Paying for Performance in Public Pension Plans

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Keywords: Public pension fund performance; compensation; incentives

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Paying for Performance in Public Pension Plans*

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Abstract

We examine the relation between public pension plan Chief Investment Officer (CIO) compensation and plans' investment performance. Higher paid CIOs outperform their counterparts by 47 – 60 bps per year, largely through increased and superior investment in private equity and real estate. This outperformance generates an additional $74.91 – $95.63 million in economic value. 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 directly affect performance. Demand- and supply-side frictions help explain the variation in CIO pay and the persistent low compensation paid by some plans despite the positive relation between compensation and performance.

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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.[5] Academic research on public pension plans has largely focused on exploring these funding gaps, with particular attention paid to how various assumptions such as the discount rate affect the magnitude of these funding gaps, and how the funding gaps affect plan-level asset allocation and risk taking. (see, e.g., Novy-Marx and Rauh, 2009; Andonov, Bauer, and Cremers, 2017). Less attention has been paid to the factors that affect the investment performance of these pension plans. This dearth of attention comes even though any future shortfalls arising from funding gaps could be mitigated by better plan performance. Our study attempts to remedy this oversight by examining one factor that could affect plan performance: manager compensation. Simply put, we examine whether higher Chief Investment Officer (CIO) pay results in better performance, and if so, how, and why.

The link between executive compensation and performance has been studied in a wide range of contexts (e.g. Ma, Tang, and Gomez, 2019, Ibert et al, 2018, Murphy, 2012). The setting of public pension plan CIOs is particularly well suited to such a study for several reasons. First, CIOs' compensation levels and structure can be observed through public databases and Freedom of Information Act (FOIA) requests. Second, plan performance is easily observable in the form of

[5] 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 (2011) 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.

investment returns. Furthermore, given the availability of granular data on plans' asset allocations, allocation performance, and equity holdings, it is possible to identify specific sources of the variation in performance across CIOs. This data rich setting, together with the potential implications regarding how CIO compensation could mitigate the pressing issue of plan underfunding, motivates our study.

Why might higher CIO compensation levels lead to better performance? We hypothesize three channels: better *hiring*, improved *retention*, and the presence of *incentives* for more highly compensated managers. While the links between higher compensation and better hiring and retention outcomes are clear, we elaborate on the link between compensation, incentives, and performance. It may be possible that higher compensation is associated with explicit or implicit performance incentives and that any documented relation between higher compensation and performance is driven by the presence of those incentives, rather than the compensation level itself. Our data on the educational backgrounds of hired CIOs, incidence of CIO turnover, and the breakdown of CIO compensation into specific components (e.g. bonus amounts, raises) allow us to observe whether pay affects performance through better *hiring*, higher *retention*, or providing better *incentives*.

Our main finding is that plans with higher paid CIOs generate significantly higher future investment returns. Plans that pay their CIOs top quartile compensation significantly outperform plans paying bottom quartile compensation by 47 – 60 bps annually. This result appears linear and monotonic (see Figure 1) and is robust to the use of multiple alternative performance measures (e.g., raw returns, Sharpe ratios).

We next explore the sources of outperformance for plans with higher paid CIOs. The results of multivariate regressions suggest that about 42% of the 60 bp (approximately 25 bp) outperformance can be explained by other observable variables such as plans' asset allocations, plan size, and the presence of a separate investment board. Further analysis shows that higher paid managers allocate significantly more of their portfolios to private equity and real estate (the highest performing asset classes in our sample), and significantly less to commodities (the worst performing asset class in our sample).

Better investment selection within asset classes also helps explain higher paid CIOs' outperformance. Specifically, higher paid CIOs choose significantly better investments within the private equity and real estate asset classes. This superior investment picking ability explains an additional 23 bp of the remaining 35 bp of outperformance. While we are unable to precisely identify the sources of the remaining 12 bp of outperformance, analysis of the equity holdings of the subset of plans that file 13F disclosures suggests higher compensated CIOs appear less susceptible to behavioral biases such as the disposition effect, holding lottery stocks, and over-trading which may help explain some of the remaining outperformance.

While our results indicate that higher compensation leads to better performance, this finding may be driven by endogeneity. Specifically, it may be possible that our findings are driven either by reverse causation or omitted variables. 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 plan size, risk-taking, culture, location, level of resources, and independence of the investment function are some of a few things that could be correlated with compensation and could also affect performance. We attempt to control for as many of these potential covariates as possible and note that our results are robust to their inclusion in regressions. Moreover, our results still hold when using risk adjusted measures of performance such as Sharpe ratio.[6] However, we also acknowledge that it is impossible to control for all omitted variables and we caveat our results accordingly.

The results presented provide evidence that higher CIO compensation is associated with better plan performance and that the primary sources of this outperformance appear to be better asset allocation and security selection. Next, we examine why higher compensation leads to better performance. We posit that higher compensation could lead to better *hiring*, improved *retention*, or be correlated with the presence of *incentives* and examine each of these channels in turn.

To examine whether paying more leads to hiring more talented CIOs, we need a measure of talent. Chevalier and Ellison (1999) use the quality of managers' education as a proxy for ability and talent. We collect data on the admission selectivity and the average SAT scores at the managers' undergraduate institutions and examine whether higher paying pension plans hire managers who attended more prestigious schools. We find evidence supportive of this hypothesis. Specifically, CIOs paid top quartile compensation graduate from undergraduate institutions with 64.60 point higher average SAT scores and 13.7% lower admission rates relative to the schools

[6] For the subsample of plans that file 13F holdings reports, we also find that higher compensated managers take *less* risk when we examine a wide variety of holdings-based risk measures and factors (VIX, MACRO, FIN, policy uncertainty, VaR, etc.) and have higher risk adjusted performance measures.

attended by managers in the lowest quartile of compensation. Moreover, we find that plan performance is significantly higher for CIOs who went to more selective institutions.

Next, we examine whether plans that pay more are better able to retain their CIOs. We estimate Cox proportional hazard models to predict voluntary CIO departure and find that plans with lower CIO compensation experience higher CIO turnover. Additionally, measures of both realized and predicted CIO turnover are negatively related to future performance. Thus, it appears that improved retention is one channel through which higher compensation leads to better performance.

A third possibility is that the compensation contracts of higher paid CIOs also contain performance incentives and the presence of performance incentives, rather than the level of compensation, that drives the link between higher compensation and better plan performance. To examine this hypothesis, we first confirm that higher pay is correlated with the presence of incentives in our sample. Indeed, 43.1% of plans with CIO compensation in the top quartile pay a bonus constituting 20% or more of total compensation compared to only 3.8% of plans in the bottom quartile of compensation. However, when examining the link between future performance and both compensation level and the presence of incentive pay simultaneously, we find that future performance is only significantly linked to overall levels of pay.[7]

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[7] 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.

Together, these results suggest that higher CIO compensation leads to better performance in public pension plans. In terms of economic magnitude, our results imply that a $350,150 increase in annual CIO compensation leads to 47 – 60 bps higher investment returns per year. These higher investment returns translate to an additional $74.91 – $95.63 million of economic value each year for the average plan in our sample. Thus, it appears that higher CIO compensation is a good deal for public pension plans.[8] For this reason, it is important to ask why lower paying plans do not offer higher compensation.

We attempt to answer this question by analyzing determinants of CIO compensation, paying particular attention to potential frictions in the CIO labor market. Consistent with findings documented in Dyck, Manoel, and Morse (2021), we find that plans headquartered in Democrat leaning areas and states with higher corruption levels pay less. To gain further insight into this labor market, we also analyze the subset of CIOs who move between public pension plans. First, CIOs who move between plans are underpaid, relative to the size of the plans they manage, in 77% of the cases we observe. Second, CIOs receive large increases in compensation and are no longer more likely to be underpaid after they move. Third, CIOs with local ties and longer tenure at a given plan are less likely to move. Together, these results suggest that demand side frictions (e.g., underpayment by plans headquartered in Democratic leaning areas) and supply side frictions (e.g., local ties making it difficult for CIOs to move) contribute to some plans persistently offering low

[8] This back of the envelope likely understates the true cost of increased compensation. For instance, increased CIO compensation would likely be accompanied by other costs such as increased compensation for the entire investment staff and additional resources such as data and travel. However, given the large size of these pension plans and the magnitude of the outperformance, it is likely that benefits still exceed the total costs associated with increased CIO compensation.

compensation. However, the plan-to-plan moves we observe help resolve some situations in which CIOs are underpaid. We discuss the implications of these results further in our conclusions.

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 examines the relation between compensation and plan performance and the explanations for this relation. Section 5 examines the labor market for pension plan CIOs. Section 6 concludes.

2. Literature Review and Contribution

Our main contribution is to document a positive link between compensation and performance in the unified setting of pension plan investment management. The pension plan setting has 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, they are unable to link better hiring with higher productivity on the job. Our setting is advantageous 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 suffers from several well-documented endogeneity concerns.[9] 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 salary, which can contaminate analyses (Chhaochharia, and Grinstein, 2009; Guthrie, Sokolowsky, and Wan, 2012). Our setting avoids many of these issues.

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

The public pension plan 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, 2012; 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, Tang, and Gomez, 2019; Agarwal, Daniel, and Naik, 2009) and face the indirect incentives provided by investor flows (Lim, Sensoy, and Weisbach, 2016; Yin, 2016).

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 represent 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 second 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.[10] 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.[11]

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

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[10] See the survey by Pink (2009) for a summary of this research.

[11] 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." 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

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 investments which negatively affect 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 (2021) study the role that political outrage over executive compensation plays in a public pension plan's performance and find that plans subject to higher levels of outrage suffer worse performance. 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.

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'

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

assets, asset allocations, liabilities, investment returns, actuarial assumptions, and many other variables. According to the Center for Retirement Research, these 190 plans represent 95 percent of public pension membership and assets nationwide.

Our main performance measure is *Peer-Adjusted Return* which we calculate by subtracting the average return of the other plans during the same fiscal year from a plan's annual investment return. We also calculate a plan's *Sharpe Ratio* as its average annual return divided by the standard deviation of those annual returns using periods of 4 years of return data.

We augment the PPD dataset with information from the plans' comprehensive annual financial reports (CAFRs). Specifically, we construct an indicator variable, *Separate Investment Board*, equal to 1 if the plan has a separate investment board tasked with monitoring the investment functions of the plan and 0 otherwise. We conduct internet searches (e.g., LinkedIn, Google searches) to obtain biographical information on the sample of CIOs. Specifically, we collect data on CIOs' undergraduate institutions, ages, and tenures. We collect measures of the quality of the CIOs' academic 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.

We also construct two variables based on the plans' locations. 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 a Metropolitan Statistical Area (MSA) whose population is in the top quartile of the MSAs in which our plans are headquartered and 0 otherwise.

Most importantly, to obtain information on the CIOs' compensation, we submitted FOIA requests to the state, county, or municipality responsible for each plan's 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 several 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. These plans are excluded from our analysis.[13]

3.2. Summary Statistics

[13] The composition of our sample can be found in Table A1 of the Online Appendix.

We report summary statistics in Table 1. The average (median) CIO in our sample earns $263,043.90 ($207,422.80) in total compensation per year during our sample period. The CIO in the 90th percentile of compensation earns $504,854.80 while a CIO in the 10th percentile earns $105,000 which indicates that there is a large amount of variation in the compensation paid to public pension plan CIOs. 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 6.33 years. CIOs voluntarily leave their funds in 6.00% of fund-years while they are only fired in 1.1% of fund-years.[14]

(insert Table 1 about here)

The average (median) plan in our sample has assets with a market value of $22.16 billion ($10.83 billion), is funded at 76.44% (76.38%) and generates an annual return of 6.96% (9.30%). Finally, these plans allocate an average of 51.75% to equities, 26.42% to fixed income securities, and 10.99% to alternative assets such as hedge funds and private equity funds. During our sample period, the average annual returns to private equity (11.40%) and real estate (8.97%) were the highest while the returns for investing in commodities (3.43%) and hedge funds (4.63%) were the lowest.

4. Empirical Results

[14] CIO retirements and deaths explain the remaining turnover implied by the average 6.33-year tenure.

In this section, we first document the relation between CIO compensation and plan performance. Next, we attempt to uncover the sources of highly paid CIOs' outperformance. Finally, we investigate the three channels that may explain our baseline results: *hiring*, *retention*, and *incentives*.

4.1. Main Result

We begin by conducting univariate analysis by sorting the CIOs into quartiles each year based on the level of their total compensation. We then calculate the average performance of the plans run by CIOs in each quartile in the next year and compare the difference in average performance for the highest and lowest quartiles. We also present the average compensation paid to CIOs in each compensation quartile to aid in interpreting the economic magnitude of the results. The results are presented in Table 2.

(insert Table 2 about here)

First, the average plan performance is monotonically increasing with each compensation quartile. Second, plans with CIO compensation in the lowest compensation quartile underperform their peers by a statistically significant 0.215% per year. Third, plans with CIO compensation in the top quartile outperform their peers by a statistically significant 0.251% per year. Finally, 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).

The univariate sort analysis above does not explore the functional relationship between pension performance and compensation. This relation is important from a policy perspective as one can imagine additional compensation having differential effects for CIO positions at different points on the compensation distribution. For instance, it is possible that increasing compensation an additional \$5,000 for a position currently paying \$105,000 per year (i.e., the 10^{th} percentile in our sample) may not be enough to attract the requisite talent to boost returns. To explore this relation, we use Stata's binscatter function to plot plan performance versus the log of CIO compensation after controlling for year fixed effects.[15] We present the illustration in Figure 1.

(Insert Figure 1 about here)

The figure shows that the relation between CIO compensation and plan performance is fairly linear which suggests that our main result is not driven by any particular portion of the compensation domain. The figure also mitigates potential concerns over the use of a linear regression specification for our subsequent multivariate tests.

4.2. Sources of Outperformance

In this section, we explore the ways higher paid CIOs generate higher investment returns. To begin this analysis, we estimate a series of multivariate regressions of pension plan performance on the log of CIO compensation and various sets of control variables. It is important to note that for these regressions we restrict the sample to the subset of plan-year observations for which we have zero missing variables so that we can gauge how the inclusion of a given covariate(s) affects the coefficient on log compensation without the potentially conflating effect of changes in sample size. This constraint reduces our sample size from 1,470 observations in Table 2 to 1,141 observations in Table 3. The results of these regressions are contained in Table 3.

(insert Table 3 about here)

[15] Information on the binscatter function can be found at: https://michaelstepner.com/binscatter/ . We thank the referee for this helpful suggestion.

Column 1 of Table 3 contains the results of a regression of plan performance on only the log of CIO compensation and year fixed effects. The coefficient on log compensation in Column 1 is 0.477. We note that the coefficient on compensation in the base regression of performance on compensation and year fixed effects in Table 3 implies a difference of 60 bps of outperformance (the coefficient of 0.477 multiplied between the difference in log compensation, 1.26, for the top and bottom quartiles of compensation). This 60 bp difference is slightly higher than difference of 47 bps we find using the unrestricted sample as shown in Table 2.

In columns 2 – 4 of Table 3, we begin augmenting this regression with additional covariates. Specifically, we estimate the following linear regression:

$$Performance_{i,t} = \beta Compensation_{i,t-1} + \gamma' X_{i,t-1} + \delta' Y_{j,t-1} + \varphi_t + \varepsilon_{i,t} \quad (1)$$

where *i* indexes plans, *j* indexes CIOs, and *t* indexes time. $Performance_{i,t}$ is plan i's peer-adjusted performance at time t and $Compensation_{i,t-1}$ is the natural logarithm of plan i's CIO compensation at time $t - 1$. $X_{i,t-1}$ is a vector of plan or location characteristics, $Y_{j,t-1}$ is a vector of CIO characteristics, and φ_t denotes year fixed effects. The standard errors are double clustered by plan and year.

In the second column of Table 3, we augment our regression by including the prior year's plan performance, the lag of plan size, and the lag of the plan's funding level. The latter two variables are included as prior research has shown that larger pension plans outperform smaller plans (Dyck and Pomorski, 2011) and that funding level affects plans' risk-taking (e.g., Andonov, Bauer, and Cremers, 2017). The inclusion of these three variables reduces the coefficient on log compensation to 0.347. In Column 3, we add the plan's allocations to various asset classes to the regression. The inclusion of these variables lowers the coefficient on log compensation to 0.289. Finally, in Column 4, we add in indicator variables equal to 1 when the plan has a separate investment board, its CIO attended a college in the top quartile of acceptance selectivity, and it is headquartered in a financial center. The inclusion of these variables decreases our coefficient from 0.289 to 0.278.

There are several takeaways from the regressions in Table 3. First, the added covariates explain approximately 42% of the total effect that compensation has on plan performance (i.e., the coefficient on compensation goes down from 0.477 to 0.278). Second, these regressions help identify potential sources of the outperformance we document. For instance, greater allocations to private equity, equity, and real estate are associated with higher peer-adjusted returns.[16]

We next test whether CIO compensation is related to asset allocation. We regress plans' allocations to individual asset classes on the log of CIO compensation and year fixed effects. We present the results of these regressions in Panel A of Table 4.

(insert Table 4 about here)

The results of these regressions provide strong evidence that asset allocation is one source of highly paid CIOs' outperformance. Specifically, we find that highly paid CIOs allocate more of their portfolios to private equity and real estate. Our results imply that CIOs in the top quartile of compensation allocate approximately 3.4% more of their portfolios to private equity and 2.4% more to real estate relative to CIOs in the lowest quartile of compensation. Because private equity and real estate are the two asset classes with the highest average returns during our sample period, plans that allocated greater percentages of their portfolios to these classes outperformed their peers

[16] This finding is consistent with Ibbotson and Kaplan (2000) who find that asset allocation explains approximately 40% of the cross-sectional variation in pension plan performance.

on average. CIOs in the top quartile of compensation also allocate about 0.8% less of their portfolios to commodities, which was the worst performing asset class during our sample period, when compared with those in the lowest compensation quartile.

We next attempt to explain the remaining 58% of the effect compensation has on plan performance. In addition to allocating to asset classes with higher average returns, highly paid CIOs may also impact performance by picking higher returning assets *within* a given asset class. We explore this possibility by estimating regressions of each plan's asset class returns on the log of CIO compensation and year fixed effects and present our findings in Panel B of Table 4. The results suggest that highly paid CIOs choose better assets in both the private equity and real estate classes. Specifically, our results suggest that the CIOs in the top quartile of compensation outperform those in the lowest quartile of compensation in these classes by between 1.1 – 2.0% per year.

Consider a CIO in the highest quartile of compensation. The average allocation to private equity (real estate) for CIOs in this group is 7.7% (7.0%). On average, our results imply that the highest paid CIOs' superior asset selection skills would lead to outperformance in their private equity (real estate) allocations of 2.0% (1.1%) per year. Thus, superior asset selection in private equity (real estate) can explain approximately 15 bps (8 bps) of the remaining outperformance of top quartile CIOs. Together the outperformance in private equity and real estate explains about approximately 66% of the remaining coefficient in Table 3, Column 4.[17]

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[17] As mentioned above, the coefficient in column 1 of Table 3 implies a difference of 60 bps between the performance of plans run by the highest and lowest paid CIOs. The coefficient of 0.278 in column 4 implies that 58% of these 60

Next, we also investigate the possibility that highly paid pension plan CIOs possess asset class timing ability. To do so, we regress the average returns to a given asset class each year on the log of CIO compensation, a plan's change in allocation to that asset class, and the interaction of asset class changes and compensation. We find no evidence that public pension plan CIOs, whether highly paid or not, possess any timing ability as changes to asset class allocations have no predictive power for the returns of that asset class.[18]

Lastly, we investigate other potential sources for the remaining outperformance using the equity holdings of the subsample of public pension plans who file 13F forms with the Securities and Exchange Commission (SEC). We manually 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 behavioral bias. *Portfolio Turnover* follows Barber and Odean (2000, 2001). *% Lottery Stocks Held* is the percentage of the plan's equity portfolio that is made up of stocks classified as lottery stocks using the Kumar (2009) definition.[19] 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

bps (35 bps) remain unexplained. Outperformance in private equity and real estate accounts for 23 out of these remaining 35 bps, or 65.7%.

[18] For brevity, we do not tabulate these results but they are available upon request.

[19] Kumar (2009) considers a stock to be a lottery stock if it is in the lowest 50th stock price percentile at the end of the previous month, the highest 50th idiosyncratic volatility percentile (using the past 6 months of daily returns), and the highest 50th percentile of idiosyncratic skewness (using the past 6 months of daily returns) where each sort is conducted independently.

realized minus the percentage of gains realized such that a higher number means a manager is less prone to this bias. Each of the three behavioral biases has been shown to be detrimental to investment performance.

We compare the propensity of CIOs in each quartile of compensation to fall victim to these three measures of behavioral bias and present the results in Table 5. The results indicate that higher paid CIOs are less prone to behavior biases. Higher paid 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%. 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.[20] 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. Each of the differences mentioned are statistically significant at the 5% level or better. Our results using holdings-based measures provide evidence that highly paid CIOs are less likely to engage in behaviors that adversely affect performance. However, given that this analysis only covers a subset of plans, we are hesitant to quantitatively link these results to the overall magnitude of 60 bps of outperformance discussed above.

(insert Table 5 about here)

[20] Our results on lottery stocks are robust to the use of the *MAX* measure of Bali, Cakici, and Whitelaw (2011) to define lottery stocks.

Combined, the results in this section provide evidence that highly paid CIOs generate higher investment returns than their peers and that much of that outperformance can be explained by better asset class allocations and superior investment selection within asset classes. It appears that an avoidance of behavioral biases may also explain some of the remaining outperformance.

4.3. 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 returns to determine current CIO compensation, we nevertheless attempt to rule out this possibility by examining the link between a plan's performance *two years* in the future and its CIO's current compensation. We present the results of these regressions in Panel A of Table A2 in the Online Appendix. The coefficients on $Log\ Compensation_{t-2}$ are 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 prior regressions 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. Specifically, *Sharpe Ratio* is equal to a plan's average annual return divided by the standard deviation of these annual returns for the previous 4 years. We present the results of these regressions in Panel B of Table A2. The results continue to indicate a positive and statistically significant relation between CIO compensation and plan performance, regardless of the performance measure chosen.[21]

We further examine plans' risk taking by examining their equity holdings. Specifically, we infer the daily, or monthly, equity returns of each plan for a given quarter using their reporting holdings at the end of the previous quarter. We then use these inferred returns to measure plans' exposures to a variety of risk and mispricing measures. First, we regress these returns on factors including: i) VIX and VXO, ii) the systemic risk measure (CATFIN) of Allen, Bali, and Tang (2012), iii) the macroeconomic risk measure of Bali, Brown, and Caglayan (2014), iv) the economic policy uncertainty index of Baker, Bloom, and Davis (2016), v) the behavioral risk factors, PEAD and FIN, of Daniel, Hirshleifer, and Sun (2020), and the vi) stock-level mispricing score of Stambaugh, Yu and Yuan (2015). We also calculate plans' vii) exposure to lottery stocks by calculating their MAX return following Bali, Cakici, and Whitelaw (2011), viii) idiosyncratic and total volatility, and ix) exposure to tail risk by calculating the Value-at-Risk (VaR) and conditional value-at-risk (CoVaR) using the inferred equity returns.

[21] We also estimate multivariate regressions using different specifications for our compensation variable. Specifically, we use indicator variables for each compensation quartile, a single indicator variable for top quartile compensation, and an indicator variable for above median compensation. The results of these tests can be found in Table A2, Panel C and uniformly provide evidence of a positive relation between compensation and performance.

We then regress these factor loadings or risk variables on the log of CIO compensation and our plan-level control variables and present the results in Table A3. The results uniformly suggest that highly paid CIOs take less risk in their equity portfolios. In total, our analysis in Tables A2 and A3 provides strong evidence that highly paid CIOs are not generating higher returns simply by taking more risk.[22]

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 (i.e., our *Separate Investment Board* indicator) as a measure of governance and investigate whether this structure is driving our results. 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 use our two indicator variables, *Financial Center* and *Top Quartile MSA*, to control for this possibility.

[22] We also examine the possibility that plans run by highly paid CIOs use more derivatives and that this usage helps explain our performance results. The overall magnitude of derivatives usage is likely too small to explain highly paid CIOs' outperformance. For brevity, we do not tabulate these results but they are available upon request.

We note that our regression in Column 4 of Table 3 included these variables and continued to show a positive and statistically relation between compensation and future performance.[23]

Lastly, while it is tempting to explore using exogenous shocks to CIO compensation to provide a cleaner identification strategy, two issues preclude such analysis. First, the time horizon required to translate any shock in CIO compensation into better hiring outcomes makes it difficult to precisely examine the effects of shocks. Second, finding instances of exogenous shocks to CIO compensation is a difficult task. One such change is the Arizona Legislature's amendment of State Statute 38-611.01 in 2013 that allowed public agencies to pay incentive compensation to investment related personnel which, in turn, significantly increased CIO compensation. Immediately after the passage of the law, the CIO of the Arizona State Retirement System began receiving a bonus of approximately $40,000. Unfortunately, we could not find enough of these law changes to conduct meaningful analysis.

4.4. Better Hiring, Improved Retention, or Incentives?

In this section, we turn our attention to investigating why 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 plans 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 *incentives* channel

[23] For each potential omitted variable discussed above, we also estimated our base regression (e.g., the one presented in Column 4 of Table 3) for the 0 and 1 groups separately as well as with each potential omitted variable included individually. We continue to find positive and statistically significant relations between performance and CIO compensation for each group regardless of the specification. These results can be found in Table A4 in the Online Appendix.

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 leads to higher performance. We investigate each channel individually below, starting with the incentive channel as it is the most complex of the three channels.

4.4.1. Does the Structure of CIO Compensation Impact Performance?

In this section, we explore the possibility that highly paid CIOs outperform their lower paid counterparts because of the sensitivity of their compensation to performance rather than the overall compensation level. We call this the *incentives* channel. Specifically, we investigate whether higher compensation is associated with i) higher termination risk as function of poor performance or ii) explicit performance incentives (e.g., a bonus).

First, we explore the possibility that higher paid CIOs have higher termination risk. 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, and their high salaries. To conduct this analysis, we investigated every CIO turnover event in our sample and classified each as being a retirement, poaching, firing, or a death. 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.[24] Nevertheless, we model the likelihood a CIO is fired using the following linear probability model:

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[24] 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:

$$CIO\ Fired_{i,t} = \beta_1 Compensation_{i,t-1} + \beta_2 Compensation_{i,t-1} \times Performance_{i,t-1} + X'\gamma_{i,t-1} + \varphi_t + \varepsilon_{i,t} \quad (2)$$

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 fixed effects in these regressions. Our coefficient of interest is β_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 6, Panel A.

The results indicate that the termination risk CIOs face is not related to the level of their compensation. The coefficients, β_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, independent of their investment performance. We interpret these results as evidence that is unsupportive of the *incentives* channel.

Another possibility is that highly paid CIOs also have high levels of performance-based compensation. That is, it may be that CIOs who are attempting to maximize their incentive compensation are those who are outperforming their counterparts. As discussed earlier, the data the pension plans provided us break the CIO's compensation into net annual salary, bonuses, and

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/

deferred compensation components. We use this data to construct two measures of incentive-based pay. The first measure, *20% Bonus*, is an indicator variable equal to 1 if the plan has ever paid its CIO a bonus equal to 20% of his total compensation in the past, and 0 otherwise.[25] We also construct a second indicator variable, *PPS*, that considers the possibility that some CIOs receive implicit performance-based pay in the form of salary increases based on their past performance (Murphy, 2012).

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:

$$LogCompensation_{i,t} = \beta_1 Performance_{i,t-1} + \beta_2 PlanSize_{t-1} + \beta_3 CIOTenure_{t-1} + \varepsilon_{i,t} \quad (3)$$

We include plan size and CIO tenure in the regression as 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) β_1 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.

[25] We also used 10% and 50% as our threshold bonus values and found qualitatively similar results.

We find that both measures of incentive compensation are positively correlated with total compensation.[26] To examine whether it is the presence of incentive compensation, rather than overall compensation level that explains our main result, we re-estimate our main regression specification in Equation 1 after augmenting it with the two incentive compensation indicator variables, *Bonus20* and *PPS*. Panel B of Table 6 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.[27]

(Insert Table 6 about here)

Combined, the results in this section do not provide evidence in support of the incentives channel. These results are consistent with press articles suggesting 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.[28]

4.4.2. Does Higher Compensation Attract CIOs of Higher Ability?

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[26] The correlations of *Bonus20* and *PPS* with total compensation are 0.47 and 0.04, respectively.

[27] This result is consistent with analysis by compensation consulting firms and industry professionals. Specifically, compensation consulting firm McLagan notes in their report for the Wyoming Retirement System in 2018 that "After reviewing annual reports, board minutes, and plan websites for the list of 72 pensions, we were not able to determine if there was a correlation between producing superior returns and having incentive compensation plans in place." The report can be found here: https://www.wyoleg.gov/InterimCommittee/2018/02-2018102419-02_WRSJACResponses.pdf. Additionally, 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." 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

[28] Bob Jacksha 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.

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. We follow Chevalier and Ellison (1999) and use academic institution prestige as a proxy for managerial talent. To examine this hypothesis, we begin by examining the education of the CIOs of our plans based on their compensation. Specifically, we sort plans into quartiles based on the compensation paid to their CIOs. We then examine the average SAT scores and 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 more selective universities and universities with higher average student SAT scores. Specifically, plans in top quartile of pay attract managers who attended universities with admission rates (SAT scores) that are 13.7% lower (64.60 points higher) than the universities attended by managers who are hired by plans paying bottom quartile compensation. These differences are statistically significant at the 1% level.

Lastly, we examine whether hiring more talented managers has a positive effect on performance. 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. Columns 1 and 2 of Panel C of Table 7 contain 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, these results suggest that higher compensation allows plans to hire more talented managers who, in turn, positively impact investment performance.

4.4.3. Does Compensation Affect the Likelihood of a CIO Being Poached?

A large literature in finance and management provides evidence that retaining productive employees positively affects firm performance (e.g., Khorana, 2001). New managers often make drastic changes to an organization to implement their own agenda (Li and Scherbina, 2011; Pan and Wang, 2012). In the context of pension plan management, CIO turnover could lead to costly portfolio turnover. It could also be the case that having a CIO who is likely to depart may adversely affect fund performance if that CIO exerts less effort or devotes less attention to his current job. In this section, we investigate whether compensation impacts a plan's ability to retain its CIO.

We investigate and classify each instance of CIO turnover in our sample by reading press releases announcing each event. 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 a poaching. We then estimate Cox proportional hazard models which predict the probability that a CIO is poached from a given plan Specifically, we estimate the following regressions:

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

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 present the results of these regressions in Table 7, Panel B.

The results indicate that higher compensation makes it less likely that a CIO gets poached. 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 leave the plan for an external opportunity. Interestingly, CIOs who work for better performing and more well-funded plans are also less likely to be poached, 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 to be poached 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.

(Insert Table 7 here)

Next, we examine whether there is a relation between future performance and CIO retention. As discussed above, both potential and realized turnover may adversely affect future performance. To examine these possibilities, we calculate four measures of potential or realized CIO turnover. The measures of potential CIO turnover are the probability estimates we obtain from Models 1 and 2 in Table 7, Panel B. The first measure of realized turnover is an indicator 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 year.

To test our hypothesis, we augment the regressions in Equation 1 with our turnover measures described above. The results can be found in Columns 3 through 6 of Panel C in Table 7. The results provide strong support for the idea that turnover adversely affects plan performance. Specifically, the coefficients on both the predicted and realized turnover measures are all negative and highly statistically significant. 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.[29]

Combined, the results in Section 4.2 support both the *hiring* and *retention* hypotheses. Conversely, we find little support for the *incentives* hypothesis. In short, it appears as though CIO compensation helps public plans attract and retain talented CIOs who in turn bolster plan performance.

5. The Labor Market for Public Pension Plan CIOs

Our main finding is that higher paid CIOs generate higher investment returns. Specifically, our results imply that an increase of $350,150 in CIO compensation is associated with 47 – 60 bps higher investment returns per year. These higher investment returns translate to an additional $74.91 – 95.63 million of economic value each year for the average plan. It is thus important to ask why there exists so much heterogeneity in the compensation of public pension plan CIOs and, specifically, why some plans persistently offer their CIOs low compensation.

5.1. What are the Determinants of CIO Compensation?

To answer this question, we first examine the determinants of CIO compensation. We begin by regressing the natural logarithm of total CIO compensation on various sets of fixed effects to gain understanding about whether the variation we observe is driven by time series or cross-sectional variation. Specifically, we regress CIO compensation on year fixed effects, plan fixed effects, and both sets of fixed effects simultaneously to understand whether the variation in

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[29] In unreported results, we also examine the portfolio turnover using the subsample of plans who report 13F equity holdings. We find that portfolio turnover also increases around realized CIO turnover events.

compensation is coming from within or across plans. The results of these regressions can be found in Columns 1 – 3 of Table 8. We find that the R^2 of these regressions are 0.235, 0.747, and 0.917, respectively, which suggests that most of the variation in CIO compensation is cross-sectional. In Column 4 of Table 8, we regress compensation on plan fixed effects and a time trend and obtain an R^2 of 0.916, suggesting that the year fixed effects are largely picking up the effect of CIOs being paid more over time.

Our next goal is to understand which factors are driving the cross-sectional heterogeneity in compensation we document above. Broadly speaking, we group potential factors into three categories: plan-level, CIO-level, and location-level variables. For the plan-level variables, we include the natural logarithm of plan size, the plan's level of funding, the percentage of the plan's board that is made of up plan members, the separate investment board indicator variable, the average plan member's salary, and the natural logarithm of the average salary paid to CIOs who manage plans in the same size quartile.

We include plan size as Gabaix and Landier (2008) show theoretically that CEO compensation should be directly linked to firm size. We hypothesize that better funded plans will also be better able to justify paying higher compensation to their CIOs. We expect that the percentage of the plan's board that is made of up plan members will be negatively related to CIO total compensation. Because most public pension plan members' salaries are well below that of the CIO, we expect that these board members would act as a constraint against paying high compensation for reasons of jealousy or political outrage. We expect CIO compensation to be positively related to the average plan member salary as plan members who are owed more would presumably want a more talented CIO to manage the plan responsible for paying them their retirement benefits. Lastly, we expect CIO compensation to be positively related to that of his peer group of CIOs. This prediction is motivated by the reports of compensation consulting firms who use peer group plans when making their recommendations.

We regress CIO compensation on the plan-level variables and year fixed effects in Columns 5 and 6 of Table 8. We find evidence broadly consistent with most of our predictions. The coefficients on plan size, plan funding, and peer group compensation are all positive and highly statistically significant. None of the other coefficients are statistically significant. Perhaps more importantly, the R^2 of the regression in Column 6 is 0.530, which means that these plan-level variables help explain a sizeable portion of the cross-sectional variation in CIO compensation.

For the CIO-level variables, we include the *CIO Local* indicator variable, the logarithm of the CIO's tenure, and the average SAT of the undergraduate institution the CIO attended. We include *CIO Local* because it is possible that, if they are less willing to relocate for a new job, local CIOs command lower compensation. We include *CIO Tenure* in the regressions as most government jobs pay small raises over time. Finally, we include *CIO Undergraduate Institution SAT* as our *hiring* hypothesis, and earlier results, suggest that more talented CIOs command higher compensation.

We present the results of the regressions of CIO compensation on the CIO-level variables in Column 7 of Table 8. The results are consistent with each of our predictions. CIOs with longer tenures and those from more prestigious universities receive statistically higher compensation than their counterparts. Although it is statistically insignificant, the coefficient on *CIO Local* is negative which is consistent with the idea that local CIOs are less likely to bargain for higher compensation. The R^2 of this regression is 0.320, which suggests that CIO-level variables do explain some of the variation in compensation across plans.

Finally, we regress compensation on a set of location-level variables derived from the plans' headquarters location. First, we obtain cost of living information from AdvisorSmith and create an indicator variable equal to 1 for cities that are in the top quartile of this index and 0 otherwise.[30] We also create an indicator variable equal to 1 for MSAs in the top quartile of population and 0 otherwise. We also obtain data on each location's voting and political preferences from political scientist Chris Tausanovitch's website and construct an indicator variable equal to 1 if a location is in the top quartile of Democratic vote share and 0 otherwise.[31] Lastly, we obtain data on public official corruption convictions from Cordis and Milyo (2016) and construct an indicator variable equal to 1 for states in the top quartile of public official corruption convictions and 0 otherwise.

We expect plans in larger, more expensive locations to pay higher compensation to their CIOs. Our prediction about how political preference will affect compensation is unclear, ex-ante. On the one hand, it is possible that more conservative locations would prefer to pay lower salaries in the name of being fiscally responsible. On the other hand, it is possible that more liberal areas would prefer to pay lower compensation to relative high earners in the name of perceived fairness. Finally, our rationale for including a measure of corruption in our model is that benefits from engaging in corruption may serve as a substitute for direct compensation (An and Kweon, 2017; Van Rijckeghem and Weder, 2001).

[30] The cost-of-living data can be found here: https://advisorsmith.com/data/coli/#city.
[31] The political voting and preference data can be found here: https://americanideologyproject.com/.

These results of these regressions can be found in Column 8 of Table 8. We find evidence consistent with most of our predictions. Cost of living is positively related to CIO compensation, while both Democratic vote share and level of corruption are negatively related to compensation. We believe that these results, particularly the result on Democratic vote share, are complementary to those of Dyck, Manoel, and Morse (2021) who find that political outrage is a key determinant of public pension plan CIO compensation. The R^2 of this regression is 0.392, which suggests that location-level variables explain some of the variation in compensation across plans.

(insert Table 8 here)

Lastly, in column 9 of Table 8, we regress CIO compensation on all three sets of independent variables along with the year fixed effects. The most important takeaway from this test is the R^2 of the regression, 0.649, which suggests that we have identified factors that explain much of the cross-sectional variation in CIO compensation. However, given the R^2 of a regression of compensation on plan and year fixed effects is 0.917, we acknowledge that we have not captured all the factors that explain CIO compensation.[32]

The results in this section shed some light on both the sources of the variation in CIO compensation as well as explanations for the persistent low levels of compensation paid by some plans. Because characteristics such as a location's Democratic vote share and culture of corruption

[32] In unreported results, we also included other variables in our regressions such as government budget surpluses or shortfalls and CIO gender and age. None of these variables loaded significantly in any of our models so we excluded them from our models for the sake of parsimony.

are relatively static, it appears as though these demand-side frictions help explain the persistently lower levels of CIO compensation some plans pay.

5.2. Evidence from Labor Market Moves

Lastly, we examine the 23 instances in our sample in which a CIO moves between public pension plans. We engage in this analysis to uncover whether labor market moves work to resolve some of the inefficiencies generated by the frictions documented above (e.g., does a talented CIO who starts in an underpaid position move to a more appropriate position?). We first examine these CIOs' compensation before and after their moves and report the results in Panel A of Table 9. We find strong evidence that CIOs leave their current positions for higher paying jobs. Specifically, the average CIO leaving his job receives a 100.4% pay raise in new job and zero CIOs leave for a lower paying job. The 100.4% increase in pay is statistically significant at the 1% level. We also find that 77% of these CIOs were underpaid, relative to the compensation that would be predicted by the size of the plans CIOs manage, prior to their moves. After the move, only 46% of these CIOs remain underpaid. Thus, it does appear that labor market moves resolve some of the inefficiencies in CIO compensation.

(insert Table 9 here)

Second, we conduct univariate comparisons of the characteristics of CIOs who move between pensions each year and those that do not. At the time of their moves, CIOs who move receive lower compensation, are approximately 3.3 years younger, have 2.5-year shorter tenures, and are 20% less likely to be local. Each of these differences is statistically significant at the 5% level or better. These results suggest that supply-side frictions appear to hamper CIOs from resolving some of the inefficiencies in this labor market. Specifically, local CIOs and CIOs more likely to have established roots in an area (i.e., older CIOs and those with longer tenures) are likely less willing to leave their current jobs.

In short, our results provide evidence that there are both supply- and demand-side frictions which help explain the heterogeneity in CIO compensation. From the supply side, CIOs with a locational preference or those less willing to uproot their families are less willing to leave even if doing so would increase their compensation. From the demand side, factors such as the political environment hinder plans' abilities to pay higher compensation even if doing so appears to generate economic value.

6. Conclusion

We document a positive link between higher CIO compensation and public pension plan investment performance, driven largely by improved allocation decisions, better security selection, and reduced susceptibility to behavioral biases. From a policy perspective, we are not claiming that raises in CIO compensation would lead to immediate improvements in plan investment performance. While increased pay would presumably improve retention outcomes fairly quickly, the effect that higher compensation has on a plan's ability to hire a better CIO will not materialize until the next CIO is hired.[33] Furthermore, to the extent elements of plan culture, such as having a separate investment board, are correlated with CIO compensation and plan performance, any increase in CIO compensation would ideally be accompanied with changes in plan culture to yield maximum performance benefits.

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[33] If CIO compensation is indiscriminately increased for an *untalented* CIO hired under a lower compensation regime, it may even be counterproductive, leading to increased retention, and a longer tenure for such a CIO.

Regardless, we interpret our results as indicating that higher CIO compensation, at least in the long run, would lead to better performance outcomes that generate economic value for plans. Such performance increases would likely mitigate the underfunding experienced by some public pension plans. More generally, our study suggests further exploration of the determinants of public pension plan performance may help identify other cost-effective ways plans could improve investment performance and thus reduce underfunding.

The seemingly clear economic benefits from increased CIO compensation prompt the question: why does low CIO compensation persist for some plans? Our results suggest that demand side frictions, such political considerations, as well as supply side frictions, such as local ties making it hard for CIOs to move, combine to generate the observed state of the CIO labor market. We do note that CIO moves work to rectify inefficiencies in this market as moving CIOs are significantly less likely to be underpaid after they move. These moves, combined with the overall trend of increasing CIO compensation, suggest that the market is moving slowly towards an equilibrium in which CIO compensation is higher.

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Figure 1: Relation Between Lagged Compensation and Peer-Adjusted Return

This figure contains a graphical representation of the relation between the lagged CIO compensation and public pension plan peer-adjusted performance. The figure is generated using Stata's binscatter function and controls for year fixed effects.

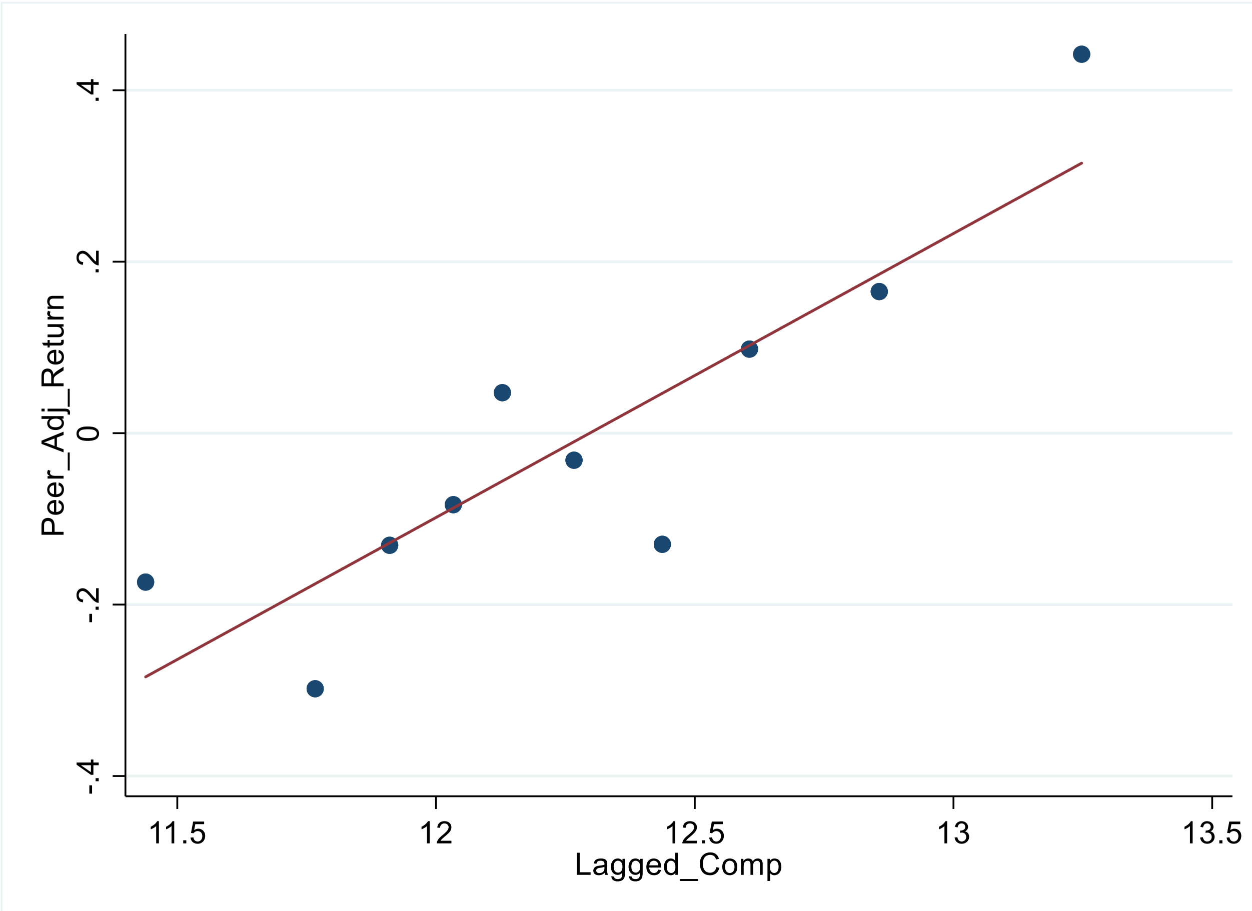

Table 1: Summary Statistics

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. CIO Total Compensation is the sum of CIO Salary and CIO Bonus. CIO Local is an indicator variable equal to 1 if the CIO attended high school or college in the same state as the plan in which he works and 0 otherwise. CIO Institution SAT and CIO Institution Admit Rate are the average SAT score and the admission rate of the undergraduate university the CIO attended. CIO Poached is an indicator variable equal to 1 if the CIO departs his current plan to take a job in public pension plan or in a for-profit firm. Plan Size is the market value of the plan's assets. Funding ratio is the ratio of the plans assets to its liabilities. Separate Investment Board is an indicator variable equal to 1 if the plan has a separate board responsible for the investment function of a plan and 0 otherwise. Financial Center is an indicator variable equal to 1 if the plan is headquartered in the financial centers identified by Christoffersen and Sarkissian (2009) and 0 otherwise. % Allocations are the percentage of the plans' portfolios that are allocated to each asset class. The return variables are each individual asset class' return. 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	1,662	$263,191.90	$179,132.60	$105,000.00	$145,113.30	$207,422.80	$318,362.00	$504,854.80
CIO Salary	1,660	$237,207.90	$134,529.60	$104,844.10	$141,203.90	$200,000.00	$300,132.00	$408,983.20
CIO Bonus	1,660	$25,836.02	$82,285.41	$0.00	$0.00	$0.00	$0.00	$69,641.46
CIO Local (0/1)	1,653	0.52	0.50	0.00	0.00	1.00	1.00	1.00
CIO Institution SAT	1,300	1,281.27	135.26	1,107.00	1,185.00	1,270.00	1,407.00	1,461.00
CIO Institution Admit Rate	1,332	0.53	0.26	0.15	0.28	0.59	0.77	0.82
CIO Age	1,653	51.17	8.68	39	45	51	57	62
CIO Tenure	1,613	6.33	7.51	0	1	4	8	15
CIO Fired (0/1)	1,612	0.011	0.105	0	0	0	0	0
CIO Poached (0/1)	1,613	0.060	0.237	0	0	0	0	0

Panel B. Pension Plan Variables

	N	Mean	Std. Dev	Distribution				
				10th	25th	50th	75th	90th
Plan Size ($mill)	1,662	21,313.97	30,437.12	1,851.456	4,619.496	10,849.42	23,043.19	51,936.4
Funding Ratio (%)	1,654	76.58	17.82	55.20	64.60	76.40	88.405	99.10
Annual Investment Return	1,662	6.96	9.97	-5.39	1.10	9.28	13.91	17.80
Separate Investment Board (0/1)	1,655	0.26	0.44	0	0	0	1	1
Financial Center (0/1)	1,662	0.11	0.31	0	0	0	0	1
% Allocation Equity	1,608	51.82%	10.71%	37.10%	45.14%	53.40%	59.62%	64.30%
% Allocation Fixed Income	1,608	26.29%	7.69%	17.10%	21.30%	25.20%	30.90%	36.3%
% Allocation Private Equity	1,608	6.55%	5.88%	0.00%	0.20%	6.10%	9.92%	13.70%
% Allocation Hedge Funds	1,608	4.34%	6.38%	0.00%	0.00%	0.57%	6.99%	13.40%
% Allocation Real Estate	1,608	6.00%	4.48%	0.00%	1.90%	6.10%	9.00%	11.43%
% Allocation Commodities	1,608	1.67%	3.09%	0.00%	0.00%	0.00%	2.04%	7.00%
% Allocation Cash	1,608	1.77%	2.09%	0.00%	0.10%	1.00%	2.60%	5.00%
Equity Portfolio Return	1,419	8.02%	15.73%	-12.37%	-3.01%	11.87%	19.80%	24.68%
Fixed Income Portfolio Return	1,390	5.16%	4.50%	-0.10%	1.62%	5.10%	7.60%	11.00%
Private Equity Portfolio Return	1,093	11.41%	12.28%	-4.40%	7.17%	13.20%	18.91%	23.80%
Hedge Fund Portfolio Return	732	4.70%	8.85%	-4.80%	0.43%	5.60%	9.30%	13.00%
Real Estate Portfolio Return	1,172	8.97%	12.35%	-5.00%	7.10%	10.80%	14.60%	20.11%
Commodities Portfolio Return	455	3.43%	12.16%	-10.66%	-2.30%	4.80%	10.56%	16.27%
Cash Portfolio Return	710	1.76%	2.26%	0.10%	0.30%	1.00%	2.40%	5.17%

Table 2: 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). Plans are assigned to quartiles each year based on their CIO's compensation. The performance measure is *Peer-Adjusted Return* which is the difference of a plan's return and the average pension plan return each year. This table reports the results of univariate comparisons of the differences in compensation and peer-adjusted returns for the top and bottom quartiles. *t*-statistics are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Comp. Quartile (t – 1)	**Log (Comp.)**	**Avg. Comp. ($000s)**	**Peer-Adj. Return (t)**
1	11.73***	131.5***	-0.215%**
	(671.62)	(57.69)	(-2.20)
2	12.10***	188.59***	-0.028%
	(778.92)	(66.58)	(-0.27)
3	12.44***	269.96***	-0.021%
	(648.87)	(54.20)	(-0.20)
4	13.00***	481.65***	0.251%**
	(583.74)	(47.78)	(2.52)
4 - 1	1.27***	350.15***	0.466%***
	(43.42)	(27.56)	(3.34)

Table 3: CIO Compensation and Fund Performance Regressions

This table reports results of tests that regress the returns of public pension plans 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. Our main independent variable of interest is the natural logarithm of the CIO's total compensation, lagged one year. The other independent variables are as defined in Table 1. The standard errors are double clustered by plan and year. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	Peer-adjusted Return (t)			
Log Compensation (t-1)	0.477**	0.347*	0.289***	0.278***
	(2.42)	(1.89)	(2.95)	(2.70)
Peer-adjusted Return (t-1)		0.097	0.052	0.045
		(1.38)	(0.77)	(0.68)
Log Plan Size (t-1)		0.094*	0.012	0.015
		(1.74)	(0.22)	(0.27)
Plan Funding % (t - 1)		-0.380	-0.689	-0.657
		(-0.75)	(-1.53)	(-1.39)
% Private Equity Allocation			6.069**	6.182**
			(2.34)	(2.58)
% Equity Allocation			5.369*	5.881**
			(2.01)	(2.33)
% Fixed Income Allocation			0.246	0.898
			(0.06)	(0.24)
% Hedge Fund Allocation			0.056	0.458
			(0.02)	(0.15)
% Real Estate Allocation			5.020	6.043*
			(1.45)	(1.88)
% Commodities Allocation			-1.407	-0.127
			(-0.35)	(-0.03)
% Alternatives Miscellaneous			6.361***	7.223***
			(4.55)	(6.48)
% Cash			1.122	2.126
			(0.27)	(0.55)
Separate Investment Board (0/1)				0.211***
				(2.73)
Top Quartile College (0/1)				0.096
				(0.72)
Financial Center (0/1)				0.260
				(1.11)
Year Fixed Effects	YES	YES	YES	YES
Number of Observations	1,141	1,141	1,141	1,141
Adj. R-squared	0.045	0.058	0.115	0.120

Table 4: CIO Compensation and Asset Class Allocation and Performance

This table reports results of tests that regress the asset class allocations and asset class returns of public pension plans on the compensation of their chief investment officer (CIO). The independent variable of interest is the natural logarithm of the CIO's total compensation, lagged one year. The dependent variables in Panel A are the percentages of the plan's assets allocated to various asset classes. The dependent variables in Panel B are the annual returns from investing in each asset class. The tests contain year fixed effects, and the standard errors are double clustered by plan and year. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A. Asset Class Allocations

	% Private Equity	% Equity	% Fixed Income	% Hedge Funds	% Real Estate	% Commodities	% Cash
Log Compensation (t-1)	0.027***	-0.017	-0.009	-0.006	0.019**	-0.008*	-0.003
	(3.04)	(-1.13)	(-0.87)	(-0.69)	(2.66)	(-1.98)	(-1.38)
Year FE	YES	YES	YES	YES	YES	YES	YES
Observations	1,432	1,432	1,432	1,432	1,432	1,432	1,432
Adj. R-squared	0.196	0.162	0.215	0.183	0.162	0.131	0.049

Panel B. Asset Class Performance

	PE Return	Eq. Return	FI Return	HF Return	RE Return	Comm. Return	Cash Return
Log Compensation (t-1)	0.016**	0.001	0.001	-0.005	0.009*	-0.001	0.001
	(2.81)	(0.41)	(0.29)	(-0.71)	(1.86)	(-0.07)	(0.90)
Year FE	YES	YES	YES	YES	YES	YES	YES
Observations	961	1,259	1,244	655	1,028	400	620
Adj. R-squared	0.761	0.985	0.730	0.554	0.751	0.476	0.446

Table 5: Holdings-Based Evidence

This table reports results of tests using the 13F filings of the pension plans in our sample. These tests first sort plans into quartiles based on their CIO's compensation each year and then compare the mean of variables calculated from the plans' equity holdings. *Turnover Ratio* is the turnover in the plan's equity portfolio following Barber and Odean (2000, 2001). *Disposition* is calculated following Odean (1998) and is equal to Percentage Gains Realized minus Percentage Losses Realized. *% Lottery Stocks Held* is the percentage of the plan's equity portfolio that is made up of stocks classified as lottery stocks using the Kumar (2009) definition. The parentheses below each mean value contain *t*-statistics and coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Comp. Quartile (t-1)	Turnover Ratio	Disposition Effect	% Lottery Stocks Held
1	31.89%	-0.091	6.41%
	(12.64)	(-2.30)	(31.87)
2	30.30%	0.045	4.74%
	(11.08)	(1.32)	(18.94)
3	15.94%	-0.001	3.83%
	(7.08)	(-0.04)	(40.74)
4	21.00%	-0.027	2.84%
	(9.60)	(-2.85)	(22.51)
4 -1	-10.88%***	0.054**	-3.57%***
	(-3.26)	(2.08)	(-9.74)

Table 6: CIO Compensation and Incentives

This table explores the relation between CIO compensation and various types of incentives. Panel A contains results of linear probability models predicting a CIO's involuntary departure (e.g., firing). Panel B contains the results of regressions of plan performance on lagged CIO's total compensation, measures of incentive compensation, and various control variables as defined in Table 1. All models contain year fixed effects. 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. Are Higher Paid CIOs More Likely to Be Fired for Poor Performance?

	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)
Other Control Variables	YES	YES
Year Fixed Effects	YES	YES
Observations	1,297	1,288
Adj. R-squared	0.008	0.011

Panel B. Does Incentive Compensation Explain the Outperformance of Higher Paid CIOs?

	Peer-Adj. Return (t)	
	(1)	(2)
Log Compensation (t-1)	0.333***	0.212**
	(4.38)	(2.19)
20% Bonus Dummy	-0.149	
	(-1.18)	
PPS (t-stat >=2)		0.200
		(1.30)
Control Variables	YES	YES
Year Fixed Effects	YES	YES
Observations	1,433	901
Adj. R-squared	0.056	0.059

Table 7: CIO Compensation, Hiring, and Retention

This table reports results of tests examining the relations between CIO compensation and a pension plan's ability to attract and retain talent. Panel A contains the results of univariate comparisons of the undergraduate institutions attended by managers in different compensation quartiles. *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 B contain the results of Cox proportional hazard models predicting a CIO being poached. The plan level control variables are defined in Table 1. Panel C contains regressions of plan performance on measures of talent or retention. The first two columns of Panel C regress *Peer-Adjusted Performance* on the two measures of undergraduate institution quality. Columns 3 and 4 regress *Peer-Adjusted Performance* on the predicted probability the CIO is poached, as calculated from the hazard models in Panel B. Columns 5 and 6 regress *Peer-Adjusted Performance* on *Turnover Dummy*, an indicator variable equal to 1 for observations that are in the 3-year period around a realized CIO turnover event, and *# CIO Turnovers*, the number of realized CIO turnovers since the beginning of our sample period (2001) until the current year. Standard errors for all regressions 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. Do Higher Paid Managers Attend More Prestigious Universities?

Compensation Quartile	**Bachelor Institution SAT score**
1	1257.54
2	1245.72
3	1301.36
4	1322.15
4 – 1	64.61***
	(6.15)

Compensation Quartile	**Bachelor Institution Admission Rate**
1	0.613
2	0.549
3	0.486
4	0.476
4 – 1	-0.138***
	(6.44)

Panel B. Are Higher Paid Managers Less Likely to get Poached?

	Failure = CIO Poach	
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 Plan Size (t – 1)	1.360***	1.301***
	(2.19)	(2.74)
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 C. Regressions of Plan Performance on Measures of Talent and Retention

	Peer-adjusted Return (t)					
Top Quartile SAT (t – 1)	0.263***					
	(2.86)					
Top Quartile Admission (t – 1)		0.211**				
		(2.23)				
Predicted Prob (Model 1)			-2.323***			
			(-4.91)			
Predicted Prob (Model 2)				-0.018***		
				(-3.12)		
Turnover Dummy					-0.268**	
					(-2.76)	
# CIO Turnovers						-0.112**
						(-2.19)
Control Variables	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Observations	1,668	2,105	800	763	2,105	2,105
Adj. R-squared	0.061	0.048	0.051	0.041	0.052	0.051

Table 8: Determinants of CIO Compensation

This table reports results of regressions of CIO compensation on plan-, location-, and CIO-level variables and year fixed effects. Plan characteristics include plan size, level of funding, the percentage of the plan's board made up of plan members, the presence of a separate investment board, average plan member salary, and the log of the average peer CIO's compensation. CIO characteristics include an indicator variable, *CIO Local*, equal to 1 for CIOs who are originally from the state in which the plan is located and 0 otherwise, the CIO's tenure, and the average SAT score of the undergraduate institution the CIO attended. Location-level variables include indicator variables equal to 1 for plans whose headquarter location are in the top quartiles of i) cost of living (*Top Quartile Cost of Living*), ii) population (*Top Quartile Population*), iii) Democratic vote share (*Top Quartile Democratic Vote Share*), iv) and public official corruption convictions (*Top Quartile Corruption*) from Corlis and Milyo (2016), or zero otherwise. 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.

	Log (Compensation)								
	Fixed Effects Only			Time Trend	Plan Chars.		CIO Chars.	Geographic Chars.	All
Time Trend				0.056***					
				(16.17)					
Plan Size (t - 1)					0.193***	0.098*			0.101**
					(5.30)	(2.08)			(2.65)
Plan Funding (t - 1)						0.606***			0.127
						(3.36)			(0.76)
% Board Members = Plan Participants						0.248			0.219
						(1.34)			(1.27)
Separate Investment Board (0/1)						0.104			0.217**
						(1.09)			(2.45)
Average Plan Member Salary						-0.042			-0.117*
						(-0.48)			(-1.80)
Log (Peer Group Salary Average)						0.451***			0.367***
						(3.40)			(3.31)
CIO Local (0/1)							-0.052		0.011
							(-0.69)		(0.18)
CIO Tenure							0.014**		0.009**
							(2.31)		(2.22)
CIO Undergraduate Institution SAT							0.101***		0.063***
							(3.18)		(3.17)
Top Quartile Cost of Living (0/1)								0.315**	0.215***
								(2.62)	(2.97)
Top Quartile Population (0/1)								-0.016	0.137
								(-0.11)	(1.03)
Top Quartile Dem. Vote Share (0/1)								-0.247*	-0.166*
								(-1.75)	(-2.05)
Top Quartile Corruption (0/1)								-0.330***	-0.302***
								(-3.57)	(-3.72)
Year FE	YES	NO	YES	NO	YES	YES	YES	YES	YES
Plan FE	NO	YES	YES	YES	NO	NO	NO	NO	NO
Observations	967	967	967	967	967	967	967	967	967
R-squared	0.235	0.747	0.917	0.916	0.416	0.530	0.320	0.392	0.649

Table 9: CIO Labor Market Dynamics

This table reports results from tests examining the labor market dynamics of public pension plan CIOs. Panel A contains the comparison of the compensation the subsample of CIOs who move between public pension plans in our sample receive before and after their moves. Panel B contains the results of univariate *t*-tests comparing characteristics of the sample of CIOs who move to another plan in our sample versus those who do not. 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. CIO Compensation Before and After Job Changes

	Before	After	% Change
CIO Total Compensation	$167,847.4	$312,062.8	100.45***
Underpaid	0.77	0.46	0.31**

Panel B. Characteristics of Moving and Non-Moving CIOs

	Movers	**Non-Movers**	**Difference**
Log CIO Compensation	11.99	12.30	-0.31***
Underpaid (0/1)	0.77	0.51	-0.26***
CIO Total Compensation ($)	$169,280	$264,946	-$95,665***
CIO Age	47.63	50.95	-3.32**
CIO Tenure	4.16	6.63	-2.47***
CIO Local (0/1)	0.29	0.49	-0.20**

Online Appendix:
Paying for Performance in Public Pension Plans

This appendix contains the following tables:

1. The specific plan-years that compose our sample.
2. Regressions that mitigate concerns about the specification of our models and reverse causality.
3. Regressions of various risk-taking measures on manager compensation
4. Regressions which include potential omitted variables added individually.

Table A1: Sample Description.

This table contains the list of pension plans for which we obtained CIO compensation data as well as the years for which we have this 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 A2: Alternate Specifications & Reverse Causality

This table reports results of regressions which use alternative versions of CIO compensation as our main independent variables of interest. The dependent variable for all regressions is *Peer-Adjusted Return*. In Panel A, we use indicator variables for each compensation quartile or an above or below median compensation indicator variable instead of the continuous compensation variable. Panel B contains regressions of various return measures on compensation lagged two years to mitigate concerns that future performance explains current compensation. The parentheses below each coefficient contain *t*-statistics computed from standard errors that are double clustered by plan and year. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A. Reverse Causality, Compensation Lagged Two Years

	Peer-Adjusted Return (t)	Raw Return (t)	Sharpe (t to t + 3)
Log Compensation (t – 2)	0.216**	0.210**	0.100**
	(2.32)	(2.07)	(2.13)
Peer-adjusted Return (t – 1)	0.035	0.055	-0.002
	(0.53)	(0.91)	(-0.24)
Log Plan Size (t – 1)	0.042	0.076***	-0.010
	(1.14)	(3.39)	(-0.37)
Plan Funding % (t – 1)	-0.580	-0.537	-0.039
	(-1.61)	(-1.04)	(-0.33)
% Equity Allocation (t – 1)	1.506	1.026	0.023
	(0.62)	(0.35)	(0.08)
% Fixed Income Allocation (t – 1)	-3.401	-1.446	0.640*
	(-1.16)	(-0.49)	(2.13)
% Private Equity Allocation (t – 1)	0.481	-0.037	1.235**
	(0.79)	(-0.03)	(2.26)
% Hedge Fund Allocation (t – 1)	-3.922*	-3.477	-0.583
	(-1.73)	(-1.43)	(-1.38)
% Real Estate Allocation (t – 1)	0.880	0.619	-0.500
	(0.32)	(0.22)	(-0.58)
Year FE	YES	YES	YES
Observations	1,035	1,031	740
R-squared	0.061	0.951	0.819

Panel B. Alternative Performance Measures

	Raw Return	Sharpe Ratio (t to t + 3)
	(1)	(2)
Log Compensation (t-1)	0.327***	0.073*
	(3.34)	(1.81)
Peer-adjusted Return (t-1)	0.069	0.000
	(0.89)	(0.02)
Log Fund Size (t-1)	0.049	-0.003
	(1.58)	(-0.13)
Plan Funding % (t - 1)	-0.767*	0.000
	(-1.80)	(0.00)
% Equity Allocation	2.192	-0.067
	(0.92)	(-0.24)
% Fixed Income Allocation	-0.540	0.462
	(-0.20)	(1.63)
% Private Equity Allocation	1.712*	0.949
	(2.06)	(1.71)
% Hedge Fund Allocation	-3.552	-0.598
	(-1.55)	(-1.49)
% Real Estate Allocation	1.996	0.052
	(0.93)	(0.09)
Year Fixed Effects	YES	YES
Number of Observations	1,428	1,061
Adj. R-squared	0.955	0.823

Panel C. Alternative Regression Specifications

	Peer-Adjusted Return		
2nd Quartile Comp (t – 1)	0.120		
	(1.43)		
3rd Quartile Comp (t – 1)	0.247**		
	(2.42)		
Top Quartile Comp (t – 1)	0.411***	0.257**	
	(4.19)	(2.65)	
Above Median Comp (t – 1)			0.254**
			(2.76)
Peer-adjusted Return (t – 1)	0.069	0.071	0.070
	(0.95)	(0.97)	(0.97)
Log Plan Size (t – 1)	0.040	0.062*	0.051*
	(1.31)	(1.76)	(1.89)
Plan Funding % (t – 1)	-0.775*	-0.698*	-0.725*
	(-2.01)	(-1.79)	(-1.87)
% Equity Allocation (t – 1)	1.787	1.680	1.704
	(0.87)	(0.83)	(0.84)
% Fixed Income Allocation (t – 1)	-1.558	-1.571	-1.656
	(-0.67)	(-0.68)	(-0.71)
% Private Equity Allocation (t – 1)	0.998	1.139*	0.929
	(1.62)	(1.95)	(1.49)
% Hedge Fund Allocation (t – 1)	-3.837*	-3.871*	-3.991*
	(-1.87)	(-1.89)	(-1.95)
% Real Estate Allocation (t – 1)	2.255	2.332	2.342
	(1.00)	(1.03)	(1.05)
Year Fixed Effects	YES	YES	YES
Number of Observations	1,423	1,423	1,423
Adj. R-squared	0.051	0.051	0.052

Table A3: Holdings-Based Evidence on Risk-Taking

This table reports results of tests using the 13F filings of the pension plans in our sample. These tests first sort plans into quartiles based on their CIO's compensation and then compare mean differences of measures of risk calculated using the plan's equity holdings. Specifically, for each plan that files Form 13F, we use the plan's portfolio holdings to infer its daily, or monthly, returns. We then regress these inferred returns on the risk and behavioral factors listed below. Lastly, we regress the betas from these regressions on the log of CIO compensation, lagged one year as well as plan size, funding, and past performance. Panel A contains measures of volatility or economic policy risk. VIX and VXO are computed following . CATFIN is from Allen, Bali, and Tang (2012). MACRO is from Bali, Brown, and Caglayan (2014). POLICY is the economic policy uncertainty index of Baker, Bloom, and Davis (2016). Panel B contains measures of tail risk or behavioral factors. VaR is the value at risk factor, calculated by . CoVaR is the conditional value-at-risk measure, calculated by . PEAD and FIN are the behavior factors of Daniel, Hirshleifer, and Sun (2020). Panel C contains measures of mispricing. MAX and IVOL are from . *Mispricing Score* is the stock-level measure of mispricing from Stambaugh, Yu, and Yuan (2015). Finally, we compute *Total Volatility* and *Sharpe Ratio* using the daily portfolio returns inferred from a plan's equity holdings. The parentheses below each coefficient contain *t*-statistics computed from standard errors that are double clustered by plan and year. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A. Volatility and Economic Policy Risk

	VIX	VXO	CATFIN	MACRO	POLICY
Log Compensation (t-1)	-0.025**	-0.024*	-0.029***	-0.022***	-0.003*
	(-2.08)	(-1.83)	(-2.88)	(-4.99)	(-1.93)
Plan Control Variables	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES
R-squared	0.168	0.114	0.644	0.442	0.509
Number of Observations	1084	1084	263	263	263

Panel B. Tail Risk and Behavioral Factors

	VaR	CoVaR	PEAD	FIN
Log Compensation (t-1)	-0.004***	-0.005***	-0.029***	-0.004***
	(-3.65)	(-3.33)	(-2.88)	(-3.65)
Plan Control Variables	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
R-squared	0.510	0.486	0.644	0.510
N	1084	1084	263	1084

Panel C. Risk/Behavior/Mispricing Factors

	MAX	IVol	Mispricing Score	Total Volatility	Sharpe Ratio
Log Compensation (t-1)	-0.081***	-2.096*	-0.028	-0.005**	3.281***
	(-4.43)	(-1.86)	(-1.69)	(-2.11)	(3.06)
Plan Control Variables	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES
R-squared	0.293	0.376	0.143	0.464	0.348
N	1084	1084	1084	1084	1084

Table A4: Omitted Variables

This table reports results of regressions which control for various omitted variables. The dependent variable for all regressions is *Peer-Adjusted Return*. In Panel A, we control for plan culture using *Separate Investment Board*, an indicator variable equal to 1 for plans which have a separate board tasked with overseeing the CIO's investments. In Panel B, we control for plan location using *Financial Center*, an indicator variable equal to 1 if the plan is headquartered 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. For each variable, we estimate regressions in which we control for the variable as well as split our sample based on each variable and estimate our main regression for each subsample. The parentheses below each coefficient contain *t*-statistics computed from standard errors that are double clustered by plan and year. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A. Separate Investment Board/Fund Culture

		Peer-Adjusted Return (t)	
		Sep. Invt. Board = 1	Sep. Invt. Board = 0
Log Compensation (t-1)	0.307***	0.689**	0.221**
	(5.57)	(2.88)	(2.62)
Separate Investment Board (0/1)	0.235**		
	(2.17)		
Control Variables	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Adj. R-Squared	0.055	0.067	0.049
Number of Observations	1,428	361	1,067

Panel B. Financial Center/Plan Location

		Peer-Adjusted Return (t)	
		Fin. Center = 1	Fin. Center = 0
Log Compensation (t-1)	0.321***	1.425**	0.271**
	(5.29)	(2.66)	(4.90)
Financial Center (0/1)	0.176		
	(1.08)		
Control Variables	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Adj. R-Squared	0.053	0.151	0.069
Number of Observations	1,433	159	1,274

Panel C. Big City/Plan Location

		Peer-Adjusted Return (t)	
		Top Quartile MSA = 1	Top Quartile MSA = 0
Log Compensation (t-1)	0.287***	0.448**	0.258**
	(5.24)	(2.88)	(3.81)
Top Quartile MSA (0/1)	-0.032		
	(-0.30)		
Control Variables	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Adj. R-Squared	0.052	0.079	0.048
Number of Observations	1,423	311	1,112