount rate choices of U.S. public pension funds. We find that U.S. public funds with a higher level of underfunding per participant use higher discount rates, which is consistent with their incentives to report a lower funding deficit. Further, pension funds governed by boards heavily populated by state-political trustees use discount rates that are around 46 to 56 basis points higher than funds governed by boards without state-political trustees. We find that funds with more trustees who are elected plan members do not use higher discount rates, but fund maturity remains positively related to the chosen discount rate. Unlike state-political trustees who have incentives to use a higher discount rate regardless of fund maturity, elected trustees representing plan participants seem more likely to be influenced by the percentage of retired participants and their interest to delay pension reforms that could have negative consequences for them.

Table 11 examines the relation between fund performance, underfunding, and governance. We find that the percentage of retired participants and the level of underfunding per participant are not significantly related to performance, but the board composition variables are significant. The lower performance of U.S. public pension funds presented earlier is mainly due to the lower performance of funds governed by participant-elected and state-political board members. Based on column (4), an increase of one standard deviation in the percentage of state-political trustees (0.208) is associated with net benchmark-adjusted performance that is 30 basis points lower ($=-1.445\times0.208$). These results indicate that higher risk-taking does not necessarily lead to lower net benchmark-adjusted performance, but in combination with poor governance it tends to deliver lower returns.[39]

[39] We find that pension funds governed by participant-elected and state-political board members invest relatively more in risky assets in response to regulatory incentives. However, these trustees do not seem to have the right skills and incentives to select well-performing investments. Andonov, Hochberg, and Rauh (2016) show that

Table 9
Regressions: Percentage allocated to risky assets by U.S. public pension funds

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Percentage allocated to risky assets				
%Retired	0.011	−0.019	−0.060	−0.067	−0.061
	[0.077]	[0.090]	[0.096]	[0.096]	[0.098]
Underfunding per participant	0.075**		0.068*	0.072**	0.072**
	[0.036]		[0.037]	[0.036]	[0.034]
%State-political		0.096**	0.097*	0.097*	0.087*
		[0.046]	[0.052]	[0.052]	[0.051]
%PlanMem-elected		0.075*	0.074**	0.074**	0.069*
		[0.040]	[0.037]	[0.037]	[0.037]
%GenPublic-appointed		0.148***	0.152***	0.150***	0.143***
		[0.043]	[0.048]	[0.048]	[0.048]
Fund size	0.008*	0.006	0.006	0.005	0.005
	[0.004]	[0.004]	[0.005]	[0.005]	[0.005]
Board size			0.002	0.002	0.002
			[0.002]	[0.002]	[0.002]
InvBoard			0.004	0.002	0.004
			[0.018]	[0.018]	[0.019]
Unionization				0.036	−0.019
				[0.114]	[0.119]
Population growth				−0.002	−0.002
				[0.004]	[0.003]
GDP per capita				−0.036	−0.066**
				[0.034]	[0.032]
GDP growth				0.002	0.003**
				[0.001]	[0.002]
Government expenditures					0.028**
					[0.013]
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes
Observations	1,117	1,117	1,117	1,117	975
R^2	0.447	0.466	0.473	0.477	0.487

The dependent variable is the percentage allocated to risky assets by U.S. public pension funds. *%Retired* measures the percentage of retired members from total pension fund members. *Underfunding per participant* is estimated by dividing the total underfunding in $million (difference between the liabilities discounted with the ten-year Treasury rates and the actuarial assets) with the total number of active and retired plan members. We include the following board composition variables in the models. *%State-political* captures the percentage of board members representing the employer (state, country, city, or other public entity), who are either appointed by a government executive or serve as ex officio members by the virtue of holding another government position. *%PlanMem-elected* measures the percentage of board members representing the plan participants, who are either elected by the plan members or serve on the board as union leaders. *%GenPublic-appointed* measures the percentage of board members appointed from the general public. We also control for *Board size*, the total number of pension fund board members, and *InvBoard*, an indicator equal to one if a pension fund has a separate investment board. *Fund size* measures the logarithm of total pension fund assets. We control for the following economic variables on a state level: public employee unionization rates, GDP per capita, GDP growth, population growth, and state and local government expenditures per capita. The government expenditures data on a state level is not available in 2001 and 2003, and this reduces the number of observations in column (5). Every regression includes year fixed effects and state fixed effects. We also independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

elected plan participants underperform because they have the least financial experience (as their careers are in teaching, public safety, or another area of public service), while state trustees underperform because they exercise political favoritism and direct decisions in order to gain political support.

Table 10
Regressions: Liability discount rates of U.S. public pension funds

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Liability discount rate				
%Retired	0.809**	0.985**	0.722*	0.686*	0.733**
	[0.393]	[0.385]	[0.370]	[0.362]	[0.366]
Underfunding per participant	0.356**		0.366**	0.388**	0.367**
	[0.166]		[0.162]	[0.162]	[0.159]
%State-political		0.463*	0.557**	0.557**	0.550**
		[0.238]	[0.219]	[0.219]	[0.226]
%PlanMem-elected		0.053	0.043	0.048	0.058
		[0.168]	[0.147]	[0.148]	[0.149]
%GenPublic-appointed		0.579**	0.672***	0.664***	0.654***
		[0.236]	[0.213]	[0.215]	[0.221]
Fund size	0.010	−0.003	0.008	0.008	0.009
	[0.015]	[0.018]	[0.015]	[0.015]	[0.015]
Board size			0.017	0.017	0.015
			[0.011]	[0.011]	[0.011]
InvBoard			−0.238**	−0.239**	−0.248**
			[0.115]	[0.116]	[0.117]
Unionization				−0.477*	−0.651**
				[0.276]	[0.289]
Population growth				−0.006	−0.006
				[0.011]	[0.008]
GDP per capita				−0.030	−0.093
				[0.068]	[0.088]
GDP growth				0.005**	0.007*
				[0.002]	[0.004]
Government expenditures					0.039
					[0.031]
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes
Observations	1,117	1,117	1,117	1,117	975
R^2	0.538	0.560	0.595	0.597	0.577

The dependent variable is the liability discount rate used by U.S. public pension funds. *%Retired* measures the percentage of retired members from total pension fund members. *Underfunding per participant* is estimated by dividing the total underfunding in $million (difference between the liabilities discounted with the ten-year Treasury rates and the actuarial assets) with the total number of active and retired plan members. We include the following board composition variables in the models. *%State-political* captures the percentage of board members representing the employer (state, country, city, or other public entity), who are either appointed by a government executive or serve as ex officio members by the virtue of holding another government position. *%PlanMem-elected* measures the percentage of board members representing the plan participants, who are either elected by the plan members or serve on the board as union leaders. *%GenPublic-appointed* measures the percentage of board members appointed from the general public. We also control for *Board size*, the total number of pension fund board members, and *InvBoard*, an indicator equal to one if a pension fund has a separate investment board. *Fund size* measures the logarithm of total pension fund assets. We control for the following economic variables on a state level: public employee unionization rates, GDP per capita, GDP growth, population growth, and state and local government expenditures per capita. The government expenditures data on a state level is not available in 2001 and 2003, and this reduces the number of observations in column (5). Every regression includes year fixed effects and state fixed effects. We also independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

Our analysis also examines the percentage of board members who are appointed to represent the general public. These trustees effectively represent taxpayers and resemble outside independent directors governing corporations (Adams, Hermalin, and Weisbach 2010). Public board members do not

Table 11
Regressions: Performance of U.S. public pension funds

	(1)	(2)	(3)	(4)	(5)
			Dependent variable: Net benchmark-adjusted returns		
%Retired	−1.066	0.468	0.720	0.558	2.129
	[1.737]	[0.993]	[1.421]	[1.583]	[1.297]
Underfunding per participant	−0.875		−0.585	−0.486	−0.598
	[1.182]		[1.005]	[1.012]	[1.098]
%State-political		−1.761***	−1.448***	−1.445***	−1.818***
		[0.666]	[0.555]	[0.551]	[0.540]
%PlanMem-elected		−1.618**	−1.446***	−1.435***	−1.752***
		[0.754]	[0.470]	[0.460]	[0.325]
%GenPublic-appointed		−1.107	−0.753	−0.794	−1.226**
		[0.888]	[0.582]	[0.589]	[0.507]
Fund size	−0.048	−0.062	−0.105	−0.109	−0.145
	[0.150]	[0.132]	[0.140]	[0.134]	[0.125]
%External	−0.158	−0.315	−0.378	−0.378	−0.425*
	[0.300]	[0.233]	[0.302]	[0.272]	[0.236]
%Active	0.093	0.089	0.052	−0.001	−0.433
	[0.764]	[0.705]	[0.704]	[0.679]	[0.703]
Board size			0.097**	0.097**	0.108**
			[0.043]	[0.045]	[0.046]
InvBoard			0.230	0.223	0.526***
			[0.331]	[0.340]	[0.095]
Unionization				−1.526	−1.162
				[1.314]	[1.416]
Population growth				0.140***	0.135
				[0.039]	[0.085]
GDP per capita				−0.132	0.257
				[0.422]	[0.506]
GDP growth				0.025	0.001
				[0.071]	[0.066]
Government expenditures					−0.228
					[0.248]
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Double-clustering	Yes	Yes	Yes	Yes	Yes
Observations	1,117	1,117	1,117	1,117	975
R^2	0.153	0.158	0.162	0.163	0.177

The dependent variable is the net benchmark-adjusted performance of U.S. public pension funds. *%Retired* measures the percentage of retired members from total pension fund members. *Underfunding per participant* is estimated by dividing the total underfunding in $million (difference between the liabilities discounted with the ten-year Treasury rates and the actuarial assets) with the total number of active and retired plan members. We include the following board composition variables in the models. *%State-political* captures the percentage of board members representing the employer (state, country, city, or other public entity), who are either appointed by a government executive or serve as ex officio members by the virtue of holding another government position. *%PlanMem-elected* measures the percentage of board members representing the plan participants, who are either elected by the plan members or serve on the board as union leaders. *%GenPublic-appointed* measures the percentage of board members appointed from the general public. We also control for *Board size*, the total number of pension fund board members, and *InvBoard*, an indicator equal to one if a pension fund has a separate investment board. *Fund size* measures the logarithm of total pension fund assets. *%External* captures the percentage of assets delegated to external managers, and *%Active* is the percentage of assets managed actively. We control for the following economic variables on a state level: public employee unionization rates, GDP per capita, GDP growth, population growth, and state and local government expenditures per capita. The government expenditures data on a state level is not available in 2001 and 2003, and this reduces the number of observations in column (5). Every regression includes year fixed effects and state fixed effects. We also independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

personally benefit from higher pensions if increased risk-taking pays off, but they represent taxpayers who presumably would prefer to avoid paying higher taxes to cover any pension funding deficit. On the other hand, these trustees are usually finance practitioners, which could potentially give rise to opportunistic behavior. Accordingly, many pension funds have adopted explicit rules regulating potential conflicts of interest. Of course, codes of conduct do not resolve all potential agency conflicts, and board members appointed from the general public may propose to invest more in risky assets for opportunistic reasons. Additionally, public trustees are finance professionals and may be relatively more confident that high rates of return are achievable by selecting riskier assets so that a high discount rate could be justified. We find that pension funds with more trustees from the general public invest more in risky assets and use higher discount rates, but there is no indication that their performance is different. Thus, their higher allocation to risky assets does not seem to adversely affect performance.[40]

Online Appendix Table E.3 shows that our results are robust to an alternative, simplified calculation of the level of underfunding per participant. In this robustness test, we assume that every pension fund has a duration of ten years (instead of making assumptions about the demographic characteristics of active and retired plan members) and we estimate the value of ABO liabilities (instead of EAN liabilities).

While our results only indicate associations and cannot show causation, they seem broadly consistent with the incentives and skills of board members. The fact that pension funds change board composition quite infrequently suggests that the relation between asset allocation, performance, and board representation is unlikely to arise mainly from the endogenous selection of different trustee types by pension funds.

7. Conclusion

In this paper, we examine whether and how the GASB regulatory link between the discount rates and expected return on assets is related to the asset allocation and performance of U.S. public DB pension funds. To do so, we compare the investments of U.S. public pension funds with U.S. corporate pension funds, as well as Canadian and European pension funds. Our results suggest that, over time, U.S. public pension funds have become the biggest risk-takers among pension funds internationally. In addition, U.S. public funds with a higher percentage of retired participants invest more in risky assets and maintain higher

[40] One explanation could be that board members appointed from the general public have relatively more financial skill and experience and thus are better able to monitor more risky investments. Indeed, the biographies of pension fund board members indicate that general public trustees generally have more asset management experience than the other trustees (Andonov, Hochberg, and Rauh 2016). Alternatively, even if the business connections of public trustees negatively affect some investments, these trustees still manage to compensate with a better performance on the remaining investments.

liability discount rates. We find that U.S. public pension funds underperform compared with other pension funds in the sample by about 50 basis points per year. This underperformance is particularly strong for U.S. public funds that are more mature, and with large allocations to equity and alternative assets.

These findings are consistent with the hypothesis that U.S. public pension funds (or at least a subset of them) use the GASB regulation strategically to maintain higher liability discount rates by increasing their allocation to risky assets with higher expected returns. The extent to which U.S. public pension funds respond to the regulatory incentives depends on their level of underfunding and board composition. First, U.S. public pension funds with a higher underfunding per participant invest more in risky assets and use a higher discount rate in order to avoid the prospect of increasing required contributions today. Second, U.S. public pension funds with a higher percentage of state-political or participant-elected board members also invest more in risky assets and use higher discount rates because their trustees have more incentives to transfer the economic cost of underfunding to the future.

When deciding whether to lower the level of the liability discount rate, government entities sponsoring an underfunded DB pension fund face a trade-off between the immediate extra costs necessary to cover the funding deficit if the discount rate is lowered and the potential costs from postponing in the form of higher costs in the future. On the one hand, government entities may face political problems when they need to raise more cash to cover a larger reported funding gap, because additional cash flows to the pension system are tangible and visible. On the other hand, government entities could also face problems from creating an unsustainable pension system if an excessive discount rate camouflages situations where the fund is actually rapidly losing assets and has a deteriorating ability to fulfill the projected future pension benefits. The political costs of such camouflage seem vague and are arguably only relevant if the taxpayers can see through the framing effects. Our interpretation is that our results are most consistent with U.S. public pension funds opting primarily for the second option—that is, justifying higher discount rates and transferring the economic cost of underfunding to the future.

Our evidence that pension funds seem to act on their regulatory incentives has important implications for designing retirement systems and governance of institutional investors. Pension fund investment decisions and performance could influence overall welfare and result in intergenerational wealth transfers. Further, given the amount of assets under management by pension funds, correlated changes in their strategic asset allocation could also have implications for asset pricing. We leave these questions for future research.

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