Investment Behavior in Public DB and Non-DB Pension Plans[1]

JAMES FARRELL
Florida Southern College

DANIEL SHOAG
Harvard Kennedy School

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Public employee pension plans are increasingly transitioning towards defined contribution and hybrid models. This shift has provoked fears that individual employees will manage their funds poorly. In this paper, we use new data to describe the universe of public plan investments and to compare investment behavior in public DB and non-DB plans. Using information on thousands of individual investors in Florida's DC plan along with new data on the investment behavior of thousands of public plans, we explore how plan design affects investment allocations, the distribution of investment outcomes, and the prevalence of common investment biases.

1 Introduction

State and local pension plans cover more than 19 million members and manage nearly $3 trillion dollars on their behalf. Benefit payments from these plans in 2010 equaled 11% of state government revenue, and these expenses are projected to grow rapidly over the next thirty years. Though $3 trillion in assets is sizeable by any measure, it is grossly insufficient to cover committed pension obligations in the event of poor investment outcomes. Rauh and Novy-Marx (2012) calculate that the underfunding in state-administered pension plans would require additional contributions on the order of 2% of gross state product should plan investments grow at the risk-free rate.

In response to perceived underfunding and investment risk, public sector retirement systems have increasingly shifted away from the defined benefit (DB) model. In the past fifteen years, non-DB plans have opened in Alaska, Colorado, Florida, Georgia, Michigan, North Dakota, Ohio, Oregon, Rhode Island, South Carolina, and Utah among others (Snell 2012). Defined contribution (DC) and hybrid pension plans account for a rapidly increasing share of the retirement assets managed on behalf of public employees. In 1987, only 9% of full-time state and local government employees

Contact information: jfarrell@flsouthern.edu and dan_shoag@hks.harvard.edu

participated in a DC plan while 93% participated in a DB plan. In 2010, 25% of state employees and 14% of local employees participated in a non-DB plan, whereas participation in DB plans fell to 78% and 79% for these groups.

This trend has led some to fear that these changes in plan design will lead to poor outcomes for public sector workers. Critics argue that "most [public] employees lack the knowledge of investment concepts and practices needed to succeed" (NASRA 2005) in a DC plan. These skeptics argue that the individual investment control found in most non-DB plans opens the door for individuals to improperly diversify their assets, pay unnecessary fees, fail to rebalance, chase returns, and otherwise assume too much risk and underperform. While these fears are real (indeed we provide evidence for many of them in this paper), these investment biases are not limited to defined contribution plans alone. The public employees, consultants, and investment managers supervising assets in public defined benefit funds exhibit many of the same behaviors. To properly assess the risks associated with changing plan design, a quantitative comparison of investment outcomes and processes in actual public DB and non-DB plans is necessary.

Despite this need, there are few studies that explore the investment practices of state-run plans. One of the reasons for this is the paucity of data on the investment decisions and outcomes earned in these systems. The unavailability of data is particularly severe for defined contribution public sector plans. This paper uses newly collected data from a number of sources to fill this gap.

1.2 Data and Prior Literature

The first source of novel data we introduce comes from the Standard & Poor's Money Market Directories, which contains information on the investments of thousands of public DB and non-DB plans. This data opens up a new window on non-DB public plans, a sector on which there is almost no aggregate data available to researchers. This database is typically used by fund sponsors, investment management firms, and pension consultants and was made available for academic research under a special license. The data were collected primarily from in-depth interviews and surveys of plan officials. This dataset also contains detailed data on plan-consultant and plan-manager links, opening up an important new area of study.

To examine the impact of individual investment control on individual outcomes, we construct a unique new data set on individual accounts in the Florida Retirement System defined contribution plan. We matched this data set, which contains information on individual contributions and holdings, to demographic and education data collected by the

Florida Department of Education for eligible participants. One of the primary concerns regarding non-DB pension designs is that these systems may create outcome distributions that produce disproportionately poor results for low education or low income workers. The FRS data (also used in Farrell & Bythewood 2011) is one of the first to match public pension data to these demographic variables, allowing us to quantify this problem for the first time.

We use these new data in conjunction with a number of more commonly used data sets. The Survey of Public Employee Retirement Systems, which contains data on membership, flows, and selected assets for public DB plans, is collected by the Census Bureau. The Public Plans Database maintained by the Center for Retirement Research at Boston College provides data from plan annual reports for large public DB plans and a handful of DC plans from 2001-on. Two data sets obtained from *Pensions & Investments*, a trade publication, contain data on plan allocation targets and component returns. Finally, we used the data set described in Shoag (2010), which contains data on long-run investment returns for state administered DB plans.

This work builds on an extensive and important literature analyzing investment behavior in public sector pensions. Brown, Pollet and Weisbenner (2009) and Hochberg and Rauh (2011) look at the prevalence of in-state bias heuristic for public DB plans. Goyal and Wahal (2008) analyze return chasing across managers within in these plans and Sunden and Munnell (1999) looks at politically motivated public pension management. A smaller set of literature looks at individual investment behavior in public DC plans. Agnew and Szykman (2005) and Chalmers and Reuter (2012) look at individual investor competence within two public university retirement systems, and Papke (2004), Clark and Pitts (1999), Clark, Ghent and McDermed (2006), and Brown and Weisbenner (2012) explore which public employees opt to participate in DC systems. This paper adds to this literature by analyzing new data on both public DB and non-DB systems and comparing investment outcomes across plan types.

2 Asset Allocation

The most important determinant of a plan's investment performance is its asset allocation (Brinson, Hood, and Beebower 1986). A large literature has focused on the ability of defined contribution plan participants in the private sector to manage these assets wisely (for example see Brown et al 2007, Tang et. al. (2010) and Choi et. al. 2001). In this section, we explore investment decisions within public sector defined contribution systems and compare it, not to an "ideal" investor, but rather to the allocations chosen by public DB plans. These comparisons are designed to shed light on the plausibility of claims that workers in non-DB plans will improperly diversify their holdings, fail to take appropriate risks, or be excluded from certain asset classes. These concerns are particularly acute for low-income, low-education workers as well as older workers who "have to modify their risk profile based upon age-specific characteristics" (Matson & Dobel 2006). This section also explores how well both DB and non-DB plans select portfolios that balance risky high-return assets with safe lower-return assets. It also explores how these diversification failures vary across individuals in the Florida system and which segments of the population are most at risk.

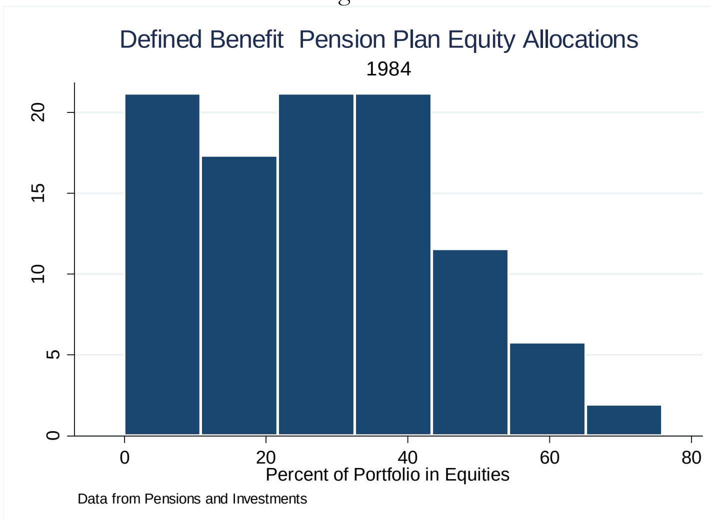
2.1 Evolution and State of Public DB Plan Assets

Before characterizing the current allocation of state and local DB plans, it is useful to reflect on the evolution of these systems. One of the starkest features of the data collected for this project is the diversification of public retirement assets due to the rising share of portfolios allocated towards equities and other variable return investment. In the earliest available year, 1947, non-governmental securities accounted for only 7% of the book value of state pension assets. This number grew rapidly and reached 27% by 1954. Despite this, Census reports indicate that these securities were mostly public utility bonds, industrial bonds, railroad equipment trust certificates, and mortgages, and that only a small portion was in stocks. In 1957, the first year for which specific data on corporate stocks is available, equities represented just 1.4% of the aggregate holdings measured by the Census. This figure rose steadily over time and hit 35.4% by 2001. In 2010, using the Census' alternate market value definition[2], domestic equities represent 34.8% of state and local government retirement system portfolios, with non-domestic securities accounting for an additional 16%.

This trend is apparent in other data sources as well. We collected market value data on allocations by plan from an annual survey conducted by *Pensions and Investments,* which first included asset class data in 1984. Unlike the Census data, this survey is limited to only the largest state-administered funds. The data indicate that in the early 1980s there was substantial heterogeneity across plans in their asset allocations. Figure 1 shows that in 1984 roughly 25% of the *Pensions and Investments* sample held less than 15% of their portfolios in equities, while at the same time 25% of the sample held more than 35% in equities. Plan risk exposure and potential returns varied widely, and a number of these major plans benefitted little from the significant stock market returns achieved in this period.

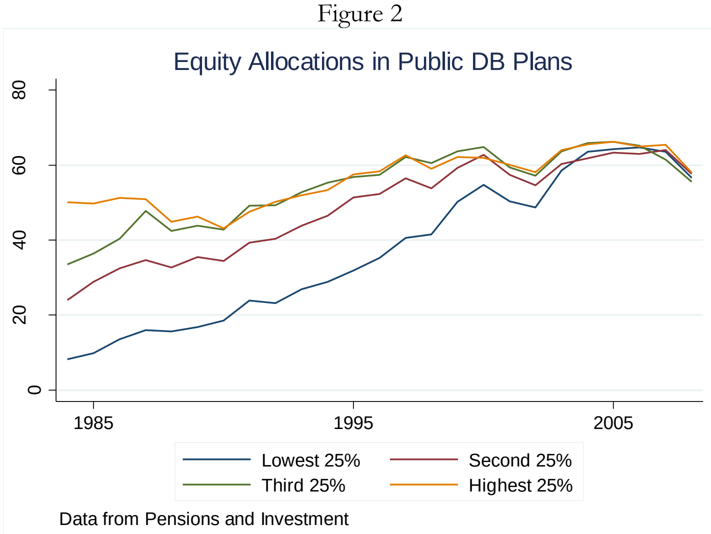
[2] Unfortunately the Survey of Public-Employee Retirement Systems did not collect market values for public pension corporate equities or bonds until 2002.

Figure 1



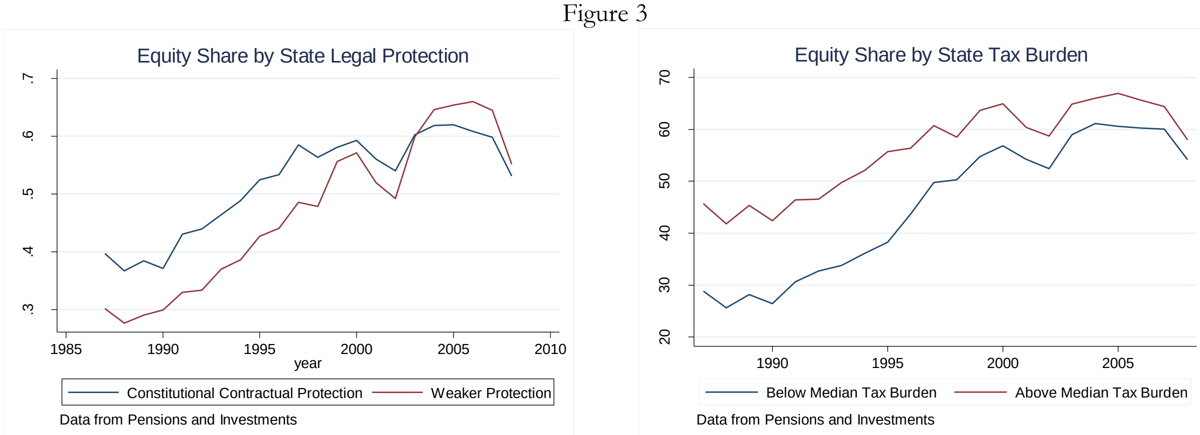
As demonstrated in Figure 2, much of the increase in public DB plan variable return holdings since the 1980s has been driven by plans with the lowest initial investment in this asset class. One reason for the switch is legislative. In the beginning of the sample, West Virginia, South Carolina, and Indiana had clauses in their state constitutions which prohibited investments in equities. These clauses were removed in Indiana and South Carolina in 1996 and in West Virginia in 1997. While plans in these states certainly contribute to the trend, the overall pattern of growing equity shares and convergence across plans holds even when these states are eliminated. This convergence is not complete amongst the smaller plans, as roughly 6% of the 2010 Census sample report holding only fixed income and short term assets. Still, as a result of this convergence, most of the major retirement systems now have relatively diversified portfolios.

Figure 2



It is worthwhile to consider whether the convergence of allocations amongst major plans was due to a change in the determinants of the optimal equity share for these plans. Brown and Wilcox (2009) note that different states offer different levels of legal protection for public sector pensions, and these differences may have implications for the optimal pension portfolio risk. Similarly, Peskin (2001) argues that the desired risky asset allocation should be made with reference to the asymmetry of outcomes for taxpayers. Figure 3 below displays the average equity share for plans in states with weak vs. strong constitutional protections for public pensions and initially low vs. high tax burdens.[3] As demonstrated in the figure, states with strong protections had higher initial shares, but there are no longer any significant differences along this dimension. Further, counter to the intuition regarding tax asymmetries, states with larger tax burdens hold –if anything—a greater share of their pension portfolios in risky assets.

Figure 3



A third possible determinant of the optimal risky asset share is the future wage risk borne by a plan. Lucas and Zeldes (2006) note that future benefit obligations (via wages) are correlated with long-run stock market performance, and hence equity investments can help states hedge future wage growth. The value of this hedging device is balanced by the decreased welfare costs of raising funds in good relative to bad states of the world.

Based on the arguments of Lucas and Zeldes, one might expect that the changes in public plan equity shares were related to changes in future wage growth risk for these plans. We test this hypothesis by regressing the share of a plan's portfolio invested in equities on the ratio of plan active to retired workers, using plan fixed effects to isolate changes

[3] Our measure of state legal protections comes from the National Conference on Public Employee Retirement Systems (http://www.ncpers.org/Files/News/03152007RetireBenefitProtections.pdf). Data on state and local tax burdens are from the Tax Foundations. States are split along the pooled median rate for the sample in this period (9.5%). We also fail to find any difference today when splitting on balance budget restrictions using the measure from the Advisory Commission on Intergovernmental Relation index used by Poterba (1994).

over time. As in the original Lucas and Zeldes analysis, we find that this intuition is not borne out in the data. The first two columns actually estimate that plans with more current retirees have *higher* equity shares, though these coefficients are economically and statistically insignificant. After adding plan specific trends, the estimation returns a negative coefficient, but it too is tiny (a one standard deviation increase in the fraction retired reduces the equity position by .8% of the portfolio) and insignificant.

Table 1: Determinants of Changing Equity Share

	(1) Equity Share	(2) Equity Share	(3) Equity Share
Retirees to Active Members	0.26	0.01	-0.05
	(0.16)	(0.01)	(.04)
Fixed Effects	Plan	Year Plan	Year, Plan Plan Trends
Observations	1,522	1,522	1,522

Data described in text. Standard Errors Clustered by Plan

In summary, while the major public DB plans initially had a wide distribution of risk profiles, this distribution has compressed over time. This trend does not appear to be driven by changes in the determinants of the optimal equity share. Rather, the driving force appears to be legislative and institutional changes precipitated by bouts of impressive equity returns in the 1980s and 90s and a widespread desire for more balanced portfolios.

Virtually all large public defined-benefit plans hold diversified portfolios that cover a range of asset classes today. In 2009, the latest year for which we have data from *Pensions and Investments* for the largest 100 DB funds, the average plan in our sample had roughly 50% of its assets in equities, 28% in fixed income, 3% in cash, and 22% in alternative and other investments. On average, roughly 2/3rds of the equity portion and fixed income portions are in domestic assets. Though there is, of course, variation in the total equity and fixed income components, the standard deviation of the equity and fixed income shares are only 10.5 pp and 8 pp respectively. While there are a few outliers (the South Carolina Retirement System reports 10% of its holdings in public equity, while the NM PERF reports 70%), these positions are mostly offset by correspondingly large and small shares in alternative investments like private equity and hedge funds. There is, therefore, far less variation across large plans in overall risk exposure and return potential.

2.2 Aggregate Asset Allocations in non-DB Public Plans

The existing data sources on aggregate outcomes for non-DB retirement plans in the public sector are sparse for all but the largest plans, presenting a major obstacle for researchers. We remedy this problem by introducing data from Standard and Poor's Money Market Directory of Funds, which contains data on more than 300 non-DB systems (see online appendix for a list). Though the majority of these systems are supplemental, they serve more than 8 million participants and oversee more than $500 billion in assets (these figures are 5 million participants and $225 billion when limiting to only state and local plans).

In Table 2, we report the average allocation by plan type and size. The data organizes plans by retirement system, and in Columns (5) and (6), we classify the largest plan in a retirement system as the 'primary' one. As is evident in the table, at a broad level of aggregation, the asset holding of these plans are similar across plan types.

Table 2: Average Asset Class Allocation by Plan Type in the Public Sector

	(1) Defined Benefit	(2) Non-DB Plans	(3) DB Plans Assets > $500 Million	(4) Large Non-DB Plans Assets >$500 Million	(5) Non-DB Primary Plans	(5) Non-DB Non-Primary Plans
Domestic Variable Return	.469	.603	.450	.500	.613	.600
Domestic Fixed Return	.424	.231	.304	.281	.263	.218
International Variable Return	.072	.068	.180	.090	.065	.069
International Fixed Return	.008	.012	.020	.016	.003	.015
Other	.026	.087	.045	.114	.055	.099
N	1,379	344	245	83	97	247

Data collected from MMD. See text for description.

Though these general allocations are similar, differences across plan types are evident at finer levels of aggregation. Only 18% of the non-DB systems in the data report holding any alternative investments (private equity, venture capital, hedge funds, commodities, or real estate) compared to 36% of the DB plans and 93% of the DB plans with more than $500 million in assets. These differences do not seem to be driven entirely by plan size and remain significant even after flexibly controlling for total plan portfolio size. This supports the argument that "defined benefit plans are able to invest in…areas that are generally not open to defined contribution participation" (Matson and Dobel 2006), though it should be noted that there are exceptions to this rule amongst the non-DB plans. [4]

Despite these differences, the average allocation in public non-DB plans is relatively unlikely to be concentrated in a single asset class; less than 1.2% of the non-DB plans in the MMD data set hold exclusively fixed income securities. This is actually a slightly lower fraction than amongst the DB plans, where 4.5% hold no variable return securities.

2.3 The Distribution of Individual Allocations in a Public DC Plan

Skeptics of the movement away from DB plans in the public sector argue that seemingly acceptable average allocations mask substantial individual heterogeneity, and that DC plans may generate particularly poor outcomes for certain types of workers. For example, a report by the National Institute on Retirement Security claims that "half of all DC plan participants had either no funds invested in stocks—which exposes them to very low investment returns-- or had almost all their assets allocated to stocks, making for a much more volatile portfolio." (Almeida and Fornia 2008)

To examine the investment behavior of participants at the individual level we use data from public employees in Florida who have elected to join the defined contribution plan within the Florida Retirement System[5] (FRS). The FRS, since 2002, has allowed employees to choose between a defined contribution and a defined benefit plan, with the defined benefit plan being the default option. Until recently, employers were required to make the full contribution to the plans, while employees contributing nothing. For DC participants the contribution amounts are determined as a percentage of their salary. Participants that elected the DC plan are allowed to choose between a set of available mutual funds covering the equity, foreign equity, bond, money market and TIPS asset classes, as well as 3 balanced funds of varying risk. Since the DC plan's inception in 2002 the number of funds available has ranged from 40 to 19, with 20 available as of 2009. Participants are defaulted into the Moderate Balanced fund which is designed to provide the level of risk appropriate to the "average" investor; however participants are free to reallocate both their existing balances and contributions.

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[4] For example, the Virginia Retirement System 457 plan offers the opportunity to invest in the VRS portfolio, which has substantial private equity and real estate components.

[5] Further details on this data can be found in Farrell and Bythewood (2011).

As of 2009 the DC plan has grown to nearly 100,000 active participants and $4B in assets. To enhance our ability to study investor behavior, the investment behavior was combined with demographic data from the Florida Department of Education, which includes approximately 40,000 of the 100,000 total participants. The added data allows us to have an improved understanding of the investment behavior by age, education, race, and job type.

Before proceeding, we first document a number of salient characteristics of plan participants. Table 3 summarizes the demographic characteristics of participants from 2008 through 2009. The participants are primarily female (74.6%) and white (73.3%) with an educational attainment of either a bachelors (38.4%) or masters degree (22.8%). They have an average age of 44.4, although the age ranges from 15 – 89.

There is significant heterogeneity within the plan across age and income levels. Panel B highlights the difference across age groups. The increasing proportion of male participants across age bins likely reflects the steeper drop in labor force participation among women relative to men.

Table 3: Summary Statistics

Panel A	**Mean**
Demographic Profile	
Age	44.6
Male	25.6%
Race	
White	73.3%
Black	14.6%
Hispanic	10.3%
Asian/Pacific Islander	1.6%
American Indian	0.2%
Education	
Associates Degree	0.1%
Bachelors Degree	38.1%
Masters Degree	22.8%
Specialist Degree	1.6%
Doctoral Degree	1.2%
No Degree Reported	36.2%

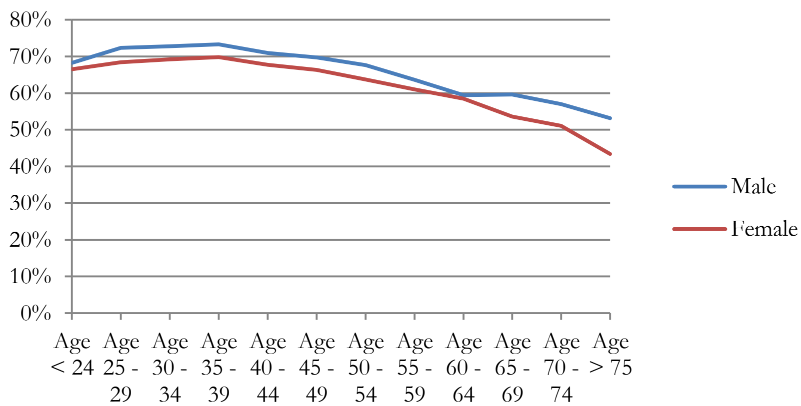
Panel B		
Age Range	Income	Male
Age < 25	$27,739	18.1%
Age 25 - 29	$34,606	18.2%
Age 30 - 34	$35,280	22.2%
Age 35 - 39	$34,461	22.7%
Age 40 - 44	$32,470	20.8%
Age 45 - 49	$31,536	23.0%
Age 50 - 54	$33,345	24.9%
Age 55 - 59	$35,949	30.0%
Age 60 - 64	$34,901	36.5%
Age 65 - 69	$27,461	42.6%
Age 70 - 74	$21,855	47.5%
Age > 74	$18,564	45.6%

It is also important to document how these demographic characteristics are correlated with average allocation outcomes. Figure 4 reports the age profile of the equity allocations by gender. This figure demonstrates two important correlations. The first is that like in many other contexts[6], women in the Florida DC plan hold a smaller share of their assets in risky assets. Second, the average equity share peaks between 30 and 39 years old for both male and female participants and

[6] See, for example, Bajtelsmit and Bernasek (1996), Hinz, McCarthy and Turner (1997), Barber and Odean (1999), Croson and Gneezy (2009) and Farrell (2011).

declines steadily as participants near retirement and begin to reduce risk. This is consistent with the optimal lifecycle behavior described in Gomes, Kotlikoff, and Viceira (2008). Though these differences are statistically significant and important to understand, they are relatively minor in magnitude. Equity allocations, though declining with age, remain substantial for even the oldest plan participants. This evidence ameliorates the common fear among critics that participants' "shift to a more conservative asset allocation as they age" will not lead them to excessively "sacrifice investment returns." (Almeida and Fornia, 2008)

Figure 4: Age Profile of Equity Allocations by Gender



There is surprisingly little heterogeneity in the distribution of equity shares across income and education. Table 4 shows the relative consistency of equity shares as income increases, with equity shares rising from 63% of the portfolios for those making under $25K, increasing to 69% in the $40K - $55K range before dropping to 65% for the highest income earners. A similarly non-monotonic and relatively stable relationship is evident for education as well.

Table 4: Equity Allocations by Education and Income

	Degree N/A	College Degree	Graduate Degree	Total
<$25,000	61.0%	66.7%	66.2%	62.6%
$25,000-$40,000	64.9%	67.9%	67.0%	67.1%
$40,000-$55,000	67.0%	69.0%	68.9%	68.8%
$55,000+	67.3%	67.0%	64.2%	65.4%
Total	62.4%	68.0%	67.1%	65.9%

Despite the relatively narrow distribution of equity shares across education and income there is still a possibility that a portion of the DC population will significantly under- or over-allocate to risky assets. To explore this, we tabulate the demographics of those potentially under allocated to equities (allocation <25%) and those potentially over allocated to this asset class (allocation >95%). On the under-allocation side, 8.3% of black female participants between 25 and 40 years old have an equity allocation below the 25% threshold; this is nearly double the 4.6% occurrence rate of all participants of the same age. On the over-allocation side, 24.1% of white male participants between the ages of 25 and 40 with incomes greater than $55,000 have an equity allocation higher than 95%; this is also nearly double the 12.8% occurrence rate found in all participants of the same age. These two groups account for a relatively small portion of the sample, with black females in the 25 – 40 age range accounting for 4.4% of the population and white males of the same age and incomes above $55,000 accounting for only 0.35% of the population in the Q3 2009. While these cases highlight the extremes, these tabulations show that asset allocation failures can occur, and that there are identifiable groups at risk.

Analysis

The data described above indicate that, on average, asset allocations in public retirement systems do not differ wildly across plan types. There has been substantial convergence in the fraction of these assets devoted to risky assets within defined benefit plans, and currently most DB systems hold well-diversified portfolios. To the extent that diversification remains a problem, it is most severe within the tail of very small funds surveyed by the Census of Public Employee Retirement Systems. The aggregate holdings of the non-DB systems surveyed in the MMD database show that, on average, the assets held in DC plans are also diversified across asset classes. The differences in the aggregates across plan types appear to be largely about the more frequent use of alternative investments in DB plans. As the number and size of DC plans grow, increasing the alternative offerings may help to even the diversification playing field for participants.

These aggregate similarities mask a wide range of allocations within a DC system. While some of there are differences in allocations along demographic lines like age, gender, and education, on average these differences are relatively minor. When focusing on the population with excessively safe portfolios we find that there are subsets of participants who are at significant risk of falling short of DB-level performance, likely lowering retirement income and/or extending their working years. On the other end of the spectrum, without proper diversification and the risk-sharing present in a DB plan, the population with excessively risky portfolios risks significant loss shortly before retirement as we saw in the recent market collapse. The cumulatively compounded returns of the over-allocating white men since 2003 was 12.72% as of Q3 2009 after peaking at over 117% in Q1 2007, while the under-allocating black females finished with a return of

21.95% after peaking at 33% in Q1 2008. Their returns are in contrast to the participants with allocations between 25% and 95% who finished with a return of 22.82% after peaking at 87.44%. Despite the substantial collapse, the diversified participants beat the under-allocating participants while retaining the potential upside and were less impacted than the over-allocating group, reducing their individual underfunding, or retirement, risk.

3 Investment Returns and Fees

In the previous section we analyzed asset allocations in both public DB and non-DB pensions. In this section we explore the outcome of these allocations and document how investment returns and management fees vary with plan design in the public sector.

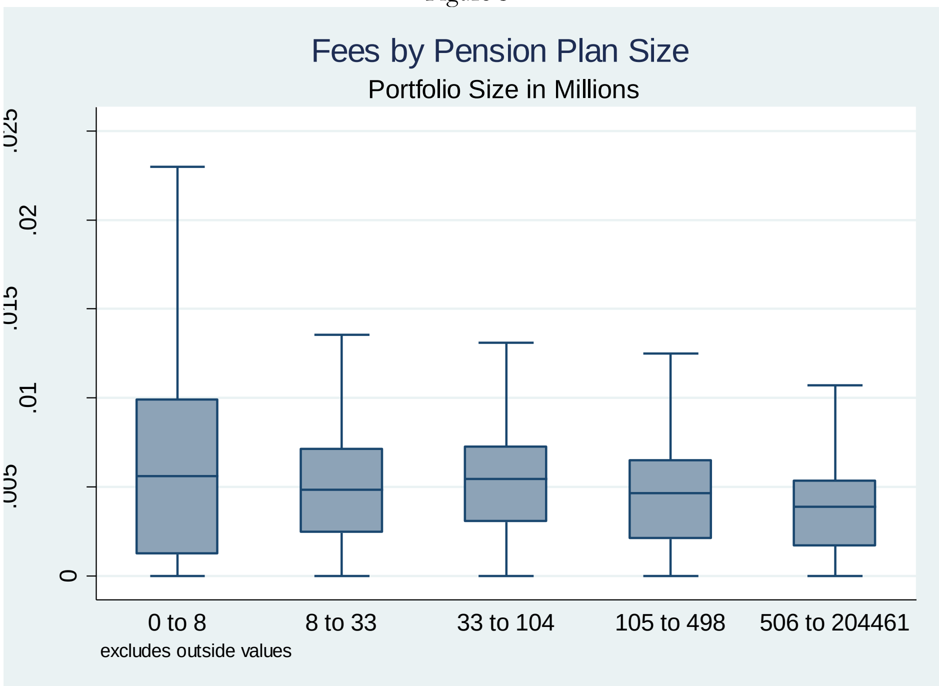
3.1 Fees

Another prominent concern with the public sector's movement away from defined benefit plans is that non-DB plans require larger administrative expenses. For example, a recent NASRA report claims that "in almost every instance, DC plans cost more—usually much more—than DB plans." (2005) This intuition, based on the fact that non-DB plans generally require the costly tracking of individual accounts, may not be true in practice due to differences in asset allocations chosen in different plan types. Additionally, a straight comparison of fees in existing public DB and non-DB plans is difficult as fees often depend on the size of pension plan. In this section, we explore the realized distribution of administrative expenses across plan design using a number of data sources and attempt to control for the issues discussed above. This analysis builds on the work of Mitchell and Bateman (2003), James, Smalhout, and Vittas (2001), and others by comparing costs across plan designs within the US public sector. We find that, after controlling for plan size and asset allocation, plan design appears to have no appreciable effect on aggregate investment and administrative expenses. We then use the individual account data from the Florida Retirement System to explore how individual control affects the distribution of fees paid across individuals. We find that, while outcomes do differ across investors, Florida's plan design prevents any investor from paying fees that greatly exceed the distribution of outcomes in the DB sector. Moreover, unlike in the DB system where the smallest plans face the highest fees, high fees in the DC system are more likely to fall on the wealthiest investors.

3.1.1 Average Fees in State and Local DB and non-DB Plans

The Annual Survey of Public-Employee Retirements Systems reports data on the administrative expenses of 1,216 defined benefit plans in 2010. These fees include investment management fees, in addition to the salaries of system employees, building rentals, and the like. The data show that the median defined benefit plan in the sample paid fees equal to 0.5% of its total asset holdings in 2010, a sum that closely mirrors the median in previous years. The distribution of these fees depends heavily on the size of the fund. As is demonstrated in the Figure 5 below, larger plans pay smaller fees as a percent of their portfolio and the distribution of fees is compressed. Specifically, less than 2% of the plans with over $5 billion in assets paid more than 1% in total administrative expenses. Roughly 25% of the plans with under $ 8 million in assets paid this amount. As with diversification failures, there is a prominent tail of administrative and investment fees amongst these small (and potentially unsophisticated) plans.

Figure 5



Across the major plans in the *Pensions and Investments* sample, the average internally managed portfolio accounts for 32% of plan assets. This average masks a large degree of heterogeneity. Major plans like the Oregon Public Employees and the Public Employees Retirement System of Mississippi manage less than 1% of their portfolios internally. The retirement systems in Georgia and Alabama, on the other hand, internally manage their entire portfolios. There is a similar divergence across plans in the share of assets that are passively managed. Many large systems, such as the Illinois State Teachers' Retirement and the Hawaii Employees' Retirement System report almost no passively managed asset, others such as New York State Plans and the Colorado Public Employees Retirement Association have large indexed holdings. Both of these measures are associated with lower fees: a 1 standard deviation increase in the fraction managed internally reduces fees by roughly a .5 standard deviation and a 1 standard deviation increase in the fraction passively managed reduces fees by roughly 1/3 of a standard deviation.

The distribution of expenses in the Boston College Public Plans Data for large DB plans unsurprisingly resembles the expenses of the largest DB plans in the Census data. The median plan in the Public Funds sample paid fees equal to 0.3% of its portfolio in this period. The mean was slightly higher (0.5%), with a rightward tail that truncates slightly above 2.5%. Once again, the fee distribution appears relatively stable over time in this data set.

The Boston College Public Plans Data set also contains data on the administrative expenses for a small number of state-administered defined contribution funds. We supplement this set with data on the expenses of the available state-administered deferred compensation funds (401K, 403(b) and 457) from a number of states, including California, Michigan, Colorado, New Jersey, Texas, and Pennsylvania. The median administrative expenses amongst these larger plans in 2009 also equaled 0.4% of total assets. As in the defined benefit case, we encountered very large expense ratios for the handful of small deferred compensation funds for which we were able to obtain data. Statistical significance is hard to evaluate in such a small sample, but conventional tests fail to reject any difference in the distributions of fees and the distribution in the Census sample.

Finally, we compare system-wide investment manager fees by plan type in the MMD data. This data is organized on the plan-management firm level and reports fees as a percent of a mandate. While this data is not complete, it has the great advantage of allowing for flexible controls for asset class and mandate size. Table 5 demonstrates that these controls are important. DB plans are more likely to utilize high-fee asset classes creating a spurious positive relationship. When controlling for asset classes or restrict to common management firms, we find no relationship between plan design and fees. Thus, the available data suggest that there are little differences between the average fee outcomes between public DB and non-DB plans.

Table 5: Fees by Mandate

VARIABLES	(1) Fees (Percent of Mandate)	(2) Fees (Percent of Mandate)	(3) Fees (Percent of Mandate)	(4) Fees (Percent of Mandate)	(5) Fees (Percent of Mandate)	(6) Fees (Percent of Mandate)
Defined Benefit	0.012**	0.012**	0.0002	0.0004	0.001	-.001
	(.005)	(.005)	(.005)	(.002)	(.002)	(.002)
Mandate Size (Billions)		-0.125***	-0.031		-0.773***	-0.267
		(.047)	(.043)		(.168)	(.190)
Controls	-	-	Asset Class Dummies			Asset Class Dummies
Sample	All	All	All	Common Managers	Common Managers	Common Managers
Observations	13,720	13,720	13,612	1,585	1,585	1,563

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.1.2 Individual Fees in a Public DC Plan

As with asset allocations, the fears regarding fees in DC plans are not just about the average outcomes but about the distribution as well. We again address this issue by looking at data from the Florida Retirement System's DC plan, from 2010 through the first quarter of 2012[7], and examine the distribution of fees across individual investors. Because of the size of the Florida Retirement system and the level of fees for their DB plan, they are able to provide relatively low fee mutual funds to their individual participants. The fees for the first quarter of 2012 ranged from a low of 0.02% annually to a high of 0.92% annually, with passively managed stock and bond funds, as well as the balanced funds, in the sub-0.10% range and the actively managed funds in the plus-0.50% range. We can look at the distribution of fees across participants based on their allocations to the individual funds in each quarter. The active participants are not assessed any other fee, while non-active participants currently pay a small account maintenance fee.

Across all participants and periods, the average fee is 0.142%, although this has been dropping over time from a peak in Q2 2010 of 0.149% to a low in Q1 2012 of 0.135%. While these fees may be low, there remains significant heterogeneity among the participants. Male participants pay an average of 0.164% while female participants pay an average of 0.129%,

[7] This data set is similar to the 2002 – 2009 Florida DC data set, except that rather than having contribution allocations we have fund balances at the quarter end date. It was also matched against the 2009 – 2010 Florida Department of Education demographics data by date of birth, date of hire, gender and agency resulting in a match of approximately 65% of the participants.

this difference reflects the tendency of female participants to remain in the default investment which carries a fee of 0.04% while male participants tend to more heavily use actively managed funds, which carry higher fees.

Looking at fee distribution by portfolio value, we see that participants with portfolios greater than $100K are more likely to use the high fee funds and have a wider distribution of fees. At the median they pay 0.26% while the other participants pay 0.05%, they also have higher fees at both the 25th and 75th quartiles. Their choice of high-fee funds is also reflected in their returns over this period. The participants in the 75th percentiles of the $50K - $100K and $100K+ categories also had net returns that were higher than the participants in the lower categories. The returns were also higher at the median, although this difference is less pronounced.

In Table 6, we regress fees on portfolio values and find that fees increase significantly with increases in wealth. However, wealth is not the only factor in determining fees at the individual level. Column 2 of Table 6 uses gender, race, age, education and experience as controls. This regression shows that the effect due to wealth is less substantial, however it is still significant. As wealth increases, the increase in fees paid is substantial and significant, with the portfolio value of $100K+ category paying 0.103 pp higher fees. Also significant is the male effect, with a 0.015 pp increase relative to female participants.

Table 6: Wealth Effects on Fees

	Fees (%) (1)	Fees (%) (2)
Male	-	0.015***
	-	(.001)
$5 - $10K	-0.005***	-0.011***
	(.002)	(.002)
$10 - $20K	0.015***	0.0002
	(.002)	(.002)
$20 - $50K	0.04***	0.016***
	(.002)	(.002)
$50 - $100K	0.131***	0.088***
	(.002)	(.002)
$100K+	0.184***	0.103***
	(.002)	(0.003)
Controls	None	Age, Race, Education, Experience
Observations	213,618	213,618

These results reflect the fact that less wealthy participants may shy away from active management, in this case remaining with a low fee default investment, while more wealthy participants may seek the higher returns found in actively managed funds. This is in contrast to DB plans where size translates into economies of scale and the smallest portfolios paid the largest fees in percentage terms. This counter-intuitive result suggests that – to the extent that heterogeneity in a DC framework creates a distribution of outcomes – the tail end of the fee distribution contains the wealthiest and most sophisticated investors.

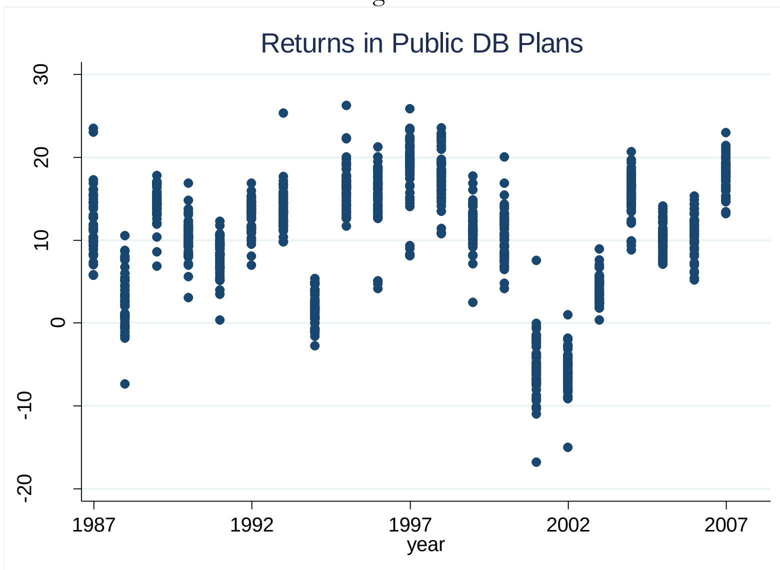
3.2 Investment Returns in DB and non-DB Systems

There is considerable debate as to whether returns are higher in public DB or non-DB plans, and as to whether either type of public plan outperforms the market. Coronado, Engen, and Knight (2003), Hsin and Mitchell (1997), and Dyck and Pomorski (2011) all find that public DB plans underperform relative to private sector plans. Others, such as Munnell and Sunden (2001) conclude that public DB plans perform as well as private ones, and DB plan defenders note that plan returns have exceeded the average assumed rates over extended periods of time. While there is little aggregate data on state DC investment outcomes, a number of studies (Towers Watson 2009, Tapia 2009, and others) have found that private DC plans earn lower returns than DB systems. Critics of the movement away from DB systems in the public sector note that this underperformance could occur within public non-DB plans as well. In this section, we use the available data on investment returns for state and local plans to address these issues.

Unfortunately, long-run data on the investment returns earned by public plans are scarce. The Public Pension Database maintained by the Boston College Center for Retirement is an invaluable resource for major plan performance, and contains data extracted from plan reports going back to 2001. We were able to obtain additional data for the 2005-2010 period, including policy benchmark returns and fund performance within asset classes, from *Pensions and Investments Public 100* database. For data before 2001, we turn to the state-administered return data set used in Shoag (2010). This data was collected from open records request and plan financial reports from the Library of Congress and at various state libraries. The data were validated, where possible, using data from the biennial Public Funds Surveys and the NEA Characteristics of Large Public Employee Pension Plans.

In Figure 6, we plot the distribution of returns for plans with fiscal years ending in June. There is clearly substantial heterogeneity in returns across time, but there is also substantial variation within years. Though the trend cannot be precisely estimated, the data suggest only a modest decline in the standard deviation of returns, despite the fact that asset class allocations are strongly converging.

Figure 6



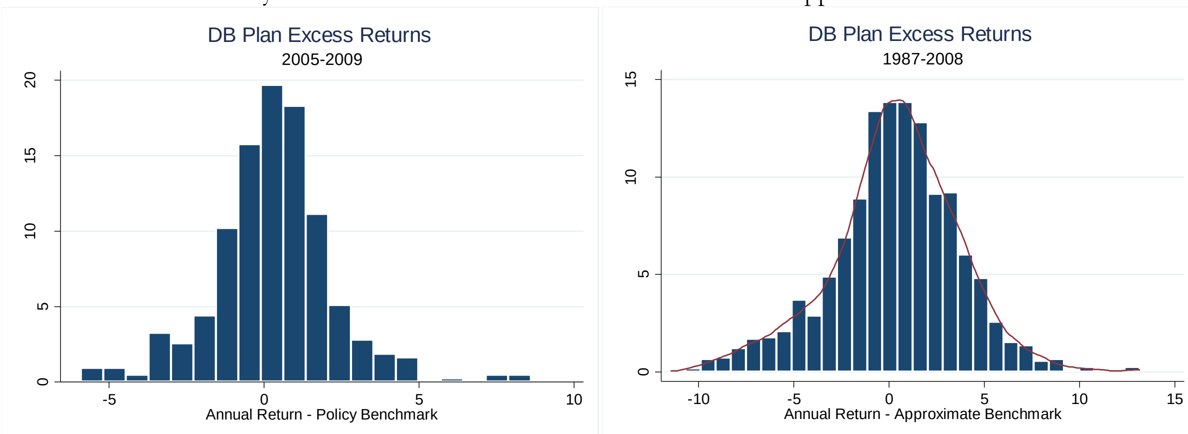
In Figure 7, we plot the distribution of deviations from the policy index reported by *Pensions and Investments* and the deviations from synthetic benchmarks for the longer sample used in Shoag (2010). The mean value of the *Pensions and Investments* deviations is .32 and .34 in the longer sample. The median in the *P&I* sample is 0.3 and .43 in the longer sample. While modest, these non-zero means are statistically significant, suggesting, if anything, that public pension plans may achieve some alpha before adjusting for fees. We also do not see evidence of underperformance over longer horizons. This slight over performance on average is robust at the 10 year interval as well. Though the average is positive, the standard deviation of these deviations is 1.94, which means that desired returns do vary considerably around their own benchmark.

While there is little evidence of underperformance, we also do not see evidence that a systems' ability to outperform its benchmark is persistent. Using the extended sample, we regress plan excess returns on the lagged value of excess returns, after controlling for fiscal year fixed effects. We find a coefficient of only .03, and this estimate is not significantly different than zero.

Figure 7: Excess Returns in State-Administered DB Plans

Panel A: *Pensions and Investments*
Relative to Policy Benchmark

Panel B: *Extended Data from CAFRs*
Relative to Approximate Benchmarks



At the individual level, using the FRS data, we find substantial heterogeneity of returns. Figure 8 shows the distribution of returns between Q4 2002 and Q3 2009 for the participants. From 2002 – 2009 the mean return was -0.33% with a standard deviation of 7.6% and a median of 1.83%, reflecting a fat left tail that was expected given the market crash of 2008 and 2009. From 2002 to Q3 2007, there was a mean of 2.85% with a standard deviation of 3.23% and a median of 2.84%. There is a wide distribution in participant returns within each year as well as across years. When comparing this to the latter portion of historical DB returns, it is worth noting that even during strong market years (2003 – 2007), many participants had returns of 0% or lower in contrast to the DB plans, all of whom managed non-negative returns over that time frame. This brings to light one of the risks involved with pushing participants away from DB plans and towards DC plans. In the periods when the DB plans had positive returns (2003 – 2007), 25% of participants still had a zero or negative return for the quarter, the likelihood of which increases for male (2.3 pp) and higher educated (5.2 pp) participants and decreased with age.

When comparing the distribution of the DB plans' and DC individuals' annual returns in the FRS over the same time frame we can see that DB plans tend to slightly outperform at the median and have a narrower dispersion of results. This can be seen for most years in Figure 9. The mean of the DB distribution is 1.6 percentage points above the mean of the FRS DC distribution, though this difference is larger in years when the market does well (0.8 pp and marginally significant in years where the average return was negative relative to nearly 2 pp and highly significant otherwise). This may reflect the fact, documented in previous sections, that DB plans are more likely to hold high-beta assets like private equity and venture capital.

Figure 8: Distribution of Individual Returns by Quarter

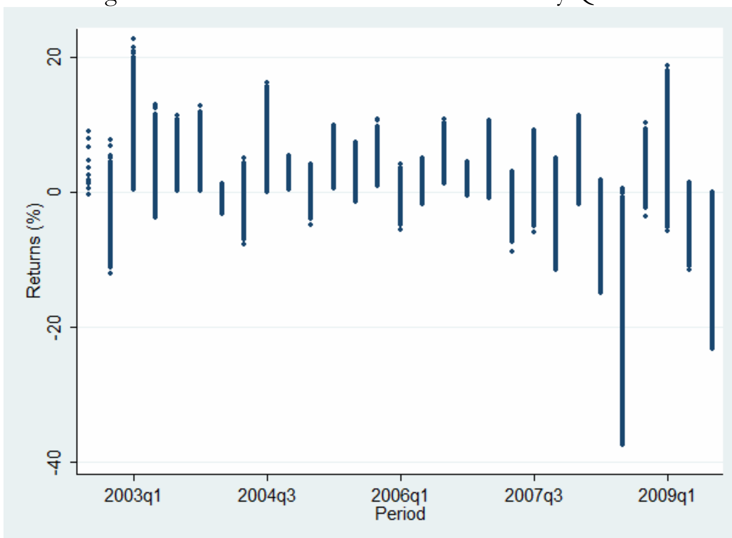
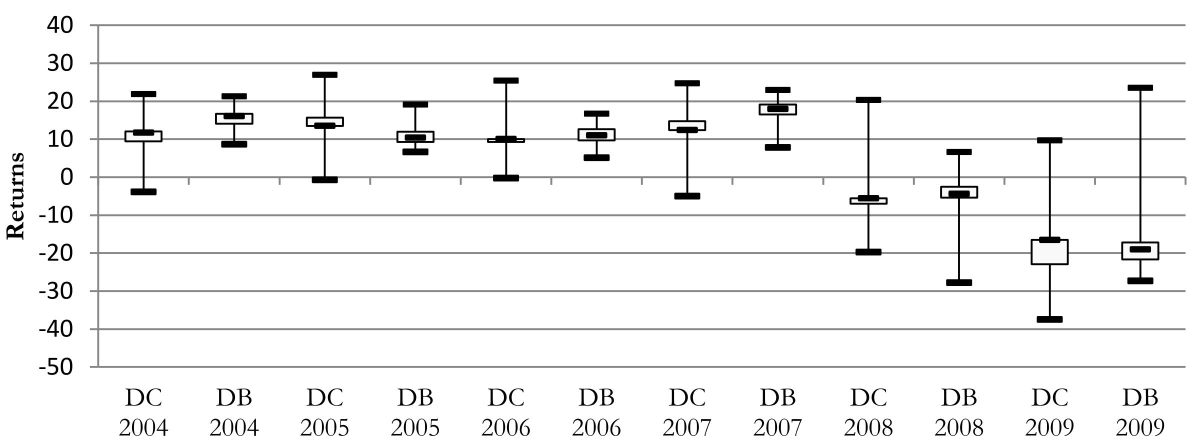
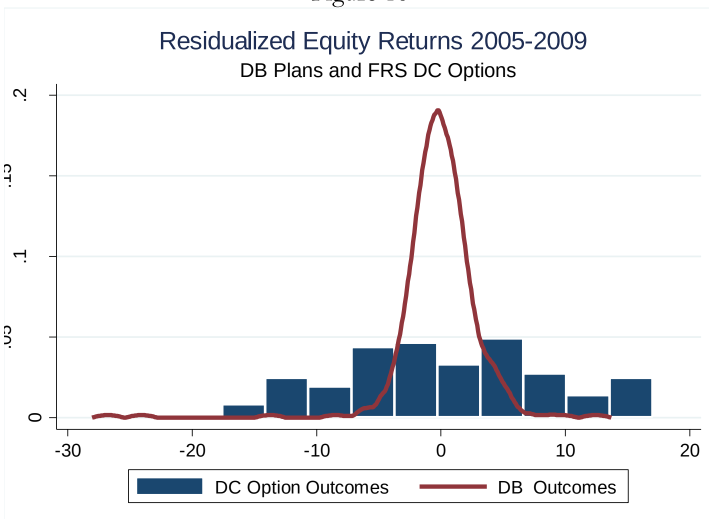


Figure 9: Distributions of DB plan and the FRS DC Plan Returns



To further explore the possibility underperformance stems from, we compare the within asset class performance. Figure 10 plots the distribution of equity returns for DB funds and the returns on the 25 equity investment options in the FRS system. A common set of year fixed effects has been removed from the two distributions, and the sample is for June FY plans and returns. As is evident in the figure, the DC distribution is more variable. Nevertheless, there is no statistically significant difference in the mean, and if anything, the DC options performed slightly better. Again, this suggests that average differences in investment outcomes are mostly due to differences in asset classes like alternatives.

Figure 10



Analysis

The data described above indicate that, on average, fees are quite small for both large DB and non-DB public plans. Fees are most likely to be a problem for very small DB plans and for DB plans investing heavily in alternative assets. When comparing within asset class fees, there appears to be no difference across plan types. Interestingly, and counter to the fears of many, it is the wealthiest investors that pay the highest fees within a DC system. Wealthy investors are more likely to sort into expensive and aggressive funds, as opposed to poorer investors who are more likely to sort into inexpensive and low-risk funds.

On the return side, unlike many previous studies, we find no evidence that public DB plans underperform the market. The average DB plan slightly outperforms its benchmark, though this outperformance is not persistent. Like many previous studies in the private sector, we find that the distribution of DB returns has a higher mean and is compressed relative to FRS distribution of individual returns. This effect is strongest in up-years and is not evident in within asset class comparisons. These facts suggest that differential allocations to alternative investments by DB plans may explain this difference.

4 Rebalancing, Return Chasing, and Peer Effects

In the previous sections we've compared the asset allocations and returns of public DB and DC plans. While these comparisons are important, differences along these dimensions cannot be used to make welfare judgments about the effectiveness of investment behavior across plan designs. The objective function in DB and DC systems are different, and facts like the greater use of alternatives in DB plans could be interpreted not as institutional failures, but as reflections of these objectives.

In this section, therefore, we focus on three behaviors, rebalancing, return chasing, and peer effects, where the welfare implications are more straightforward. Under weak assumptions about the efficiency of markets and the stability of preferences, better investors should rebalance more often and be less likely to have their allocations influenced by peers or past returns under any plan design. By comparing the incidence of these behaviors across plan design, we can make stronger claims about the relative performance of these types of systems.

4.1 Rebalancing and Return Chasing in DB Plans

We explore rebalancing and return chasing in DB plans using two data sources. The first source is the CUSIP level equity holdings reported 13F filings of public pension plans, similar to the data used in Brown, Pollet, and Weisbenner (2009). Institutional investment managers supervising more than $100 million in 13F securities (mostly domestic equity) must report their quarterly holdings to the SEC. The applicability of this law to public pension plans is unclear. Nevertheless, 24 state-administered DB retirement systems did file 13F forms during at least one quarter between 1980 and 2010. These filings allow us to construct quarterly CUSIP level data on the internally managed equity portfolios of these plans. We show that that states do not fully rebalance their stock holdings in this segment of their portfolios, and even portfolio aggregates like beta and industry composition are allowed to drift over short to medium horizons.

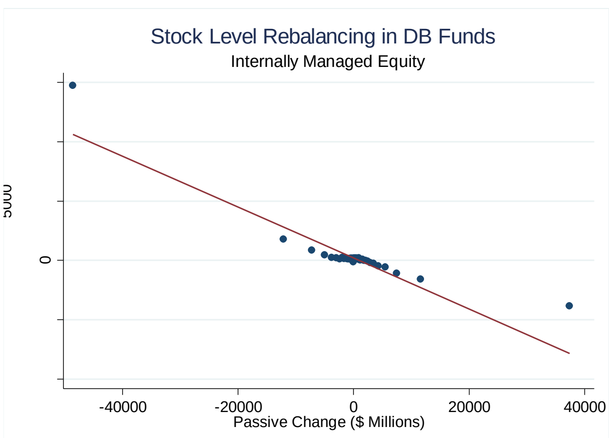
To measure rebalancing, we decompose total portfolio changes into active and passive changes as in Calvet, Campbell and Sodini (2009). The passive changes reflect the change in equity share that would have occurred based solely on market movements and the active change is the change due to active rebalancing. In a full rebalancing regime, active changes would offset passive changes one for one.

Figure 11 shows the change in holdings versus the passive change in holdings (i.e. the change that would have taken place if the plan did not adjust the number of shares it owned) at the plan-stock-quarter level. The figure bins the 1.8 million observations into one hundred quantiles, and panels A and B documents this relationship in dollars and portfolio shares respectively. These results are only calculated over stocks which appear for at least two adjacent quarters.

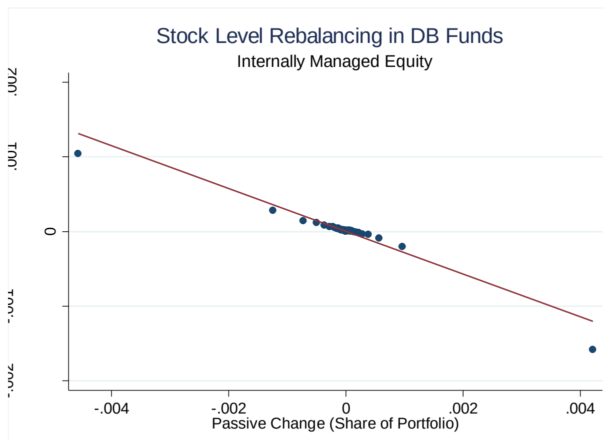
As the graph shows, changes in the allocation to a single stock caused by price movements are partially offset at the quarterly frequency. Rebalancing seems far stronger in response to extreme passive changes, a feature that may be driven by measurement error (i.e. unobserved stock splits, unaccountable swings in reported portfolio sizes).

Figure 11: Actual Change vs. Price Induced Change

Panel A:



Panel B:



To get a better handle on this issue, in Table 7, we regress the active portfolio change on the passive change and the passive change interacted with a dummy registering a passive change in the 90th percentile in the absolute value distribution. The regression shows that rebalancing occurs, is modest for moderate changes, and is significantly more responsive to extreme movements.

Table 7: Active Response to Price Movements

	(1) Active Change (Dollars)	(3) Active Change (Percent of Portfolio)
Passive Change	-.05***	-0.16***
	(.01)	(.01)
Passive Change * Large Change Dummy	-0.52**	-0.74***
	(.21)	(.13)
R-squared	.16	.80
Observations	1,822,156	1,822,156

Data collected from 13F filings. Dummy registers change greater in absolute value than the 90th percentile of the absolute value distribution. See text for description. Robust standard errors in parentheses

While these results suggest that public pension plans quickly rebalance only extreme movements at the stock level, it is possible that these changes are undone through composition of stocks. That possibility does not appear to be true in the data, however. In Table 8, we report the relationship between passive (price movement induced) changes in portfolio betas and the actual change in portfolio betas reported over the quarter, biannual and four year horizon. Stock level betas are taken from the CRSP data set, and the portfolio betas are calculated through a weighted average of the individual stocks for which an estimate was available. Passive changes are calculated only for stocks present at the initial and final time period.

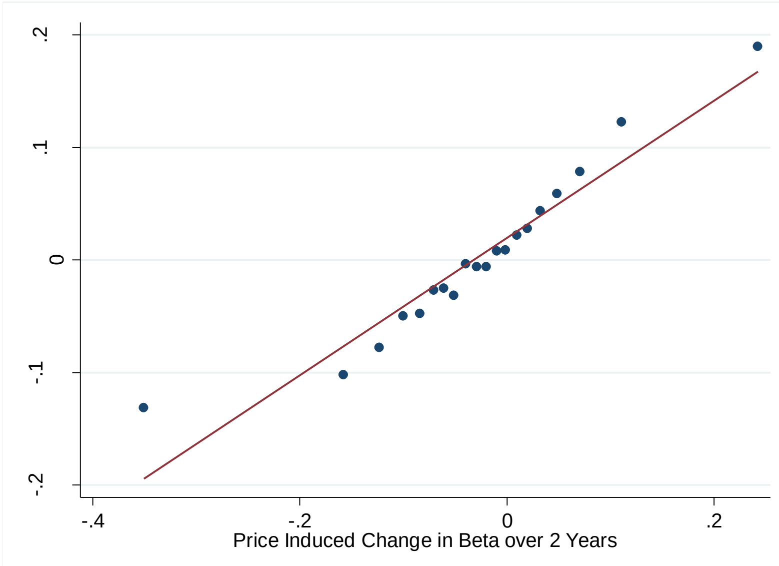
The table shows that at all frequencies, changes in the actual beta of these portfolios are highly linked to the changes that would have taken place absent any rebalancing. Estimates of the persistence decline over time, but remain over 46% at the two- year horizon. The two-year relationship between the active is also presented in Figure 12, which plots the realized change against the passive change. These results suggest that plans do not actively target a specific beta in the short to medium run.

Table 8: Change in Beta due to Price Movements

	(1) $\Delta\beta$	(3) $\Delta\beta$	(4) $\Delta\beta$
Price induced $\Delta\beta$	0.87***	0.46***	0.09**
	(.03)	(.06)	(.04)
Horizon	Quarterly	Two Years	Four Years
Observations	1,961	1,773	1,564
R-squared	0.66	0.33	0.01

Data collected from 13F filings and CRSP. See text for description. Robust standard errors in parentheses

Figure 12: Two Year Change in Beta vs. Two Year Change from Price Movements



In addition to calculating rebalancing at the stock level and for the portfolio beta, we also test for rebalancing behavior at the level of industry composition. Once again using the CRSP data set, we match the 13F filings data to two-digit SIC industry identifiers. We then calculate the change in the share of the state portfolios invested in each industry and the change in that share that would have occurred from price movements alone. We find that, once again, the passive change is highly predictive. Table 9 demonstrates the results at the quarterly frequency for a number of industries.

Table 9: Quarterly Industry Share Rebalancing

	(1) Change in Share	(2) Change in Share	(3) Change in Share	(4) Change in Share	(5) Change in Share
Passive Change in Share	0.50*** (.01)	0.59*** (.03)	0.49*** (.02)	0.62*** (.03)	0.55*** (.03)
Industry	Pooled	FIRE	Real Estate	Manuf.	Retail
Observations	32,669	1,743	1,343	1,651	1,609
R-squared	0.16	0.14	0.33	0.17	0.18

Data collected from SEC filings and CRSP. See text for description.

Given the moderate levels of rebalancing within the internally managed equity component of state pension portfolios, it is worth investigating how quickly funds are rebalanced across asset classes. Using data from *Pensions and Investment*, we explore how persistent are deviations from asset class targets. These data report both the actual percentage of a plan's investment in a given asset class as well as the target percentage set by the system's board.[8].

To quantify persistence, in columns (1), (4) and (7) of Table 10, we regress the gap between the actual and target allocations on the gap in the previous year. We find that the gap is persistent in every category, with estimates ranging between 84% for private equity and 35% for fixed income.

There are two ways in which a plan can close the gap between its actual investment share and its target, it can adjust its investments or alter the target. Columns (2) , (5), (8) regress the change in the actual share allocated towards equity, fixed income and private equity on the lagged gap. The coefficients can be interpreted as the percentage change invested in the asset class given a 1 percentage point allocation over the target in the previous year. The estimates imply that if the fund held 1 pp more of its assets in equities than its desired target, it would reduce its equity holdings as a percentage of its portfolio by .3 pp of the following year. This indicates a modest amount of rebalancing, consistent with what was demonstrated in the previous section.

Columns (3), (6) and (9) present the results for the change in the target. The estimates indicate that when 1 pp more of the portfolio is over allocated towards equities, the equity target is adjusted upwards by .08 pp of the portfolio the following year. The corresponding estimate for fixed income is .27 pp and .11 pp for private equity. Thus, a non-trivial fraction of the closing of the gap in these categories stems from adjusting the target and not rebalancing.

Table 10: Deviations from Allocation Targets

	Equity			Fixed Income			Private Equity		
	(1) Gap from Target	(2) Change in Allocation	(3) Change in Target	(4) Gap from Target	(5) Change in Allocation	(6) Change in Target	(7) Gap from Target	(8) Change in Allocation	(9) Change in Target
Lagged Gap from Target	0.62*** (.07)	-0.30*** (.07)	0.08* (.04)	0.35*** (.07)	-0.37*** (.08)	0.27*** (.08)	0.84*** (.07)	-.05 (.05)	0.11** (.05)
Obs	333	339	334	328	335	.329	228	231	230

Data from *Pensions & Investments*. Standard errors clustered by plan.

[8] The mean of (Equity Share $_{Actual}$ – Equity Share $_{Target}$) is 1.06%, with a standard deviation of 5.4%. The equivalent numbers for fixed income are 0.7% and 4.3%, and for private equity are -1.36% and 2.86%.

This target shifting suggests that plans may be chasing returns. Prior returns are one of the central evaluation criteria for most public DB plans in the hiring and firing of asset managers, but it is unclear if this phenomenon holds true at the asset allocation level. We are able to use the information on target allocations and within asset class returns to explore the possibility that DB plans 'chase returns' by shifting towards asset classes that have earned high returns. While this data is available for only a short period of time, it does feature a period of high (2005-2007) and low (2008-2009) market returns, a rich division of asset classes (16 in total), and meaningful cross-sectional dispersion across plans. Table 11 shows that there does appear to be a relationship between returns and asset class targets, but the estimated coefficient is very small (a 1% increase in returns is associated with a .03 pp increase in the allocation target) implying only marginal return chasing across asset classes in this period.

Table 11: Return Chasing in DB Plans

	Change in Allocation Target (% of portfolio)
Component Return	0.03***
	(.01)
Controls	Asset Class-Year
Observations	1,464
R-squared	0.18

Data from *Pensions & Investments*. Standard errors clustered by plan.

4.2 Rebalancing and Return Chasing in a DC Plan

One of the concerns espoused by critics of the push towards defined contribution plans is that participants lack the ability and/or desire to rebalance their portfolios to maximize risk adjusted returns. Prior research has shown that investor behavior can vary considerably across contexts, with discount brokerages showing frequent trading (Odean, 1999) while 401k type accounts tend to show very infrequent rebalancing (Agnew, Balduzzi & Sunden, 2003) and the tendency to stay with a default investment (Choi, Laibson, Madrian & Metrick, 2002; Madrian & Shea, 2001). To examine rebalancing at individual level we use the matched subset of 2010 – 2012 Florida participants, which includes fund balances as well as elections.

The table below provides summary statistics for the active and passive changes to equity allocations for the participants. The mean values are close to zero in this period, with -0.07% for active change and 0.03% for passive change. The vast majority (96.8%) of participant-quarters do not feature an active change greater than 0.5% of the portfolio in absolute value, suggesting that there is very little rebalancing in this plan from quarter to quarter. There appears to be a high level of inertia from the participants intra-quarter.

Table 12: Summary of Active and Passive Changes

	Active Change	Passive Change	Total Change
Mean	-0.07%	0.03%	-0.04%
Std. Dev.	5.75%	0.80%	5.81%
Min	-100.00%	-7.44%	-100.00%
Max	100.00%	4.70%	100.00%
Observations	186,506	186,506	186,506

From 2010 to Q1 2012, of the 20911 participants in the full sample period, 13% had an aggregate active change greater than 0.5% in absolute value. The table below compares the characteristics of these active participants and non-active participants. In terms of age, race and education, these groups are fairly similar; with the only substantial difference being the proportion of participants with advanced degrees at 31.6% to 27.2%. However we see large differences in income, portfolio value and gender ratios. The active participants have a higher income ($39,256 to $34,082), larger portfolio balances ($47,587 to $31,255) and a larger proportion of them are male (32.7% to 22.7%). These income and portfolio balance differences occur despite nearly identical average employment tenures across groups. The active participants have earned a slightly better return over the sample period, have a slightly lower equity share, and have a much smaller average allocation to the moderate balanced fund (default investment).

To further examine what impacts active rebalancing, Table 14 reports the results from regressing the active change on the passive change and the initial equity share. In the first specification, passive change has a positive effect on active change, suggesting that active movements may *amplify* market-driven changes. Initial equity share has a negative effect, suggesting that participants tend to revert towards the mean. The second specification added the average equity returns to control for potential return chasing, which we explore in depth below. While equity returns have a significant positive impact on the active change, the addition does not significantly change the size or sign of the passive change or initial equity share. Both of these specifications suggest that the quarter to quarter impacts of market movements on rebalancing are small.

Table 13: Comparison of Active Participants and Non- Active Participants

	Active Participants	Non-Active Participants
College Degree	39.6%	40.0%
Advanced Degree	31.6%	27.2%
White	74.5%	75.7%
Black	14.0%	13.2%
Hispanic	9.6%	9.4%
Income	$39,256	$34,082
Portfolio Value	$47,587	$31,255
Male	32.7%	22.7%
Age	46.2	45.4
Tenure	6.2	6.2
Average Quarterly Return	6.4%	5.5%
Equity Share	61.6%	65.9%
Average MBF Share (Default)	14.8%	54.2%

The third specification looks at the changes over the whole period, focusing on the participants that have remained in the plan for the 2.25 year span. This regresses the total active change over the time period on the total passive change and the equity share in the first period. This method significantly increases the magnitude and reverses the sign on the passive change impact (0.0324 pp to -0.4305 pp), suggesting that, while market drift dominates quarter to quarter, over a longer period of time participants are rebalancing to adjust for the movements. In the final specification, we added an interaction term for the low income[9] participants to the total change regression to test for differences in rebalancing behavior across income groups. There is a significant difference in rebalancing behavior for low income and non-low income participants, even with controls for portfolio value. The low income participants have a passive impact of 0.8110 pp while the non-low income participants have a -0.7045 pp passive impact given a passive change of 1%.

[9] Low income was defined as participants below the 25th percentile of income, in this case $20,880 per year.

Table 14: Rebalancing - Effects on Active Change

	Quarterly Active Change(1)	Quarterly Active Change(2)	Total Active Change(3)	Total Active Change(4)
Passive Change (%)	0.0330	0.0389	-0.4305	-0.7084
	0.0165	0.0165	0.1382	0.1527
Initial Equity Share (%)	-0.0290	-0.0289	-0.1035	-0.1032
	0.0006	0.0006	0.0033	0.0033
Equity Returns (%)		0.0178		
		0.0012		
Low Income Interaction with Passive Change				1.528
				.3588
Controls	Age, Gender, Education, Race, Income, Portfolio Value	Age, Gender, Education, Race, Income, Portfolio Value	Age, Gender, Education, Race, Income, Portfolio Value	Age, Gender, Education, Race, Portfolio Value
Observations	186,506	186,506	20,911	20,911
R-squared	0.013	0.014	0.048	0.048

Return Chasing

Another investment bias we explore is the possibility that participants will chase returns, i.e. rebalance their portfolio to account the prior period's investment performance rather than rebalance based on future expectations. To test whether individual participants chase returns we analyze the changes in their equity allocation with respect to equity returns, conditional on a vector of demographics. We address this using the 2002 – 2009 Florida participant data, which contains fund contribution elections rather than balance allocations. This eliminates the issues associated with passive change in equity share, as positive returns will not directly affect the contribution allocations. In the last section, we showed that participants may actively rebalance to counter a passive change. Though this rebalancing could be achieved by alternative the allocations directly, participants may also rebalance by altering their elections and inflows. Because the passive rebalancing works against the active change, at least over longer periods of time, it is expected that this effect would bias the relationship between returns and elections downward.

Most participants rarely changed their elections. 97.5% of the observations of quarterly changes in equity elections are within 0.5% of zero, suggesting that participants rarely change their investment strategy. The quarterly change in equity share has a mean of -.05% with a standard deviation of 4.4%. The Table 15 shows that the prior quarter's performance has a small, but significant, effect on the equity election, with a 1% increase in performance leading to a .02 pp increase in equity allocation. This suggests that, quarter to quarter, participants are only slightly influenced by a prior period's return on their allocation choices and they tend to increase their allocation with an improving market.

In order to see if participants are affected more by significant changes in the market, the equity returns were classified into strong, normal and weak returns, with strong returns being at or above the 75^{th} percentile of equity returns during the time period, weak returns being at or below the 25^{th} percentile and average being between the 25^{th} and 75^{th} percentiles. Using dummies for the market returns, it appears as though there is little difference between average and good markets, however bad performances tend to send allocations down, with a weak return resulting in a change of equity share of -0..40 pp. This implies that participants tend to allocate away from poor performances rather than chase the good ones.

Table 15: Return Chasing – Change in Equity Election Share at the Individual Level

	Quarterly Change in Equity Share (%) (1)	Quarterly Change in Equity Share (%) (2)	Annual Change in Equity Share (%) (3)	Annual Change in Equity Share (%) (4)
Lag of Equity Return (%)	0.0225		0.0864	
	0.0010		0.0040	
Lag of Strong Returns		-0.0386		0.9552
		0.0137		0.1155
Lag of Weak Returns		-0.3963		-2.3932
		0.0154		0..643
Intercept	0.4152	0.5090	1.5862	2.2481
	0.0251	0.0255	0.1614	0.1290
Controls	Age, Gender, Income, Education	Age, Gender, Income, Education	Age, Gender, Income, Education	Age, Gender, Income, Education
Observations	611,737	611,737	88,527	118,590
R-squared	0.002	0.002	0.0106	0.0179

Specification 3 checked for the effects of annual equity returns on the annual change in equity shares. We see the impact of equity returns increase to 0.09, implying that a 10% equity return would yield a 0.9 pp increase in equity share and while that effect is still small, participants tend to chase returns slightly more over a longer time horizon. In specification 4, which looks at the effects of the strong and weak markets on the annual changes, we can see that the strong markets now have a significant positive impact on the change in equity shares, while the weak markets have a significant negative impact on the equity shares. These results suggest that poor markets have a larger impact on investor behavior than strong markets, with investors reducing their equity shares more following the weak markets than they increase following the strong markets. This may be better categorized as loss fleeing rather than return chasing behavior.

Another way to look at return chasing is at the fund level. Using the participants' elections from the 2010 – 2012 Florida data, pooled over funds, we can see if there is a fund level relationship between returns and elections. Specification 1 of the following table shows the regression results of the effects of the funds' prior period returns on the change in election to the fund. With 99.5% of the elections having no change it is not surprising that fund returns show a small, but significant effect. Given the very small number of changes in fund elections, specification 2 looks at return chasing conditional on participants making a change in the period. For those participants that do change allocations, the results are substantial and significant, with a 10% return resulting in a 3.9 pp increase in election allocation.

Table 16: Return Chasing - Quarterly Change in Fund Election Share at the Individual Level

	Change in Fund Share (%) (1)	Change in Fund Share (%) (2)
Lag of Fund Return (%)	0.0019	0.3917
	0.0002	0.0317
Controls	Age, Gender, Income, Education	Age, Gender, Income, Education
Observations	3,730,120	17,733
R-squared	0	0.008

4.3 Peer Effects in DB Plans

Pension consultants are often used by public pension plans to evaluate and select investment managers. While ideally public plans would evaluate managers objectively, in practice consultant relationships with investment managers are important determinants in the selection process. The unique pension-manager and pension-consultant network data in the MMD data set allow us to explore the importance of this relationship by looking at the correlation of manager employment decisions amongst plans employing the same consultant.

Evaluating this relationship requires a nuanced approach as both the manager and consultant relationship are endogenously chosen. To solve this issue, we look at the correlation of changes in employment decisions amongst groups of plans who initially employed the same consultant. The initial consultant relationship instruments, in a sense, for later consultant relationships. The identifying assumption is that the initial consultant selection is not correlated with other factors affecting changes in relationships with manager in the future.

We limit our sample to pension plans and managers that appear in every year from 2005-2012 in the MMD data, and construct an employment dummy equal to one for each year. We then regress changes in this dummy for a manager-plan pair on changes in the dummy for the other plans that initially shared a consultant with the plan. To account for the obviously complicated correlation structure in this data organization, we cluster by initial consultant. We control for manager level shocks using a manager-year fixed effect.

Table 17: Peer Effects in DB Plans

	(1) ΔEmployed
ΔSame Consultant Employment	0.22***
	(0.06)
Controls	Manager-Year Dummies
Observations	3,515,995
R-squared	0.01

Standard errors clustered by consultant.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 17 displays the results of the test. Unsurprisingly, there is a correlation between the manager selection decisions of plans using the same consultant. These results imply that, if every other plan using the same consultant hired a manager in a year, then your plan is 22% more likely than average to hire that manager. This effect appears large, but the standard deviation of consultant-manager employment changes is fairly small (.02). Thus a two standard deviation increase would only change the probability of hiring/firing a manager by 4-5 percentage points.

4.4 Peer Effects in an Individual DC Plan

In addition to looking at the peer effects at the plan level, we can also look at peer effects at the individual level across funds. Specifically, we can explore how participant fund elections vary with their peers' fund elections. While most of the work in peer effects has been focused in areas other than investment choices (education, employment are common), Duflo & Saez (2002) have found a positive relationship between peer and individual behavior in investment decisions. Using the 2010 – 2012 Florida data we are able to sort participants into schools and therefore identify their workmates and calculate each participant's peer group change in election of each fund.

There are 3,112 schools represented in the sample. The DC plan has an average of just under 8 participants per school, although the number of participants varies significantly with a high of 735. To evaluate the peer effects we regress the individual fund allocation change on the average fund allocation change for other participants at the same school, along with controls for gender, race and income. We also explore the how these peer effects differ along these demographic lines in Table 18 below. Column (1) shows a small but statistically significant positive peer effect; for a 1 pp change in the average peer group's fund election the participant election increases by 0.01 pp. The impact of the peer effect is affected by participant characteristics, including income, race and gender. Low income participants are less affected by peers, as are black participants, while male participants are more affected by their peers. The columns 2 through 5 show the same results when setting a minimum number of participants in a peer group. From this we can see that as the peer group size increases to 40, the magnitude of the coefficients also increases. This suggests that the number of peers you have may influence the group behavior, however the effects diminish when the peer group size becomes too large.

Table 18: Individual Fund Choice Peer Effects

	Change in Fund Election (1)	Change in Fund Election (2)	Change in Fund Election (3)	Change in Fund Election (4)	Change in Fund Election (5)
Change in Peer Group Fund Election	0.0083	0.0347	0.0501	0.0674	-0.0079
	(0.0018)	(0.0046)	(0.0121)	(0.0244)	(0.0318)
Low Income Interaction	-0.0083	-0.0197	-0.0941	-0.1502	-0.1009
	(0.0032)	(0.0079)	(0.0179)	(0.0309)	(0.0399)
Black Participant Interaction	-0.0178	-0.0599	-0.0638	-0.0757	-0.0686
	(0.0037)	(0.0118)	(0.0261)	(0.0386)	(0.0459)
Male Participant Interaction	0.0234	0.0588	0.0817	0.0982	0.1485
	(0.0033)	(0.0075)	(0.0170)	(0.0302)	(0.0395)
Peer Group Size Restriction	None	10	20	40	100
Observations	3,671,100	1,918,880	897,860	625,280	497,920
R-squared	0.0004	0.0005	0.0005	0.0005	0.0005

Analysis

This section concludes that, while DB plans do rebalance their portfolios, there is substantial short to medium run inertia in state pension plan investments. This inertia is present within the internally managed equity component and occurs at both the level of individual stocks and portfolio aggregates such as beta and industry composition. There is also inertia in the allocation across asset classes. Deviations from investment targets ultimately cause adjustments to both the actual allocation and the target. Direct return chasing across asset classes by DB plans appears limited in recent years. Similarly, peer effects through consultant networks, while statistically observable, have a modest affect on investment management.

Our analysis of individual investors in the FRS DC system produces extremely similar results. Rebalancing by individuals is harder to detect in the short-run, though a similar degree of moderate rebalancing can be seen over longer horizons. As with DB plans, return chasing and peer effects exist and can be observed, but do not have a substantial impact on allocations. There is, however, heterogeneity in the magnitude of these effects across demographic groups, meaning that certain segments of the population are more susceptible to these biases.

5 Conclusion

The past thirty years have seen a rapid movement away from defined benefit plans in the private sector, and to a lesser extent this trend has been mirrored in public sector during the last two decades. Concerns about the ability of state and local governments to meet existing pension commitments may speed that transition toward defined contribution designs in the coming years. This change will have a meaningful impact on the lives of millions of public employees and on the substantial assets allocated for their retirement. It is important to understand how these changes are likely to affect the allocation and management of these assets.

In this paper, we use new data to provide the first comparison of asset allocations, fees, and returns across plan designs in the US public sector. We also use unique data on individuals in the Florida state DC plan matched to demographic information from the Florida Department of Education to analyze how individual heterogeneity affects the distribution of outcomes within a public DC system and what segments of the population are most adversely affected.

We find that aggregate asset allocations are broadly similar across plan designs, though there is substantially greater use of alternative investments amongst DB plans. The data suggest that this difference explains much of the fee and return differentials across plan designs.

Within the Florida DC system, most investors hold diversified portfolios (presumably in part due to a well chosen default). A small segment of investors, in which those with low incomes, minorities, and women are over-represented, hold extremely conservative funds that may not offer a sufficient rate of return. Contrary to the fears of many, this group is relatively insulted from fees, which are significantly higher for wealthier and more aggressive participants.

The individual participants in the Florida DC plan are not ideal investors. They do not adequately rebalance their portfolios over the short-to-medium term horizon, and they demonstrate mild return chasing and peer effects. We believe, though, that the comparison for these investors is not a fully optimizing agent but the investment decisions made in public DB plans. We demonstrate that these systems also fail to rebalance at high frequencies and demonstrate similar behavioral biases.

This analysis suggests that, while some of the concerns about the movement toward DC plans are misplaced, others need to be address. The current inaccessibility of certain asset classes in non-DB systems appears to have an effect on performance and could be remedied by the construction of more balanced investment options. Additionally, while on average DC systems seem to produce favorable outcomes, a minority of investors with distinct demographic profiles are disproportionately at risk for holding undiversified and poorly rebalanced portfolios. Interventions designed to provide investment education could be targeted towards these groups.

Considering all of the dimensions explored here, though, it appears that the management of retirement assets is consistent across plan designs amongst existing public sector plans. This suggests that, while the movement away from DB plans may generate a significant change in the incentives and risks facing public employees, it will not have a dramatic impact on the way in which these employees' retirement assets are invested.

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