# Paying for Performance in Public Pension Plans[*]

Yan Lu[†] Kevin Mullally[‡] Sugata Ray[§]

January 2021

**Abstract**

We examine the relation between public pension plan CIO compensation and plans' investment performance. Higher paid CIOs outperform their counterparts by 25 – 47 bps per year. This outperformance generates an additional $108.58 – 201.59 million for these plans. Plans offering higher compensation hire better educated CIOs and are more likely to retain their CIOs. Higher CIO compensation is positively correlated with the use of incentive compensation, but incentive compensation does not appear to directly affect performance. Our results suggest that higher compensation leads to better investment performance and that plans may be using incentive compensation to justify paying their CIOs more.

JEL Classification:

Keywords: Public pension fund performance; compensation; incentives

[*] We are grateful to Andrew Johnston and seminar participants at the University of Central Florida and Middle Tennessee State University for helpful comments and suggestions.

[†] Yan Lu is from the University of Central Florida, College of Business Administration, PO Box 161400, Orlando, FL 32827, USA. Email: yan.lu@ucf.edu. Tel: +1 407-823-1237.

[‡] Kevin Mullally is from the University of Central Florida, College of Business Administration, PO Box 161400, Orlando, FL 32827, USA. Email: kevin.mullally@ucf.edu. Tel: +1 407-823-2360. Corresponding author.

[§] Sugata Ray is from the University of Alabama, Culverhouse College of Business, PO Box 870224, Tuscaloosa, AL 34587, USA. Email: sugata.ray@cba.ua.edu. Tel: +1 205-348-5726.

Recent academic work, mainstream media and policy debate has noted with concern that public pension funds, in aggregate, face a funding gap in the order of trillions of dollars.[1] Recent academic research has largely focused on the effect of various assumptions on pension liabilities on plan "fundedness" and how plans' funding levels impact their asset allocations (Novy-Marx and Rauh, 2009; Andonov, Bauer, and Cremers, 2017). Less attention has been paid to examining the investment performance of these pension plans in general, and more specifically on the role of plan management on plan performance, despite the fact that any future shortfalls arising from funding gaps could be mitigated by better plan performance.[2] Our study attempts to fill this gap by examining one aspect of plan management, manager compensation (specifically Chief Investment Officer (henceforth, CIO) compensation), and its effects on fund performance. Simply put, we examine whether better CIO pay results in better performance and, if so, why.

Understanding the link between manager pay and performance has been the focus of a long line of literature. Higher levels of pay can be used to hire more talented people (Dal Bo, Finan, and Rossi, 2013). Generous compensation could also retain managers in the face of competing offers while underpaying managers may lead higher managerial turnover (Wade, O'Reilly, and Pollock, 2006). Finally, compensation contracts that provide incentives for better performance

[1] The funding gap, defined as the difference between the present values of their assets and liabilities is estimated in the $1 to $3 trillion range. While total assets are estimated at $4.4 trillion based on observed market values, different discount rates used to discount future liabilities leads to the large range in the funding gap. Pew Research suggests that the gap exceeds $1 trillion: https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2019/06/the-state-pension-funding-gap-2017. Novy-Marx and Rauh (2011a) estimate that, when using proper actuarial assumptions, the gap in June 2009 was between $1.26 and $2.49 trillion dollars. Additionally see "The Coming Pension Crisis Is So Big That It's A Problem For Everyone," *Forbes*, May 20th, 2019, and "A Plan to Avert the Pension Crisis," *The New York Times*, Aug 5th, 2013.

[2] There are several studies examining the investment performance of public pension plans in general. We discuss these studies in the Literature Review and Contribution section below.

using bonuses or stock options could lead managers to exert more effort (Agarwal, Daniel, and Naik, 2009; Murphy, 1999, 2012). We term these three potential channels through which compensation could affect performance as *hiring, retention*, and *incentives.* Publicly disclosed compensation and investment performance data for public pension plan CIOs allow us to study the link between pay and performance in this setting and examine whether pay affects performance for pension plan CIOs.[3] Additionally, data on hiring and turnover, together with detailed information on CIO compensation components (e.g. bonus amounts, raises), allow us to observe whether pay affects performance through better *hiring*, higher *retention*, or providing better *incentives*.

Examining the overall link between compensation and performance, we find that better paid CIOs generate significantly better returns going forward. CIOs with top quartile compensation garner 30 – 40 bp higher returns annually. This result holds controlling for pension plan size, funding levels, asset class allocations and is robust to using other measures of compensation (e.g. continuous, above/below median, etc.) and performance (absolute returns, peer adjusted returns, Sharpe ratios, DGTW returns, etc.). While this result suggests that better compensation leads to better performance through one of the three channels noted above, we acknowledge that the link between compensation and future performance may be endogenous. Specifically, it may be

[3] There are advantages to our setting of public pension plan CIOs relative to other settings used to examine this issue. For example, we observe productivity after hiring (as opposed to Dal Bo, Finan, and Rossi, 2013) and exact compensation amounts (as opposed to Ma, Tang, and Gomez, 2019). Moreover, our inferences are not clouded by equity ownership (as in the case of many executive compensation studies. For example, Guthrie, Sokolowsky, and Wan (2012) find that the inferences made in Chhaochharia and Grinstein (2009) are driven by two instances of CEO pay being paid $1 or less.

possible that our findings are driven either by reverse causation or omitted variables that are correlated with compensation that also affect future performance.

Reverse causation is unlikely, due to the difficulty of predicting future returns and linking current compensation to such returns. However, to mitigate even this unlikely possibility, we examine the effects of current compensation on performance two years in the future. Our findings still hold, suggesting reverse causation is unlikely to be driving our results.

Omitted variables are a more serious concern. Compensation levels are likely to be correlated with many other variables that may affect performance. Factors such as pension plan culture, location, and independence of the investment function are some of a few things that could be correlated with compensation and could also affect performance. Additionally, it may be possible that the documented higher performance is a function not of better investment skill but of additional risk-taking, another unobserved factor correlated with performance. We attempt to control for as many of these potential covariates as possible and note that our results are robust to their inclusion, but acknowledge it is impossible to control for all omitted variables. We interpret our results as support for the idea that better compensation leads to better investment performance, through channels of hiring, retention and/or incentives, but caveat our interpretation accordingly given this limitation.

We return to our baseline finding that higher compensation is associated with superior future performance and analyze whether this superior performance is driven by better hiring, improved retention, or the presence of explicit incentive pay commonly associated with higher levels of compensation.

To examine whether paying more leads to hiring more talented CIOs, we need a measure of talent. We use admission selectivity and the average SAT scores at the manager's undergraduate institution as a proxy for talent following Chevalier and Ellison (1999). First, we confirm the positive links between these measures and investment performance hold in our sample. We find that they do: CIOs who attend more selective schools and schools with higher average SAT scores do have significantly better performance. Next, we examine whether paying more allows pension plans to hire managers who went to such schools and find evidence supportive of this hypothesis. Specifically, CIOs paid top quartile compensation come from undergraduate institutions with 56.31 point higher average SAT scores and those that have 13.1% lower admission rates. Additionally, managers who attended higher quality universities are less prone to behavioral biases. These managers hold fewer lottery stocks and are less prone to the disposition effect, both traits associated with better performance (see Kumar (2009) and Odean (1998)). These results indicate better hiring is one of the channels through which higher compensation generates better performance.

We next examine whether plans that pay more are better able to retain their CIOs. Li, Lourie, Nekrasov, and Shevlin, 2020, argue that "[e]mployee turnover is a significant cost for businesses" and provide evidence that "turnover is negatively associated with future financial performance." A white paper by Morningstar finds similar effects in the investment context, documenting "firms with a better record of retaining their investment staff also have a better record of their funds both surviving and outperforming." In particular, the piece finds that "while high manager retention doesn't guarantee outperformance, low manager retention is a strong indicator of underperformance.[4]" Moreover, Li and Scherbina (2011) and Pan and Wang (2012) find that new managers often try to implement their own agendas. In the investment management setting, this agenda setting could lead to an increase in costly portfolio turnover.

We find similar effects in our sample where we examine cases of CIOs leaving voluntarily for other jobs. We use Cox proportional hazard regressions to model the determinants of such turnover and find that the probability of CIO departure is significantly and negatively linked with future performance.[5] We find that higher levels of compensation significantly reduce the probability a CIO leaves a given plan. For example, being in the top quartile in terms of CIO pay reduces the CIO's probability of departure by approximately 45%.[6] More importantly, retention is positively related to future fund performance. Investment performance is 0.272% lower in the three-year period about a realized CIO turnover event. Increased portfolio turnover is one channel for this deterioration as turnover is 46.8 – 66.4% higher during these periods.

Our results so far indicate that better hiring and improved retention are two of the channels through which higher compensation translates into improved performance. Another possibility is that the compensation contracts of higher paid CIOs also contain performance incentives. Restated, it is possible that the presence of performance incentives drives the link between higher compensation and better plan performance. Although only 2-3 plans offered incentive

[4] See "The Proof is in the Pudding," available at https://www.morningstar.com/articles/568495/the-proof-is-in-the-pudding.

[5] This effect holds regardless of whether we use compensation as an explanatory variable in modeling voluntary CIO departure.

[6] This relationship is also understood by practitioners, with "Salary" being the most common tool with which Chief Investment Officers themselves try to retain their teams (see "Retaining the Young," *Chief Investment Officer* magazine, June 2017).

compensation in the late 1990s, pension plan "[c]onsultants estimate roughly 50% of plans appear to offer incentive pay" as of 2018. The role of incentive pay in such contracts could be two-fold. On one hand, this performance-based pay could incentivize managers to work harder or could attract better managers who are more confident in their own abilities or the prospects of the plan (Oyer and Schaefer, 2005; Lazear, 2001). On the other hand, they could simply be a mechanism to provide higher pay. As Bob Jacksha, CIO of The New Mexico Educational Retirement Board, notes, "[f]rom a public relations standpoint, if you give someone a high flat salary, the public might say you're not earning it, but incentive pay is tied to an outcome,"[7] and are more likely to be palatable. Thus, our initial finding of higher CIO pay being linked to superior future performance may be driven by such pay being linked to the presence of incentives which, in turn, lead to improved performance.

To examine this hypothesis, we first confirm that higher pay is correlated with the presence of incentives and find evidence supportive of this notion. In our sample, 43.1% of plans with CIO compensation in the top quartile are likely to pay a bonus constituting 20% or more of CIO compensation, compared to only 3.8% of plans in the bottom quartile of compensation. A similar result holds when examining the link between overall pay-for-performance sensitivity (termed PPS and measured as the slope of a regression of total compensation on previous year's performance) and overall compensation levels.[8]

[7] See "Public CIO pay getting renewed attention," Pensions & Investments, July 23, 2018, available at https://www.pionline.com/article/20180723/PRINT/180729976/public-cio-pay-getting-renewed-attention

[8] Yet another form of PPS is the threat of getting fired (and losing base salary) if performance is poor. Conversations with industry participants and our empirical analysis both suggest this is unlikely to be the case. In our analysis, there

However, when examining the link between compensation and future performance, and separately evaluating the effects of incentive pay and overall levels of pay, we find that future performance is positively and significantly linked to overall levels of pay, but not to the presence of incentive pay. Specifically, in bivariate sorts, only variation along the total compensation axis generates significant different in future performance. We estimate multivariate regressions and continue to find that only overall levels of compensation load significantly in predicting future performance.

Thus, it appears that paying CIOs more does generate better performance in public pension plans. By paying more, plans attract and retain better talent. Interestingly, incentives do not appear to explain much of this superior performance. Thus, our results suggest that incentive pay makes higher pay politically more palatable, but that the incentives themselves are not driving the better performance higher paid managers generate.

The paper proceeds as follows. Section 2 contains our discussion of the extant literature and our paper's contribution to it. Section 3 describes the data and variables we use in our analysis. Section 4 details the empirical analysis and results. Section 5 concludes.

## 2. Literature Review and Contribution

While our results showing higher pay leads better plan performance and linking this to better hiring and retention outcomes resonate with much of the extant literature discussed in the

is no predictive power of past performance on the few firings we observe. Instead, we find that firings are largely driven by non-performance linked scandals.

introduction, our principal contribution is the counterintuitive finding that incentive pay, by itself, does not lead to better performance. This finding resonates with some academic literature in management and economics showing that incentive pay may not be the best way to motivate workers.[9] For example, Glucksberg (1962) provides evidence that incentives can reduce effectiveness in solving problems requiring creativity. More generally, many studies find that humans have high intrinsic levels of motivation for activities requiring insights and creativity, while extrinsic motivation (i.e., incentive pay) may be required for more mundane tasks (Deci, 1971). Furthermore, extrinsic motivation may eventually crowd out intrinsic motivation (Bénabou and Tirole, 2003). To the extent managing a pension plan's assets requires creativity and insight, our study reinforces these findings. Incentive pay does not appear to drive outperformance in this area. Our study documents a real-life analog to these experimental and theoretical studies and supports the observation that incentive compensation may simply be used to justify overall higher levels of compensation.[10]

A second contribution of our study is to document the pay-performance link in the unified setting of pension plan investment management. The pension plan setting has some advantages over other settings used in the extant literature. For example, while Dal Bo et al (2013) use a natural experiment to show that higher levels of compensation can attract more talented workers, their study is unable to link better hiring with higher productivity on the job. Our setting is advantageous

[9] See the survey by Pink (2010) for a summary of this research.

[10] Bob Jacksha, CIO of the New Mexico Investment Council, describes the ineffectiveness of incentive pay by saying, "If the idea is to make people work harder, try harder, I see people working as hard as they can for a flat compensation."

in that regard as we can observe pension plan CIOs' productivity (e.g., their investment performance). The use of corporations as the setting for pay-performance analysis is rife with well-documented endogeneity concerns.[11] For example, CEOs often set their own pay or reset the terms of their incentive compensation when it is advantageous for them do so. Additionally, CEOs may have significant stock ownership and draw insignificant levels of compensation which can contaminate analyses (Chhaochharia, and Grinstein, 2009; Guthrie, Sokolowsky, and Wan, 2012). Our setting avoids many of these issues.

Finally, our setting also has several advantages over similar studies in the asset management setting. Although the asset management setting is arguably cleaner than that of corporate finance, it also has drawbacks. First, asset manager compensation in the United States is not publicly available which means researchers must estimate it using assumptions. For instance, Agarwal, Daniel, and Naik (2009) estimate the magnitude of the performance incentives (e.g., the "delta") of hedge fund managers by assuming that managers reinvest all fees into their funds. Second, managers of some vehicles (e.g., hedge funds) can, and do, change their own compensation contracts (Agarwal and Ray, 2013; Deuskar et al, 2012). Finally, asset managers also have incentives other than the compensation they receive. Specifically, asset managers often invest in their own funds (e.g., Ma and Tang, 2019; Agarwal, Daniel, and Naik, 2009) and face the indirect incentives provided by investor flows (Lim, Sensoy, and Weisbach, 2016; Yin, 2016).

[11] See the compensation literature reviews by Murphy (1999, 2012) for longer discussions of these endogeneity concerns.

Reiterated, the public pension plan setting has distinct advantages over these other settings. First, pension plan CIOs are government employees and seem to have little power to set their own compensation or choose board members. Second, pension plan CIOs do not possess the performance incentives stemming from investor flows or personal ownership in the plan itself. Specifically, public pension plans are retirement investment vehicles that are funded with mandatory employee and government contributions that cannot be withdrawn and are but a small percentage of a given employee's total compensation. Third, because these CIOs are government employees, we can observe the actual dollar figure of compensation they receive as well as the specifics of how that compensation is paid (salary, bonuses, etc.). Lastly, because pension plan performance and individual investments are publicly available, we can also observe the productivity and performance of the CIOs. Combined, the features of the public pension plan setting make it more ideal to study the relation between manager pay and performance.

Our final contribution is to the literature on public pension plan performance. This literature can be divided in two smaller groups. First, several studies examine the performance of pension funds as a group (Coronado, Engen, and Knight, 2003; Ennis, 2020). The main finding of these studies is that public pension plans underperform passive benchmarks.

The second strand of the literature on public pension performance focuses on the factors that influence these plans' performance such as political influence and the plan's funding level. For example, researchers have documented that public pension plans overweight their portfolios with local stocks and private equity investments which negatively affects plan performance (Bradley, Pantzalis, and Yuan, 2016; Brown, Pollet, and Weisbenner, 2015; Hochberg and Rauh, 2013; Andonov, Hochberg, and Rauh, 2018). Studies have also linked the level of underfunding to excess risk taking and worse performance (Andonov, Bauer, and Cremers, 2017). Dyck, Manoel, and Morse (2018) study the role that political outrage over executive compensation plays in a public pension plan's performance and find that plans with higher levels of outrage suffer worse performance. Binfare and Harris (2020) use IRS data to examine the determinants of executive compensation at non-profit endowments and foundations. Interestingly, little attention has been paid to the role of the pension plan manager (e.g., the CIO) in the plan's performance despite the large literature on how managers themselves impact fund performance. Our study aims to fill this gap by focusing on the role of managerial compensation on pension plan performance.

## 3. Data and Summary Statistics

### *3.1. Data and Variable Construction*

Our primary data source is the Public Plans database (henceforth PPD) created by the Center of Retirement Research at Boston College. The PPD data contains plan-level data for 190 state and local pension plans from 2001 through 2018.[12] The data contains information on plans' assets, liabilities, investment returns, actuarial assumptions, and many other variables. According to the Center for Retirement Research, these 190 plans covers 95 percent of public pension membership and assets nationwide. The dataset contains 3,403 plan-year observations.

Our main performance measure is *Peer-Adjusted Return* which is the fund's annual investment return minus the average return of the other plans during the same fiscal year. We also calculate funds' *Sharpe Ratio* as a plan's average annual return divided by the standard deviation

[12] The data can be found here at https://publicplansdata.org/.

of those annual returns using periods of 4 years of return data. For robustness, we also use funds' annual investment returns, without any adjustment, as a third performance measure (*Raw Return*). Later in the paper, we use plans' 13F filings to calculate their *DGTW Return* following Daniel et al (1997). The PPD data also contains data on each plan's asset allocations; we use these allocations to further control for any differences in risk-taking across plans.

We augment the PPD dataset with information from the funds' comprehensive annual financial reports (CAFRs). We collect data on the pension plans' boards of directors, being careful to take note if the plan features a separate investment board tasked with monitoring the investment functions of the plan.[13] If a plan has a separate board dedicated to monitoring its investment personnel, we code the indicator variable, *Separate Investment Board*, equal to 1 and 0 otherwise. Specifically, we obtained the identities of the funds' executive directors, chief investment officers, and any other listed investment officers. We conducted internet searches (e.g., LinkedIn, Google searches) to obtain biographical information on the sample of CIOs. Specifically, we obtained data on the CIOs' undergraduate institutions and then the quality of those institutions (*CIO Institution SAT Score* and *CIO Institution Admission Rate*) from the College Board. We define an indicator variable, *CIO Local*, equal to 1 if the CIO attended high school or college in the same state in which he manages a given plan and 0 otherwise. *Voluntary Turnover* is an indicator variable equal to 1 if the CIO left his current plan for another position without being explicitly fired.

[13] See Andonov, Hochberg, and Rauh (2018) for additional information about the institutional details of pension plans' boards of directors.

To obtain information on these individuals' compensation, we submitted Freedom of Information Act (FOIA) requests to the state, county, or municipality responsible for their administration. Specifically, we requested "The a) first name, b) last name, c) job title and d) compensation received by all pension system investment staff in fiscal years 2001 to 2018, broken out by all applicable compensation types – including but not limited to net annual salary, bonuses, deferred compensation, and matched profit sharing, and any other compensation." Many states changed payroll systems during this period and were unable to provide us data all the way back to 2001. On average, we received 12 years of data from each of our 102 respondents.

In many cases, one set of investment officers is responsible for multiple plans. For example, the Bureau of Asset Management, housed in the New York City Comptroller's office, is responsible for the investment management of five distinct plans: the Teachers' Retirement System, the New York City Employees' Retirement System, the New York City Police Pension Fund, the New York City Fire Pension fund, and the New York City Board of Education Retirement System. Our current sample contains CIO compensation data for 1,660 plan-years from 122 distinct plans. Many pension plans do not have a chief investment officer; these plans simply outsource the investment management to outside managers based on the recommendations of investment consultants. The composition of our sample can be found in Table 1.

### *3.2. Summary Statistics*

We report summary statistics in Table 2. Panel A contains the statistics for the CIO compensation variables. The average (median) CIO in our sample earns \$263,043.90 (\$207,422.80) in total compensation per year. The CIO in the 90$^{th}$ percentile of compensation earns \$504,854.80. CIOs earn bonuses in 15.8% of all plan-years in our sample; the average bonus in these years is $111,396.90. The average CIO in our sample attended a university with an average undergraduate SAT score of 1272 and an admission rate of 54%. The average CIO is approximately 51 years old and the average tenure for a CIO at a public pension plan is 6.6 years. CIOs voluntarily leave their funds in 5.53% of fund-years while they are only fired in 1.37% of fund-years.

Panel B contains the statistics on the pension plans. The average (median) plan in our sample has assets with a market value of $18.82 billion ($8.90 billion), is funded at 79.49% (79.50%), and generates an annual return of 6.71% (9.20%). Finally, these plans allocate an average of 52.36% to equity assets, 27.01% to fixed income assets, and 10.05% to alternative assets such as hedge funds and private equity investments.

## 4. Empirical Results

In this section, we first outline the baseline results on how CIO compensation impacts plan performance. We next attempt to rule out potential alternative explanations for our results. We then investigate the three channels that may explain our baseline results: *hiring*, *retention*, and *incentives*.

### *4.1. CIO Compensation and Plan Performance*

In this section, we examine the relation between CIO compensation and subsequent plan performance. We first present the baseline results and then carry out several robustness analyses.

#### *4.1.1 Baseline Results*

We begin by conducting univariate analysis by sorting the CIOs into quartiles based on the level of their total compensation. To do so, we divide the CIOs into quartiles each year based on their total compensation. We then examine the average plan performance of each group and compare the difference in the peer-adjusted performance for the CIOs in the highest compensation quartile with that of the plans whose CIO compensation is in the bottom quartile. The results are presented in Panel A of Table 3.

Several findings merit mention. First, the average plan performance is monotonically increasing with each compensation quartile. Second, a CIO whose compensation is in the lowest compensation quartile underperforms its peers by a statistically significant 0.215% per year. Third, CIOs in the top quartile of the compensation distribution outperform their peers by a statistically significant 0.251% per year. Given that the plans who pay top quartile compensation control an average of $46.573 billion in assets, this outperformance translates to an additional $116.90 million of plan value. Lastly, the difference between the top and bottom quartile groups is a 0.466% per year and is statistically significant at the 1% level (*t*-stat = 3.34).

Perhaps unsurprisingly, plan size is a positive and significant determinant of CIO compensation. In unreported results, we also conduct bivariate sort analysis on our sample of plans using plan size and then compensation. We continue to find a positive and statistically significant relation between plan compensation and plan performance within each size group. As an additional test, we also double sorted our sample of plans based on how well funded they are as we expect better funded plans will also be able to pay higher CIO compensation. We continue to find a positive and statistically significant relation between plan compensation and plan performance.

To formally control for any differences in plan characteristics that may be driving the relation between CIO compensation and plan performance, we estimate the following linear regression:

$$Performance_{i,t} = \beta Compensation_{i,t-1} + \gamma' X_{i,t-1} + \varphi_t + \varepsilon_{i,t} \tag{1}$$

where $i$ indexes plans, $t$ indexes time, $Performance_{i,t}$ is plan $i$'s peer-adjusted performance at time $t$ and $Compensation_{i,t-1}$ is plan $i$'s CIO compensation at time $t - 1$. $X_{i,t-1}$ is a vector of plan characteristics that includes the plan's lagged performance, lagged assets, lagged level of funding, and the plan's allocations to various asset classes. $\varphi_t$ represents year fixed effects. We adjust the standard errors for heteroskedasticity and double-cluster them by plan and year. We estimate the regression in Equation 1 using several variants of the compensation variables to allow for the possibility that the relation between compensation and plan performance is not linear or perfectly monotonic. Specifically, we use the logarithm of total compensation, indicator variables for each compensation quartile, and an indicator variable for above median compensation as our key independent variables. We present the results in Table 3, Panel B.

The coefficients on our compensation variables are positive and statistically significant at the 5% level or better in all 4 of the models we estimate. The coefficients are also economically significant. For example, the coefficient on *Log Compensation* (0.293, *t*-stat = 4.37) in column 1 suggests that a one standard deviation increase in total compensation is associated with a 0.092 standard deviation increase in peer-adjusted performance. The coefficient on *Top Quartile Compensation* in column 2 (0.387, *t*-stat = 3.86) indicates that, even after controlling for differences in plan characteristics, CIOs whose compensation is in the top quartile outperform CIOs making bottom quartile compensation by 0.387% per year.

*4.1.2. Tests to Address Endogeneity Concerns*

Although our baseline results suggest a strong relation between CIO compensation and plan performance, this finding may be driven by reverse causality or omitted variables. We begin by exploring the possibility that the relation between future performance and current compensation is driven by reverse causality. Although this seems unlikely due to the difficulty in predicting future investment returns and using those in determining current CIO compensation, we nevertheless attempt to rule out this possibility by examining the link between a plan's performance in *two years* and its CIO's current compensation. We present the results of these regressions in Panel A of Table 4. The coefficients on $Log\ Compensation_{t-2}$ remain positive and statistically significant at the 5% level or better. These tests help rule out the possibility that future performance is driving current compensation as it seems implausible that pension plans are basing current compensation on performance two years in the future.

More concerning is the potential for omitted variables to be driving our observed link between CIO compensation and fund performance. One example of an omitted variable may be risk taking. Specifically, it could be that the positive relation we document between compensation and performance is driven by higher paid CIOs simply taking more risk. While our baseline results do control for allocation percentages to different asset classes, there may be other ways to increase risk (e.g., investing in riskier securities within a given asset class). To further mitigate this concern, we re-estimate Equation 1 using *Sharpe Ratio* as our dependent variable. We calculate *Sharpe Ratio* using 4 years of plan returns, as a dependent variable as a measure of risk-adjusted performance to mitigate concerns that the positive relation we document between compensation and performance is driven by higher paid CIOs simply taking more risk. Moreover, we use *Raw*

*Return* as our measure of plan performance. We present the results of these regressions in Panel A of Table 4.

The results continue to indicate a positive and statistically significant relation between CIO compensation and plan performance. Specifically, plans who pay their CIOs top quartile compensation have 0.249 higher *Sharpe Ratio* relative to those plans which pay their CIOs bottom quartile compensation (*t*-stat = 2.72, column 2). This result supports our inference that plans which pay higher compensation are outperforming their counterparts and not simply taking more risk.

There are several other omitted variables that could be driving our results. First, higher CIO compensation could be a proxy for better plan governance or culture. Andonov, Hochberg, and Rauh (2018) find that the composition of a plan's board of directors impacts its performance. Thus, it is possible that the plan's governance, rather its CIO's compensation, is driving the relation between compensation and fund performance. We use the presence of a separate investment board as a measure of governance and investigate whether this structure is driving our results.

We investigate the possibility that our results are driven by better plan governance by double sorting our sample of plans based on the presence of a separate investment board and then the CIO's compensation. We present the results in Panel A of Table 5. We continue to find a strong relation between CIO compensation and plan performance in both groups. CIOs in the top quartile of total compensation outperform their lowest paid counterparts by 0.736% or 0.380%, depending on whether the plan has a separate investment board.

Next, we augment the regression specification in Equation 1 by including the *Separate Investment Board* indicator variable. The results of these regressions are contained in Table 5, Panel B. Several findings are worth noting. First, augmenting our main regression specification with *Separate Investment Board* makes the coefficients on our compensation variables larger and more statistically significant. As an example of this effect, compare the coefficient on *Log Compensation* in Column 1 of Table 5 to that its counterpart in Table 3. The coefficient on *Log Compensation* has increased from 0.293 to 0.307 and its associated *t*-statistic increased from 4.37 to 5.57. Second, the coefficients on *Separate Investment Board* are also positive and statistically significant in all 4 models, which is consistent with the findings of Andonov, Hochberg, and Rauh (2018). Combined, the results in Table 5 suggest that while better plan governance improves plan performance, this effect is distinct from that of higher CIO compensation.

A second potential omitted variable that could be driving our result is plan location. Christoffersen and Sarkissian (2009) find that mutual funds based in large cities or financial centers outperform and attribute this effect to knowledge spillovers and learning. Thus, it is possible that the relation we document between compensation and performance is being driven by highly paid CIOs who work in big cities and learn from other money managers. We construct two variables based on the plan's location to explore this possibility. The first variable, *Financial Center*, follows Christoffersen and Sarkissian (2009) and is an indicator variable equal to 1 for plans located in Boston, Chicago, Los Angeles, New York, Philadelphia, and San Francisco, and 0 otherwise. The second variable, *Top Quartile MSA*, is an indicator variable equal to 1 if a plan is headquartered in an Metropolitan Statistical Area (MSA) whose population is in the top quartile of the MSAs in which our plans are headquartered and 0 otherwise.

We repeat the bivariate sort analysis using our two location variables in Table 6. Specifically, we first sort our sample of funds based on their headquarters location and then sort them based on their CIO's compensation. The results can be found in Panel A of Table 6. We continue to find a positive and statistically significant relation between CIO compensation and plan performance. We also find some evidence consistent with Christoffersen and Sarkissian (2009); plans located in financial centers outperform their peers located in non-financial centers.

Next, we augment our regression specification in Equation 1 with the location variables and re-estimate the linear regressions. We report the results of these regressions in Table 6, Panel B. The main takeaway from these regressions is that controlling for a plan's location only makes our baseline results economically and statistically more significant. As an example, we compare the *Log Compensation* variable in Column 1 of Tables 3 and 6 and find that its coefficient has increased from 0.293 to 0.321 and the associated *t*-statistic has increased from 4.37 to 5.29. Combined, the results in Tables 4 through 6 help allay concerns that our results are being driven by either reverse causality or omitted variables. However, we do note that since it is not possible to control for all omitted variables, we cannot completely rule out the possibility that our result, which we interpret as causally linking higher CIO pay to plan outperformance, is driven by an unconsidered omitted variable correlated with both CIO pay and plan performance.

*4.2. Channels for the Outperformance*

In this section, we turn our attention to investigating the channels by which higher CIO compensation leads to better performance. As discussed earlier, we posit that there are three channels that may explain this relation. The first, *hiring*, predicts that paying higher compensation would help a plan attract more capable or talented managers. The second channel, *retention*, hypothesizes that plans that pay more will be less likely to lose a CIO to a voluntary departure. Lastly, the *incentive* channel conjectures that the higher level of compensation we observe is driven by higher incentive compensation and that is the incentive component, rather than the overall level, of the compensation that causes the higher performance. We investigate each channel individually below.

*4.2.1. Does Higher Compensation Attract CIOs of Higher Ability?*

Chevalier and Ellison (1999) provide evidence that managers who attend more prestigious universities outperform their peers. Thus, one channel that could explain our results is that paying a higher level of compensation enables pension funds to attract more talented CIOs, which we label the *hiring channel*. To examine this possibility, we examine the education of the CIOs of our plans based on their compensation.

Specifically, we first sort plans into quartiles based on the compensation paid to their CIOs. We then examine the average SAT score and the admission rate of the undergraduate universities that the CIOs attended. The results of this analysis can be found in Panel A of Table 7. The results indicate that plans that pay higher compensation attract CIOs who attended i) more selective universities and 2) universities with higher average student SAT scores. Specifically, plans in top quartile of pay attract managers who attended universities with admission rates that are 19% lower than the universities attended by managers who are hired by plans paying bottom quartile compensation. This difference is statistically significant at the 1% level. Funds in the top quartile of compensation also attract managers from institutions with average SAT scores that are 61.6

points higher than the institutions attended by managers hired by bottom quartile plans. This difference is statistically significant at the 10% level.[18]

Lastly, we confirm that the inferences in Chevalier and Ellison (1999) are present in our sample. We create indicator variables equal to 1 if a CIO attended a university in the top quartile of average SAT scores (*Top Quartile SAT*) or in the top quartile of admission selectivity (*Top Quartile Selectivity*) and 0 otherwise. We then regress *Peer-adjusted Return* on these indicator variables along with the vector of fund-level controls used in the prior regressions. Panel B of Table 7 contains the results. The results indicate that CIOs who attended more selective universities and those with higher average SAT scores outperform their peers by 0.184 – 0.261% per year, consistent with Chevalier and Ellison (1999). Combined, we interpret the results in this section as being supportive of the *hiring* channel hypothesis.[19]

*4.2.2. Does Compensation Affect Voluntary CIO Turnover?*

Public pension CIOs have significant outside employment options. These CIOs often leave public pension plans for jobs with hedge funds, investment consulting firms, or investment banks. Moreover, a large literature in finance and management provides evidence that retaining productive employees positively affects firm performance (Khorana, 2001). There are multiple explanations for this relation. First, new managers often make drastic changes to an organization

---

[18] We also repeated this analysis using managerial changes. Specifically, we used the compensation of the *departing* CIO to predict the education quality of the incoming CIO. We find qualitatively similar results.

[19] We plan to investigate why these managers outperform. Potential explanations could be better stock picking, a higher proclivity to index, and less engagement in the disposition effect.

to implement their own agenda (Li and Scherbina, 2011; Pan and Wang, 2012). In the context of pension plan management, the new manager's desire to implement his own agenda could lead to costly portfolio turnover, including the sale of illiquid assets like alternative asset shares. Second, it is possible that the *threat* of a CIO leaving could adversely affect fund performance if that CIO exerts less effort or devotes less attention to his current job. In our setting, this effect could manifest in the form of an increase in external manager fees or with excess portfolio turnover driven by a lack of well-researched investment ideas. In this section, we investigate whether compensation impacts a plan's ability to retain its CIO (e.g., the *retention* channel).

To begin, we investigate each instance of CIO turnover in our sample by reading press releases announcing each event. We then classify each turnover event as being a retirement, a firing, or a voluntary turnover.[20] If the press release suggests the manager is departing for another public pension plan or a position in a for-profit firm, we classify the turnover as being voluntary. We then estimate Cox proportional hazard models which predict the probability that a CIO voluntarily departs a given plan using the CIO's tenure as our time variable. Campbell et al (2011) detail the reasons why Cox proportional models are advantageous relative to logistic and multinomial logistic models that are commonly used in studies of manager turnover. Specifically, we estimate the following regressions:

$$h(t) = h_0(t)exp\left(\beta_1 Compensation_{i,t-1} + \alpha'\delta_{i,t-1}\right) \quad (2)$$

[20] There are 4 instances of CIOs dying in our sample.

where $\delta_{i,t-1}$ includes CIO compensation, past performance, plan size, plan funding, the *CIO Local* indicator variable, and the natural logarithm of the CIO's age as control variables. The regressions also include year fixed effects to control for the condition of the external labor markets each year. We remind the reader that a coefficient less than 1 indicates that a given coefficient makes failure less likely. We present the results of these regression in Table 8, Panel A.

The results indicate that higher compensation makes it less likely that a CIO voluntarily leaves a plan. Using the coefficient on *Top Quartile Compensation* in column 2 as our example, paying a CIO top quartile compensation makes that CIO 45% less likely to voluntarily leave the plan. Interestingly, CIOs who work for better performing and more well-funded plans are also less likely to voluntarily depart, which suggests that CIOs of public pension plans may gain utility from feeling like they are part of successful organizations. CIOs are also more likely depart when they work for larger pension plans, consistent with the idea that working at a larger plan provides these CIOs with greater exposure and publicity.[21]

*4.2.3. Does CIO Turnover Affect Plan Performance?*

Next, we examine whether there is a relation between future performance and CIO turnover. As discussed above, both potential and realized turnover may adversely affect future plan performance. To examine these possibilities, we calculate four measures of predicted or realized CIO turnover. The measures of predicted CIO turnover are the probability estimates we obtain from Models 1 and 2 in Table 8, Panel A. The first measure of realized turnover is an indicator

---

[21] For robustness, we also estimated these regressions using logistic regressions and find qualitatively similar results which are available upon request.

variable (*CIO Turnover Dummy*) equal to 1 for three years from t-1 to t+1 around a realized CIO turnover event and 0 otherwise. The second measure of realized CIO turnover (*Cumulative # Turnovers*) is equal to the number of realized CIO turnovers the plan has experienced from 2001 to the present date.

To test our hypothesis, we augment the regressions in Equation 1 with ourturnover measures described above (i.e. the predicted turnover measures obtained from Equation 2 or the variables capturing realized turnover events, *CIO Turnover Dummy* and *Cumulative # Turnovers*). The results can be found in Panel B of Table 8. The results provide strong support for our hypothesis. Specifically, the coefficients on both the predicted and realized turnover measures are all negative and statistically significant at the 1% level. The effects are also economically strong. A one standard deviation in the likelihood a CIO voluntarily leaves the plan is associated with a 0.143 – 0.146% decrease in peer-adjusted returns. Plans whose CIOs depart underperform by 0.272% per year for the 3 years around the turnover event. Combined, the results in this section support our hypothesis that CIO compensation helps public plans retain their CIOs and this retention bolsters plan performance.

*4.2.4. Does the Structure of CIO Compensation Impact Performance?*

A voluminous literature in finance and economics studies the impact that the structure of compensation has on performance. The basic idea is that agents should be provided with explicit incentive compensation to counteract the disutility they receive from exerting effort. In this section, we explore the possibility that highly paid CIOs outperform their lower paid counterparts because of the structure of their pay. We call this the *incentives* channel. Specifically, we investigate whether i) more highly paid CIOs also face higher termination risk and ii) more highly paid CIOs also have greater pay for performance sensitivity. Restated, it is possible that the relation between compensation and performance we document is driven by highly paid CIOs possessing "carrot" or "stick" incentives.

One possible explanation for the effect we document is that highly paid CIOs are also more likely to be terminated for poor performance. If true, this finding would suggest that CIOs are incentivized to outperform their counterparts in part because they are motivated to not lose their jobs. As mentioned in Section 4.2.2, we investigated every CIO turnover event in our sample and classified each as being a retirement, a voluntary turnover, or a firing. Our analysis reveals that CIO firings are exceedingly rare. In fact, there are only 20 instances in which a CIO is explicitly fired or resigns with no mention of a new job. Moreover, most of these terminations are the direct result of corrupt or outright illegal behavior.[22] Nevertheless, we model the likelihood a CIO is fired using the following linear probability models:

$$\begin{aligned} CIO\ Fired_{i,t} = \beta_1 Compensation_{i,t-1} + \beta_2 Compensation_{i,t-1} \times Performance_{i,t-1} \\ + X'\gamma_{i,t-1} + \varphi_t + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where $Compensation_{i,t-1}$ is either the log of the CIO's total compensation or an indicator variable equal to 1 for CIOs in the top quartile of compensation. $\gamma_{i,t-1}$ is a vector of plan and CIO characteristics that includes plan past performance, plan size, plan funding, *CIO Local*, *CIO Tenure*, and *CIO Age*. We also include year dummies in these regressions. Our coefficient of

[22] See the following cases as examples: Fred Buenrostro of CALPERS: https://calpensions.com/2016/06/06/calpers-ex-ceo-sentenced-but-probe-continues; David Loglisci of New York Common Retirement Fund: https://www.pionline.com/article/20121009/ONLINE/121009860/no-jail-time-or-probation-for-former-new-york-state-common-cio; Patricia Gerrick of North Carolina Pension: https://www.carolinajournal.com/news-article/new-questions-surround-ousted-treasury-official-and-fund-managers/

interest is $\beta_2$, as this coefficient captures the impact of a CIO's compensation on his likelihood to be terminated for poor performance. The results are presented in Table 9.

The results indicate that the termination risk CIOs face is not dependent on their compensation. The coefficients, $\beta_2$, on the interaction variable, $Compensation_{i,t-1} \times Performance_{i,t-1}$, are statistically insignificant. Moreover, the coefficients on $Compensation_{i,t-1}$ are also negative and statistically insignificant, which provides evidence against the idea that highly paid CIOs face greater termination risk, regardless of their investment performance. We interpret these results as evidence that is unsupportive of the *incentives* channel.

We now turn our attention to the possibility that highly paid CIOs also have high levels of performance-based compensation and that this performance-based compensation is driving the relation we document. As discussed earlier, the data the pension plans provided us break the CIO's compensation into net annual salary, bonuses, and deferred compensation components. We use this data to construct several measures of incentive-based pay. The first measure, *20% Bonus*, is an indicator variable equal to 1 if the plan has paid its CIO a bonus equal to 20% of his total compensation in any past year, and 0 otherwise.[23] We also construct a second indicator variable, *PPS*, that takes into account the possibility that some CIOs receive implicit performance-based pay in the form of salary increases based on their past performance (Murphy, 1999).

[23] We also used 10% and 50% as our threshold value and found qualitatively similar results.

Specifically, for a given plan year, we use all prior return and compensation observations to determine whether the CIO's pay relates to his performance. Specifically, for each CIO-year, we estimate the following regression:

$$LogCompensation_{i,t} = \beta Performance_{i,t} + \theta' \rho_{i,t-1} + \varepsilon_{i,t} \qquad (3)$$

where $\rho_{i,t-1}$ contains the CIO's tenure and plan size. It is well-known that CIOs with longer tenures and those working for larger plans earn higher compensation (Binfare and Harris, 2020). *PPS* is equal to 1 for plan-years in which i) $\beta$ is greater than 0 and ii) statistically significant at the 5% level or better, and 0 otherwise. We estimate rolling regressions to allow for the possibility that some plans begin paying their CIOs performance-based compensation at different points in time. Our *PPS* variable is equal to 1 in 19.15% of all plan-years. This relatively low figure is consistent with industry publications suggesting that performance-based pay was rare for public pension plan CIOs during most of our sample.

Next, we double sort our sample of CIOs based on whether they receive incentive compensation and then based on their overall compensation level. We compare the performance of each subgroup and present the results in Table 10, Panel A. There are several findings worth discussing. First, the number of CIOs receiving bonuses of at least 20% is monotonically increasing by compensation quartile. Only 13 CIOs in the lowest compensation quartile received a bonus greater than or equal to 20% of their total compensation while 162 CIOs in the top quartile received a large bonus. More specifically, the correlation between the log of the CIO's total compensation and the 20% bonus dummy is 0.47.[24] Second, we find no statistically significant difference in the performance of the CIOs receiving bonuses or performance-based pay within any of the compensation quartiles. Third, the higher paid CIOs continue to outperform the lower paid CIOs within both incentive pay groups by between 0.42 – 0.570% per year.[25] The results continue to suggest that it is the overall level of compensation, rather than the presence of any performance based pay, that influences plan performance.

As a final test, we re-estimate the regression in Equation 1 after augmenting it with the two incentive compensation indicator variables, *Bonus20* and *PPS*, described above. Panel B of Table 10 contains the results. We continue to find a positive and statistically significant relation between total CIO compensation and plan performance even with the inclusion of these proxies for incentive compensation. Moreover, neither *Bonus20* nor *PPS* has a statistically significant effect on plan performance.

Combined, the results in this section do not provide evidence in support of the incentives channel. We interpret these findings as evidence that plans use incentive compensation to mitigate concerns that the public may believe that CIOs are paid too highly and have not earned their compensation. Restated, our results are complementary to those of Dyck, Manoel, and Morse (2019) who suggest that public outrage over CIO compensation levels is an impediment to paying these employees competitive salaries.

---

[24] The correlation between our *PPS* dummy and CIO Total Compensation is only 0.048. We believe that the most likely explanation here is that even lower paid CIOs receive raises based on their past performance.

[25] The reason the differences in the groups of CIOs with incentive compensation are not statistically significant is due to the low number of CIOs in the bottom quartile who receive incentive compensation.

*4.3. Holdings-Based Evidence*

In this section, we use the equity holdings of the subsample of public pension plans who file 13F forms with the Securities and Exchange Commission (SEC). We manually search for and match the plans in our sample to the SEC EDGAR database and find 23 pension plans who combine to file 1,054 13Fs over our sample period. Examining the plans' equity holdings allows us to provide more evidence of the actions CIOs take to influence investment performance.

We calculate several measures of investment performance and behavior biases. *DGTW Return* follows Daniel et al (1997) and captures the manager's stock picking ability relative to benchmark portfolios based on stock characteristics. We calculate *Portfolio Turnover* following Barber and Odean (2001) as the prior literature has shown that excess trading leads to worse investment performance (e.g., Barber and Odean, 2000; 2001). we calculate the percentage of stocks in the plan's portfolio that are defined as lottery stocks (*% Lottery Stocks*) using the definition of Kumar (2009). Finally, *Disposition* is defined as in Odean (1998) and captures investors' habit of holding on to losses too long and realizing gains too quickly. Specifically, *Disposition* is equal to the percentage of losses realized minus the percentage of gains realized such that a higher number means a manager is less prone to this bias. Each of the preceding measures has been shown to be detrimental to investment performance. Our hypothesis is that higher paid managers will be better stock pickers and will be less prone to excess trading and behavior biases.

*4.3.1. Baseline Results*

To begin, we repeat the univariate analysis of Table 3, Panel A using the four holdings-based measures described above. Specifically, we sort the plans based on their CIO's compensation and see if higher paid CIOs have higher *DGTW Returns* and lower *Portfolio Turnover*, *Disposition*, and *% Lottery Stocks*. The results can be found in Table 11, Panel A.

The results strongly support our prior evidence that higher paid CIOs outperform their counterparts. Specifically, plans with CIOs in the top quartile of compensation have 0.404% higher *DGTW Returns* each quarter than their lowest paid counterparts. This difference is statistically significant at the 1% level.

Higher paid CIOs are also less prone to behavior biases. These CIOs trade less frequently, hold fewer lottery stocks, and are less prone to the disposition effect. For instance, CIOs in the highest quartile of compensation have annual portfolio turnover of 21.0% while those in the lowest quartile have turnover equal to 31.9%. This difference of 10.9% is statistically significant at the 1% level. The highest paid CIOs hold just 2.84% of their portfolios in lottery stocks while the lowest paid CIOs hold 6.41% of their portfolios in lottery stocks. The difference of 3.57% is also statistically significant at the 1% level. Finally, although the most highly paid CIOs realize 2.7% more of their gains than their losses, CIOs in the lowest quartile of compensation realize 9.1% more of their gains than they do their losses. This difference of 5.4% is statistically significant at the 5% level. Combined, these results using holdings-based measures continue to support our main finding that higher-paid CIOs outperform their lower paid counterparts.

*4.3.2. Holdings-Based Evidence for Hiring and Retention Channels*

For our final set of analyses, we examine whether our holdings-based measures of behavioral biases correlate with our attraction and retention hypotheses. Our first hypothesis was that paying higher compensation assists in hiring a more talented CIO. Indeed, in Section 4.2.1, we document that higher paid CIOs come from more selective universities. We now examine whether these CIOs are also less prone to holding lottery stocks and the disposition effect (in line with arguments in Kumar, 2009 and empirical evidence documented in Vaarmets, Liivamägi, and Talpsepp, 2019). To do so, we sort CIOs based on their education quality measures and compare these two measures across groups. We present the results of these tests in Table 11, Panel B. Our results are consistent with this conjecture. More highly educated CIOs hold 1.6 – 1.8% less of their portfolio in lottery stocks and are 20.2 – 20.9% less prone to the disposition effect, both relative to the group of the lowest paid CIOs. These differences are statistically significant at the 1% level.

Finally, we examine plans' portfolio turnover around CIO turnover. Our retention hypothesis posits that one reason why investment performance with higher managerial turnover is that new managers set their own agenda when they begin a new job. In our context, this agenda setting would mean exchanging the old CIO's investments for new ones. To test this hypothesis, we examine portfolio turnover before, around, and after CIO turnover events. The results strongly support our hypothesis and can be found in Table 11, Panel C. In the years prior to a turnover event, we find that average annual portfolio turnover is only 4.4%. However, in the three years surrounding a CIO turnover event (-1 to +1 years), portfolio turnover increases to 70.8%. This difference of 66.4% is both economically and statistically significant. In the period after the CIO turnover, portfolio turnover falls back to 24% a year. The 46.8% difference in the around – after period is also statistically significant.

Combined, the results in this section provide further evidence that i) higher CIO compensation is associated with better investment performance and ii) the channels for this outperformance are the ability to hire and retain a more talented CIO.

## 5. Conclusion

Extent academic research on public pension plans has documented that political influence and funding levels significantly affect plan investment performance. In this paper, we document another factor which influences plan performance: CIO compensation. Specifically, our results indicate that more highly paid CIOs outperform their lower paid counterparts. In economic terms, we find that CIOs in the top quartile of compensation outperform those in the bottom quartile by 47 bps per year which translates to approximately $201.59 million in additional value for the public pension plan. The relation between compensation level and plan performance is driven by higher paying funds being able to attract and retain more talented managers.

. Lastly, higher paying plans also provide higher levels of performance-based incentive compensation; however, the effect of compensation on performance is *not* driven by the structure of the compensation. Combined, these results suggest that public pension plans use incentive compensation as a means of paying their CIOs more, perhaps to reduce any outrage about the magnitude of the compensation these CIOs receive.

## References

Agarwal, V., N.M. Boyson, and N.Y. Naik, 2009, Journa*l of Financial and Quantitative* Analysis, 44(2),273–305

Agarwal, V. and S. Ray, 2013, Institutional Investment and Intermediation in the Hedge Fund Industry, working paper

Andonov, A., R.M.M.J. Baker, and K.J.M. Cremers, 2017. Pension fund asset allocation and liability discount rates, *Review of Financial Studies* 30, 2555 – 2595.

Andonov, A., Y.V. Hochberg, and J.D. Rauh, 2018. Political representation and governance: evidence from the investment decisions of public pension funds, *Journal of Finance* 73, 2041 – 2086.

Barber, B. and T. Odean, 2000. Trading is hazardous to your wealth: the common stock investment performance of individual investors, *Journal of Finance* 55, 773 – 806.

Barber, B. and T. Odean, 2001. Boys will be boys: gender, overconfidence, and common stock investment, *Quarterly Journal of Economics* 116, 261 – 292.

Binfare, M. and R.S. Harris, 2020. Does chief investment officer pay reflect performance? Evidence from non-profits, Working paper, University of Missouri and University of Virginia.

Brown, J.R., J.M. Pollet, and S.J. Weisbenner, 2015. The in-state equity bias of state pension plans, NBER Working Paper #21020.

Campbell, H. and C.B.Dean, 2013, the consequences of proportional hazards based model selection, *Statistics in Medicine*, 33, 1042-1056

Chhaochharia, V. and Y. Grinstein, 2009, CEO Compensation and Board Structure, *Journal of Finance*, 64(1), 231-262

Chevalier, J. and G. Ellison, 1999. Career concerns of mutual fund managers, *Quarterly Journal of Economics* 114, 389 – 432.

Christoffersen, S.E.K and S. Sarkissian, 2009, City size and fund performance, *Journal of Financial Economics*, 92(2), 252-275

Coronado, J.L., E.M. Engen, and B. Knight, 2003, Public Funds and Private Capital Markets: The Investment Practices and Performance of State and Local Pension Funds, *National Tax Journal*, 56(3), 579-594

Dal Bo, E., F. Finan, and M.A.Rossi, 2013, Strengthening State Capabilities: The Role of Financial Incentives in the Call to Public Service, *Quarterly Journal of Economics*, 128(3), 1169–1218

Daniel, K., M. Grinblatt, S. Titman, and R. Wermers, 1997. Measuring mutual fund performance with characteristic-based benchmarks, *Journal of Finance* 52, 1035 – 1058.

Deci, E. L., 1971, the Effects of Externally Mediated Rewards on Intrinsic Motivation, *Journal of Personality and Social Psychology* 18(1), 105-115

Deuskar, P., Z.J. Wang, Y. Wu and Q. H. Nguyen, 2012, The Dynamics of Hedge Fund Fees, Working Paper

Dyck, A., P.M. Manoel, and A. Morse, 2019. Outraged by compensation: implications for public pension performance, working paper, University of California-Berkeley

Ennis, R.M., 2020, Institutional Investment Strategy and Manager Choice: A Critique, *Journal of Portfolio Management*, Fund Manager Selection Issue

Glucksberg, S., 1962, The influence of strength of drive on functional fixedness and perceptual recognition, *Journal of Experimental Psychology* 63, 36 – 41.

Guthrie, K., J. Sokolowsky, and K.Wan, 2012, CEO Compensation and Board Structure Revisited, *Journal of Finance*, 67(3), 1149-1168

Hochberg, Y.V., J.D. Rauh, 2013, Local Overweighting and Underperformance: Evidence from Limited Partner Private Equity Investments, Review of Financial Studies, 26(2), 403–451

Khorana, A., 2001. Performance Changes following Top Management Turnover: Evidence from Open-End Mutual Funds, *Journal of Financial and Quantitative Analysis* 36(3), 371 – 393.

Kumar, A., 2009. Who gambles in the stock market?, *Journal of Finance* 64, 1889 – 1933.

Lazear, E.P., 2001, Educational Production, 2001, Quarterly Journal of Economics, 116(3), 777–803

Li J. and A. Scherbina, 2011, Inheriting Losers, *Review of Financial Studies*, 24(3), 786-820.

Li, Q., B. Lourie, A. Nekrasov, and T. Shevlin, 2020, Employee Turnover and Firm Performance: Large-Sample Archival Evidence, working paper

Lim, J.,B.A. Sensoy, M.S. Weisbach, 2016, Indirect Incentives of Hedge Fund Managers, *Journal of Finance*, 71(2), 871-918

Yin, C., 2016, The Optimal Size of Hedge Funds: Conflict between Investors and Fund Managers, *Journal of Finance*, 71(4), 1857-1894

Ma, L., Y. Tang, and J.P. Gomez, 2019. Portfolio manager compensation in the U.S. mutual fund industry, *Journal of Finance* 74, 587 – 638.

Murphy, K., 1999, Murphy, Kevin J., Executive Compensation, working paper

Murphy, K., 2012, Murphy, Kevin J Executive Compensation: Where We Are, and How We Got There, Handbook of the Economics of Finance, 2, pp 211-356

Novy-Marx, R. and J.D. Rauh, 2009. The liabilities and risks of state-sponsored pension plans, *Journal of Economic Perspectives* 23, 191 – 210.

Novy-Marx, R. and J.D. Rauh, 2011a. Public pension promises: how big are they and what are they worth?, *Journal of Finance* 66, 1211 – 1249.

Odean, T., 1998. Are investors reluctant to realize their losses?, *Journal of Finance* 53, 1775 – 1798.

Oyer, P., S. Schaefer, 2005, Why do some firms give stock options to all employees?: An empirical examination of alternative theories, *Journal of Financial Economics*, 76(1), 99-133

Pan, Y. and T.Y. Wang, 2012, First Year in Office: How Do New CEOS Create Value?, working paper

Pink., D., 2011, The surprising truth about what motivates us, *Drive*

Vaarmets, T., K. Liivamägi, and T. Talpsepp, 2019. How Does Learning and Education Help to Overcome the Disposition Effect?, *Review of Finance*, 801–830,

Wade, O'Reilly, and Pollock, 2006, *Organization Science* 17(5), 527–544

## Table 1: Sample Description.

This table contains the list of pension plans that manage at least a portion of their assets in-house and the years for which we have obtained the chief investment officer's compensation information.

| State | Plan | Years |
|---|---|---|
| AL | Alabama ERS/TRS | 2001-2018 |
| AK | Alaska PERS/TRS | 2017-2018 |
| AZ | Arizona Public Safety/Corrections Officers | 2013-2018 |
| AZ | Arizona SRS | 2001-2018 |
| AZ | Phoenix ERS | 2014-2018 |
| AR | Arkansas PERS | |
| AR | Arkansas Teachers | |
| CA | California PERF | 2001-2018 |
| CA | California Teachers | 2001-2018 |
| CA | Kern County ERS | 2001-2018 |
| CA | Orange County ERS | 2001-2018 |
| CA | Sacramento County ERS | 2001-2018 |
| CA | San Francisco City & County ERS | 2002-2018 |
| CA | Alameda County ERS | 2002-2018 |
| CA | Los Angeles Fire and Police | 2004-2018 |
| CA | Los Angeles ERS | 2005-2018 |
| CA | San Diego City ERS | 2009-2018 |
| CA | Contra Costa ERA | |
| CA | LA County ERS | |
| CA | San Diego County | |
| CA | University of California | 2004-2018 |
| CA | Los Angeles Water and Power | |
| CO | Denver Employees | 2001-2018 |
| CO | Colorado PERA | 2005-2018 |

| State | Plan | Years |
|---|---|---|
| CT | Hartford MERF | 2001-2018 |
| CT | Connecticut SERS/TRS/Municipal | 2003-2018 |
| DE | Delaware State Employees | 2008-2018 |
| DC | DC Police & Fire/Teachers | 2011-2017 |
| FL | Florida RS | |
| FL | Jacksonville ERS | |
| GA | Georgia ERS/TRS | 2001-2018 |
| HI | Hawaii ERS | 2001-2018 |
| ID | Idaho PERS | 2001-2018 |
| IL | Illinois Teachers | 2001-2018 |
| IL | Illinois Municipal | 2005-2018 |
| IL | Illinois Universities | 2006-2018 |
| IL | Chicago Police | 2009-2018 |
| IL | Illinois SERS | 2014-2018 |
| IL | Chicago Teachers | 2016-2018 |
| IL | Chicago Municipal | |
| IL | Cook County ERS | |
| IN | Indiana PERF | 2001-2018 |
| IN | Indiana Teachers | 2001-2018 |
| IA | Iowa PERS | 2001-2018 |
| KS | Kansas PERS | 2001-2018 |
| KY | Kentucky ERS/County | 2001-2018 |
| KY | Kentucky Teachers | 2001-2018 |
| LA | Louisiana Teachers | 2001-2018 |

| State | Plan | Years |
|---|---|---|
| LA | Louisiana Schools | 2001-2018 |
| LA | Louisiana SERS | 2001-2018 |
| LA | Louisiana Municipal Police | |
| LA | Louisiana State Parochial Employees | 2014-2018 |
| LA | New Orleans ERS | |
| ME | Maine Local/State/Teachers | 2001-2018 |
| MD | Maryland PERS/TRS | 2005-2018 |
| MD | Montgomery County Maryland ERS | 2014-2018 |
| MA | Boston RS | 2001-2018 |
| MA | Massachusetts SRS/TRS | 2005-2018 |
| MI | Michigan Municipal | 2001-2018 |
| MI | Michigan Public Schools | 2001-2018 |
| MI | Michigan SERS | 2001-2018 |
| MI | Detroit Police and Fire | |
| MI | Detroit General RS | |
| MN | Duluth Teachers | |
| MN | Minneapolis ERF | 2014-2018 |
| MN | Minnesota GERF/Police & Fire/TRS/SERS | 2014-2018 |
| MS | Mississippi PERS | 2001-2018 |
| MO | Missouri SERS | 2001-2018 |
| MO | Missouri DOT and Highway | 2006-2018 |
| MO | Missouri Local | |
| MO | Missouri PEERS/TRS | |
| MT | Montana PERS/TRS | |
| NE | Nebraska Schools | 2011-2018 |
| NE | Omaha Police and Fire | 2017-2018 |
| NV | Nevada Police & Fire/Regular Employees | 2001-2018 |
| NH | New Hampshire RS | 2001-2018 |
| NJ | New Jersey PERS/Police & Fire/TRS | 2001-2018 |
| NM | New Mexico Educational | 2011-2018 |

| State | Plan | Years |
|---|---|---|
| NY | NY State Teachers | 2004-2018 |
| NY | NYC TRS/Fire/Police/ERS | 2008-2018 |
| NY | NY State & Local ERS/Police & Fire | |
| NC | North Carolina Local Govt/Teachers/SERS | |
| ND | North Dakota PERS/TRS | 2001-2018 |
| OH | Ohio School Employees | 2012-2018 |
| OH | Ohio PERS | 2010-2018 |
| OH | Ohio Teachers | 2014-2018 |
| OH | Ohio Police & Fire | 2013-2018 |
| OK | Oklahoma PERS | 2001-2018 |
| OK | Oklahoma Teachers | 2001-2018 |
| OK | Oklahoma Police | 2005-2018 |
| OR | Oregon PERS | |
| PA | Pennsylvania School Employees | 2001-2018 |
| PA | Pennsylvania State ERS | 2001-2018 |
| PA | Pennsylvania Municipal | 2012-2018 |
| PA | Philadelphia Municipal | 2016-2018 |
| RI | Rhode Island ERS/Municipal | 2001-2018 |
| SC | South Carolina Police & RS | 2010-2018 |
| SD | South Dakota RS | 2019-2018 |
| TN | Tennessee Political/State & Teachers | |
| TN | Nashville-Davidson ERS | |
| TX | Austin ERS | 2001-2018 |
| TX | Texas County & District | 2001-2018 |
| TX | Texas Teachers | 2001-2018 |
| TX | Texas Municipal | 2003-2018 |
| TX | Texas ERS | 2006-2018 |
| TX | Texas LECOS | 2006-2018 |
| TX | Houston Firefighters | 2008-2018 |
| TX | Dallas Police and Fire | |

| State | Plan | Years |
| --- | --- | --- |
| UT | Utah Noncontributory/Public Safety | 2016-2018 |
| VT | Vermont State Employees/Teachers | 2015-2017 |
| VA | Fairfax County Schools | |
| VA | Virginia RS | |
| WA | Seattle ERS | 2001-2018 |
| WA | Washington Law Enforcement/PERS/SERS/TRS | 2006-2018 |
| WV | West Virginia PERS/Teachers | 2001-2018 |
| WI | Wisconsin RS | 2001-2018 |
| WI | Milwaukee City ERS | 2001-2018 |
| WY | Wyoming Public Employees | 2010-2018 |

## Table 2: Summary Statistics

This table contains the summary statistics for the variables used in our study, all of which are tabulated at the plan-year level. Panel A of this table contains the summary statistics for the chief investment officer variables in our sample. Panel B contains the summary statistics of our pension fund variables. Plan C contains summary statistics for the demographic variables in our sample. All continuous variables are winsorized at the 1% and 99% levels.

*Panel A. Chief Investment Officer Variables*

| | | | | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Std. Dev | 10th | 25th | 50th | 75th | 90th |
| CIO Total Compensation | 1660 | $263,043.90 | $179,189.70 | $105,000.00 | $145,113.30 | $207,422.80 | $318,362.00 | $504,854.80 |
| CIO Salary | 1660 | $237,207.90 | $134,529.60 | $104,844.10 | $141,203.90 | $200,000.00 | $300,132.00 | $408,983.20 |
| CIO Bonus | 1660 | $25,836.02 | $82,285.41 | $0.00 | $0.00 | $0.00 | $0.00 | $69,641.46 |
| CIO Local (0/1) | 2421 | 0.49 | 0.50 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| CIO Institution SAT | 1915 | 1272.42 | 138.55 | 1107.00 | 1162.00 | 1246.00 | 1395.00 | 1466.00 |
| CIO Institution Admit Rate | 1929 | 0.54 | 0.26 | 0.15 | 0.29 | 0.61 | 0.76 | 0.82 |
| CIO Age | 2432 | 50.90 | 8.84 | 39 | 45 | 51 | 57 | 62 |
| CIO Tenure | 2325 | 6.60 | 8.03 | 0 | 1 | 4 | 9 | 16 |
| CIO Fired (0/1) | 2329 | 0.014 | 0.116 | 0 | 0 | 0 | 0 | 0 |
| CIO Voluntary Turnover (0/1) | 2330 | 0.055 | 0.229 | 0 | 0 | 0 | 0 | 0 |

*Panel B. Pension Plan Variables*

| | | | | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Std. Dev | 10th | 25th | 50th | 75th | 90th |
| Plan Size ($mill) | 2427 | 18815.55 | 30912.28 | 1716.94 | 3576.11 | 8901.90 | 20377.24 | 43773.19 |
| Funding Ratio (%) | 2411 | 79.49 | 19.16 | 57.18 | 67.20 | 79.50 | 91.20 | 100.80 |
| Annual Investment Return | 2434 | 6.71 | 10.46 | -6.40 | 0.60 | 9.20 | 14.10 | 18.00 |
| % Allocation Equity | 2335 | 52.36% | 10.82% | 37.80% | 46.10% | 53.89% | 60.10% | 64.94% |
| % Allocation Fixed Income | 2335 | 27.01% | 8.68% | 17.90% | 21.90% | 25.80% | 31.40% | 37.50% |
| % Allocation Private Equity | 2335 | 5.97% | 5.69% | 0.00% | 0.00% | 5.09% | 9.60% | 13.20% |
| % Allocation Hedge Funds | 2335 | 4.08% | 6.49% | 0.00% | 0.00% | 0.00% | 6.34% | 13.10% |

## Table 3: Chief Investment Officer Compensation and Fund Performance

This table reports results of tests that compare the returns of public pension plans based on the compensation of their chief investment officer (CIO). The performance measure is *Peer-Adjusted Return* which is the difference of a plan's return and the average pension plan return each year. Panel A reports the univariate results and Panel B reports the results of multivariate regressions with plan level controls and year fixed effects. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Univariate Tests*

| **Compensation Quartile (t – 1)** | **Abnormal Return (t)** |
|---|---|
| 1 | -0.215%** |
| | (-2.20) |
| 2 | -0.028% |
| | (-0.27) |
| 3 | -0.021% |
| | (-0.20) |
| 4 | 0.251%** |
| | (2.52) |
| 4 - 1 | 0.466%*** |
| | (3.34) |

*Panel B. Multivariate Regressions*

| | Peer-adjusted Return (t) | | | Raw Return (t) | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log Compensation (t-1) | 0.293*** | | | 0.337*** | | |
| | (4.37) | | | (3.30) | | |
| 2nd Quartile Comp (t-1) | | 0.116 | | | 0.081 | |
| | | (1.38) | | | (0.90) | |
| 3rd Quartile Comp (t-1) | | 0.214** | | | 0.281* | |
| | | (2.12) | | | (1.90) | |
| Top Quartile Comp (t-1) | | 0.387*** | 0.251** | | 0.403** | 0.244* |
| | | (3.86) | (2.45) | | (2.80) | (1.80) |
| Peer-adjusted Return (t-1) | 0.076 | 0.073 | 0.075 | 0.030 | 0.038 | 0.040 |
| | (1.08) | (1.03) | (1.05) | (0.51) | (0.48) | (0.50) |
| Log Fund Size (t-1) | 0.034 | 0.044 | 0.063* | 0.048 | 0.062** | 0.089** |
| | (0.97) | (1.52) | (1.83) | (1.48) | (2.24) | (2.64) |
| Plan Funding % (t - 1) | -0.762* | -0.757* | -0.690* | -0.781* | -0.768* | -0.695 |
| | (-1.93) | (-1.97) | (-1.77) | (-1.81) | (-1.79) | (-1.59) |
| % Equity Allocation (t - 1) | 1.962 | 1.664 | 1.560 | 2.239 | 1.856 | 1.793 |
| | (1.02) | (0.86) | (0.81) | (0.93) | (0.76) | (0.74) |
| % Fixed Income Allocation (t - 1) | -1.271 | -1.570 | -1.598 | -0.570 | -0.901 | -0.855 |
| | (-0.55) | (-0.70) | (-0.71) | (-0.21) | (-0.33) | (-0.32) |
| % Private Equity Allocation (t - 1) | 1.367* | 1.053* | 1.164* | 1.672* | 1.304 | 1.572* |
| | (1.91) | (1.75) | (2.05) | (1.87) | (1.48) | (1.93) |
| % Hedge Fund Allocation (t - 1) | -3.347 | -3.698* | -3.748* | -3.700 | -4.129* | -4.093* |
| | (-1.68) | (-1.90) | (-1.93) | (-1.59) | (-1.81) | (-1.85) |
| % Real Estate Allocation (t - 1) | 2.256 | 2.172 | 2.234 | 2.250 | 2.091 | 2.186 |
| | (1.04) | (0.97) | (0.99) | (0.99) | (0.88) | (0.92) |
| Year Fixed Effects | YES | YES | YES | YES | YES | YES |
| Number of Observations | 1,433 | 1,423 | 1,423 | 1,428 | 1,418 | 1,418 |
| Adj. R-squared | 0.0562 | 0.0544 | 0.0544 | 0.954 | 0.954 | 0.954 |

## Table 4: Robustness Tests on the Relation Between CIO Compensation and Fund Performance

This table reports results of tests that compare the returns of public pension plans based on the compensation of their chief investment officer (CIO). Panel A contains the results when we use various CIO compensation variables lagged 2 years instead of 1. Panel B contains the results using *Raw Return* and *Sharpe Ratio* as the performance measure. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Compensation Lagged 2 Years*

| | Peer-adjusted Return (t)<br>(1) | Raw Return (t)<br>(2) | Sharpe Ratio (t to t + 3)<br>(3) |
|---|---|---|---|
| Log Compensation (t-2) | 0.219** | 0.210* | 0.081** |
| | (2.43) | (2.07) | (2.21) |
| Peer-adjusted Return (t-1) | 0.039 | 0.055 | -0.002 |
| | (0.58) | (0.91) | (-0.17) |
| Log Fund Size (t-1) | 0.052 | 0.076*** | 0.005 |
| | (1.42) | (3.39) | (0.25) |
| Plan Funding % (t - 1) | -0.590 | -0.537 | 0.009 |
| | (-1.44) | (-1.04) | (0.11) |
| % Equity Allocation (t - 1) | 1.436 | 1.026 | -0.104 |
| | (0.61) | (0.35) | (-0.33) |
| % Fixed Income Allocation (t - 1) | -2.373 | -1.446 | 0.626** |
| | (-0.97) | (-0.49) | (2.47) |
| % Private Equity Allocation (t - 1) | 0.548 | -0.037 | 0.790 |
| | (0.67) | (-0.03) | (1.63) |
| % Hedge Fund Allocation (t - 1) | -3.376 | -3.477 | -0.558 |
| | (-1.62) | (-1.43) | (-1.32) |
| % Real Estate Allocation (t - 1) | 0.999 | 0.619 | -0.179 |
| | (0.35) | (0.22) | (-0.35) |
| Year Fixed Effects | YES | YES | YES |
| Number of Observations | 1,035 | 1,035 | 952 |
| Adj. R-squared | 0.0345 | 0.951 | 0.836 |

*Panel B. Alternative Performance Measures*

| | Sharpe Ratio (t to t + 3) | | Raw Return | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log Compensation (t-1) | 0.135* | | 0.314*** | |
| | (1.88) | | (2.99) | |
| Top Quartile Comp (t-1) | | 0.171** | | 0.198* |
| | | (2.24) | | (1.80) |
| Peer-adjusted Return (t-1) | 0.008 | 0.008 | -0.020 | -0.016 |
| | (1.45) | (1.61) | (-0.21) | (-0.16) |
| Standard Deviation (t - 3, t - 1) | | | -0.009 | -0.011 |
| | | | (-0.10) | (-0.11) |
| Log Fund Size (t-1) | -0.002 | 0.004 | 0.045 | 0.090** |
| | (-0.08) | (0.17) | (1.10) | (2.19) |
| Plan Funding % (t - 1) | 0.034 | 0.042 | -0.615 | -0.509 |
| | (0.31) | (0.37) | (-1.31) | (-1.06) |
| % Equity Allocation (t - 1) | -0.338 | -0.405 | 1.838 | 1.766 |
| | (-0.94) | (-1.13) | (0.56) | (0.54) |
| % Fixed Income Allocation (t - 1) | 0.676 | 0.650 | -2.731 | -2.648 |
| | (1.44) | (1.40) | (-0.91) | (-0.87) |
| % Private Equity Allocation (t - 1) | 0.601 | 0.637 | 1.378 | 1.665 |
| | (0.74) | (0.80) | (0.96) | (1.13) |
| % Hedge Fund Allocation (t - 1) | -0.729 | -0.814* | -4.407 | -4.428 |
| | (-1.71) | (-1.95) | (-1.73) | (-1.74) |
| % Real Estate Allocation (t - 1) | 0.117 | 0.069 | 0.918 | 0.944 |
| | (0.13) | (0.08) | (0.31) | (0.32) |
| Constant | -0.496 | 1.089** | 3.792 | 7.096*** |
| | (-0.65) | (2.46) | (1.46) | (3.44) |
| | | | | |
| Year Fixed Effects | YES | YES | YES | YES |
| Observations | 1,061 | 1,056 | 1,029 | 1,029 |
| Adj. R-squared | 0.788 | 0.789 | 0.950 | 0.950 |

## Table 5: Is CIO Compensation a Proxy for Fund Culture?

This table reports results of tests examining the relations between CIO compensation, fund culture, and performance. We use *Separate Investment Board*, an indicator variable equal to 1 if the fund has a dedicated board or advisory council for the investment function of the pension plan as our proxy for culture. Panel A reports the univariate results and Panel B reports the results of multivariate regressions with plan level controls and year fixed effects. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Univariate Tests*

| Compensation Quartile (t – 1) | Sep. Investment Board = 1 | Sep. Investment Board = 0 | Difference |
|---|---|---|---|
| 1 | -0.253% | -0.211% | -0.042% |
| | (N = 61) | (N = 295) | (-0.16) |
| 2 | 0.093% | -0.08% | 0.168% |
| | (N = 112) | (N = 257) | (0.73) |
| 3 | -0.107% | 0.01% | -0.117% |
| | (N = 95) | (N = 269) | (-0.49) |
| 4 | 0.483% | 0.170% | 0.313% |
| | (N = 98) | (N = 278) | (1.38) |
| 4 -1 | 0.736%*** | 0.380%** | |
| | (2.67) | (2.34) | |

*Panel B. Multivariate Tests*

| | Peer-adjusted Return (t) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log Compensation (t – 1) | 0.307*** | | | |
| | (5.57) | | | |
| 2nd Quartile Comp (t – 1) | | 0.104 | | |
| | | (1.06) | | |
| 3rd Quartile Comp (t – 1) | | 0.240** | | |
| | | (2.29) | | |
| Top Quartile Comp (t – 1) | | 0.400*** | 0.255** | |
| | | (4.20) | (2.75) | |
| Above Median Comp (t – 1) | | | | 0.254*** |
| | | | | (2.98) |
| Separate Investment Board (0/1) | 0.235** | 0.223* | 0.229* | 0.232* |
| | (2.17) | (1.87) | (2.03) | (2.09) |
| Peer-adjusted Return (t – 1) | 0.067 | 0.064 | 0.065 | 0.065 |
| | (0.92) | (0.88) | (0.90) | (0.89) |
| Log Fund Size (t – 1) | 0.037 | 0.047* | 0.069** | 0.058** |
| | (1.21) | (1.75) | (2.16) | (2.51) |
| Plan Funding % (t - 1) | -0.847* | -0.838** | -0.766* | -0.794* |
| | (-2.06) | (-2.17) | (-1.95) | (-2.06) |
| % Equity Allocation (t - 1) | 2.115 | 1.804 | 1.713 | 1.736 |
| | (1.04) | (0.88) | (0.84) | (0.85) |
| % Fixed Income Allocation (t - 1) | -1.183 | -1.508 | -1.503 | -1.590 |
| | (-0.49) | (-0.65) | (-0.64) | (-0.68) |
| % Private Equity Allocation (t - 1) | 0.929 | 0.612 | 0.749 | 0.531 |
| | (1.28) | (1.19) | (1.56) | (1.02) |
| % Hedge Fund Allocation (t - 1) | -3.551 | -3.932* | -3.945* | -4.067* |
| | (-1.70) | (-1.92) | (-1.92) | (-1.99) |
| % Real Estate Allocation (t - 1) | 2.503 | 2.409 | 2.490 | 2.494 |
| | (1.14) | (1.06) | (1.09) | (1.10) |
| Year Fixed Effects | YES | YES | YES | YES |
| Observations | 1,428 | 1,418 | 1,418 | 1,418 |
| Adj. R-squared | 0.0549 | 0.0529 | 0.0527 | 0.0532 |

## Table 6: Is CIO Compensation a Proxy for Location?

This table reports results of tests examining the relations between CIO compensation, fund location, and performance. *Financial Center* is an indicator variable equal to 1 if the fund is located in one of the 6 financial centers used in Christofferson and Sarkissian (2009). *Top Quartile MSA* is an indicator variable equal to 1 if the pension plan is headquartered in a MSA that is the top quartile of our sample. Panel A reports the univariate results and Panel B reports the results of multivariate regressions with plan level controls and year fixed effects. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Univariate Tests*

| Compensation Quartile (t – 1) | Financial Center = 1 | Financial Center = 0 | Difference |
|---|---|---|---|
| 1 | -0.464% | -0.187% | -0.277% |
| | (N = 36) | (N = 321) | (-0.85) |
| 2 | 0.354% | -0.07% | 0.427% |
| | (N = 39) | (N = 334) | (1.24) |
| 3 | 0.169% | -0.057% | 0.226% |
| | (N = 58) | (N = 306) | (0.79) |
| 4 | 1.211% | 0.171% | 1.040%*** |
| | (N = 29) | (N = 347) | (2.82) |
| 4 -1 | 1.678%*** | 0.358%** | |
| | (4.91) | (2.40) | |

| Compensation Quartile (t – 1) | Top Quartile MSA = 1 | Top Quartile MSA = 0 | Difference |
|---|---|---|---|
| 1 | -0.372% | -0.191% | -0.181% |
| | (N = 48) | (N = 321) | (-0.63) |
| 2 | -0.108% | -0.001% | -0.107% |
| | (N = 95) | (N = 278) | (-0.44) |
| 3 | 0.216% | -0.091% | 0.307% |
| | (N = 83) | (N = 281) | (1.23) |
| 4 | 0.255% | 0.250% | 0.005% |
| | (N = 89) | (N = 287) | (0.02) |
| 4 -1 | 0.627%* | 0.441%*** | |
| | (1.78) | (2.87) | |

*Panel B. Multivariate Tests*

| | Peer-adjusted Return (t) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log Compensation (t – 1) | 0.321*** | | 0.287*** | |
| | (5.29) | | (5.24) | |
| Top Quartile Comp (t – 1) | | 0.267** | | 0.258** |
| | | (2.85) | | (2.62) |
| Financial Center (0/1) | 0.176 | 0.164 | | |
| | (1.08) | (0.97) | | |
| Top Quartile MSA (0/1) | | | -0.032 | -0.019 |
| | | | (-0.30) | (-0.20) |
| Peer-adjusted Return (t – 1) | 0.071 | 0.070 | 0.070 | 0.071 |
| | (0.99) | (0.96) | (0.96) | (0.97) |
| Log Fund Size (t – 1) | 0.024 | 0.057 | 0.033 | 0.062* |
| | (0.69) | (1.66) | (0.96) | (1.76) |
| Plan Funding % (t - 1) | -0.739* | -0.660 | -0.767* | -0.697* |
| | (-1.76) | (-1.66) | (-1.89) | (-1.78) |
| % Equity Allocation (t - 1) | 1.975 | 1.569 | 1.791 | 1.698 |
| | (0.96) | (0.76) | (0.88) | (0.83) |
| % Fixed Income Allocation (t - 1) | -1.334 | -1.653 | -1.564 | -1.558 |
| | (-0.54) | (-0.69) | (-0.66) | (-0.66) |
| % Private Equity Allocation (t - 1) | 1.147 | 0.967 | 1.003* | 1.147* |
| | (1.45) | (1.54) | (1.83) | (1.95) |
| % Hedge Fund Allocation (t - 1) | -3.508 | -3.914* | -3.801* | -3.860* |
| | (-1.66) | (-1.89) | (-1.84) | (-1.85) |
| % Real Estate Allocation (t - 1) | 2.391 | 2.379 | 2.325 | 2.328 |
| | (1.08) | (1.04) | (1.04) | (1.03) |
| Constant | -4.345** | -0.506 | -3.780** | -0.602 |
| | (-2.70) | (-0.36) | (-2.73) | (-0.44) |
| | | | | |
| Plan Fixed Effects | YES | YES | YES | YES |
| Year Fixed Effects | YES | YES | YES | YES |
| Observations | 1,433 | 1,423 | 1,433 | 1,423 |
| Adj. R-squared | 0.0532 | 0.0511 | 0.0516 | 0.0504 |

## Table 7: CIO Compensation and Hiring

This table reports results of tests examining the relations between CIO compensation and a pension plan's ability to attract talent. *Bachelor Institution SAT Score* is the average SAT score for a CIO's undergraduate institution. *Bachelor Institution Admission Rate* is the admission rate for a CIO's undergraduate institution. Panel A reports the univariate results and Panel B reports the results of multivariate regressions of fund performance on the education variables and plan level controls and year fixed effects. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Univariate Tests*

| Compensation Quartile | Bachelor Institution SAT score |
|---|---|
| 1 | 1257.54 |
| 2 | 1245.72 |
| 3 | 1301.36 |
| 4 | 1313.85 |
| 4 – 1 | 56.31*** |
| | (5.37) |

| Compensation Quartile | Bachelor Institution Admission Rate |
|---|---|
| 1 | 0.61 |
| 2 | 0.55 |
| 3 | 0.49 |
| 4 | 0.48 |
| 4 – 1 | -0.131*** |
| | (6.09) |

*Panel B. Multivariate Regressions*

| | Peer-adjusted Return (t) | |
|---|---|---|
| | (1) | (2) |
| Top Quartile SAT (t-1) | 0.261*** | |
| | (3.03) | |
| Top Quartile Admission (t-1) | | 0.184** |
| | | (2.18) |
| Peer-adjusted Return (t-1) | 0.122 | 0.121 |
| | (1.71) | (1.71) |
| Log Fund Size (t-1) | 0.031 | 0.029 |
| | (0.62) | (0.60) |
| Plan Funding % (t - 1) | -0.067 | -0.091 |
| | (-0.19) | (-0.26) |
| % Equity Allocation (t - 1) | -0.431 | -0.307 |
| | (-0.22) | (-0.15) |
| % Fixed Income Allocation (t - 1) | -3.392 | -3.295 |
| | (-1.38) | (-1.33) |
| % Private Equity Allocation (t - 1) | 0.773 | 0.816 |
| | (0.51) | (0.54) |
| % Hedge Fund Allocation (t - 1) | -5.618*** | -5.503*** |
| | (-3.14) | (-3.05) |
| % Real Estate Allocation (t - 1) | 0.641 | 0.791 |
| | (0.25) | (0.31) |
| | | |
| Clustering | 1,702 | 1,716 |
| Adj. R-squared | 0.0603 | 0.0573 |

## Table 8: CIO Compensation and Retention

This table reports results of tests examining the relations between CIO compensation and a pension plan's ability to retain its CIO. Panel A contain the results of Cox proportional hazard models predicting a CIO's voluntary departure. Columns 1 and 2 of Panel B contains linear regressions of plan performance on the predicted probability the CIO departs obtained from the models in Panel A. Columns 3 and 4 use variables based on realized CIO turnover. *Turnover Dummy* is an indicator variable equal to 1 for observations that are in the 3-year period around a realized CIO turnover event. *# CIO Turnovers* is the number of realized CIO turnovers since the beginning of our sample period (2001) until the current year. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Cox Proportional Hazard Models*

| | Failure = Voluntary Departure | |
|---|---|---|
| | (1) | (2) |
| Log Compensation (t – 1) | 0.608* | |
| | (1.87) | |
| Top Quartile Comp (t – 1) | | 0.551** |
| | | (2.36) |
| Peer-adjusted Return (t – 3, t – 1) | 0.005*** | 0.003*** |
| | (2.81) | (3.14) |
| Log Fund Size (t – 1) | 1.360*** | 1.301*** |
| | (2.19) | (2.75) |
| Plan Funding % (t – 1) | 0.235** | 0.204** |
| | (2.76) | (2.31) |
| CIO Local (0/1) (t - 1) | 0.799 | 0.801 |
| | (1.13) | (1.12) |
| Log CIO Age (t - 1) | 2.001 | 1.798 |
| | (0.86) | (0.78) |
| Year Fixed Effects | YES | YES |
| Observations | 886 | 855 |

*Panel B. Regressions of Performance on Predicted or Actual Departure*

| | Peer-adjusted Return (t) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Predicted Prob (Model 1) | -2.361*** | | | |
| | (-4.77) | | | |
| Predicted Prob (Model 2) | | -0.019*** | | |
| | | (-3.07) | | |
| Turnover Dummy | | | -0.272** | |
| | | | (-3.33) | |
| # CIO Turnovers | | | | -0.118*** |
| | | | | (-3.36) |
| Control Variables | YES | YES | YES | YES |
| Year Fixed Effects | YES | YES | YES | YES |
| Observations | 800 | 763 | 2105 | 2105 |
| R-squared | 0.078 | 0.070 | 0.061 | 0.062 |

## Table 9: CIO Compensation and Forced Turnover

This table reports results of tests examining the relations between CIO compensation and the likelihood a CIO is fired. The table contains the results of linear probability models predicting a CIO's involuntary departure. The plan level control variables are defined in Table 2. The models contain year dummies. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

| | CIO Fired = 1 | |
|---|---|---|
| | (1) | (2) |
| Log Compensation (t-1) | 0.002 | |
| | (0.29) | |
| Top Quartile Comp (t-1) | | 0.016 |
| | | (0.51) |
| Return, Past 3 years | 0.442 | -0.211 |
| | (0.61) | (-0.92) |
| Compensation × Return | -0.059 | -0.273 |
| | (-1.07) | (-0.85) |
| Log Fund Size (t-1) | 0.004 | 0.004* |
| | (1.11) | (1.80) |
| Plan Funding % (t - 1) | -0.018 | -0.020 |
| | (-0.62) | (-0.73) |
| CIO Local (0/1) | -0.003 | -0.003 |
| | (-0.29) | (-0.34) |
| Log CIO Age (t - 1) | 0.031 | 0.031 |
| | (0.88) | (0.92) |
| Log CIO Tenure (t - 1) | -0.004* | -0.004 |
| | (-1.75) | (-1.57) |
| Constant | -0.142 | -0.118 |
| | (-0.93) | (-0.93) |
| Year Fixed Effects | YES | YES |
| Observations | 1,297 | 1,288 |
| R-squared | 0.067 | 0.070 |

## Table 10: Level of CIO Compensation versus Structure of CIO Compensation

This table reports results of tests examining the interaction between the level and structure of a CIO's compensation and plan performance. Panel A reports the univariate results using the magnitude of the bonus as a proxy for incentive compensation. Panel B reports the univariate results using the pay-for-performance sensitivity (*PPS*) as the measure of incentive compensation. *PPS* is an indicator variable equal to 1 if, in a regression of CIO compensation on plan performance, the coefficient on plan performance is positive and statistically significant. Panel C contains the results of multivariate regressions of fund performance on the level and structure variables and plan level controls and year fixed effects. The plan level control variables are defined in Table 2. Standard errors are adjusted for heteroscedasticity and clustered by plan and year, and *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Bonus as Incentive*

| **Compensation Quartile (t – 1)** | **>=20% Bonus** | **<20% Bonus** | **Difference** |
|---|---|---|---|
| 1 | -0.278% | -0.213% | -0.066% |
| | (N = 13) | (N = 344) | (0.56) |
| 2 | 0.028% | -0.03% | 0.059% |
| | (N = 20) | (N = 353) | (0.13) |
| 3 | -0.188% | 0.02% | -0.203% |
| | (N = 65) | (N = 299) | (-0.75) |
| 4 | 0.221% | 0.274% | -0.053% |
| | (N = 162) | (N = 214) | (0.26) |
| 4 -1 | 0.50% | 0.49%*** | |
| | (0.92) | (2.95) | |

*Panel B. PPS as Incentive*

| **Compensation Quartile (t – 1)** | **PPS (t>=2) = 1** | **PPS (t<2) = 0** | **Difference** |
|---|---|---|---|
| 1 | 0.090% | -0.233% | 0.323% |
| | (N = 51) | (N = 231) | (1.09) |
| 2 | 0.300% | 0.02% | 0.278% |
| | (N = 43) | (N = 183) | (0.86) |
| 3 | -0.164% | -0.10% | -0.061% |
| | (N = 32) | (N = 177) | (0.18) |
| 4 | 0.512% | 0.338% | 0.174% |
| | (N = 53) | (N = 190) | (0.60) |
| 4 -1 | 0.42% | 0.570%*** | |
| | (1.22) | (2.92) | |

*Panel C. Multivariate Regressions*

| | Peer-adjusted Return (t) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log Compensation (t – 1) | 0.360*** | 0.261*** | | |
| | (4.34) | (3.85) | | |
| Top Quartile Comp (t – 1) | | | 0.285** | 0.295** |
| | | | (2.20) | (2.74) |
| 20% Bonus Dummy (t - 1) | -0.143 | | -0.088 | |
| | (-1.06) | | (-0.63) | |
| PPS (t-stat >=2) (t - 1) | | 0.196 | | 0.185 |
| | | (1.18) | | (1.07) |
| Peer-adjusted Return (t – 1) | 0.072 | 0.002 | 0.071 | 0.002 |
| | (1.00) | (0.03) | (0.97) | (0.04) |
| Log Fund Size (t – 1) | 0.028 | 0.060 | 0.064* | 0.084* |
| | (0.78) | (1.42) | (1.89) | (1.92) |
| Plan Funding % (t - 1) | -0.801* | -0.335 | -0.705* | -0.264 |
| | (-2.03) | (-0.58) | (-1.79) | (-0.51) |
| % Equity Allocation (t - 1) | 2.139 | 1.640 | 1.701 | 1.643 |
| | (1.04) | (0.78) | (0.83) | (0.80) |
| % Fixed Income Allocation (t - 1) | -1.221 | -1.865 | -1.555 | -1.932 |
| | (-0.51) | (-0.59) | (-0.67) | (-0.62) |
| % Private Equity Allocation (t - 1) | 1.337 | 0.674 | 1.154* | 0.813 |
| | (1.73) | (0.60) | (1.99) | (0.85) |
| % Hedge Fund Allocation (t - 1) | -3.314 | -4.536* | -3.785* | -4.403* |
| | (-1.60) | (-2.05) | (-1.83) | (-1.98) |
| % Real Estate Allocation (t - 1) | 2.512 | 1.406 | 2.440 | 1.044 |
| | (1.16) | (0.53) | (1.10) | (0.42) |
| | | | | |
| Year Fixed Effects | YES | YES | YES | YES |
| Observations | 1,433 | 901 | 1,423 | 896 |
| Adj. R-squared | 0.0530 | 0.0539 | 0.0507 | 0.0533 |

## Table 11: Holdings-Based Evidence

This table reports results of tests using the 13F filings of the pension plans in our sample. Panel A reports the univariate results sorting plans based on their CIO's compensation. Panel B reports the univariate results sorting plans based on their CIO's education quality. Panel C reports the univariate results of portfolio turnover before, around, and after a realized CIO turnover event. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

*Panel A. Overall Sample*

| Comp. Quartile (t-1) | DGTW Return | Turnover Ratio | Disposition Effect | % Lottery Stocks Held |
|---|---|---|---|---|
| 1 | 0.051% | 31.89% | -0.091 | 6.41% |
| | (1.23) | (12.64) | (-2.30) | (31.87) |
| 2 | 0.201% | 30.30% | 0.045 | 4.74% |
| | (1.59) | (11.08) | (1.32) | (18.94) |
| 3 | 0.199% | 15.94% | -0.001 | 3.83% |
| | (5.61) | (7.08) | (-0.04) | (40.74) |
| 4 | 0.455% | 21.00% | -0.027 | 2.84% |
| | (12.18) | (9.60) | (-2.85) | (22.51) |
| 4 -1 | 0.404%*** | -10.88%*** | 0.054** | -3.57%*** |
| | (5.02) | (-3.26) | (2.09) | (-9.74) |

*Panel B. Behavioral Biases and CIO Education*

| CIO Institution SAT Quartile | Disposition Effect | % Lottery Stocks Held |
|---|---|---|
| 1 | -0.132 | 0.066 |
| 2 | -0.105 | 0.056 |
| 3 | 0.084 | 0.036 |
| 4 (highest) | 0.070 | 0.048 |
| 4 – 1 | 0.202*** | -0.018*** |

| CIO Institution Admission Quartile | Disposition Effect | % Lottery Stocks Held |
|---|---|---|
| 1 | -0.132 | 0.065 |
| 2 | -0.071 | 0.054 |
| 3 | 0.099 | 0.036 |
| 4 (most selective) | 0.077 | 0.049 |
| 4 – 1 | 0.209*** | -0.016*** |

*Panel C. Portfolio Turnover Around CIO Turnover*

| Before | Around | After | Around-Before | Around-After |
|---|---|---|---|---|
| 0.044 | 0.708 | 0.240 | 0.664*** | 0.468*** |