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Prudent Investors: The Asset Allocation of Public Pension Plans

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Abstract

After 2000, the vast majority of defined benefit (DB) pension plans encountered a decrease in their funding ratios, largely due to a drop in asset prices. It is possible that public sector pension plans may have acted imprudently by chasing returns, once they encountered underfunding. We identify four indicators for DB plans' imprudent investment behavior: no portfolio rebalancing, employer conflicts of interest, trustee conflicts of interest, and failure to implement best investment practices. To see if public sector pension plans rebalance their portfolios, we use data from the Federal Reserve's Flow of Funds, dating from 1952 to 2007. To test for the remaining three hypotheses, we use data from the Census' State and Local Government Employee Retirement Systems data base, where consistent data for state and local government plans are available from 1993 to 2005. Our results suggest that there is no evidence that public sector plans systematically engaged in imprudent investment behavior and that this did not systematically differ after 2000 from the earlier period.

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I. Introduction

Defined benefit (DB) pensions for state and local government employees are an important source of retirement savings. DB plans offer employees a fixed level of retirement income, typically based on years of service, age and prior earnings. Employers generally absorb the consequences of the risks associated with the long-term financial commitment that a pension plan entails. Employers will have to contribute less to their pension plans if financial rates of return are better than expected, and more if rates of return are worse than anticipated. The latter was the case after 2000, when funding ratios – assets to liabilities – fell and employer contributions subsequently increased.

Pension plans may attempt to handle a drop in funding in a number of ways. One of them is to seek higher returns in the short-run by incurring more portfolio risk. A more imprudent portfolio allocation may reflect a weak governance structure, where plan trustees fail to exercise caution, thereby demonstrating a classic principal-agent problem. Alternatively, a strong governance structure would serve to limit principal-agent problems and be mirrored in a move towards a more prudent asset allocation when financial demands increase.

In this article, we are particularly interested in determining whether public sector plans responded to underfunding by increasing their risk exposure. To our knowledge, this is the first empirical effort to systematically look at the determinants of asset allocations by public sector pension plans following the stock market correction of 2000-2001. We specifically look at the question of whether public sector plans follow prudent investment practices. Here we consider the roles that asset prices, pension plan funding, past employer contributions, and peer performance play. By looking at the asset allocation of public sector plans, this article contributes to the discussion of how public sector plans responded to the drop in funding levels that occurred after 2000.

In general, we find that public sector plans from 1993 to 2006 tended to be prudent in their asset allocation – possibly overly so. Public sector plans rebalanced their asset allocations regularly in response to large price changes – indicating that managers are adhering to their allocation targets. Also, public sector plans tended to hold more risky assets when they had higher funding levels. We interpret this as evidence that principals

are able to monitor agents and prevent them from taking riskier positions when funding ratios are low. Interestingly, this relationship seems to have become stronger after 2000.

The rest of the paper proceeds as follows. We provide an overview of the relevant literature in section II, which allows us to identify several portfolio allocation determinants. In section III, we provide some background on public sector plans' asset allocations over time. This is followed by a descriptive analysis of the data in section IV and a multivariate analysis in section V. We end with some concluding remarks in section VI.

II. Literature Review

The allocation of retirement portfolios towards risky assets, mainly corporate equities, is typically a systematic indicator of the rates of return earned on all assets. For instance, Coronado, Engen and Knight (2003) find that a one standard deviation increase in the asset allocation towards equities was associated with a rate of return that was 1.3% higher in 1998.[1] At least in the past, an allocation towards corporate equity has therefore been associated with higher rates of return for public sector DB plans.

Investors' portfolio allocations are typically based on investors' risk preferences, given the available investment opportunities, and the risk-return trade off (Grossman and Stiglitz, 1980; Merton, 1969). The primary asset allocation model typically employed follows Merton (1969). The optimal allocation into risky assets, e.g. stocks, is determined by the risk-return trade-off between a risky and a risk-free asset:

$$w^* = \frac{(a - r)}{\delta \sigma^2} \qquad (1)$$

The optimal share of equities, w^*, is equal to the ratio of the difference in the expected rate of return of equities (a) and that of risk free short-term government bonds (r), relative to one-year variance of equity prices $\left(\sigma^2\right)$ weighted by an investor's risk preferences, δ.

Plans, though, may not allocate optimal shares of their assets to specific asset classes. This deviation may be explained by a range of factors, including beneficiary demographics and plan size (or sponsor strength) (McCarthy and Miles, 2007).

[1] It is important to note that such past results tend to reflect an equity premium, which may not exist in the future. Thus, these results cannot be a guide for future asset allocation decisions.

We focus on a number of additional factors to capture prudent investment behavior. In particular, we look at portfolio rebalancing, plan and employer conflicts of interest, and investor learning. Taken together, we argue that regular rebalancing, the nonexistence of conflicts of interest and the existence of investor learning provide evidence of prudent investment behavior, based on the existing literature.

II.1 Indicators for Prudent Investment

Extraordinarily large movements in equity prices should lead investors to reallocate their portfolios. Since the volatility in investment returns has increased, the optimal share of equities should decrease as equation (1) suggests provided that investor risk preferences remain the same. Additionally, a large upward movement in stock prices in one period (such as the late 1990s) increases the probability of below average rates of return in the future as asset prices revert to the mean, relative to expected earnings (Campbell and Shiller, 1988, 2001). Lower expected rates of return on equities should result in fewer stock holdings.

A third reason why large movements in equity prices are likely to reduce equity allocations is that the funding level may impact the plan sponsor's preference for risk taking. The funding ratio – assets relative to liabilities – and the equity allocation are likely to be positively correlated. Plan trustees may feel that they have enough of a cushion to engage in riskier investment allocations when a plan is well-funded. In comparison, underfunded plans, especially those that are well governed, may seek to stabilize their funding ratio by reducing their risk exposure. Empirically, there seems to be a positive relationship between funding ratios and allocations towards riskier assets. Well-funded DB plans in the private sector tend to be more heavily invested in equities than less well-funded plans (Rauh, 2007). The same is true for real estate investments (Craft, 2005).[2]

[2] Conflicts of interest can arise in public sector DB plans due to politically motivated investment decisions. Plan sponsors, for instance, may want to target local economic development or avoid investments in certain companies and geographical areas due to political pressures. A small minority of public sector plans appears to engage in politically motivated investments, e.g. only 5% of public sector plans reported to have economically targeted investments (ETI) in 1998 (Coronado, Engen, and Knight, 2003). Politically motivated investment decisions do not seem to impact the overall performance of public plans. Coronado, Engen, and Knight (2003) and Munnell and Sunden (2001) conclude that there is no conclusive evidence that politically motivated investments adversely impact the rate of return of public sector DB plans. In comparison, Mitchell and Hsin (1997) find that public sector DB plans have a lower rate of return than

Complicating the optimal allocation decision are a host of factors: poor oversight by principles, conflicts of interest, uncertainty and "learning" behavior, as well as imitation of industry leaders. When these factors are prevalent they can lead to suboptimal investment performance and a deterioration of the funding ratio. For example, absent good governance, underfunded plans may adopt riskier portfolios due to the prevalence of information asymmetries between the principal (public sector employees) and their agents (plan trustees). Plan trustees may find it opportune to increase their risk taking, assuming a bailout by the plan sponsor or taxpayers (McCarthy and Miles, 2007; Papke, 1991).

DB plan sponsors may face their own conflict of interest.[3] Public sector plan sponsors may try to minimize their contributions, at a given level of liabilities. An unexpected increase in employer contributions to their pension plans may thus result in a change towards riskier asset allocations in an effort to reduce contributions by incurring more risk (McCarthy and Miles, 2007).

Plan investment officers may learn from the investment allocation of other plans. Such peer effects seem to exist in the mutual fund industry. Specifically, mutual fund managers may mimic the performance of peers, who have shown an outstanding performance (Chevallier and Ellison, 1999; Sirri and Tufano, 1998). Similarly, investors will imitate each other's behavior, given that information is naturally limited (Jegadeesh and Titman, 1993). This may especially apply to public sector plans, where legislative and regulatory obstacles have been eliminated over time and plans have moved towards riskier asset allocations. Pomorski (2006) finds that learning from leaders can translate into higher rates of returns.

large private sector DB plans due to politically motivated investment, although this finding may result from the comparison with only large private sector DB plans (Coronado, Engen, and Knight, 2003).

[3] This does not apply to private multi-employer DB plans, which are stand-alone entities (Almeida, 2007). `

II.2 Standard Determinants of Asset Allocation

In addition to the variables that are meant to capture prudent plan investments, there are several variables that are expected to determine a plan's equity allocation: demographics, plan size, and regulatory and legislative restrictions.[4] [5]

Traditionally, equity holdings were expected to be constant with age (Merton, 1969; Mossin, 1968; Samuelson, 1969), based on a set of strict assumptions. When these assumptions are relaxed, portfolio allocations can fluctuate with age (Ameriks and Zeldes, 2004). For instance, labor income is considered a certain, non-tradeable asset by assuming the net worth of future income. As the share of labor wealth declines over time, households will maintain their share of risk-free wealth in their total portfolio by shifting financial assets towards risk-free financial assets, away from equities. Furthermore, if equity returns are negatively serially correlated, investors should seek smaller exposures to risk as they age and their investment horizon shortens (Barberis, 2000; Campbell and Viceira, 1999, 2002; Kandel and Stambaugh, 1996; and Wachter, 2002). Also, changes in utility imply a reduction in assets with age because consumers increasingly value certain wealth to finance a fixed amount of desired consumption (Samuelson, 1989, 1994) and because risk aversion may decrease with age (Bakshi and Chen, 1994; Ballente and Green, 2004, and Halek and Eisenhauer, 2001), although the empirical results seem inconclusive on this point (Ameriks and Zeldes, 2004).

Consequently, the theory indicates that as the age of the plan's beneficiaries increases, the plan's allocation towards equities should decline. Specifically, a higher dependency ratio – beneficiaries to active participants – should translate into a less risky asset allocation.

Moreover, a plan's equity allocation may be related to the plan's size for two reasons. First, transactions costs tend to be higher for smaller plans than for larger plans. For individual investors, specifically in DC plans, transactions costs tend to be one factor that could explain the low equity investments (Haliassos and Bertaut, 1995) and limited

[4] Tax policy can influence the asset allocation of private sector pension plans, but should have no bearing on public sector pension plans. See Black (1980), Tepper (1981), Papke (1991) and Ameriks and Zeldes (2004) for a discussion of the link between tax policy and private pension asset allocations.

[5] Prior research has also found that a plan's governance structure, specifically independent reviews, can influence a plan's equity allocation (Useem and Mitchell, 2000; Yang and Mitchell, forthcoming).

portfolio allocation changes (Ameriks and Zeldes, 2004; Mitchell, et al., 2006). Fees tend to be higher for very small DB plans than for either larger DB plans or DC plans. The smallest DB plans (with 15 employees) tend to have expenses equal to 3.1% of assets, compared to 1.44% for DC plans (CII, 2006).

Consequently, it is possible that smaller DB plans are less likely to invest in equities. First, transactions costs tend to be higher than in other investments. Second, plan trustees may increase a plan's risk exposure for larger plans. The may be due to their ability to diversify across a broad range of investment opportunities, the availability of professional staff, and the relatively large impact of small policy changes due to the large membership of the plan. Consequently, large sponsors will have more financial resources available if downside risk materializes and plans are in need of additional financial resources (McCarthy and Miles, 2007). We use plan size as a proxy for the strength of the plan sponsor.

Finally, public sector plans may face institutional and legislative hurdles to investing more in riskier assets. Traditionally, public plans have held smaller shares of their assets in stocks than private sector plans (Coronado, Engen and Knight, 2003). However, restrictions on public plans' investments have been gradually lifted. Many public sector plans are allowed to allocate a growing share of their assets to corporate equities and other investments, such as international securities and alternative investments (IFI, 2007; Marois, 2007). We include the asset allocation of private DB plans as a benchmark to capture the effects of the changing legal and institutional environment for public plans.

III. Background

We use two data sets to study the determinants of the asset allocation of public sector plans. Aggregate data for all state and local plans are available going back to 1952 from the Federal Reserve's Flow of Funds (BOG, 2007). These data offer the longest time horizon and includes flow variables, in particular net purchases of financial assets.

In addition, the Census' (2007) annual survey of State and Local Government Employee Systems going back to 1993 reports a range of relevant variables for state and local plans separately for each state.[6] It covers all public sector DB plans and provides

[6] Consistent data are available only through 2005 due to a change in the sample.

relevant variables beyond plans' finances, such as demographics and benefit payments.[7] In some cases, data on DC plans are included, which represents only a minor problem since the preponderance of public sector plans are DB plans and the largest public sector DC plans – Teachers' Insurance Annuity Association (TIAA) – is excluded.

These two data sets allow us to approximate the determinants of the asset allocation of public sector plans and allow for a comparison of the determinants of the asset allocation before 2001 and after 2000.

Public sector plans held slightly more stocks, 0.7 percentage points, than private sector DB plans since the 1990s (Table 1). Since 2000, stocks accounted for 60.3% of all public plan assets and for 59.6% of private pension plan assets. This allocation followed sharp increases in the stock allocation of public plans, particularly in the 1970s and 1990s. State and local government plans differ slightly in their asset allocation, although both types of plans show an increasing equity allocation (Table 2). Local plans had a greater allocation to domestic stocks than state plans. In 2005, local plans held 37.2% in domestic stocks, compared to 35.8% of state plan assets allocated to domestic stocks. This is up from 28.7% and 32.6%, respectively, showing a larger relative increase in the equity allocation for local plans than for state plans.

[7] Aggregate data provide for consistent time series observations for each state at the state and local level. Individual plan level data does not offer the same time series consistency due to a change in survey methodology and plan survivals and deaths. We thus primarily rely on the aggregate data, although we report results based on plan level data to show the robustness of our results.

Table 1
Asset Allocation of Public and Private Sector Pension Plans, Business Cycle Averages

Business cycle dates	Stocks		Corporate and foreign bonds		Treasuries and agency debt		Mutual funds		Other investments	
	Private sector	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector	Public sector
Sep-1953:Sep-1957	-	1.5	n.a.	23.6	n.a.	44.7	n.a.	0.0	n.a.	30.3
Dec-1957:Jun-1960	n.a.	2.6	n.a.	32.7	n.a.	33.3	n.a.	0.0	n.a.	31.4
Sep-1960:Dec-1969	n.a.	7.0	n.a.	48.4	n.a.	22.5	n.a.	0.0	n.a.	22.1
Mar-1970:Dec-1973	n.a.	21.5	n.a.	56.6	n.a.	8.8	n.a.	0.0	n.a.	13.1
Mar-1974:Mar-1980	n.a.	22.8	n.a.	55.3	n.a.	11.3	n.a.	0.0	n.a.	10.6
Jun-1980:Sep-1990	39.8	29.8	10.6	30.9	19.1	28.9	0.8	0.7	29.7	9.6
Dec-1990:Mar-2001	47.4	52.1	12.1	15.2	16.2	21.1	5.5	4.1	18.8	7.4
Jun-2001:Jun-2007	59.6	60.3	9.3	9.3	11.5	16.4	10.5	8.7	9.0	5.2

Notes: All figures are percent of total financial assets. Data on private DB plans are available only annually from 1985 onward. Authors' calculations based on BOG (2007). Business cycle dates are taken from the National Bureau of Economic Research's Business Cycle Data Base (NBER, 2008). Dates are inclusive.

Table 2
Asset Allocation of State and Local Government Plans, By Type of Plan and Select Years

	Stocks			Corporate bonds			Treasuries and agency debt			Other investments		
Year	Total	State	Local	Total	State	Local	Total	State	Local	Total	State	Local
1995	32.4	32.6	28.7	17.9	18.3	16.8	20.5	20.6	20.9	29.2	28.5	33.6
2000	35.4	34.6	35.8	16.3	16.4	18.1	12.9	13.2	15.0	35.4	35.8	31.1
2005	35.8	35.8	37.2	16.0	15.6	15.3	8.6	9.0	11.1	39.1	40.3	34.2

Notes: Authors' calculations based on Census (2007). All calculations are based on aggregate data.

The equity allocation may be correlated with public sector plan assets' rate of return, defined as investment earnings divided by the average of assets at the start and end of a period. Plans with equity allocation shares greater than the median showed a rate of return that was approximately half a percentage point higher than for plans that had allocation shares less than the median. Based on plan-level data, we also find that larger equity allocations tend to go along with higher rates of return, again with a difference of about half a percentage point for longer-term investment horizons (Table 3).

Table 3
Rates of Return over 1, 3, and 5 Years, by Size of Assets Allocated to Equities

Size of allocation towards equities	One-year rate of return	3-year rate of return	5-year rate of return
Aggregate data			
Small	8.0	7.0	7.0
Large	8.1	7.5	7.6
Plan level data			
Small	6.6	6.9	7.2
Large	7.9	7.3	7.6

Notes: All figures are in percent. Rates of return are averages for 1, 3, and 5 years. Size classes refer to quartiles of asset shares allocated to corporate equities averaged over 1, 3, and 5 years. Aggregate data exclude system wide observations. Data cover the entire period from 1993 to 2005. Authors' calculations based on Census (2007).

IV. Univariate Analyses

In this section we study the link between four indicators of prudent investments and public sector asset allocation: rebalancing, funding ratios, employer contributions, and leader's asset allocation. Plans that effectively rebalance their portfolios are viewed as more prudent; plans with lower funding ratios have smaller investment in equities, again demonstrating prudence. Funds with large increases employer contributions do not increase their risk positions. Finally, we find some limited evidence of "follow-the-leader" behavior. We interpret both of these, cautiously, as evidence of prudence.

IV.1 Rebalancing

Large price changes should translate into asset reallocations. We define periods of extraordinary price increases as those quarters when equities prices in the previous year

increased by more than one and a half standard deviations. We develop measures for two-year and five-year above trend price increases similarly. Finally, we define periods of extraordinary price declines as price drops in excess of one and a half standard deviations. We then divide the data from 1952 to 2007 into three subperiods: extraordinary increases, extraordinary decreases and tranquil periods. We find extraordinary one-year equity price increases preceding 9.2% of the quarters from 1952-2007, extraordinary two-year increases preceding 7.5% of the quarters, and extraordinary 5-year increases preceding 6.9% of the quarters. The shares for extraordinary decreases were 8.1%, 8.1%, and 10.2%, respectively.

Next, we test if the changes in the equity allocation immediately following extraordinary price changes were significantly different from those following tranquil periods and if the size of the differences were consistent with the hypothesis that public plans rebalanced their portfolios.[8] Pension plans should increase their stock purchases immediately following price declines and decrease them after prices have just risen. These changes should be larger than during tranquil periods.

We use three rebalancing measures. First, we use the percent change of net stock purchases following a period of extraordinary price changes relative to the relevant preceding periods. We sum over several quarters and then calculate the percent change to reduce the inherent data volatility. Our reference periods are 4, 8, and 20 quarters. Second, we use the percentage point change in the ratio of net purchases relative to stock holdings. Third, we consider the percentage point change in the ratio of stocks relative to total assets, although this variable captures both active portfolio rebalancing and price changes. In all instances, we calculate the same ratios also for private retirement plans, which include defined contribution plans.

Finally, we undertake all of our tests for the full sample and then for the period after 1982. The years after 1982 was characterized by a stock market boom that increased the need for regular rebalancing and defined contribution plans gained in popularity with the onset of 401(k) plans, which may have influenced portfolio allocation practices.[9]

[8] We also used Kruskall-Wallis tests due to the small sample sizes, which generate robust results.
[9] This may serve as an indicator for the period after 2000, for which we do not have enough observations.

The statistically significant changes typically confirm the hypotheses that public plans rebalance their portfolios after price changes (Table 4). For instance, five of the twelve tests for differences in percent changes in net purchases are statistically significant. Four of these five test statistics have the expected sign. The second measure – changes in net purchases relative to total value of stocks – shows no statistically significant difference following periods of large price changes, while the third measure indicates again more statistically significant tests with the expected sign (5) than with the unexpected sign (3). There is no systematic difference between price increases or price declines, nor is there a systematic difference between the full sample and the period after 1982.

There are differences between public and private sector plans in all three measures used. With the first measure, we see several statistically significant differences with an unexpected sign, suggesting that private sector plans disproportionately increased their purchases after they got more expensive and reduced their purchases disproportionately after stock prices had declined. In the case of net stock purchases relative to the outstanding value of stocks, which showed no differences for public sector plans, we find three instances with the expected sign and two with the unexpected sign. That is, this measure does not provide any clear support for or against our hypotheses. Only changes in the ratio of stocks to financial assets indicate that stocks increased faster as a share of assets after price declines and slower after price increases than during tranquil periods.

Table 4
Tests for Portfolio Changes after Extraordinary Price Changes, 1952 to 2007

		Change in net purchases		Change in net purchases to stocks		Change in stocks to total financial assets	
	Exp. Sign	Public	Private	Public	Private	Public	Private
Full sample							
Price increases							
1-year	"-"	-0.148	0.689	0.683	0.321	2.144**	2.536***
2-year	"-"	0.002	-1.768**	-0.469	1.919**	-1.279	0.568
5-year	"-"	3.863***	-0.090	0.451	-1.952**	-2.123**	-0.466
Price declines							
1-year	"+"	-2.080***	-0.065	-1.156	-2.121**	1.413	-0.153
2-year	"+"	0.784	5.052***	0.507	-0.698	-2.336**	0.258
5-year	"+"	-0.564	-0.068	-0.786	0.525	-5.099***	-2.073**
After 1982							
Price increases							
1-year	"-"	-0.169	-0.352	-0.051	0.083	0.679	1.466*
2-year	"-"	-0.228	-1.414	-0.409	1.767**	-0.672	-0.268
5-year	"-"	2.945***	-2.121**	0.208	-1.450*	-2.525**	-4.252***
Price declines							
1-year	"+"	-2.041***	-2.088**	-0.714	-3.883***	2.843***	-1.335
2-year	"+"	0.197	6.011***	0.382	-0.243	-1.526*	-0.878
5-year	"+"	4.960***	-0.093	0.666	0.005	-1.930**	-2.860***

Notes: For price increases, the hypothesis is that following these periods plans rebalance by selling stock more aggressively than they did during tranquil periods, i.e. a positive sign. For price declines, the hypothesis is that immediately following these plans increase equities shares relative to tranquil periods. * indicates significance at the 10%-level, ** indicates significance at the 5%-level, and *** indicates significance at the 1%-level.

Our tests suggest two tentative conclusions. First, public plans actively rebalance their portfolios. Second, the evidence in favor of active rebalancing is stronger for public sector plans than for private sector retirement savings plans.

IV.2 Funding Ratios and Equity Allocation

All types of retirement benefit plans exhibited similar improvements in funding ratios during the 1990s followed by declines in funding ratios after 2002 (Munnell et al., 2007). The strong stock market performance and higher interest rates contributed to funding ratios that exceeded 100% in the late 1990s. Starting in 2002, though, lower

interest rates and much lower stock prices translated into lower funding ratios, which fell below 80% for private sector plans and below 90% for public sector plans on average. However, by 2006, plans had recovered some of their earlier losses (Munnell et al., 2007).

We calculate a proxy for liabilities since aggregate data only cover benefit payments (Census, 2007). We assume that the median ratio of benefit payments to liabilities that held for plans in the PENDAT data set between 1998 and 2000 holds for all plans here.[10]. The median ratio of benefit payments to liabilities was 5.7% for those years.

We also assume that liabilities move in line with a plan's age profile. The ratio of beneficiaries to active participants is used as an approximation of the age profile of a plan. We index each system's ratio of beneficiaries to active participants with 1999 as the base year. Liabilities are allowed to change with the dependency ratio in addition to changes in benefit payments. Specifically, liabilities for each system are calculated as:

$$L = \frac{B}{0.057}(AgeIndex) \qquad (2)$$

Where L are the proxied liabilities, B are benefit payments, and *AgeIndex* is the dependency ratio indexed to 1999 for each system. The resulting funding ratios, weighted by asset size, for each year show the familiar pattern of improving funding ratios in the late 1990s, a sharp drop off after 2001 and stabilization in 2006.[11]

We create three categories of funding ratios to facilitate our evaluation. Specifically, funding ratios of less than 80% are considered "severely underfunded", between 80% and 100% "mildly underfunded", and funding ratios above 100% "funded".

The results of our analysis are presented in Table 5. We find that mildly underfunded plans tend to have lower equity allocations Severely underfunded public sector DB plans tend to invest less than better funded plans in domestic stocks and more in government securities. These trends are even more pronounced, when we consider plan

[10] These years are are in the middle of the Census (2007) data series and ensure sufficient observations.
[11] Authors' calculations based on Census (2007). Assets are reported here as total assets at market value. Since most public DB plans will likely use some form of smoothing to reduce swings in asset values in the calculation of plan funding ratios, our calculation will show larger swings in funding ratios than is likely the case for actuarial funding ratios.

level data instead of aggregate data. The figures thus indicate that underfunding goes along with smaller equity allocations.

Table 5
Asset Allocation of State and Local Government Retirement Plans by Funding Levels

Shares of financial assets	Funding level: <80%	Funding level: 80%-100%	Funding level: >100%
Aggregate data			
Domestic stocks	28.7	35.7	34.6
	-	(-3.67***)	(-3.55***)
Corporate and foreign bonds	15.6	18.2	17.1
	-	(-1.93*)	(-1.31)
Treasuries and agency debt	15.9	11.3	16.2
	-	(2.16**)	(-0.18)
Other investments	39.4	34.7	32.4
	-	(1.76*)	(3.05***)
Plan level data			
Domestic stocks	36.6	37.2	39.1
	-	(-3.42***)	(-2.87***)
Corporate and foreign bonds	24.5	22.9	19.6
	-	(1.36)	(1.13)
Treasuries and agency debt	11.3	13.1	18.0
	-	(-1.483)	(-7.265***)
Other investments	29.8	29.2	25.5
	-	(0.349)	(4.025***)

Notes: Authors' calculations based on Census (2007). Figures in parentheses are t-test statistics for testing the null hypothesis the respective shares are the same as for pension systems with severe underfunding. * indicates significance at the 10%-level, ** indicates significance at the 5%-level and *** indicates significance at the 1%-level. A positive sign indicates that the allocation share for systems with severe underfunding is greater than the share for other systems and a negative sign indicates that the share of systems with severe underfunding is smaller.

IV.3 Employer Contributions and Equity Allocation

Plan sponsors (employers) may try to minimize their contributions in any given year, given fixed liability levels. Following an increase in employer contributions, plan sponsors may pursue a riskier allocation strategy in the short-term.

First, we identify periods when employer contributions rose unexpectedly. These are periods when percentage point changes in employer contributions relative to outflows – the sum of benefit payments and withdrawals – increased by more than half a standard deviation above the average change for that plan type. When we use aggregate data, for

instance, 3.3% of quarterly observations are classified as periods with unexpected increases system wide, compared to 8.1% for state plans and 0.7% for local plans.

There is no evidence suggesting that plans seek more risk in the year following an unexpected increase in employer contributions (Table 6). These results are robust even for small samples as the Mann-Whitney ranksum test indicates.

Table 6
Tests for Faster Stock Allocation after Unexpected Employer Contribution Increases

	System wide data	State plans (aggregate)	Local plans (aggregate)	State plans (plan data)	Local plans (plan data)
t-test	-1.304	-1.410	0.000	0.034	0.721
Mann-Whitney test	-0.047	-1.356	-0.225	0.292	0.802

Notes: Mann-Whitney test is a ranksum test, used here to the small sample sizes to demonstrate robustness of the results. In each case, the null hypothesis that the average change in the period after an unexpected change is the same as the average change during all other periods. A negative sign indicates that change in the stock allocation immediately following an unexpected change in employer contributions is greater than during other periods, while a positive sign indicates that the average change immediately following an unexpected increase in employer contributions is smaller than during other periods. * indicates significance at the 10%-level, ** indicates significance at the 5%-level, and *** indicates significance at the 1%-level.

IV.4 Leader Investments and Equity Allocation

We also try to get a sense if pension plans follow each other's investment strategies. We first identify the best performer in each period based on a plan's rate of return. Plans that have the highest rate of return in a given year are "leaders". Next, we compare the changes in asset allocation for leaders during the year, when they are leaders, with changes of asset allocations of all plans in the following year.

There is limited evidence that public sector plans "follow the leader". Only in about 50% of the cases, regardless of the asset class and regardless of the level of aggregation, do followers follow the lead of leaders, either up or down (Table 7).

There seems to be a difference between state and local plans with respect to equity allocations. For instance, among state plans, followers increased or decreased their equity allocation in 51.2% of the cases after leaders did the same in the preceding period, based on aggregate data. Based on fund level data, this was true for 44.6% of cases (Table 7). Among local plans, followers followed leaders in 46.2% of cases, based on

aggregate data, and 33.5% of instances, based on fund level data. This suggests that state plans are somewhat more likely to follow the leader, than local plans.

Table 7
Share of Allocation Changes, when Leaders and Followers Move in the Same Direction

	Changes in stocks to assets	Changes in bonds to assets	Changes in govt. debt to assets	Changes in other investments to assets
Aggregate data				
State and local plans				
Leaders and followers increase	26.2	21.1	12.6	28.1
Leaders and followers decrease	19.8	32.2	43.0	20.8
State plans				
Leaders and followers increase	36.6	28.7	13.5	21.5
Leaders and followers decrease	14.8	26.8	41.0	28.4
Local plans				
Leaders and followers increase	7.0	12.2	10.2	21.3
Leaders and followers decrease	39.2	40.6	33.5	20.3
Plan level data				
State plans				
Leaders and followers increase	25.5	29.0	9.6	17.6
Leaders and followers decrease	19.1	20.1	47.0	30.4
Local plans				
Leaders and followers increase	33.5	39.2	0.0	n.a.
Leaders and followers decrease	0.0	0.0	53.0	n.a.

Notes: All figures are in percent. Figures are shares of all allocation changes in specified asset category. Only instances are considered, where leaders and followers move in the same direction in subsequent periods.

V. Multivariate Analysis

The discussion over asset allocations is typically concerned with factors that could raise or lower the actual asset allocation above or below its optimal level. The definition of the optimal allocation towards stocks is laid out in equation (1) in the previous discussion. We assume a constant risk parameter of 5 as an indication of trustees' risk neutrality, which is consistent with other studies (McCarthy and Miles, 2007). The rate of return on stocks is the annual rate of appreciation of the S&P500 plus the average annual dividend yield. The variance of the risky asset is the variance of the total rate of return on stocks, based on data for the S&P 500, from 1953 forward to each data year.

Our interest lies in explaining the deviation of the stock allocation from its optimum. Our regression equation is thus:

$$\left(\frac{Stocks}{FinAssets} - w^*\right)_{t,i} = \beta_0 + \beta_1\left(\frac{Beneficiaries}{ActiveParticipants}\right)_{t,i} + \beta_2\left(\frac{Assets}{Liabilities}\right)_{t-1,i} + \beta_3\left(SizeInd\right)_{t,i} + \beta_4\left(\frac{LStocks}{LFinAssets}\right)_{t-1,i} + \beta_5\left(\frac{EmpContr}{Outflows}\right)_{t-1,i} + \beta_6\frac{LStocks}{LFinAssets}_{t-1,i} + e_{t,i} \quad (3)$$

Where w^* denotes the optimal share of assets allocated to corporate equities, *SizeInd* refers to the four size groupings discussed earlier, *LStocks* and *LFinAssets* are the stock holdings and financial assets of the leader in the previous period, and *PStocks* and *PFinAssets* are the stock holdings and financial assets of private sector DB plans.

In addition to the variables used to measure prudent investment, we include plan size, dependency ratio and the equity allocation of private sector DB plans as explanatory variables. The dependency ratio is the ratio of beneficiaries to active participants and plan size is an indicator variable that takes on values from "1" to "4", depending on whether the plan fell into the first, second, third, or fourth size quartile in any given year.

The first regression shows the baseline model for system wide aggregate data (Table 8). All explanatory variables either have the expected sign or are statistically insignificant. Specifically, public plans' equity allocation increases when equity allocations by leaders private sector DB plans and increase in the previous period.

Next, we re-estimate the regression focusing on whether the determinants of public sector plans' equity allocation differed systematically after 2000. Specifically, we include a dummy variable that takes on the value of one for the years after 2000 and zero otherwise. We also include two interaction terms: one for the funding ratio after 2000 and one for employer contributions after 2000 since those are the variables that capture conservative or aggressive investment strategies.

The determinants of public sector plans' equity allocations are largely robust before and after 2000, with one exception. Specifically, the equity allocation is positively correlated with the funding ratio prior to 2000, but there is no clear link after 2000 (Table 8).

We re-estimate the regression equation with a slightly altered definition of the funding ratio to show the robustness of our results.[12] We now use the ratio of assets to (estimated) liabilities without adjusting for changes in the dependency ratio. Our previous results remain robust (Table 8). In addition, we find that plans tend to increase their equity allocation with higher funding levels and after employer contributions unexpectedly increased. Specifically, public plans' equity allocation tends to increase with higher funding levels, lower employer contributions, while also following the lead of strong performers and experienced plans. These results remain stable, when we exclude the dependency ratio from the regression, which is done to show the comparability with the regression results for state and local plans, as discussed further below. Our results suggest that public sector plans learn from performance leaders, but are not influenced by plan sponsor and trustee conflicts of interests.

When we again include the dummy variable for years after 2000 and the interaction terms, the results are generally robust. However, greater employer contributions are followed by smaller equity allocations, but only after 2000 (Table 8). While this suggests that public sector plans are not influenced by employer conflicts of interests, it may indicate that plans became overly cautious in the face of quickly rising employer contributions after 2000.[13]

We can estimate the last regression also for state and local plans separately since demographic data are not available for these plans at the aggregate level. There seem to

[12] We also estimated the regression equation based on fund level data. Aggregate data are preferable for a number of reasons, though. While the fund level data allow for more observations, they have the problem that they do not provide a consistent time series. For one, plans move in and out of the sample and second, the Census methodology changed to a survey design half way through our sampling period, which drastically reduced the number of annual observations. Moreover, there are substantial data limitations for local plans. Nevertheless, the fund level regression results are generally robust, but show two important differences from the results based on aggregate data. First, we find that plans with more assets tend to have a larger share of their assets allocated to equities. Second, state level plans do not follow the leader, but rather seem to do the opposite of what performance leaders did in the previous period. If we include an interactive term between plan size indicators for moderate, large, and very large plans and the leader's stock allocation as additional explanatory variables, we find that smaller state plans tend to move in the opposite direction from the asset allocation of performance leaders, while the equity allocation of very large plans is either not systematically connected to the equity allocation of performance leaders or may even follow it. That is, our results suggest that in the aggregate public sector plans tend to imitate the investment behavior of performance leaders, although the opposite seems to be the case for smaller plans.

[13] Table 2 also shows that there was no clear trend towards other investments. Also, while the allocation towards international securities increased, the allocation towards real estate remained relatively stable according to our calculations based on Census (2007).

be some noticeable differences between state and local plans (Table 9). The funding ratio and the leader's previous equity allocation are significant determinants of the allocation of state plans' assets, but not of local plans'. In comparison, size and employer contributions matter for the asset allocation of local plans, but not for state plans. Both types of plans, though, seem to follow the lead of private sector DB plans. Although the exact mechanism differ, both types of plans seem to follow experience and do not seem to rely on implicit taxpayer guarantees to pursue riskier investment strategies when funding ratios decline or demands on employers increase.

The results remain largely robust when we include a dummy for years after 2000 and interaction terms, although there are some differences with respect to two variables of particular interest to us – the funding ratio and employer contributions. Specifically, the allocation towards stocks is positively related with higher funding ratios for state and local plans. This difference is much weaker after 2000 than before for state plans, but shows no difference over time for local plans (Table 9). In addition, employer contributions in the previous period have no systematic relationship to the allocation towards stocks by state and local plans before 2000, but there is a statistically significant link after 2000. Again, this suggests no employer conflicts of interest, but it may indicate an overly cautious investment allocation after rapid changes in employer contributions.

Table 8
Regression Results for Determinants of Equity Allocation, System Wide Aggregate Data

	Coeff.	Std. Dev.	Coeff.	Std. Dev.	Coeff.	Std. Dev.	Coeff.	Std. Dev.	Coeff.	Std. Dev.	Coeff.	Std. Dev.
Dependency ratio	0.251	0.462	-0.526	0.467	0.390	0.429	-0.393	0.453				
Lagged funding ratio	-0.012	0.009	0.125	0.081								
Funding ratio times indicator after 2000 (lagged)			-0.125	0.081								
Lagged funding ratio (alt.)					0.165***	0.058	0.070**	0.076	0.169***	0.058	0.589	0.075
Funding ratio (alt.) times indicator after 2000 (lagged)							0.122	0.089			0.136	0.088
Size indicator	0.007	0.264	0.031	0.252	0.031	0.263	0.073	0.251	0.029	0.263	0.075	0.251
Lagged leader's stock allocation	2.157***	0.363	4.190***	0.494	2.002***	0.364	4.170***	0.494	2.005***	0.364	4.164***	0.494
Lagged employer contribution to outflows	0.225*	0.129	0.124	0.273	-0.488*	0.256	0.186	0.307	-0.532***	0.252	0.227	0.303
Emp. cont. to outflows times indicator after 2000 (lagged)			-0.492*	0.288			-1.223***	0.337			-1.206***	0.337
Lagged private DB plan stock share	8.127***	1.014	27.991***	3.089	6.701***	1.056	28.189***	3.138	6.781***	1.056	27.837***	3.112
Indicator for years after 2000			-2.236***	0.364			-2.2104***	0.364			-2.202***	0.364
Constant	-5.296***	0.838	-14.912***	1.678	-4.429***	0.879	-15.133***	1.717	-4.274***	0.861	-15.16***	1.716
N	623		623		623		623		623		623	
F-statistic	28.97***		27.75***		30.28***		28.67***		36.18***		32.17	
R-squared	0.235		0.308		0.243		0.315		0.242		0.314	

Notes: All regressions include plan fixed effects. * indicates significance at 10%-level, ** indicates significance at 5%-level and *** indicates significance at 1%-level.

Table 9
Regression Results for Determinants of Asset Allocation, State and Local Plans, Aggregate Data

	State Plans				Local Plans			
	Coeff.	Std. Dev.	Coeff.	Std. Dev.	Coeff.	Std. Dev.	Coeff.	Std. Dev.
Funding ratio times indicator after 2000 (lagged)			-0.921***	0.138			0.127	0.098
Size indicator	-0.017	0.235	0.184	0.195	0.405*	0.222	0.429**	0.221
Lagged leader's stock allocation	3.410***	0.296	6.850***	0.346	0.150	0.260	0.293	0.259
Lagged employer contribution to outflows	0.063	0.291	0.504	0.274	-0.626**	0.286	-0.140	0.342
Employer contributions to outflows times indicator after 2000 (lagged)			-1.350***	0.346			-1.163***	0.392
Lagged private DB plan stock share	8.993	0.883	48.527***	2.570	10.055***	1.138	14.381***	2.896
Indicator for years after 2000			-3.668***	0.275			-0.110	0.296
Constant	-8.447***	0.827	-27.722***	1.384	-6.416***	0.960	-8.764***	1.642
N	608		608		545		545	
F-statistic	83.80***		109.65***		27.03***		19.50***	
R-squared	0.432		0.615		0.216		0.242	

Notes: All regressions include plan fixed effects. * indicates significance at 10%-level, ** indicates significance at 5%-level and *** indicates significance at 1%-level.

VI. Conclusion

In the wake of declining funding ratios for public sector plans, their professional management has occasionally been criticized. Well-governed defined benefit pensions follow prudent investment plans and use best practices in their management. Thus, we study the determinants of public plans' equity allocations with a particular focus on the years after 2000. We examine whether public sector plans regularly rebalance, avoid employer and trustee conflicts of interests and learn from the investment experiences of others.

Our descriptive statistics and multivariate analyses of public sector plan data from 1993 to 2006 indicate that public plans tend to be prudent in their asset allocation – possibly overly so. For one, public sector plans tend to rebalance their assets regularly in response to large price changes. Moreover, public sector plans hold less risky assets when they have lower funding ratios. Had this not been the case, we would interpret this as increased risk taking by trustees. Had trustees adopted riskier equity allocations in the face of funding shortfalls we would have been concerned that this represented a conflict of interests, and that trustees' fallback position would be a bailout by the plan sponsor or taxpayers. The fact that trustees choose lower equities exposure when funding ratios are low indicates that trustee conflicts of interests are not prevalent.

We were also encouraged to find that the equity allocations are larger in the period after we observe higher funding levels, suggesting that trustees wait to know what their financial situation is, before they change the risk exposure of their portfolio. Finally, public sector plans tend to hold smaller shares of equities when demands on employers in the form of higher contributions increase. This relationship seems to have become stronger after 2000, which suggests that public sector plans not only avoided employer conflicts of interest as larger demands on employers in the previous period translate into a "flight from risk", but may have become overly cautious in their asset allocation following large underfunding.

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