11-18-2011

An Analysis of Risk-Taking Behavior for Public Defined Benefit Pension Plans

Nancy Mohan
University of Dayton

Ting Zhang
University of Dayton

Upjohn Institute working paper ; 12-179

W.E. UPJOHN INSTITUTE
FOR EMPLOYMENT RESEARCH
Researching the causes and consequences of unemployment

An Analysis of Risk-Taking Behavior for Public Defined Benefit Pension Plans

Upjohn Institute Working Paper 12-179

Nancy Mohan
and
Ting Zhang
Department of Economics and Finance
School of Business Administration
University of Dayton
e-mail: nancy.mohan@notes.udayton.edu
tzhang1@notes.udayton.edu

November 18, 2011

ABSTRACT

This paper investigates the determinants of public pension plan risk-taking behavior using the percentage of total plan assets invested in the equity markets and the pension asset beta as measures of investment risk. We find that government accounting standards strongly affect public fund investment risk, as higher return assumptions (used to discount pension liabilities) are associated with higher equity allocation and beta. Unlike private pension plans, public funds undertake more risk if they are underfunded and have lower investment returns in the previous years, consistent with the risk transfer hypothesis. Furthermore, pension funds in states facing financial constraints allocate more assets to equity and have higher pension asset betas. There also appears to be a herding effect in that a change in CalPERS portfolio beta or equity allocation is mimicked by other pension funds. Finally, the results offer mild support of a public union effect.

JEL Codes: G23, H75, G11

Keywords: Public pension funds, investment risk, state financial constraints, risk transfer, government accounting

Acknowledgments: We are grateful to the W.E. Upjohn Institute for Employment Research for providing generous research funding for this research. We thank the Center for Retirement Research at Boston College for providing the Public Plans Database (PPD) and thank Moody's for providing data on the state credit ratings and net tax-supported debt. We thank Barry Hirsch and David Macpherson for making the Union Membership and Coverage Database available on their Web site and thank Lisa Hagerman of the Pension Funds and Urban Revitalization Center, University of Oxford, for providing the data on pension funds' economically targeted investment (ETI) policies. We also thank Keith Brainard and Liz Antin of the National Association of State Retirement Administration for providing the Public Plans Database used in the earlier draft. Comments are welcome.

An Analysis of Risk-Taking Behavior for Public Defined Benefit Pension Plans

Nancy Mohan and Ting Zhang*

November 18, 2011

Abstract

This paper investigates the determinants of public pension plan risk-taking behavior using the percentage of total plan assets invested in the equity markets and the pension asset beta as measures of investment risk. We find that government accounting standards strongly affect public fund investment risk, as higher return assumptions (used to discount pension liabilities) are associated with higher equity allocation and beta. Unlike private pension plans, public funds undertake more risk if they are underfunded and have lower investment returns in the previous years, consistent with the risk transfer hypothesis. Furthermore, pension funds in states facing financial constraints allocate more assets to equity and have higher pension asset betas. There also appears to be a herding effect in that a change in CalPERS portfolio beta or equity allocation is mimicked by other pension funds. Finally, the results offer mild support of a public union effect.

G23 - Pension Funds; Other Private Financial Institutions
H75 - State and Local government; Health; Education; Welfare; Public Pensions
G11 - Portfolio choice; Investment Decisions

Key words: public pension funds, investment risk, state financial constraints, risk transfer, government accounting

---

*The authors are from the Department of Economics and Finance, School of Business Administration, University of Dayton, Dayton, OH 45469. E-mails: nancy.mohan@notes.udayton.edu (Mohan) and tzhang1@notes.udayton.edu (Zhang). We are grateful to the W.E. Upjohn Institute for Employment Research for providing generous research funding for this research. We thank the Center for Retirement Research at Boston College for providing the Public Plans Database (PPD) and thank Moody's for providing data on the state credit ratings and net tax-supported debt. We thank Barry Hirsch and David Macpherson for making the Union Membership and Coverage Database available on their Web site and thank Lisa Hagerman of the Pension Funds and Urban Revitalization Center, University of Oxford, for providing the data on pension funds' economically targeted investment (ETI) policies. We also thank Keith Brainard and Liz Antin of the National Association of State Retirement Administration for providing the Public Plans Database used in the earlier draft. Comments are welcome.

An Analysis of Risk-Taking Behavior for Public Defined Benefit Pension Plans

1. Introduction

Public pension plans play an important role in the financial market. By 2008, their investments exceeded 6 percent of total financial assets, with aggregate assets of more than $2.5 trillion.[1] These plans, which are mostly defined benefit (DB) plans, cover pension benefits for 12.8 million active public employees and 5.9 million retirees and other annuitants.[2] Despite their size, the plans appear to be underfunded. The Pew Center on the States reports a $1.26 trillion shortfall for the fiscal year ending in 2009, a 26 percent increase from the prior year.[3] Other researchers argue for more conservative accounting of promised benefits, which could further raise the shortfall estimate. Novy-Marx and Rauh (2010) suggest that the dollar value gap of "already promised" benefits over asset value is between $1.27 and $3.26 trillion. This means that each tax-paying household would need to contribute an additional $21,500 to fully fund the obligation (Novy-Marx and Rauh 2009).[4] Rauh (2010) estimates that the existing unfunded pension debt would exhaust assets, in aggregate, by the year 2028. However, several funds would run out much sooner. For example, Illinois would run out of pension fund assets in 2018, and during the next year Connecticut, Indiana, and New Jersey would follow suit (Rauh 2010). The effect of underfunded pensions touches a large percentage of the population, including not only those at risk but also the taxpayers who may be called upon to close the funding gap.

The severe funding gap prompts questions of why the underfunding occurred and whether the pension fund administrators will adopt riskier investment positions in the hope of raising returns and lowering the shortfall. In this study we provide some explanation for the first question; however, we focus our research on risk-taking behavior. In particular, using data from the Public Plans Database maintained by the

[1] The numbers are from the Federal Reserve Statistical Release *Flow of Funds Accounts of the United States* dated September 17, 2009, put out by the Board of Governors of the Federal Reserve System, Washington, D.C.

[2] Source: The National Association of State Retirement Administration's Web site, http://www.nasra.org.

[3] "The Widening Gap: The Great Recession's Impact on State Pension and Retiree Health Care Costs," April 2011, available at http://www.pewcenteronthestates.org/uploadedFiles/Pew_pensions_retiree_benefits.pdf. The figure cited includes both pension and health care costs.

[4] The $21,500 figure is calculated by using the number of households filing tax returns for 2008 (Novy-Marx and Rauh 2009).

Center for Retirement Research at Boston College, we investigate the determinants of pension risk-taking behavior during the period 2001 through 2009 after taking into consideration state government incentives, political pressure, fiscal constraints, and workforce features. Our measures of investment risk include the percentage of total plan assets invested in the equity markets and the pension plan asset beta (Jin, Merton, and Bodie 2006). We offer evidence that government accounting standards strongly affect risk-taking behavior, as most pension plans use higher return assumptions to discount their pension liabilities. Unlike reported results for private pension plans (Rauh 2009), results for public pension plans indicate public fund managers appear to take on more risk if the plans are already underfunded and have had low investment returns in the previous years, behavior consistent with risk-transfer or an intent to pass underfunded current pension obligations on to future tax payers (Gold 2003). Similarly, there is some evidence to support the hypothesis that state fiscal constraints are associated with higher levels of pension fund risk. There also appears to be a herding effect in that plan managers tend to follow the risk-investing behavior of CalPERS (California Public Employees' Retirement System). Furthermore, the results offer mild support of a public union effect—that is, in order to provide larger retirement benefits for unionized public employees, the fund manager pursues a riskier investment allocation. Finally, we find limited evidence that economically targeted investment policies are associated with lower pension investment risk.

The rest of the paper is organized as follows. In Section 2 we discuss the institutional background, providing a quick example of a DB plan and commenting on government accounting standards. A literature review and presentation of hypotheses is provided in Section 3. We summarize the data and empirical results in Section 4, and offer conclusions in Section 5.

2. Institutional background

2.1. Example of defined benefit pension plan mechanics

To better understand the underfunding status of public pension funds, we first provide a quick review of DB plan benefit mechanics. Typically, the retirement benefit is a function of salary, years of service, and a benefit factor. For example, consider a DB

plan for teachers in which the benefit factor is 2.2 percent. Suppose a teacher retires after 30 years, at a peak salary of $70,000, and earns a retirement benefit of $46,200 (0.022 × 30 × 70,000), with the duration of payments as the only unknown. State funding of this retirement is considered to be a cost, or a part of the employee's compensation. Thus, each year the state recognizes the cost of employee benefits accrued (earned). Usually, both employees and employers fund the pension obligations, so the state is partially paying for the retirement obligation. In Ohio, for example, members of the State Teachers Retirement System (STRS) Fund contribute 10 percent of gross earnings to the trust fund, while employers contribute an additional 14 percent. These contributions, plus earnings from their investment during the employee's working life, flow into the fund. Returning to the example above, if a teacher starts with a starting salary of $34,206 and receives annual raises of 2.5 percent, the lifetime contributions amount to $360,416. The undiscounted value of retirement benefits (assuming the same 2.5 percent inflation and 30 years postretirement) is just over $2 million. The most recent five-year return for the Ohio STRS was 2.69 percent; using this return for both investing and discounting obligations provides a liability of more than $1.3 million, with invested assets of $518,000 at the time of retirement. Clearly, the rate of return on investment and the appropriate discount rate to apply to forecasted benefits are key actuarial assumptions.

2.2. Pension effects from government accounting standards

From an accounting perspective, states are required to follow the guidelines specified in Governmental Accounting Standards Board Statement No. 25 (GASB 25), which "stipulates that states should make annual required contributions (ARC) to include the cost of newly accrued benefits due to service and wage increases, amortized payments to make up unfunded actual liabilities, and amortized payments to make up any actuarial loss" (GASB 1994).[5] However, states do not always contribute sufficient funds to cover the amortized unfunded liabilities and/or actuarial loss. According to the Pew Center on the States, only 22 states fully funded their 2009 fiscal year pension obligations. Although the average contribution of all states exceeded 90 percent, many states contributed a small portion of the required contribution—e.g., 31 percent for

[5] See, for example, Rauh (2010, p. 12).

Pennsylvania.[6] More states may experience difficulty meeting the required contribution as the current level of underfunding increases the amortization burden part of the ARC. Thus, a second problem is the states' current inability to devote more of the budget towards amortizing the underfunding.

Finally, GASB accounting standards have contributed to the problem on the liability side. According to GASB 25, liabilities (retiree benefits) may be discounted at a rate equal to the expected return on assets. Most plans assume 8 percent.[7] Lower valuations for pension cost require lower ARCs. Novy-Marx and Rauh (2010) believe that the inappropriate matching of the expected return on the investment strategy to the certainty of paying benefits is responsible for the current underfunding crisis. Stated another way, stocks are risky, and although the long-term return is a historical 11.4 percent, there have been several periods of negative returns. The current financial crisis deepened the deficit for state public employee DB plans; however, underfunding was already a prevalent issue in 2005, when Wilshire Research reported two problems: 1) 94 percent of state retirement systems were underfunded and 2) average asset allocations were skewed towards equity (67 percent equity, including real estate and private equity, and 33 percent fixed income). GASB 25 thus provides an incentive that results in underfunding and exposing the assets to high levels of market risk in order to minimize the service costs.[8]

In summary, academic researchers and industry practitioners are alerting the public to the magnitude of the pension plan underfunding problem and are suggesting various contributory causes.[9] Indeed, it appears that accounting and political influence may provide managers with an incentive to allocate more funds to riskier assets.[10] Anecdotal evidence from CalSTRS and CalPERS appear to support this projection.[11]

---

[6] These statistics are available on the center's Web site: http://www.pewcenteronthestates.org.

[7] This is from an asset allocation target of 60 percent equity, earning 11.4 percent, and 40 percent debt, earning 3 percent. The weighted average of returns is about 8 percent (GASB 1994).

[8] Although the ARC requires a payment for underfunding, the amount of underfunding is subject to an amortization period of 30 years.

[9] Other contributory factors, outside the scope of this research, include ill-timed benefit increases following the large fund returns during the 1990s, and structural issues such as spiking pay or early retirement. See *The Trillion Dollar Gap: Underfunded State Retirement Systems and the Road to Reform*, February 18, 2010, Pew Center on the States.

[10] Munnell, Haverstick, Sass, and Aubry (2008) argue that because public funds use the "entry-age normal" cost method, which front-loads pension expense, underfunding is not as severe as indicated by the media.

3. Literature review and hypotheses

There is a rich history of research concerning private pension plans; however, empirical study of public pension plans is more limited. This is due to data availability problems as well as to the different orientation of issues. For example, the corporate sponsor of private plans has to answer to shareholders and must comply with or follow strict regulatory and accounting guidelines. Moreover, the PBGC (Pension Benefit Guaranty Corporation) is available as a vehicle to insure bankrupt plans. Theories regarding corporate DB pension fund management include risk management (Rauh 2009), risk shifting (Sharpe 1976; Treynor 1977), tax benefit (Black 1980; Tepper 1981), and earnings management (Bergstresser, Desai, and Rauh 2006). In general, except for risk management and risk shifting, these are not the research issues associated with public DB plans. In this section we discuss potential hypotheses for explaining public pension plan risk-taking behavior. We use pension plan asset beta or equity asset allocation percentage as a proxy for public pension plan risk, the dependent variable that will be used in the regression models. Appendix A contains a summary of various hypotheses, related variables, and predicted signs for variable coefficients.

3.1. Risk management

Several recent articles describe the inadequacy of funding (for DB plans) and discuss the incentives state governments harbor that have led to the current high levels of underfunding (Novy-Marx and Rauh 2009, 2010; Rauh 2010; Bonafede, Foresti, and Yang 2005). As a consequence of the underfunding, many states and municipalities are reducing services—that is, a greater percentage of their budget must be used for payments into pension funds. This evidence suggests that one incentive both private and public DB funds may have in common is risk management. Unexpected increases in required funding for pension contributions may reduce the ability to invest in capital expenditures because, in the short run, the state/municipal budget is fixed. For states,

---

They support the 80 percent funding benchmark as acceptable for public plans. They argue that the true menace to state budgets is unfunded health care liability.

[11] During 2009, both CalSTRS (California State Teachers' Retirement System) and CalPERS announced a shift in investment policy. CalSTRS will shift some investment funding from stock to high-yield debt and underpriced assets being held by banks and expects to earn 15 percent on this category. CalPERS loosened asset allocation and added new assets classes to include infrastructure, commodities, and timber, among others.

expenditures would be for schools, police, etc. The implications are that, from a risk management perspective, states would prefer to have predictable pension contributions.[12] Accordingly, asset allocation decisions would be a function of funding status: safe, well-funded plans could invest in more risky securities, while underfunded plans would invest in less risky assets. We use pension funding ratio to test the risk management hypothesis; we expect lower pension plan asset betas and lower equity allocations to be associated with lower levels of funding. We predict a positive coefficient for the pension funding ratio variable.

3.2. Risk transfer

Although the moral hazard (or risk transfer) issue is apparent for private DB pension plans, as they are insured by the PBGC, public plans may also be affected.[13] Taxpayers are ultimately responsible for underfunded public pension plans. Early research on funding levels, such as Epple and Schipper (1981) or Inman (1981, 1982) suggests that underfunding is a method of passing current pension costs to future taxpayers. Presumably, the government can always raise taxes to fund pension plans. D'Arcy, Dulebohn, and Oh (1999) consider a theoretical model for state pensions and suggest that underfunding is not optimal, though, unless the growth in pension costs is less than the growth in the tax base. However, politicians are "are not concerned about long-term funding issues because they operate under a relatively short time horizon" (Giertz and Papke 2007, p. 314). If the risk transfer hypothesis holds, the predicted sign for the funding ratio is negative, as the severely underfunded pension funds would take on more risk. In addition to the pension funding ratio we also use the previous years' investment return (i.e., 1-, 3-, and 5-year) to test the risk transfer incentive. Funds that experienced low returns in prior years may react by increasing risk in the current year; thus, the predicted sign for the investment return coefficient is negative.

[12] Indeed, one rationale for smoothing investment gains/losses is to provide more predictability of contributions. Consequently, during severe market downturns, such as that experienced in 2008, the reported underfunding is underreported.

[13] Theoretically, private DB pension plan sponsors have an incentive to invest in a maximum level of risky assets so that the put value of the PBGC insurance can be maximized (Sharpe 1976; Treynor 1977). The recent empirical evidence from Rauh (2009), however, does not support moral hazard issue.

3.3. Political influence

Politics may play a role in pension fund investment policy. A typical board of trustees includes representatives of active and retired members, plus political appointees.[14] Coronado, Engen, and Knight (2003) examine whether a government entity can invest money on behalf of employees in the same manner as a private pension fund. They suggest that conflicts of interest result in public fund returns lying below the risk/return frontier. After controlling for differences in asset allocation, they find evidence that plan asset returns are diminished by certain types of political interference. Illustrations of political influence include pressure to buy bonds issued by the state or local government or to direct funds to economically targeted investments (ETI). The prominent CalPERS fund directs a portion of its portfolio to *The California Initiative* for private equity investment in businesses in underserved areas.[15] As of 2007, 10.8 percent of the total CalPERS fund was invested in California.[16] Nofsinger (1998) suggests that those funds investing in ETI experience lower returns compared to a benchmarked portfolio and that underfunded plans that use high actuarially assumed returns are more likely to invest in ETI. In contrast, Munnell and Sundèn (2001) argue that the amount of ETI is small, less than 2.5 percent of assets, and does not adversely affect return. These are early studies and include small sample sizes. Over the past decade more states (21) have passed legislation allowing state pension funds to make targeted investments. In 2008, the Florida legislature passed a bill that allowed state pension funds to invest up to 1.5 percent of assets ($1.9 billion) in technology and high-growth investments that would create high-wage jobs for Florida.[17] We consider political influence to invest locally or to give consideration to social goals and include dummy variables if the state system

[14] Typically a board oversees the fund investment. The STRS Ohio board includes seven teachers (five active teachers and two retired teachers) and four investment experts appointed by the governor, the speaker of the house, the senate president, and the superintendent of public instruction. The New Jersey pension system has three teachers, two governor appointments, one elected by the board, and one treasurer appointment.

[15] This is from Hoffer (2004), p. 8.

[16] From CalPERS (2007), p. 4.

[17] OPPAGA (2008). A review of the Florida Growth Fund performance appears in OPPAGA Report No. 10-60, *The Florida Growth Fund Added Investments in 2010, but It Is Still Too Early to Assess Total Economic Impact*. According to the data in the report, $73 million was invested in 11 companies. Although some jobs were created, "the SBA does not expect to earn competitive rates of return on these investments for at least 8 to 10 years because such investments typically involve relatively young or start-up companies" (p. 3).

supports economically targeted investments. The predictive sign for the dummy coefficient is positive. If, because of political influence, the plan administrators make investments below the risk/return frontier, the remaining assets may be invested in riskier securities, resulting in a higher plan beta or a larger percentage of equity allocation.

3.4. Fiscal constraints

When states are constrained from issuing additional debt, underfunding pension funds may substitute for borrowing (Novy-Marx and Rauh 2009). There is some evidence that fiscal constraints do affect public pension plans. According to Eaton and Nofsinger (2004), fiscal constraints cause states to manipulate actuarial assumptions to lower required contribution. And, because states can justify a higher discount rate for liabilities through the assumed rate of return, states facing financial constraints may subsequently invest in riskier assets, resulting in higher pension plan betas or larger equity allocations, or both. Proxy variables for state fiscal constraints include Moody's state ratings for general obligation bonds and state net tax-supported debt as a percentage of personal income.[18] According to the fiscal constraints hypothesis, states that have severe fiscal constraints (e.g., lower debt ratings and higher debt/personal income ratios) would be more likely to substitute pension underfunding for debt and to take more risk in their pension asset investment. We predict that the signs for the coefficients for state ratings (lower rating coded with higher numeric value) and debt-to-personal income ratio will be positive. We also use the percentage of actual employer contribution to annual required contributions as a third measure of state fiscal constraints, assuming that states with fiscal pressure are less likely to fully fund the yearly expense. We expect a negative coefficient for employer contribution percentage if financial constraints hypothesis holds.

3.5. Accounting effect

Public pension plans are regulated by GASB 25, which requires that the underfunding gap be amortized and results in an increase to the required annual contributions. The impact of amortizing the underfunding gap could be reduced by increasing the return assumption. Furthermore, as discussed earlier, administrators are allowed to discount liabilities at the assumed return. However, the pension plan may not

[18] Both measures are obtained from Moody's. As one of the two key measures used by analysts to compare state debt burdens, net tax-supported debt refers to any debt "to which state resources are pledged for payment." See Moody's Investors Service (2010). Another measure is debt per capita.

subsequently achieve the higher return. Indeed, Eaton and Nofsinger (2001) find that the return assumption is not correlated with the actual fund performance, whereas the percentage of the fund invested in equity is highly predictive of returns. Unless the fund increases its actual return, underfunding will continue to grow.

Does the pension fund manager subsequently increase the allocation of funds to equity to justify the high return assumption? Weller and Wenger (2009) do not find evidence that public fund managers chase returns when they are underfunded. It does appear, though, that funds are increasingly investing outside of the traditional debt/equity mix, possibly to increase realized returns. Robertson and Wielezynski (2008) consider the increase in asset allocation to alternative investments such as hedge funds, real estate, and private equity funds and report no significant differences in the Sharpe ratio between pension plans that invested in alternative assets and those that did not.

These findings support Rauh's (2010) conclusion that public DB pension funds are pursuing riskier investments. Park (2009) reports that public plan sponsors who use high discount rates are 3.6 percent more likely to invest in higher risk assets than those who use low discount rates. High discount groups may use more alternative investments, but the same equity allocation. The accounting effect predicts a positive coefficient for the return assumption.

3.6. Union effect

Public employees represent a large voting bloc, and during the 1970s several states gave public employees the right to collective bargaining.[19] Freeman (1983) reports that employees associated with unions receive better benefits, such as changes in the retirement factor and eligibility, early retirement without penalty, and increased COLAs. Increased benefits naturally result in higher pension obligations.[20] Mitchell and Smith

[19] For example, The Dill Act in 1978 gave California public employees the right to collective bargaining.

[20] Current studies show that when compensation is viewed as a package, public employees are paid, on average, 3.7 percent less than private employees. However, Keefe (2010) acknowledges that retirement benefits account for a higher percentage of employee compensation: 8.1 percent for state and local employees versus 4.8 percent for larger private employers (more than 500 employees). When comparing defined benefit plans for private versus public employees, these are the salient differences: the factor applied to the final average salary, an average of 2 percent versus 1.5 percent; early retirement opportunities; and inflation-indexing of benefits (Munnell and Soto 2007). A direct comparison between public and private retirement benefits is difficult, though, in that the defined benefit plan role for private companies is shrinking. (Companies are focusing on 401(k) plans because in these plans market risks are borne by the retiree, not the employer.)

(1994) find that greater unionization is associated with lower levels of pension funding. That is, the demand for more wages and benefits occurs at the expense of less funding. Concurrently, to cover the increased benefit expense, the investment policy, in terms of equity and other asset allocation, could shift. For example, Proposition 21, passed by the California legislature in 1984, removed the percentage limitations on equity and alternative investments and simply required that the investments be "prudent," i.e., exhibiting "the degree of care expected of a prudent person, who is knowledgeable in investments."[21] Our data include the percentage of public employees who are union members and the percentage of public employees who are covered by a collective bargaining agreement. A positive coefficient for the percentage of union employees (and for the percentage covered by collective bargaining) supports the union effect.

3.7. Demographic effects

Age and gender of DB plan participants may affect the risk-taking behavior of the fund. Traditional portfolio theory expects risk-taking tolerance to decline with age. We use (1) the ratio of active members to annuitants and (2) the average age of active employees as proxies for risk tolerance. We expect higher active-to-retired ratios and a lower average age to be associated with higher levels of pension plan beta (equity allocations). Eaton and Nofsinger (2008) cite more female active participants in the plan as a primary factor associated with significantly lower funding ratios. Our data does not provide gender variables. But the type of plan (teachers, police, firemen, etc) is provided, and, traditionally, public school teachers are predominantly female. The effect of gender on fund risk-taking behavior is ambiguous. Some studies have documented that females are less likely to assume portfolio risk (e.g., Dwyer, Gilkeson, and List 2002). Conversely, the observation that plans with more female active participants have higher equity allocations or betas suggests that they may be more aggressive risk-takers. We use a dummy variable to indicate whether a pension plan is for teachers, police/firefighter, or the general public.

[21] California Governor Arnold Schwarzenegger campaigned to change the pension system so that new employees would be covered by a 401(k)-style plan. However, the California state employees association effectively mobilized and successfully campaigned against the proposal. This example is from Byrnes (2005).

3.8. Herding

Herding is common among institutional investors. According to Park (2009), managers of public pension funds tend to follow peer group norms so that asset allocation-to-equity hovers at around 64–75 percent. Pension fund managers, like other fund managers, have career concerns and tend not to deviate from peer group investments by holding nonconventional portfolios. Alternatively, public pension plan managers may mimic the top performers or pension funds considered to be large and influential, such as CalPERS.

Similar to Weller and Wenger (2009), we construct several variables to test herding behavior in pension investment, including the top performer (winner) and CalPERS's equity percentage and pension asset beta. A positive and significant coefficient for the measures supports the herding effect.

3.9. Other effects

Larger DB plans enjoy economies of scale for transaction fees. Accordingly, these plans may invest more in equity and alternative investments and have higher pension plan betas. We include the log of the plan size to test this effect. As mentioned by Eaton and Nofsinger (2004), other funding assumptions may be manipulated. We look at the amortization period for unfunded accumulated liability and project that funds that try to minimize the effect of losses by having a longer amortization period will take more investment risks.

4. Data and variable construction

The data required for this study include public pension plan asset allocation, funding ratios, plan asset returns, state government contributions and measures of fiscal constraints, public employee unionization, and plan demographics. The major data source is the Public Plans Database (PPD), obtained from the Center for Retirement Research at Boston College.[22] The data are available from fiscal years 2001 through 2009, covering 126 pension systems for 50 states and the District of Columbia. These pension systems together held $2.09 trillion pension assets at the end of fiscal year 2009. Each state

[22] The PPD data are "collected from plans, annual reports, actuarial valuations, member handbooks, and contact with plan administrators" (Center for Retirement Research at Boston College 2011).

administers at least one pension system, and each system has at least one pension plan.[23] State government typically establishes multiple pension plans within one pension system for different employee groups, such as teachers, police and firefighters, and state and local government employees. The full sample has 1,134 pension system-year observations from 2001 through 2009.

In regard to the state finance measures, we obtain the historical data on the state general obligation bond ratings and net tax-supported debt as a percentage of personal income from Moody's. The public employee union membership and coverage data are obtained from the Union Membership and Coverage Database.[24] In addition, some public pension funds have special investment policies or initiatives related with economically targeted investment (ETI), such as urban economic development policies. This information is obtained from the Pension Funds and Urban Revitalization Center, University of Oxford.[25]

We describe the construction of pension risk, funding ratios, and the investment herding measures in detail below and provide the definitions of other variables in Appendix B.

4.1. Pension risk

The first measure of pension risk is the percentage of total plan assets invested in the equity market. The information is available in the Public Plans Database and reported at pension system level. An alternative measure is pension asset beta, which is first used by Jin, Merton, and Bodie (2006) as a measure of private pension plan asset risk. It is

[23] The number of pension systems in each state ranges from one to six—California and Texas each have six pension systems. 84 pension systems (out of a total of 126) have one pension plan, with the rest having more than one pension plan. The number of pension plans for each state thus also varies, ranging from one to seven—Washington and Texas each have seven pension plans.

[24] The data are available at http://www.unionstats.com and are constructed by Barry Hirsch and David Macpherson based on the Current Population Survey (CPS), a monthly household survey (Hirsch and Macpherson 2003).

[25] The data on the ETI are only available for the fiscal years 2001 and 2003. In addition, we obtain the fiscal year 2008 ETI information from a research report conducted by the Office of Program Policy Analysis and Government Accountability of the State of Florida (OPPAGA 2008). This report lists 21 states that made economically targeted investments using pension funds at the end of fiscal year 2008. We assume these states had an ETI allocation in the fiscal year 2009.

estimated as the weighted average beta of all asset classes in a pension plan's total assets.[26] That is,

$$\text{PENSION\_ASSET\_BETA} = \sum_{i=1}^{n} W_i \times \beta_i \quad , \qquad (1)$$

where W_i is the weight of each asset class and $\sum_{i=1}^{n} W_i = 1$, and β_i is the estimated beta of each asset. [27]

Public pension plans generally classify their pension assets into five categories—1) equities, 2) fixed income, 3) real estate, 4) alternatives, and 5) cash and other assets. The weight of each asset class in the pension plan is obtained from the Public Plans Database. The betas for equities, fixed income, real estate, and cash equivalents asset classes are from Jin, Merton, and Bodie (2006, Table 4, p. 9), as reported in Panel B of Table 1. According to the authors, these beta estimates for asset classes are drawn from a study by Harvard Management Company to determine the portfolio asset allocation. Note that Jin, Merton, and Bodie (2006) do not have the estimated beta of alternatives. The alternative investments of public pension plans generally refer to private equity investments, venture capital, and commodities.[28] Previous studies have reported various estimates of private equity beta. We assume a beta of 1.2 for the alternative asset class in this study. [29]

---

[26] The Public Plans Database also reports actuarial pension assets. We do not use actuarial pension assets in calculating pension asset beta because the data report each asset category as the percentage of a pension system's total market value, not as a percentage of pension actuarial assets.

[27] Beta measures the sensitivity of financial asset returns to the overall stock market change (i.e., using the S&P 500 Index as a proxy). Pension asset beta captures the risk of a pension plan's exposure to alternative investments, including private equity, venture capital, hedge funds, and other alternative assets, while the use of the equity percentage could underestimate the true level of pension risk.

[28] For example, the Alternative Investment Management Program (AIM) of CalPERS had a total of $48.4 billion in private equity investments as of March 31, 2010. According to a report by the U.S. Government Accountability Office (GAO 2010), the most popular alternative investments currently held by the public pension funds include private equity (venture capital and buyout), commodities, and hedge funds.

[29] The estimated betas of private equity include 1.10 (Ljungqvist and Richardson 2002), 0.6 (Hwang, Quigley, and Woodward 2005), 1.80 for venture capital and 0.66 for LBO (Kaplan and Schoar 2005), 1.7 (Cochrane 2003), 1.48 (Phalippou and Zollo 2005) and 1.01 (Nielsen 2009). For commodities beta, we estimate the beta to be 0.77 using the S&P iShare GSCI Commodity Index from July 2006 to September 2010, based on the in-sample regression and using the S&P 500 as the benchmark. It is generally believed that the alternative asset class has a beta greater than one. The beta of 1.2 is the simple average of the estimated betas mentioned above, which we believe is a conservative estimate of an alternative asset beta. Our results remain significant if we use other, higher beta values for the alternative asset class.

4.2. Funding ratios

Pension funding ratio is defined as the ratio of pension assets over pension liabilities. As pension assets and liabilities can be measured by both actuarial value and economic (market) value, we estimate actuarial and economic funding ratio, respectively. In particular,

$$\text{FUND\_RATIO\_ACTUARIAL} = \frac{ACTUARIAL\ PENSION\ ASSETS}{ACTUARIAL\ PENSION\ LIABILITIES} \quad (2a) \quad ;$$

$$\text{FUND\_RATIO\_ECONOMIC} = \frac{MARKET\ VALUE\ OF\ PENSION\ ASSETS}{MARKET\ VALUE\ OF\ PENSION\ LIABILITIES} \quad (2b) \quad .$$

Both actuarial value and market value of pension plans are available in the Public Plans Database. In measuring pension liabilities, the key difference between the actuarial and the economic pension liabilities is the discount rate used to estimate the present value of total pension liabilities. The expected rate of return of pension assets (in most cases, 8 percent) is used as the discount rate to estimate actuarial pension liabilities. This method is currently used by actuaries and pension sponsors. As previously discussed, Novy-Marx and Rauh (2010) contend that this method is not consistent with the risk level associated with public pension liabilities.[30] They advocate the use of either Treasury rate or municipal bond yield as the appropriate discount factors in estimating public pension liabilities. We obtain the economic pension liabilities for 50 states (excluding the District of Columbia) from Novy-Marx and Rauh (2009, 2010). The measures are available only for fiscal years 2008 and 2009. As a result, our measures of economic pension funding ratios are available for 2008 and 2009.

Note that the pension asset allocation information and the market value of pension assets are reported at pension system level, while actuarial assets and actuarial liabilities are reported at pension plan level. In estimating actuarial pension funding ratio, we first aggregate actuarial pension assets and liabilities across pension plans to arrive at the actuarial pension assets and liabilities at system level, and then estimate pension funding ratio based on Equation (2a). When estimating economic pension funding ratios, as the economic pension liabilities estimated by Novy-Marx and Rauh (2010) are at the state

[30] Novy-Marx and Rauh (2010, p. 1) contend that discounting liabilities in such a way "runs counter to the entire logic of financial economics: financial stream of payment should be discounted at a rate that reflects their risk (Modigliani and Miller 1958), and in particular their covariance with priced risks (Lintner 1965; Sharpe 1964; Treynor 1961)."

level, we first aggregate pension assets across systems to obtain the state-level pension assets, then we estimate economic funding ratios based on Equation (2b).

4.3. Herding variable

We use several measures to examine pension plan sponsors' herding behavior in making investments. In the spirit of Weller and Wenger (2009), to examine whether pension plan sponsors follow the top performer, we identify the "winner" as the pension plan with the highest annual investment returns year *t*. We look at the association between the winner and the rest of pension funds' equity allocation and pension asset beta. Similarly, to examine whether plan sponsors follow other big and influential plans with a high profile, such as CalPERS, we examine the relation between all other pension funds' equity allocation and pension asset beta with CalPERS.

4.4. Other variables

Other variables include pension plan return assumption, employer contributions as a percentage of annual required amount, measures of state government financial constraints and unionization, and measures related to plan demographics and features. We summarize the definitions of these variables in Appendix B.

5. Empirical Results

5.1. Descriptive statistics

Table 1 provides summary statistics for all plans during the entire period for returns, funding ratios, demographic features, and other pension plan characteristics (Panel A), state finance and unionization results (Panel B), asset allocations and plan betas (Panel C), and restricted sample statistics for economic funding ratios (Panel D). Based on prior research we expect to find plans, on average, to be underfunded and to assume high investment returns with substantial equity allocations. Our sample statistics confirm prior results, as discussed below.

The statistics in Panel A suggest that plans assume a high expected rate of return but, on average, fail to reach those expectations. The mean investment return assumption is 7.97 percent, with three-quarters of the observations higher than 7.80 percent. Furthermore, the standard deviation, at 0.44 percent, indicates that plans do not often change their assumed rate of return. In contrast to the assumed rate, the results for the

investment returns are much lower. We provide the average one-, three- and five-year return results and determine that pension plans underperform their expectations in each case. At best, using the five-year average investment return, the plans underperform the assumed rate of return by 2.54 percent. Figure 1 provides a comparison of the investment return assumption versus the actual five-year investment return from 2001 to 2009. Over the nine-year period, the funds suffered several disastrous returns compared to the 8 percent benchmark. Preliminary analysis, therefore, supports prior findings that public pension funds are assuming unrealistic investment returns, which is contributing to the underfunding status in that contributions are based on the assumed return. And our descriptive data shows that funds were, on average, underfunded during 2001–2009.

The mean actuarial funding ratio for 2001–2009 is 86.01 percent, with half of the observations lying within the range of 76.1 to 98.2 percent. The minimum (19.1 percent) and the maximum (147.7 percent) suggest high variability of pension funding status. Figure 2 illustrates that a major factor of underfunding status is the drop in pension assets' market value. As the stock market fell sharply in late 2008 and early 2009, pension funds with large allocations of stocks would be more adversely affected. Note that the average economic funding ratios shown in Panel D of Table 1, which are estimated based on the data for the period 2008–2009, are much smaller than actuarial funding ratios. The lower funding ratios are a function of higher pension liabilities, a result caused by a more realistic discount factor reflecting the near certainty of retiree payments. If the Treasury rate is used to discount liabilities, the funding ratio drops by half.

As noted above, plans allocating a high percentage to equity are most affected by market corrections. And most funds do invest a majority of their assets in stocks. As shown in Panel C of Table 1, three-fourths of the sample observations have equity allocations of 51 percent or more. On average, more than 56 percent of a plan's assets are allocated to equity, but the range (0 to 82 percent) and standard deviation (10.41 percent) are large. The average asset beta of 0.6564 (and range from 0.1638 to 0.9096) is consistent with the average asset allocations in that the maximum equity allocation is slightly more than 80 percent. In Figure 3, we provide a comparison of asset allocation and portfolio beta by year. Equity allocation peaked in 2004–2006 at 60 percent and then

declined to 50 percent during 2008 and 2009. Accordingly, portfolio beta follows a similar trend, but decreases less than the equity allocation. We observe that the fixed income allocation is lower in the later part of the sample period, thus the reduced allocation to equity is matched more by increases in alternative investments than by debt. Although the average alternative allocation over the entire period is 2.85 percent, from Figure 3 we see that the 2009 allocation is closer to 5.51 percent (increased from 1.64 percent in 2001). In summary, compared to the mean values for the total period, equity allocation is trending lower and fixed income allocation is relatively stable, but real estate and alternative investment allocation are higher. As expected, pension asset betas, as of 2009, are close to the sample period average despite decreases in equity allocation due to the increased investment in alternatives.

Factors that affect the underfunding problem include an aging workforce and state budget problems. First, underfunding requires the plan sponsor to increase contributions in order to diminish the gap. If a state faces financial constraints, then the increased contributions necessary to amortize the underfunding amount attenuates the financial crisis. Panel B of Table 1 shows that some states do face fiscal pressures, as measured by state net tax-supported debt as a percentage of personal income or state credit ratings. The reported range for the sample is 0.0 to 12.1 percent, with one-fourth of our observations higher than 4.3 percent. For comparison purposes, consider that the median debt percentage, as reported by Moody's, was 2.1 percent in 2001 and 2.5 percent in 2009.[31] Additional signs of fiscal pressure may include the amortization period. And, although the median amortization period for underfunding is 29 years, the maximum observation is 40 years, and 25 percent of the observations exceed 30 years. Furthermore, underfunded plans are more alarming if the workforce is aging. Plan descriptive data from Panel A indicate an aging workforce because there are relatively few working employees (2.69) for each retiree. Additional supporting evidence of workforce age is the average age for active employees, nearly 45, with a standard deviation of just over 3 years.

[31] From Moody's Investors Service (2010).

5.2. Regression analysis

5.2.1. Univariate results

Results from univariate regressions for both equity allocation (column 1) and pension asset beta (column 2) appear in Table 2. In general, the results are similar for both dependent variables and provide consistent support for the accounting effect, risk transfer, herding, fiscal constraint, and demographic and union effect hypotheses. In contrast, the results do not support the risk management or political influence hypotheses. We discuss the implications from these results below.

Positive and significant coefficients for the return assumption support the accounting effect, which implies that a higher pension return assumption is associated with a larger equity allocation and pension asset beta. Negative and significant coefficients for five of the six proxy variables (the economic funding ratio variables and the lagged three- and five-year return variables) support the risk transfer hypothesis. That is, managers take on more risk if the plan is underfunded and experienced poor investment returns in the previous three or five years.[32] The coefficients for state contribution as a percentage of annual required contributions, state debt ratings, and debt burden are all consistent with the financial constraints hypothesis. In particular, pension funds contributing less relative to annual required contributions have higher equity allocations and pension asset betas. Similarly, pension funds sponsored by the states that have lower credit ratings and higher tax-supported debt have higher allocations of equity and higher betas. (We note that the coefficient for debt burden, although positive when beta is the dependent variable, is not significantly different from zero.) In addition, there appears to be a union effect, in that higher union membership percentages and a higher percentage of employees covered by collective bargaining are associated with more risk. Finally, strong results appear for the herding hypothesis using the CalPERS proxy: funds tend to follow CalPERS for equity allocation, and funds tend to mimic changes in CalPERS beta. On the other hand, the "winner" effect is significant for beta, but not for equity allocation.

[32] The one-year lagged return provides a conflicting result. We will discuss this finding in the multivariate regression analysis.

Pension fund type falls into three categories, including teacher (32 percent), police/firefighter (8 percent), and general (60 percent). As reported by Eaton and Nofsinger (2008), funds that have a higher percentage of females are more likely to be underfunded. Consequently, the underfunding may result in these plans adopting riskier investment policies. Traditionally, teacher funds have the highest proportion of women, and for our sample the dummy variable coefficient for teachers is positive and significant at the 1 percent level for equity and the 5 percent level for beta, indicating that, by our measure, this type of fund does have more risk. Conversely, the general fund dummy variable is negative and significant at the 5 percent level for equity and the 10 percent level for beta. We observe the insignificant coefficients for ETI in column 1, where the dependent variable is equity percentage, indicating a lack of support for the political influence hypothesis. On the other hand, we find that the coefficient for ETI is negative and significant when pension asset beta is used as a dependent variable (column 2). This result suggests that pension funds directing investment to ETI have significantly lower risk, as measured by portfolio beta, which we believe to be the appropriate risk measure for this variable.

Univariate analysis provides a preliminary indication of a variable's effect on risk, as measured by equity allocation or pension asset beta. In the next section we offer multivariate models that include proxy variables for each hypothesis, since risk may be affected by multiple factors.

5.2.2. Multivariate regression analysis

In this section we discuss the results from a series of multivariate regression models that combine proxy variables for each hypothesis. We specify four models for the full sample that use a different combination of variables for those hypotheses supported in the univariate analysis. We specify multiple models employing different independent variables, because of the colinearity of proxy variables for each hypothesis. This allows us to check for robustness of the results. In addition, for each model, we report regression results for equity allocation and asset beta as the dependent variables. Full sample results are provided in Table 3.

In general, we interpret the results from the full sample regressions to be consistent with an accounting effect, to support risk transfer, and to suggest a tendency for funds to mimic (herd) the winner or influential (CalPERS) fund. Furthermore, there is some evidence indicating that a state's fiscal environment affects the pension plan risk. In most cases, the sign and significance level for the coefficients are consistent when the regressions use either equity allocation percentage or pension asset beta as the dependent variable. The following analysis provides a more detailed review of the results.

We observe consistent support for the accounting effect in that the coefficients for the return assumption are positive and significant for all model specifications. In particular, the coefficients for the return assumption for the equity allocation models range from to 1.722 to 4.5101, implying that a 100-basis-point increase in pension return assumption is associated with about a 1.72 to 4.51 percent increase in equity allocation. The corresponding increase in pension asset beta given the same increase in the return assumption is 0.0353 to 0.0627. If a fund assumes a higher rate of return, then the allocation to equity increases and, correspondingly, the pension asset beta also increases.

The multiple regression results are consistent with the risk transfer hypothesis. The coefficients for the lagged funding ratio and lag five-year returns are negative and significant in Models 1 and 4, suggesting that pension funds tend to take high investment risks when funding ratios are low and the previous-five-year investment returns are poor. When investment risk is measured as pension asset beta in Model 3, the coefficient is negative and significant for the lagged three-year return, supporting the risk transfer hypothesis. An inconsistent result is the positive and significant coefficient for the one-year lagged investment return for both equity and pension beta (Model 2), suggesting that the overall pension asset risk would be higher (lower) following a high (low) investment return in the prior year. This could be due to the change of portfolio weights—after a good (bad) year, pension funds could tilt towards more (less) equity, thus the change of portfolio allocation is merely an artifact of the market value of stocks in a good (or bad) year.

If fiscal constraints affect risk-taking behavior, we would expect states with high debt burdens and lower debt ratings to make riskier portfolio decisions. The regression results are consistent with this hypothesis. The coefficients for state credit ratings (Model

1) are significant at the 1 percent levels. As we define increasing credit risk with higher scores, this result indicates that states with higher credit risk have riskier pension funds. In Model 2, the coefficient for the DEBT_INCOME variable is positive and significant at the 5 percent level for the equity allocation model, suggesting that higher state debt burdens result in higher equity allocations. Finally, in Models 3 and 4, the negative and significant coefficients for EMPLOYER_CONTRIBUTION, which is employer contributions as a percentage of annual required contributions, indicates that employers paying a lower percentage of the required contribution have higher allocations to equity. These regression results suggest that states are substituting increased pension underfunding for borrowing when they face fiscal constraints, consistent with the fiscal constraint hypothesis.

The independent variables CALPERS_EQUITIES and WINNER_EQUITIES measure the previous year's equity allocation and are used to test the herding effect. Across all models, the positive and significant coefficient for CALPERS_EQUTIES indicates that pension funds indeed follow the investment strategy of high-profile plans such as CalPERS. There is also some evidence that pension funds chase winners in their investment, as shown in Model 2 when using pension asset beta as the dependent variable. Similar results appear when using the beta change of CalPERS and winner as measures for herding. The positive and significant coefficients suggest that funds mimic changes in beta reported by influential pension funds.

Other variables, although significant in the univariate analysis, have mixed results in the multivariate analysis. Results on the union effect are mixed, in that the only significant coefficient appears in Model 1 for the beta specification, indicating higher union membership results in higher asset betas. However, there appears to be no effect when using equity allocation as a measure of investment risk, as evidenced by the insignificant coefficients for the percentage of public employees who are union members and the percentage of employees who are covered by a collective barging agreement. Higher ratios for active employees are associated with more risk for both equity (Models 1 and 2) and beta specifications (Model 1),[33] while a higher average age negatively

[33] Note that the coefficient for active to annuitant ratio in the univariate regression is negative. A further examination of the data shows that the inconsistent result could be due to data outliers. In particular, the

affects beta (Model 1) but not equity allocation. The fund size is consistently significant and positive for beta specifications and for equity allocation in Models 3 and 4. This may be due to the observation that larger funds allocate more to alternative investments, which would affect beta more than equity allocation. Larger funds could also be more likely to invest in alternative investments instead of fixed income. The plan type effect disappears in the multiple regression models. Eaton and Nofsinger (2008) find that teacher plans are more underfunded. A primary factor associated with such underfunding is the fact that more females are active participants in these plans. Therefore, the relatively high risk exposure of teacher pension plans could be related to their underfunding levels and is not necessarily an indication of high risk preference.

Results and conclusions are similar when the sample is restricted to economic funding ratio and ETI data in Table 4. For Models 1 to 3, the sample period is fiscal years 2001, 2003, 2008, and 2009, while the sample period is 2008 and 2009 for Models 4 and 5 because of the data availability of ETI and economic funding ratios, respectively. Again, we run two sets of regressions, using either equity allocation or pension asset beta as the dependent variable. We observe support for the accounting effect in Models 1–3: higher return assumption is associated with higher allocations to equity and higher betas. The negative and significant coefficients for economic funding ratios (using either Treasury rate or municipal bond yield as a discount rate for pension liabilities) in Models 4 and 5 are consistent with the risk transfer hypothesis, indicating that funds increase equity allocation or pension asset beta when they have lower funding ratios. The coefficients of previous three- or five-year investment returns are negative and significant, which suggests that pension funds assume more risks following low investment returns, providing further evidence supporting the risk transfer hypothesis. Furthermore, evidence suggests that funds with more active members are riskier. Somewhat surprisingly, there is some evidence suggesting that ETI investing is associated with lower risk, in that the coefficients for ETI in Models 1–3 are significant and negative. We also note that LOGSIZE in Model 5 (where the dependent variable is

active to annuitant ratios for the pension system of Washington School Employees and Teachers were 31.59 from 2001 to 2004, much larger than the sample average ratio of 2.69 (see Panel A of Table 1). If we truncate the top ten percentile data and run the univariate regression again, we obtain the coefficient for active to annuitant ratio of 0.0179 (t = 2.44). Meantime, the multivariate regression result using this revised sample does not change significantly.

equity allocation) has a negative coefficient (significant at the 10 percent level), suggesting that the larger size of pension assets is associated with lower equity allocation. Again, this could be related to larger funds investing in higher levels of alternative assets.[34]

5.2.3. Endogeneity issue

If equity allocation, the actuarial funding ratio, and the state rating are jointly determined, then OLS regression provides biased estimators. In effect, there is a possible feedback effect between equities allocation and underfunding; that is, the causal effect could extend in both directions. Furthermore, the same logic applies to the state rating and severe pension underfunding. As public pension plans are a contractual liability, lower pension funding could result in lower credit ratings. To account for the endogeneity issue, we construct a simultaneous set of regression equations for equity allocation, state ratings, and funding ratios. We then use a two-stage procedure to estimate the model coefficients; those results appear in Table 5. In column 1, when the dependent variable is equity allocation, we continue to see that our results are consistent with those previously reported. In particular, there is a positive and significant coefficient for the return assumption, consistent with the accounting effect. A significant and negative coefficient for the funding ratio is consistent with the risk transfer hypothesis. Consistent with a herding effect, there is a positive and significant coefficient for CalPERS equity allocation. Finally, the coefficient for a state's credit rating is positive and significant, consistent with the fiscal constraints hypothesis.

It is worth noting some other interesting findings when dependent variables are state credit ratings and actuarial pension funding ratios. As shown in column 2, lower funding ratios, heavy debt burden, and higher union membership are associated with lower credit ratings. The results in column 3 suggest that larger equity allocation is actually related to lower pension funding ratios. In addition, larger union membership, higher active to annuitants ratio, and younger workforce age are associated with better actuarial pension funding ratios.

[34] This could also be due to the significantly reduced sample size, which has 53 observations for fiscal years 2008 and 2009.

5.2.4. Asset allocation in credit crisis period

Our sample period extends through one of the largest market crises in 2008. We expect that the risk-taking behavior of public pension funds may differ between pre- and post-2008. In Table 6, we provide the preliminary findings on the public pension risk-taking during credit crisis. In examining the mean and median for asset allocation categories, pension asset beta, and return assumption, we find a significant drop in equities and significant increases in real estate and alternative investments. Cash allocation, on average, increased by more than 3 percent. The significant drop in pension asset beta follows the allocation change, in that the beta for real estate and cash equivalents is less than that for equity. Overall, we observe that pension funds are taking less risk after the recent financial crisis.

6. Conclusion

During the period 2001–2009, the average actuarial funding ratio for public defined benefit plans was 86 percent, with a trend of decreased funding. Prior research suggests that public pension plans are underfunded because of public accounting rules that allow managers to assume high discount rates for relatively certain retiree payouts. Initially, this high discount rate reduces required contributions. But, in reality, the liabilities are understated, and the plan may become severely underfunded on an economic basis. Consequently, plan managers could attempt to increase return and would hope to reduce the underfunding by investing in riskier assets. But riskier assets are more volatile, and given the market downturns in 2008 and 2009, the funding ratio is slightly below 80 percent (as of 2009) and the aggregate market value of pension assets has fallen to near-2001 figures.

An investment policy of increasing risk exposure on the asset side, while liabilities continue to increase with near certainty, can be a poor gamble. Why would managers play this game? One motivation might be political decisions to make certain investments. Another could be transferring funding shortfalls as tax burdens to future generations. In addition, bargaining by unions could result in higher benefits, accounting incentives tend to guide behavior, and states may feel pressure because of fiscal constraints. Yet another motivation may be a desire on the part of managers to mimic the

actions of the best fund or of other large funds. Using proxy variables for these hypothesized effects, we look at the risk measures, as defined by allocation to equity and pension plan asset beta, for public plans from 2001 to 2009 and provide the first comprehensive analysis of public pension funding risk-taking behavior.

Unlike reported results for private pension plans, results for public plans indicate that public fund managers appear to assume more risk if the plans are already underfunded. This evidence is consistent with risk-transfer or with an intention to pass underfunded current pension obligations on to future taxpayers. There is a degree of "follow the leader," in that plan managers tend to follow the risk-investing behavior of successful pension fund managers. We find evidence to support the hypothesis that state and local fiscal constraints are associated with higher levels of pension fund risk. Furthermore, the results offer just mild support of a public union effect—that is, in order to provide for larger retirement benefits, the fund manager pursues a riskier investment allocation. Ironically, it has been suggested that public employees accept lower pay, compared to the private sector, in exchange for job security and better benefits. Yet, higher promised retirement benefits are not consistently funded by state and local governments, and fund managers may take additional risks to compensate for the underfunding. The appropriate response by the employer may be to increase contributions to the fund instead of increasing the risk of the fund's investment.

Appendix A: Summary of Hypotheses, Treatment Variables and Expected Signs

Hypothesis	Treatment variable (notation)	Expected sign for treatment variable if dependent variable is	
		Pension asset beta	Equity percentage
Risk management	1) Lagged funding ratio—actuarial (LAG_FUND_RATIO_ACTUARIAL)	+	+
	2) Lagged funding ratio—economic, using Treasury yield as a discount rate (LAG_FUND_RATIO_TREASURY)	+	+
	3) Lagged funding ratio – economic, using muni bond yield as a discount rate (LAG_FUND_RATIO_MUNIS)	+	+
Risk transfer	1) Lagged funding ratio—actuarial (LAG_FUND_RATIO_ACTUARIAL)	–	–
	2) Lagged funding ratio—economic, using Treasury yield as a discount rate (LAG_FUND_RATIO_TREASURY)	–	–
	3) Lagged funding ratio—economic, using muni bond yield as a discount rate (LAG_FUND_RATIO_MUNIS)	–	–
	4) Lagged 1-year pension fund investment returns (LAG_INVRETURN1YR)	–	–
	5) Lagged 3-year pension fund investment returns (LAG_INVRETURN3YR)	–	–
	6) Lagged 5-year pension fund investment returns (LAG_INVRETURN5YR)	–	–
Political influence	Economically targeted investment (ETI) dummy 1) ETI	+	+
Fiscal constraint	1) Moody's state ratings for general obligation bond (RATING)	+	+
	2) State net tax-supported debt as a percentage of personal income (DEBT_INCOME)	+	+
	3) Employer contribution as a percentage of annual required amount (EMPLOYER_CONTRIBUTION)	–	–
Accounting effect	1) Pension plan return assumption (RETURN_ASSUMPTION)	+	+
Union	1) Public employee union membership percentage (UNION_MEMBERSHIP_PCT)	+	+
	2) Public employee covered by collective bargaining agreement % (BARGAIN_PCT)	+	+
Demographic	1) Active to annuitant ratio (ACTIVE_ANNUITANT)	+	+
	2) Average age of active employee (ACTIVE_AGE)	+	+
	3) Teachers (dummy)—more female (TEACHERS)	?	?
	4) Police or fire (dummy) (POLICEFIRE)	?	?
	5) General (dummy) (GENERAL)	?	?
Herding	1) CalPERS's percentage of equity allocation (CALPERS_EQUITY)	+	+
	2) CalPERS's pension asset beta (CALPERS_BETA)	+	+
	3) Top performer's (winner) percentage of equity allocation (WINNER_EQUITY)	+	+
	4) Top performer's (winner) pension asset beta (WINNER_BETA)	+	+
Other	1) Log of pension system market value (LOGSIZE)	+	+
	2) Amortization period (AMORTIZATION_PERIOD)	+	+

Appendix B: Variable Definitions and Data Sources

This table summarizes the variable definitions and data sources. The major data source is the Public Plans Database (PPD), obtained from the Center for Retirement Research at Boston College (2011). In addition, we obtain the historical data on the state general obligation bond ratings and the net tax-supported debt as a percentage of personal income from Moody's, and the public employee union membership and coverage from the Union Membership and Coverage Database. ETI data for years 2001 and 2003 are obtained from the Pension Funds and Urban Revitalization Center, University of Oxford. Data for the years 2008 and 2009 are from the Office of Program Policy Analysis and Government Accountability of the State of Florida.

Variable notation	Definition	Data source
EQUITIES	The percentage of pension fund assets invested in the equity market.	Public Plans Database
PENSION_ASSET_BETA	Pension asset beta is estimated as the weighted average beta of all asset classes in a pension fund, as in Equation (1).	Public Plans Database; Jin, Merton, and Bodie (2006, Table 4)
FUND_RATIO_ACTUARIAL	Pension plan actuarial funding ratio is estimated as the ratio of actuarial pension assets over actuarial pension liabilities, as in Equation (2a). Actuarial pension liabilities are estimated using the expected rate of return on plan assets as a discount factor.	Public Plans Database
LAG_FUND_RATIO_ACTUARIAL	Previous year's pension plan actuarial funding ratio	Public Plans Database
FUND_RATIO_ECONOMIC FUND_RATIO_TREASURY FUND_RATIO_MUNIS	Pension plan economic funding ratio, as in Equation (2b), is estimated as the ratio of the market value of pension assets over the market value of pension liabilities, where the market value of pension liabilities is estimated using Treasury bond yield or state municipal bond yield as a discount factor. We obtain pension economic liabilities for year 2008 and 2009 from Novy-Marx and Rauh (2009, 2010).	Public Plans Database; Novy-Marx and Rauh (2009, 2010) tables
LAG_ FUND_RATIO_TREASURY LAG_FUND_RATIO_MUNIS	Previous year's pension-plan economic funding ratio using Treasury rate/municipal bond yield as a discount rate for pension liabilities	Public Plans Database; Novy-Marx and Rauh (2009, 2010) tables
RETURN_ASSUMPTION	The expected rate of return on pension plan assets	Public Plans Database
INVRETURN1YR	1-year investment returns of total pension assets	Public Plans Database

INVRETURN3YR	3-year investment returns of total pension assets	Public Plans Database
INVRETURN5YR	5-year investment returns of total pension assets	Public Plans Database
LAG_INVRETURN1YR	Previous 1-year investment returns of total pension assets	Public Plans Database
LAG_INVRETURN3YR	Previous 3-year investment returns of total pension assets	Public Plans Database
LAG_INVRETURN5YR	Previous 5-year investment returns of total pension assets	Public Plans Database
ETI	A dummy variable that takes 1 if a pension plan has economically targeted investment and/or urban revitalization investment policy; zero otherwise.	Pension Funds and Urban Revitalization Web site, University of Oxford; State of Florida research report
RATING	A state credit rating for its general obligation bond. We convert the letter rating to numerical value as follows (larger number indicates higher credit risk): Aaa=1; Aa1=3; Aa2=5; Aa3=7; A1=9; A2=11; Baa1=13; with large number indicating high credit risk or strong fiscal constraint.	Moody's
DEBT_INCOME	A state net tax-supported debt as a percentage of personal income	Moody's
EMPLOYER_CONTRIBUTION	Employer contribution as a percentage of annual required contribution	Public Plans Database
UNION_MEMERSHIP_PCT	The percentage of state public employees that is unionized	Union Membership and Coverage Database
BARGAIN_PCT	The percentage of state public employees that is covered by a collective bargaining agreement	Union Membership and Coverage Database
CALPERS_EQUITIES	CalPERS's equity asset allocation	Public Plans Database
WINNER_EQUITIES	Pension funds top performer's (winner) equity asset allocation, where the winner is defined as the pension plan with the highest annual investment return	Public Plans Database
CALPERS_BETA	CalPERS's pension asset beta. Beta measures the sensitivity of financial asset returns to the overall stock market change (i.e., using the S&P 500 Index as a proxy.	Public Plans Database and Jin, Merton, and Bodie (2006, Table 4)
WINNER_BETA	Pension funds top performer's (winner) pension asset beta, where the winner is defined as the pension plan with the largest annual investment return. Beta	Public Plans Database and Jin, Merton, and

	measures the sensitivity of financial asset returns to the overall stock market change (i.e., using the S&P 500 Index as a proxy.	Bodie (2006, Table 4)
ACTIVE_ANNUITANT	The ratio of active employees over annuitants of a pension plan	Public Plans Database
TEACHERS	A dummy variable that takes 1 if a pension plan is a teachers' plan, and 0 otherwise.	Public Plans Database
POLICEFIRE	A dummy variable that takes 1 if a pension plan is a police/firefighters plan, and 0 otherwise	Public Plans Database
GENERAL	A dummy variable that takes 1 if a pension plan is a general plan that covers public employees (excluding teachers and police/firefighters), and 0 otherwise.	Public Plans Database
LOGSIZE	Log of the market value of a pension system	Public Plans Database
AMORTIZATION_PERIOD	The years of a pension plan's amortization period	Public Plans Database
FIXED_INCOME	The percentage of pension fund assets invested in fixed income	Public Plans Database
REAL_ESTATE	The percentage of pension fund assets invested in real estate	Public Plans Database
ALTERNATIVES	The percentage of pension fund assets invested in the alternatives	Public Plans Database
CASH_OTHER_ASSETS	The percentage of pension fund assets invested in cash and other assets	Public Plans Database
DOMESTIC_EQUITIES	The percentage of pension fund assets invested in the domestic equity market	Public Plans Database
INTL_EQUITIES	The percentage of pension fund assets invested in the international equity market	Public Plans Database
DOMESTIC_FIXEDINCOME	The percentage of pension fund assets invested in domestic fixed income	Public Plans Database
INTL_FIXEDINCOME	The percentage of pension fund assets invested in international fixed income	Public Plans Database

References

Bergstresser, Daniel, Mihir Desai, and Joshua Rauh. 2006. "Earnings Manipulation, Pension Assumptions and Managerial Investment Decisions." *Quarterly Journal of Economics* 121(1): 157–195.

Black, Fischer. 1980. "The Tax Consequences of Long-Run Pension Policy." *Financial Analysts Journal* 36(4): 21–28.

Bonafede, Julia K., Steven J. Foresti, and Benjamin J. Yang. 2005. *2005 Wilshire Report on State Retirement Systems: Funding Levels and Asset Allocation*. Santa Monica, CA: Wilshire Associates.

Byrnes, Nanette. 2005. "Sinkhole! How Public Pension Promises Are Draining State and City Budgets." *BusinessWeek*, June 13.

California Public Employees' Retirement System (CalPERS). 2007. *The Economic Impacts of CalPERS Investments on the California Economy*. Sacramento, CA: Applied Research Center, California State University, Sacramento.

Center for Retirement Research at Boston College. 2011. *Public Plans Database*. Chestnut Hill, MA: Center for Retirement Research at Boston College. http://pubplans.bc.edu/pls/htmldb/f?p=198:3:3667012107971550 (accessed October 31, 2011).

Cochrane, John H. 2003. "The Risk and Return of Venture Capital." Working paper, Graduate School of Business, University of Chicago.

Coronado, Julia L., Eric M. Engen, and Brian Knight. 2003. "Public Funds and Private Capital Markets: The Investment Practices and Performance of State and Local Pension Funds." *National Tax Journal* 56(3): 579–594.

Current Population Survey. 2011. *Union Membership and Coverage Database from the CPS*. Washington, DC: U.S. Census Bureau, Current Population Survey. http://www.unionstats.com (accessed October 31, 2011).

D'Arcy, Stephen P., James H. Dulebohn, and Pyungsuk Oh. 1999. "Optimal Funding of State Employee Pension Systems." *Journal of Risk and Insurance* 66(3): 345–380.

Dwyer, Peggy D., James H. Gilkeson, and John A. List. 2002. "Gender Differences in Revealed Risk Taking: Evidence from Mutual Fund Investors." *Economics Letters* 76(2002): 151–158.

Eaton, Tim V., and John R. Nofsinger. 2001. "An Examination of ERR and Asset Allocation in Public Pension Plans." *Financial Accountability and Management* 17(2): 119–132.

———. 2004. "The Effect of Financial Constraints and Political Pressure on the Management of Public Pension Plans." *Journal of Accounting and Public Policy* 23(3): 161–189.

———. 2008. "Funding Levels and Gender in Public Pension Plans." *Public Budgeting and Finance* 28(3): 108–128.

Epple, Dennis, and Katherine Schipper. 1981. "Municipal Pension Funding: A Theory and Some Evidence." *Public Choice* 37(1): 141–178.

Freeman, Richard B. 1983. "Unions, Pensions, and Union Pension Funds." NBER Working Paper No. 1226. Cambridge, MA: National Bureau of Economic Research.

Giertz, J. Fred, and Leslie E. Papke. 2007. "Public Pension Plans: Myths and Realities for State Budgets." *National Tax Journal* 60(2): 305–323.

Gold, Jeremy. 2003. "Risk Transfer in Public Pension Plans." In *The Pension Challenge: Risk Transfers and Retirement Income Security*, Olivia S. Mitchell and Kent Smetters, eds. Oxford: Oxford University Press, pp. 102–115.

Government Accountability Office (GAO). 2010. *State and Local Government Pension Plans: Government Practices and Long-Term Investment Strategies Have Evolved Gradually as Plans Take On Increased Investment Risk*. Report to the Ranking Member, Committee on Finance, U.S. Senate. GAO-10-754. Washington, DC: Government Accountability Office.

Governmental Accounting Standards Board (GASB). 1994. *Statement No. 25: Financial Reporting for Defined Benefit Pension Plans and Note Disclosures for Defined Contribution Plans*. Washington, DC: Governmental Accounting Standards Board.

Hirsch, Barry T., and David A. Macpherson. 2003. "Union Membership and Coverage Database from the Current Population Survey." *Industrial and Labor Relations Review* 56(2): 349–354.

Hoffer, Doug. 2004. *A Survey of Economically Targeted Investments: Opportunities for Public Pension Funds*. A report for the Vermont State Treasurer and the State Retirement Boards. Montpelier, VT: Office of the Vermont State Treasurer. www.highroadvermont.org/articles/1/ETI%20report%20v.711.pdf (accessed October 31, 2011).

Hwang, Min, John M. Quigley, and Susan E. Woodward. 2005. "An Index for Venture Capital, 1987 – 2003." *Contributions to Economic Analysis and Policy* 4(1): 1–32.

Inman, Robert. 1981. "Municipal Pension Funding: A Theory and Some Evidence: A Comment." *Public Choice* 37(1): 179–187.

———. 1982. “Public Employee Pensions and the Local Labor Budget.” *Journal of Public Economics* 19(1): 49–71.

Jin, Li, Robert C. Merton, and Zvi Bodie. 2006. “Do a Firm’s Equity Returns Reflect the Risk of Its Pension Plan?” *Journal of Financial Economics* 81(1): 1–26.

Kaplan, Steve, and Antoinette Schoar. 2005. “Private Equity Performance: Returns, Persistence, and Capital Flows.” *Journal of Finance* 60(4): 1791–1823.

Keefe, Jeffrey. 2010. “Debunking the Myth of the Overcompensated Public Employee: The Evidence.” EPI Briefing Paper No. 276. Washington, DC: Economic Policy Institute.

Lintner, John. 1965. “The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets.” *Review of Economics and Statistics* 47(1): 13–37.

Ljungqvist, Alexander, and Matthew P. Richardson. 2002. “The Cash Flow, Return, and Risk Characteristics of Private Equity.” Working paper, New York University.

Mitchell, Olivia S., and Robert S. Smith. 1994. “Pension Funding in the Public Sector.” *Review of Economics and Statistics* 76(2): 278–290.

Modigliani, Franco, and Merton H. Miller. 1958. “The Cost of Capital, Corporation Finance, and the Theory of Investment.” *American Economic Review* 48(3): 261–297.

Moody’s Investors Service. 2010. *2010 State Debt Medians Report*. Special Comment. New York: Moody’s Investors Service.

Munnell, Alicia H., Kelly Haverstick, Steven A. Sass, and Jean-Pierre Aubry. 2008. *The Miracle of Funding by State and Local Pension Plans*. State and Local Pension Plans Issue in Brief No. 5. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Munnell, Alicia H., and Mauricio Soto. 2007. *State and Local Pensions Are Different from Private Plans*. State and Local Pension Plans Issue in Brief No. 1. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Munnell, Alicia H., and Annika Sundén. 2001. “Investment Practices of State and Local Pension Funds: Implications for Social Security Reform.” In *Pensions in the Public Sector*, Olivia S. Mitchell and Edwin C. Hustead, eds. Philadelphia: University of Pennsylvania Press, 153–194.

Nielsen, Kasper Meisner. 2009. “The Return to Pension Funds’ Direct Investments in Private Equity: New Evidence on the Private Equity Premium Puzzle.” Working paper, Chinese University of Hong Kong and CEBR.

Nofsinger, John R. 1998. "Why Targeted Investing Does Not Make Sense!" *Financial Management* 27(3): 87–96.

Novy-Marx, Robert, and Joshua D. Rauh. 2009. "The Liabilities and Risks of State-Sponsored Pension Plans." *Journal of Economic Perspectives* 23(4): 191–210.

———. 2011. "Public Pension Promises: How Big Are They and What Are They Worth?" *Journal of Finance* 66(4): 1211–1249.

Office of Program Policy Analysis and Government Accountability (OPPAGA). 2008. *Economically Targeted Investment Program under Development*. Report No. 08-72. Tallahassee, FL: Office of Program Policy Analysis and Government Accountability. www.oppaga.state.fl.us/reports/pdf/0872rpt.pdf (accessed October 31, 2011).

Park, Youngkyun. 2009. "Public Pension Plan Asset Allocations." *Employee Benefit Research Institute Notes* 30(4): 1–12.

Petersen, Mitchell A. 2009. "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches." *Review of Financial Studies* 22(1): 435–480.

Pew Center on the States. 2010. *The Trillion Dollar Gap: Underfunded State Retirement Systems and the Road to Reform*. Washington, DC: Pew Center on the States. http://downloads.pewcenteronthestates.org/The_Trillion_Dollar_Gap_final.pdf (accessed October 31, 2011).

———. 2011. *The Widening Gap: The Great Recession's Impact on State Pension and Retiree Health Care Costs*. Washington, DC: Pew Center on the States. www.pewcenteronthestates.org/uploadedFiles/Pew_pensions_retiree_benefits.pdf (accessed October 31, 2011).

Phalippou, Ludovic, and Maurizio Zollo. 2005. "What Drives Private Equity Fund Performance?" Working paper, University of Amsterdam and INSEAD.

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

———. 2010. "Are State Public Pensions Sustainable? Why the Federal Government Should Worry about State Pension Liabilities." Working paper, Northwestern University.

Robertson, Douglas, and Ellen Wielezynski. 2008. "Alternative Assets and Public Pension Plan Performance." OCC Economics Working Paper 2008-2. Washington, DC: Office of the Comptroller of the Currency.

Sharpe, William F. 1964. "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk." *Journal of Finance* 19(3): 425–442.

———. 1976. “Corporate Pension Funding Policy.” *Journal of Financial Economics* 3(3): 183–193.

Tepper, Irwin. 1981. “Taxation and Corporate Pension Policy.” *Journal of Finance* 36(1): 1–13.

Treynor, Jack L. 1961. “Toward a Theory of Market Value of Risky Assets.” Unpublished manuscript.

———. 1977. “The Principles of Corporate Pension Finance.” *Journal of Finance* 32(2): 627–638.

Weller, Christian E., and Jeffrey B. Wenger. 2009. “Prudent Investors: The Asset Allocation of Public Pension Plans.” *Journal of Pension Economics and Finance* 8(4): 501–525.

Table 1: Descriptive Statistics

Panel A: Descriptive statistics of pension plan characteristics

	Mean	Std.	Min.	P25	Median	P75	Max.	N
RETURN_ASSUMPTION	0.0797	0.0044	0.0450	0.0780	0.0800	0.0825	0.0900	1,112
FUND_RATIO_ACTUARIAL	0.8601	0.1629	0.1910	0.7610	0.8720	0.9820	1.4770	1,111
LAG_FUND_RATIO_ACTUARIAL	0.8705	0.1611	0.1910	0.7759	0.8811	0.9940	1.4770	990
INVRETURN1YR	0.0347	0.1166	–0.3802	–0.0490	0.0371	0.1270	0.2883	859
INVRETURN3YR	0.0478	0.0610	–0.0916	0.0000	0.0450	0.1019	0.1790	857
INVRETURN5YR	0.0543	0.0406	–0.0220	0.0250	0.0462	0.0877	0.1750	858
LAG_INVRETURN1YR	0.0563	0.0967	–0.2890	–0.0240	0.0702	0.1336	0.2883	758
LAG_INVRETURN3YR	0.0539	0.0597	–0.0901	0.0000	0.0500	0.1070	0.1790	756
LAG_INVRETURN5YR	0.0561	0.0406	–0.0170	0.0260	0.0500	0.0890	0.1750	757
EMPLOYER_CONTRIBUTION	0.9251	0.3198	0.0000	0.8130	1.0000	1.0000	2.6300	1,134
TEACHERS	0.3175	0.4657	0.0000	0.0000	0.0000	1.0000	1.0000	1,134
POLICEFIRE	0.0794	0.2704	0.0000	0.0000	0.0000	0.0000	1.0000	1,134
GENERAL	0.6032	0.4895	0.0000	0.0000	1.0000	1.0000	1.0000	1,134
SMOOTHING_PERIOD	3.9927	2.1900	0.0000	1.0000	5.0000	5.0000	10.0000	1,096
AMORTIZATION_PERIOD	25.7120	7.9549	0.0000	20.0000	29.0000	30.0000	40.0000	989
ETI	0.4514	0.4983	0.0000	0.0000	0.0000	1.0000	1.0000	350
CALPERS_EQUITIES	0.5713	0.0559	0.4375	0.5656	0.5970	0.6078	0.6190	1,134
WINNER_EQUITIES	0.4291	0.2431	0.0000	0.4653	0.4708	0.5840	0.7187	1,134
CALPERS_BETA	0.7077	0.0302	0.6409	0.6963	0.7165	0.7283	0.7422	1,134
WINNER_BETA	0.5297	0.2045	0.1708	0.5295	0.5680	0.6735	0.7781	1,134
ACTIVE_AGE	44.7048	3.2673	34.4100	43.6000	44.6000	45.7000	60.0000	867
ACTIVE_ANNUITANT	2.6891	3.8282	0.0387	1.6265	2.0144	2.5222	31.5900	1,119
MKT_VALUE ($ bil.)	17.8034	27.4094	0.1799	3.6374	8.8014	18.7825	251.1227	1,132
LOGSIZE	15.9353	1.2618	12.1003	15.1068	15.9904	16.7484	19.3415	1,132

Panel B: Summary statistics of state finance and unionization

UNION_MEMERSHIP_PCT	0.3297	0.1759	0.0517	0.0517	0.2818	0.5010	0.7241	459
BARGAIN_PCT	0.3746	0.1719	0.1038	0.1038	0.3298	0.5424	0.7484	459
RATING	4.6511	2.5666	1.0000	1.0000	5.0000	7.0000	13.0000	407
DEBT_INCOME	0.0301	0.0226	0.0000	0.0000	0.0240	0.0430	0.1210	450

Panel C: Summary statistics of pension plan asset allocation and pension asset beta

	Mean	Std.	Min.	P25	Median	P75	Max.	N	Assumed Beta
EQUITIES	0.5634	0.1041	0.0000	0.5100	0.5790	0.6300	0.8200	1,134	1.0000
DOMESTIC_EQUITIES	0.3673	0.1468	0.0000	0.3210	0.4010	0.4575	0.7500	1,119	--
INTL_EQUITIES	0.1505	0.0720	0.0000	0.1180	0.1610	0.1990	0.3262	1,119	--
FIXED_INCOME	0.2884	0.1014	0.1000	0.2315	0.2700	0.3343	1.0000	1,134	0.1750
DOMESTIC_FIXEDINCOME	0.1537	0.1630	0.0000	0.0000	0.1600	0.2680	1.0000	1,092	--
INTL_FIXEDINCOME	0.0113	0.0258	0.0000	0.0000	0.0000	0.0040	0.1900	1,091	--
REAL_ESTATE	0.0534	0.0482	0.0000	0.0002	0.0500	0.0852	0.2840	1,134	0.1500
ALTERNATIVES	0.0285	0.0506	0.0000	0.0000	0.0000	0.0440	0.4200	1,134	1.2000
CASH_OTHER_ASSETS	0.0660	0.0626	0.0000	0.0130	0.0490	0.1050	0.3040	1,134	0.0060
PENSION_ASSET_BETA	0.6564	0.0975	0.1638	0.6067	0.6708	0.7191	0.9096	1,134	--

Panel D: Summary statistics of restricted sample (2008/2009)

	Mean	Std.	Min.	P25	Median	P75	Max.	N
FUND_RATIO_ACTUARIAL	0.7976	0.1504	0.3910	0.7010	0.7920	0.9000	1.2800	245
FUND_RATIO_TREASURY	0.3796	0.0901	0.2115	0.3030	0.3857	0.4402	0.5920	155
FUND_RATIO_MUNIS	0.5782	0.1249	0.3419	0.4934	0.5608	0.6799	0.8333	155
LAG_FUND_RATIO_TREASURY	0.3566	0.0839	0.2115	0.2924	0.3517	0.4082	0.5305	58
LAG_FUND_RATIO_MUNIS	0.5833	0.1313	0.3419	0.4763	0.5741	0.6799	0.8333	58

This table reports descriptive statistics for the major variables used in the study. Panel A provides summary statistics for pension plan return assumption, investment returns, employer contributions, and other plan characteristics, based on full sample from 2001 to 2009, except for the variable of ETI (a dummy variable indicating whether a pension plan makes economically targeted investments), which has a sample period of 2001, 2003, 2008, and 2009. Panel B provides summary statistics for measures of state financial constraints and state unionization data. Panel C provides summary statistics of pension plan asset allocation and pension asset beta. Panel D provides pension funding ratios, based on a restricted sample of 2008 and 2009. The major data source is the Public Plans Database (PPD), obtained from the Center for Retirement Research at Boston College (2011). In addition, we obtain the historical data on the state general obligation bond ratings and the net tax-supported debt as a percentage of personal income from Moody's, and we obtain the public employee union membership and coverage from the Union Membership and Coverage Database. ETI data for the years 2001 and 2003 are obtained from the Pension Funds and Urban Revitalization Center, University of Oxford, and ETI data for the years 2008 and 2009 are from the Office of Program Policy Analysis and Government Accountability (OPPAGA) of the State of Florida. The betas for equities, fixed income, real estate, and cash equivalents asset classes in Panel C are from Jin, Merton, and Bodie (2006, Table 4, p. 9), and the beta for alternative assets is the author's estimation. The full sample is from 2001 to 2009, with 1,134 pension system-year observations for 50 states and the District of Columbia. The variable definitions are summarized in Appendix B.

Table 2: Univariate Regression Analysis of Public Pension Risk-Taking Behavior, Using Equities or Pension Asset Beta as a Dependent Variable

	Column 1	Column 2
	EQUITIES	PENSION_ASSET_BETA
RETURN_ASSUMPTION	4.1811***	5.3763***
(*N* = 1,112)	(4.55)	(5.91)
LAG_FUND_RATIO_ACTUARIAL	–0.0140	–0.0284*
(*N* = 990)	(-0.84)	(–1.76)
LAG_FUND_RATIO_TREASURY	–0.5123***	–0.4719***
(N = 55, 58)	(–4.09)	(–3.20)
LAG_FUND_RATIO_MUNIS	–0.2963***	–0.3207***
(*N* = 58)	(–3.88)	(–3.51)
LAG_INVRETURN1YR	0.0788**	0.0966***
(*N* = 758)	(2.13)	(3.07)
LAG_INVRETURN3YR	–0.2695***	–0.1433**
(*N* = 756)	(–4.58)	(–2.53)
LAG_INVRETURN5YR	–0.8296***	–0.5488***
(*N* = 756)	(–9.63)	(–6.35)
EMPLOYER_CONTRIBUTION	–0.0210**	–0.0188**
(*N* = 1,134)	(–2.33)	(–2.07)
ETI	–0.0158	–0.0236
(*N* = 350)	(–1.38)	(–2.14)
RATING	0.0055***	0.0049***
(*N* = 1,107)	(5.10)	(4.79)
DEBT_INCOME	0.1892**	0.1752
(*N* = 1,107)	(2.38)	(1.38)
UNION_MEMBERSHIP_PCT	0.0458**	0.0531***
(*N* = 1,125)	(2.55)	(3.19)
BARGAIN_PCT	0.0484***	0.0515***
(*N* = 1,125)	(2.59)	(3.00)
CALPERS_EQUITIES	0.5080***	
(*N* = 1,134)	(9.36)	
WINNER_EQUITIES	–0.0016	
(*N* = 1,134)	(–0.13)	
CALPERS_BETA		0.5677***
(*N* = 1,134)		(5.92)
WINNER_BETA		0.0335**
(*N* = 1,134)		(2.39)
ACTIVE_AGE	–0.0039***	–0.0049***
(*N* = 867)	(–3.56)	(–4.65)
ACTIVE_ANNUITANT	–0.0032***	–0.0048***
(*N* = 1,119)	(–7.97)	(–10.46)
TEACHERS	0.0213***	0.0146**
(*N* = 1,134)	(3.60)	(2.52)
POLICEFIRE	–0.0138	–0.0100
(*N* = 1,134)	(–1.00)	(–0.96)
GENERAL	–0.0153**	–0.0101*
(*N* = 1,134)	(–2.51)	(–1.78)
LOGSIZE	0.0070***	0.0116***
(*N* = 1,132)	(3.17)	(5.72)
SMOOTHING_PERIOD	–0.0028	–0.0037**
(*N* = 1,096)	(–1.53)	(–2.28
AMORTIZATION_PERIOD	0.0011***	0.0017**
(*N* = 989)	(2.92)	(2.92)

This table reports the results of univariate regression analyses of public pension risk-taking behavior. The dependent variable is EQUITIES, or the percentage of pension fund assets invested in the equity market and pension asset beta (PENSION_ASSET_BETA). *t*-values are reported in parentheses, with the standard errors clustered at system-year level (Petersen 2009) and adjusted for heteroskedasticity. The full sample is from 2001 to 2009, with 1,134 pension system–year observations for 50 states and the District of Columbia. An exception is for the variable of ETI (a dummy variable indicating whether a pension plan makes economically targeted investments), which has a sample period of 2001, 2003, 2008, and 2009. *N* in the parenthesis shows the number of observations used for the univariate regression. The variable definitions and data sources are summarized in Appendix B. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Multivariate Regression Analysis of Public Pension Risk-Taking Behavior

	Model 1		Model 2		Model 3		Model 4	
	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA
RETURN_ASSUMPTION	1.7220*	3.5279***	4.5101***	5.9580***	4.3189***	6.1668***	4.4581***	6.2724***
	(1.95)	(4.17)	(2.98)	(3.84)	(2.90)	(4.05)	(2.97)	(4.10)
LAG_FUND_RATIO_ACTUARIAL	–0.0481**	–0.0382**						
	(–2.01)	(–2.48)						
LAG_INVRETURN1YR			0.2009***	0.1311***				
			(6.78)	(4.89)				
LAG_INVRETURN3YR					–0.1019	–0.1433**		
					(–1.54)	(–2.01)		
LAG_INVRETURN5YR							–0.3207***	–0.3000***
							(–3.54)	(–3.62)
RATING	0.0047***	0.0022***						
	(3.21)	(2.61)						
DEBT_INCOME			0.3968**	0.1518				
			(2.40)	(0.95)				
EMPLOYER_CONTRIBUTION					–0.0247**	–0.0138	–0.0240*	–0.0120
					(–1.99)	(–1.13)	(–1.95)	(–0.98)
UNION_MEMERSHIP_PCT	0.0340	0.0543***						
	(1.39)	(2.83)						
BARGAIN_PCT			0.0197	0.0149	0.0244	0.0150	0.0190	0.0109
			(0.68)	(0.58)	(0.93)	(0.66)	(0.72)	(0.48)
CALPERS_EQUITIES	0.5054**				0.5946***		0.5666***	
	(7.72)				(7.08)		(7.43)	
WINNER_EQUITIES			0.0110					
			(0.71)					
CALPERS_BETA		0.4940***				0.8276***		0.7421***
		(5.04)				(4.89)		(5.75)
WINNER_BETA				0.0392**				
				(2.35)				
ACTIVE_ANNUITANT	0.0208***	0.0164***	0.0188**	0.0061	0.0115	0.0033	0.0096	0.0017
	(4.80)	(5.68)	(2.20)	(0.80)	(1.36)	(0.45)	(1.16)	(0.23)
ACTIVE_AGE	–0.0009	–0.0024***						
	(–0.67)	(–4.39)						
TEACHERS	0.0101	–0.0067						
	(1.27)	(–1.62)						
POLICEFIRE			0.0083	–0.0037				
			(0.44)	(–0.27)				
GENERAL					–0.0068	0.0094	–0.0076	0.0088
					(–1.05)	(1.55)	(–1.17)	(1.44)
LOGSIZE	0.0036	0.0090***	0.0029	0.0109***	0.0065**	0.0125***	0.0073**	0.0131***
	(1.00)	(5.17)	(0.92)	(3.66)	(2.12)	(4.37)	(2.40)	(4.62)
AMORTIZATION_PERIOD	0.0009*	0.0016***	0.0005	0.0007*	0.0004	0.0008**	0.0003	0.0007**
	(1.67)	(3.99)	(1.23)	(1.79)	(0.97)	(2.26)	(0.70)	(2.01)
Adj. R^2	0.1917	0.1839	0.0979	0.1214	0.1121	0.1273	0.1232	0.1369
N	638	638	788	788	786	786	787	787

This table reports the results of multivariate regression analyses of public pension risk-taking behavior. The dependent variables are equity allocation or pension asset beta. *t*- values are reported in parentheses, with the standard errors clustered at system-year level (Petersen 2009) and adjusted for heteroskedasticity. The variable definitions and data sources are summarized in Appendix B. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Multivariate Regression Analysis of Public Pension Risk-Taking Behavior Based on a Restricted Sample

	Model 1		Model 2		Model 3		Model 4		Model 5	
	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA	EQUITIES	PENSION_ ASSET_BETA
RETURN_ASSUMPTION	6.3979**	6.2545**	6.4418**	6.2946*	6.999**	6.6449**	0.0095	5.0495	0.0451	4.6552
	(2.18)	(2.00)	(2.15)	(1.98)	(2.22)	(2.01)	(0.01)	(1.14)	(0.01)	(1.17)
LAG_FUND_RATIO_TREASYRT							–0.3310**	–0.3855**		
							(–2.19)	(–2.04)		
LAG_FUND_RATIO_MUNIS									–	–0.2854***
									0.1823**	(–2.82)
									(–2.03)	
LAG_INVRETURN1YR	–0.0105	0.0028								
	(–0.16)	(0.05)								
LAG_INVRETURN3YR			–0.2454**	–0.1520						
			(–2.08)	(–1.32)						
LAG_INVRETURN5YR					–0.5458***	–0.3553**				
					(–3.31)	(–2.18)				
ETI	–0.0289*	–0.0303**	–0.0264*	–0.0292**	–0.0254*	–0.0279**				
	(–1.91)	(–2.13)	(–1.71)	(–2.03)	(–1.70)	(–1.98)				
UNION_MEMERSHIP_PCT							0.0830	0.0230	0.0741	0.0270
							(0.66)	(0.37)	(0.59)	(0.35)
ACTIVE_ANNUITANT							0.0601*	0.0598**	0.0649*	0.0650**
							(1.73)	(2.23)	(1.86)	(2.50)
TEACHERS							0.0380	0.0021	0.0362	–0.0025
							(1.02)	(0.08)	(0.96)	(–0.09)
LOGSIZE							–0.0302	–0.0106	–0.0334*	–0.0123
							(–1.56)	(–0.70)	(–1.74)	(–0.88)
AMORTIZATION_PERIOD							0.0020	0.0001	0.0023	0.0002
							(0.87)	(0.02)	(0.95)	(0.09)
Adj. R^2	0.0709	0.0780	0.0914	0.0884	0.1238	0.0962	0.2035	0.2376	0.1969	0.2781
N	200	200	200	200	200	200	53	53	53	53

This table reports the results of multivariate regression analyses of public pension risk-taking behavior based on a restricted sample. That is, the sample period used for Models 1 to 3 is 2001, 2003, 2008 and 2009 because of the data availability of ETI. The sample period for Models 4 and 5 is 2008 and 2009 because of the data availability used to estimate economic pension funding ratios. The dependent variables are EQUITIES and PENSION_ASSET_BETA. *t*- values are reported in parentheses, with the standard errors clustered at system-year level (Petersen 2009) and adjusted for heteroskedasticity. The variable definitions and data sources are summarized in Appendix B. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Simultaneous Regression Equations of Equity Allocation, State Credit Ratings, and Funding Ratios

	Column 1	Column 2	Column 3
	Dependent variable: EQUITIES	Dependent variable: RATING	Dependent variable: FUND_RATIO_ACTUARIAL
RETURN_ASSUMPTION	1.8868*	–21.1765	10.9721
	(1.75)	(–0.64)	(1.12)
LAG_FUND_RATIO_ACTUARIAL	–0.0792**		
	(–2.12)		
FUND_RATIO_ACTUARIAL		–2.8033***	
		(–2.84)	
EQUITIES		–3.9679	–7.5268***
		(–0.92)	(–3.35)
LAG_INVRETURN3YR		–1.5639	–0.1462
		(–0.80)	(–0.30)
RATING	0.0057*		0.0017
	(1.82)		(0.04)
DEBT_INCOME		36.5359***	0.5350
		(4.56)	(0.25)
UNION_MEMBERSHIP_PCT	0.0303	3.7100***	0.5572**
	(0.74)	(4.64)	(1.99)
CALPERS_EQUITIES	0.5089***		
	(6.84)		
ACTIVE_ANNUITANT	0.0406***		0.3568***
	(4.65)		(3.08)
ACTIVE_AGE	–0.0029		–0.0279*
	(–1.55)		(–1.75)
TEACHERS	0.0054		
	(0.54)		
LOGSIZE	0.0021		
	(0.47)		
AMORTIZATION_PERIOD	–0.0006		
	(–0.10)		
Adj R^2	0.1617	0.1313	0.0149
N	498	498	498

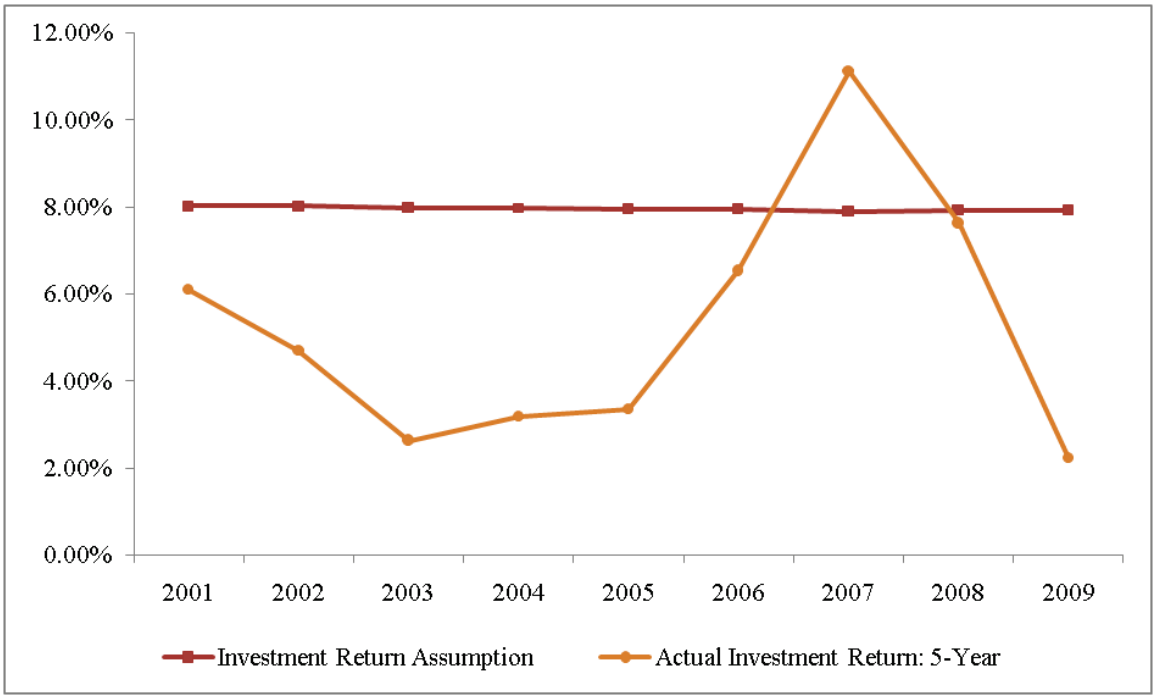
This table reports the simultaneous regression results where the dependent variables are equity allocation, state credit ratings, and actuarial pension funding ratios. *t*- values are reported in parentheses and adjusted for heteroskedasticity. The variable definitions and data sources are summarized in Appendix B. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Public Pension Fund Asset Allocation and Asset Betas during Credit Crisis Period

This table compares the pension asset allocation, return assumption, and pension asset beta between pre- and postcrisis periods. A Wilcoxon two-sample test is used to compare the medians. The year 2009 is identified as credit crisis period. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

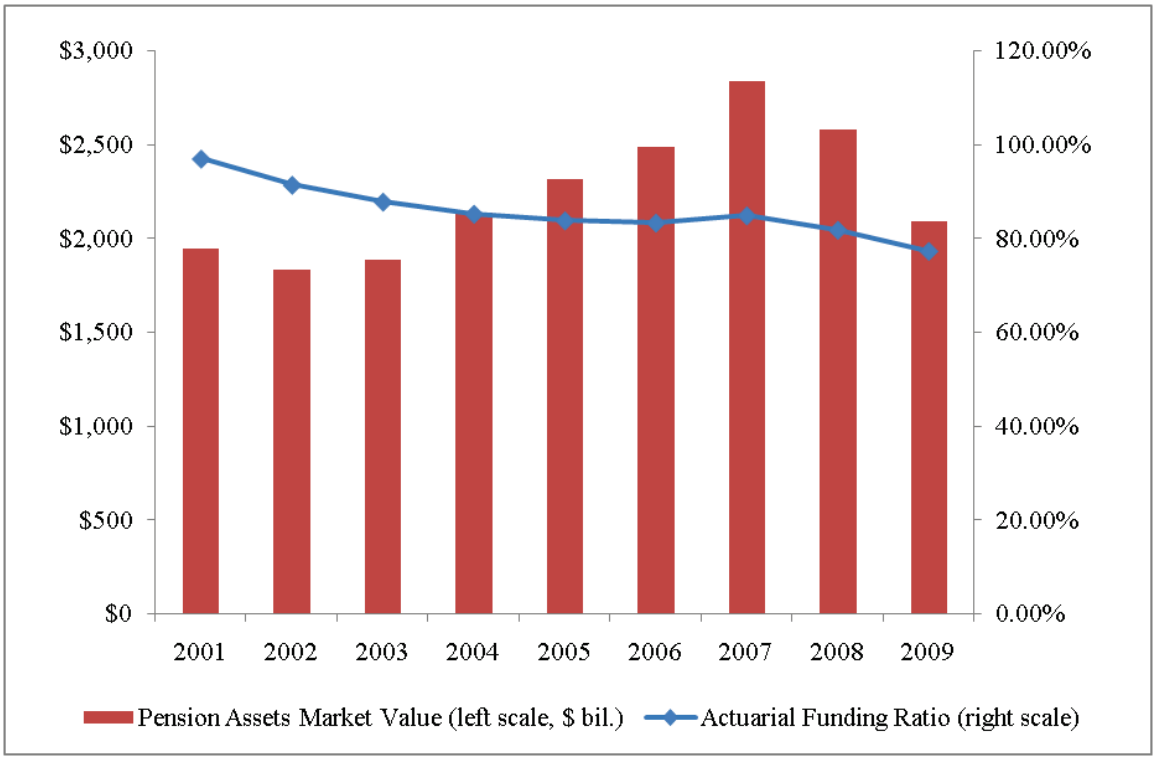
	Precrisis (2001 to 2008)		Postcrisis (2009)		Difference (post – pre)	
	Mean	Median	Mean	Median	Mean	Median
EQUITIES	0.5706	0.5830	0.5059	0.5224	–0.0647***	–0.0606***
FIXED_INCOME	0.2898	0.2720	0.2777	0.2670	–0.0121	–0.0050
REAL_ESTATE	0.0521	0.0490	0.0642	0.0590	0.0121**	0.0100**
ALTERNATIVES	0.0251	0.0000	0.0551	0.0233	0.0300***	0.0233***
CASH_OTHER_ASSETS	0.0623	0.0440	0.0951	0.0810	0.0328***	0.0370***
PENSION_ASSET_BETA	0.0066	0.6735	0.0063	0.6372	–0.0003***	–0.0363***
RETURN_ASSUMPTION	0.0798	0.0800	0.0794	0.0800	–0.0004	0.0000

Figure 1: The Average Pension Plan Assets Investment Return Assumption and Five-Year Actual Investment Returns from 2001 to 2009



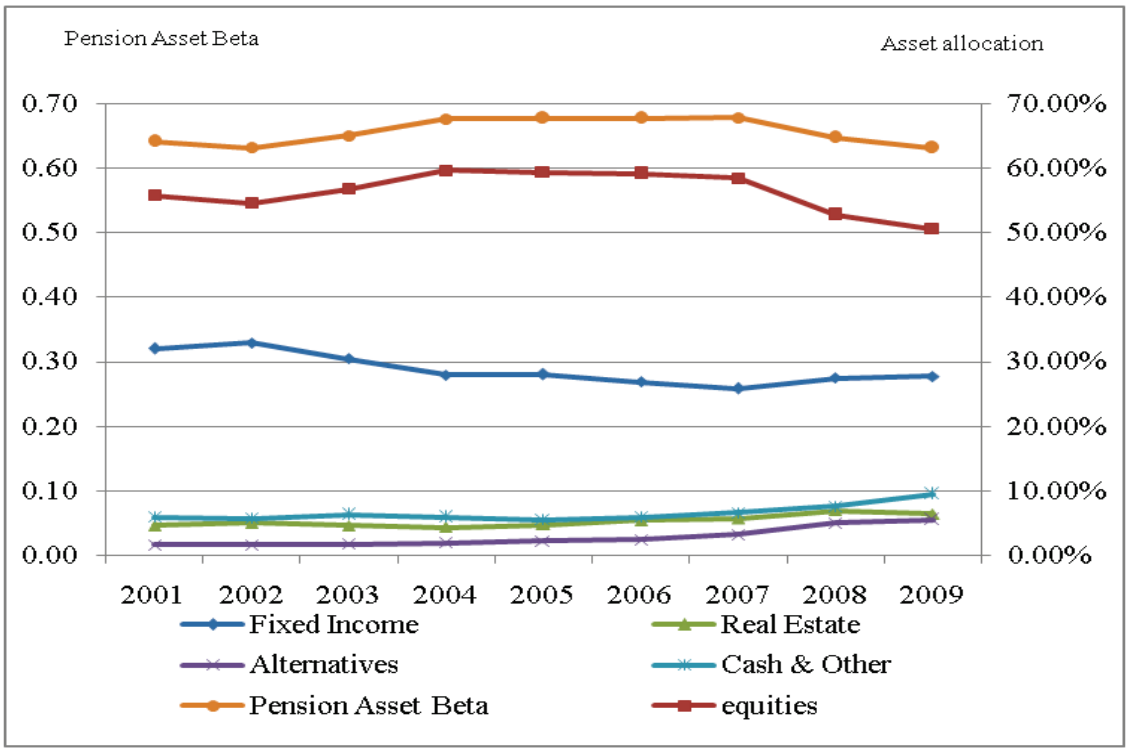
NOTE: This figure plots the annual average pension plan assets assumed investment returns and actual investment returns from 2001 and 2009. The data source is the Public Plans Database (PPD), obtained from the Center for Retirement Research at Boston College (2011). The full sample is from 2001 to 2009, with 1,134 pension system–year observations for 50 states and the District of Columbia.

Figure 2: The Aggregate Market Value of Pension Assets and Actuarial Funding Ratios from 2001 to 2009



NOTE: This figure plots the annual aggregate pension assets market value and actuarial funding ratios from 2001 and 2009. The right vertical axis shows aggregate pension asset market value (in $ bil) and the left shows the actuarial funding ratios. The data source is the Public Plans Database (PPD), obtained from the Center for Retirement Research at Boston College (2011). The full sample is from 2001 to 2009, with 1,134 pension system–year observations for 50 states and the District of Columbia. The pension plan actuarial funding ratio is estimated as the ratio of actuarial pension assets over actuarial pension liabilities, as in Equation (2a).

Figure 3: The Annual Average Pension Assets Allocation and Asset Beta from 2001 to 2009



NOTE: This figure plots the annual average pension asset allocation and pension asset beta from 2001 and 2009. The data source is the Public Plans Database (PPD), obtained from the Center for Retirement Research at Boston College (2011). The full sample is from 2001 to 2009, with 1,134 pension system–year observations for 50 states and the District of Columbia. The right vertical axis shows the percentage of each asset class in the total fund assets, and the left shows pension asset beta. Pension asset beta is estimated as the weighted average beta of all asset classes in a pension fund, as in Equation (1).