# Scale Economies, Bargaining Power, and Investment Performance: Evidence from Pension Plans<sup>\*</sup>

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#### Abstract

We explore the relation between the size of a defined benefit pension plan and its choice of active vs. passive management, internal vs. external management, and public vs. private market investments. We document significant scale economies in pension plan investments: large plans possess greater bargaining power over their external managers in negotiating fees, and have access to better performing actively managed funds, relative to small plans. Further, switching from external to internal management (within an asset class) is associated with substantially lower per-unit costs for large plans, especially in private assets, reinforcing the enhanced bargaining power conferred by their scale.

**Keywords**: Pension plans, active versus passive management, internal versus external asset management, power law, economies of scale, asset allocation, private versus public asset classes, investment performance

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# 1 Introduction

Over recent decades, the professional asset management industry has undergone significant structural changes. The competitive landscape, influenced by both passive and active managers, has led to a substantial reduction in fees. Advancements in technology and increased availability of information, much of which diffuses through information networks between investment managers and their consultants (Rossi et al., 2018), have also played a role in this fee reduction. Furthermore, both active and passive managers have refined their investment offerings, focusing on specialization in their investment strategies (Blake et al., 2013). Simultaneously, large institutional investors—like sovereign wealth funds, pension plans, and endowments—have expanded their allocations to alternative asset classes, including hedge funds, private debt, private equity, and real assets.

Among these large institutional sponsors, defined-benefit (DB) pension plans continue to play a significant role in the global financial market, with the total assets under management (AUM) of DB pensions experiencing substantial growth. Notably, state and local government DB plans in the U.S. have seen their AUM increase from \$1.4 trillion in 1995 to \$5.1 trillion in 2020, while private-sector DB plans in the U.S. have grown from \$1.5 trillion to \$3.4 trillion over the same period (Investment Company Institute, 2021, p. 177). Moreover, the DB landscape now includes several very large pension plans, such as CalSTRS, one of the world's largest pension sponsors, with total assets of \$349.5 billion as of March 31, 2025.<sup>1</sup>

The confluence of the above-noted shifts in the asset management industry with the increased bulk of the largest DB plans brings several new issues to light, such as a potential increase in the bargaining power of DB plans in their interactions with their external money managers. Simply put, the negotiating power of very large DB plans, of late, may bring substantial changes in the balance of power between large plans and their investment managers. Such negotiating power, and its evolution over time, is especially salient in understanding which institutions gain access to the best alternative market investment managers, such as those managing private equity and hedge funds—since these managers are the most restrictive in accepting new capital (Barth et al., 2023). However, it is also important in understanding which institutions gain access to the top active managers in traditional asset classes, especially given the increasing competitiveness of active management over time, as evidenced by the significant growth in the number of actively managed investment funds over the past several decades.

<sup>&</sup>lt;sup>1</sup>See https://www.calstrs.com/investment-portfolio

To explore these issues, our study conducts a granular analysis of the DB industry, with an emphasis on the impact of DB plan size on (per-unit) fees, asset allocation, and investment performance. An economically important trend is that large DB plans are, over time, increasingly managing assets "in-house" to cut fees while potentially maintaining a reasonable level of performance (Beath et al., 2022).<sup>2</sup> A key issue that we explore is whether such in-house management brings greater bargaining power to plans when they negotiate fees and shop for the best investment managers for external management services—and, whether such bargaining power mainly resides with the largest pension plans due to the substantial fixed costs of establishing and maintaining internal management.<sup>3</sup>

Our analysis investigates the impact of scale in pension plans on asset allocation trends. For example, it is unclear whether the bargaining power of large plans results in a greater use of external *active* managers (at lower fee levels and/or higher levels of skill) or a greater tendency to internally manage assets (either actively or passively). As another example, as large plans move assets to internal management, it is important to assess whether the potential reduction in pre-fee active performance, compared to external managers, leads to a greater allocation to internal *passive* management—potentially at lower unit costs than external management. And, these tradeoffs are plausibly different across asset classes. Further, these tradeoffs have clearly changed substantially over time, as the unit costs of active and passive management, as noted above, have dropped precipitously—both for internal and external management of capital. Thus, our paper provides a unique inquiry into the scale economies of pension plans and the associated bargaining power at the level of plan asset and sub-asset classes. And, central to our inquiry is the use of internal management by large plans, with the threat posed by this investment approach to external managers.

We begin by formulating a set of hypotheses about the technological nature of scale economies in the costs of asset management, which sets up our subsequent novel assessment of the role of internal management in creating bargaining power. Specifically, our first hypothesis is that there are significant economies of scale in pension investment management, while our second hypothesis is that it is easier to scale up management

 $<sup>^{2}</sup>$ As an important example, CalSTRS recently stated that in-house management and co-management with external managers has been instrumental to their cost savings (see link). However, it remains unclear whether the choice of in-house management—or, at least, the threat thereof—leads to greater negotiating power with external managers to obtain better pre-fee performance and/or lower fees.

<sup>&</sup>lt;sup>3</sup>Our focus on the central role of internal management (or the threat posed by it) in creating negotiating power provides new insight into why large pension plans outperform, as documented by Dyck and Pomorski (2011).

in public vs. private asset classes, due to the more labor intensive nature of screening and acquiring private assets and the more opaque nature of information on these assets. Third, due to the highly scalable technology involved with passive strategies, we hypothesize that it is easier to achieve cost economies of scale for passively as opposed to actively managed assets. Fourth, because internal and external asset management plausibly use similar underlying research technologies, we hypothesize that scale economies for costs are the same for internally and externally managed assets. Adopting a power law setting well-known from other areas of economics and finance (e.g., Gabaix (2009, 2016)), we show how these hypotheses are naturally translated into parametric restrictions on the economies-of-scale coefficient and, thus, can be rigorously tested on our data.

Next, we turn to the central focus of our inquiry: examining how scale economies in asset management costs—and, thus, negotiating power with external managers—influence plans' choice of asset management style (internal versus external, and active versus passive), as well as their allocation between public and private assets. To provide a foundation for our subsequent empirical analyses in this more complex part of our study, we develop economic hypotheses that build on the modeling framework of Gârleanu and Pedersen (2018) (GP). In the GP model, investors incur a fixed search cost to identify skilled external asset managers who, in turn, incur a fixed cost from acquiring information about asset returns that enables them to outperform passive investments. Investment management fees in the GP model are determined through Nash bargaining, leaving a natural mechanism through which plan size (as a proxy for bargaining power) impacts per-unit fees and net-of-fee returns when investors are not atomistic in size. Further, information acquisition costs can be expected to be higher in the less transparent private asset markets than in public asset markets. This is consistent with an equilibrium in which investment management costs are relatively high in private asset markets, and the largest plans benefit disproportionately from their higher ability to engage with skilled managers, either due to their enhanced ability to overcome fixed search costs and/or to negotiate lower investment management fees once they identify skilled managers.

Importantly, GP assume that investors choose not to acquire an informative signal themselves in order to potentially manage their assets internally. This is a natural assumption for (atomistic) retail investors, but one that does not apply to the large pension plans on which we focus. To better fit the framework of our empirical setting with nonatomistic pensions, we generalize the GP model in three ways. First, we incorporate economies of scale in investors' cost functions. Second, we give investors the choice of managing their assets internally, and we model their choice among four alternative investment management approaches: Internal Passive, Internal Active, External Passive, and External Active. Third, in a further generalization of the GP model, we introduce two risky asset classes, labeled public and private assets, each characterized by different levels of search costs, competition among managers, and risk-return trade-offs.

These generalizations of the GP model produce a second set of empirically testable hypotheses. In particular, a version of the GP model calibrated to our data suggests that small pension plans (those plans with lower AUM in public and/or private asset classes) prefer external active management, but switch to external passive management as they grow larger due to the increased (negotiated) reduction in fees for external passive managers that result from being bigger. As plans grow even larger, they first switch to internal active management as the per-unit fixed costs of setting up and maintaining an internal process diminish and become less important, relative to the search costs of locating external skilled managers. However, the very largest plans switch to managing assets through internal passive management, as the cost economies of passive management outweigh the higher fixed costs of active internal management at large scale. From these predictions, it follows that the frequency with which plans manage assets internally both actively and passively—should be an increasing function of AUM. Further, the proportions of internally and, separately, externally managed assets that are passively managed should increase in plan size.

To test these hypotheses empirically, our inquiry exploits a unique database to explore several dimensions of the pension plan sector, including both cross-sectional and time-series aspects. Our data is sourced from CEM, a Toronto-based private consulting company that collects information from a diverse range of pension plans. Each year, CEM gathers data on these plans' asset allocations as percentages within major asset classes (e.g., public equities, fixed income, hedge funds, private equity, public debt, private debt, and real assets), sub-asset classes (e.g., small-cap U.S. equities or infrastructure investments), and, within each sub-asset class, the allocation of each pension plan to active vs. passive management, as well as between internal and external management. The CEM database uniquely includes data on AUM, gross returns, and investment costs for each sub-asset class/active-passive combination. Additionally, the CEM staff routinely apply a battery of checks to obtain the most precise data possible.<sup>4</sup>

With this CEM database, we find that large pension plans tend to invest a greater share of their plan assets in less-liquid sectors of the market, as well as sectors of the

<sup>&</sup>lt;sup>4</sup>From our discussions with CEM, it is apparent that CEM researchers maintain frequent contact with their "subscribers" in cases where data looks suspect in order to maintain the integrity of their database.

market where scale-related bargaining power can be expected to be especially keen in achieving net-of-fee active management alphas, such as private equity investments (see also Andonov, Kok and Eichholtz (2013), Dyck and Pomorski (2016), and Andonov (2024)).<sup>5</sup> Further, large plans tend to use internal management to a greater degree, particularly in public asset classes where the fixed-cost of establishing and maintaining internal investment management is lower.

Next, in our empirical tests of our second set of hypotheses, we find strong evidence of significant economies of scale in investment management costs, and document that these follow a power law as a function of the amount of assets invested by a plan. The associated concave relation between investment management costs and plan holdings is strongest for public asset classes. Conversely, for the more labor-intensive private asset classes, we find that it is more difficult to reduce per-unit costs as plan size increases. We also document larger economies of scale in fees for passively managed than for actively managed investments, consistent with the predictions of our model.

Also consistent with our model predictions, plan size is of key importance for explaining the choice between internal and external investment management. Larger plans are significantly more likely to manage assets internally in all sub-asset classes, except for hedge funds and multi-asset class funds.<sup>6</sup> Moreover, this holds both for actively and passively managed assets. Further, larger pensions increasingly harness the substantial economies of scale offered by passive management in public securities—consistent with our model. We also note that the shift toward passive management is more pronounced over time, given the rapid decrease in fixed costs associated with passive management. This trend aligns with the diminishing capacity of larger plans to extract alpha from public securities markets, especially equities, as mentioned above. For the share of equities and fixed income managed externally, large plans are more likely to allocate to equities passively, while preferring to manage fixed income investments actively, relative to smaller plans.

Our model implies that the choice of management style (internal versus external and active versus passive) is endogenous, as it depends on plan size and asset class characteristics. To account for such confounding effects (and, notably, to control for plan size) when estimating the impact on plan per-unit costs in the presence of these

 $<sup>{}^{5}</sup>$ Carlo et al. (2023) further show that large plans with larger PE allocations are more likely to allocate to infrastructure as well.

<sup>&</sup>lt;sup>6</sup>Interestingly, non-U.S. plans, in general, have a higher tendency to internally manage allocations relative to U.S. plans, indicating either a fundamental difference in investment approach and/or a higher level of external manager search costs across more fragmented non-U.S. securities markets.

endogenous choices, we use a difference-in-differences approach that matches plans that switch management style (e.g., from external to internal management) with similar plans that retain the same management style in our panel dataset. We find strong evidence that per-unit management costs uniformly decrease when plans switch from external to internal or from active to passive management, whereas costs increase when switching from internal to external or from passive to active management.

Our model also implies that plan size has a positive effect on net returns, but no impact on gross returns, and plans' choice of whether to manage their assets internally or externally should not affect their gross returns.<sup>7</sup> We find empirical evidence that is largely supportive of these implications. First, for public asset classes, we find no significant association between plan size and gross return performance, but a significantly positive association between net return performance and plan size for stocks and alternative assets, such as private equity and real assets.<sup>8</sup> Plans' choice of internal versus external investment management also does not appear to have an effect on gross return performance for any asset class, with the notable exception of private equity, for which externally managed investments perform significantly better. A final implication of our model is that the effect of plan size on net return performance should be greater in private than in public asset markets. We find strong empirical support for this implication with plan size mattering significantly for hedge funds and multi-asset, private equity, and real asset accounts.

Our paper builds on prior research that examines the relation between plan size, scale economies, allocation to alternative assets, and investment performance. Specifically, Dyck and Pomorski (2011) regress plan costs scaled by AUM on log AUM, a specification which our results suggest is misspecified and underestimates scale economies in investment costs.<sup>9</sup> They find that large plans allocate more to asset classes such as private equity and real estate, where their scale provides bargaining power with respect to the fees charged by external asset managers. Andonov (2024) also finds significant economies of scale for alternative asset classes, while Andonov, Kok and Eichholtz (2013) find that large plans pay lower fees than small plans, and obtain higher benchmark-adjusted net returns.<sup>10</sup> Our study provides a model that delivers predictions, and we provide empirical results that explain and significantly expand on these papers.

 $<sup>^7\</sup>mathrm{We}$  note that these model implications are another novel contribution of our work.

<sup>&</sup>lt;sup>8</sup>These results are based on "policy-adjusted returns." We explain, in detail, how these policy-adjusted returns are constructed in Section 7.

<sup>&</sup>lt;sup>9</sup>Their cost analysis is also limited to alternative asset classes.

<sup>&</sup>lt;sup>10</sup>Begenau and Siriwardane (2024) document a two-tier fee structure for private equity funds with larger investors more likely to receive lower fee terms.

Assets under management also have an important effect on plans' allocation to alternative assets and their performance within these asset classes. Andonov (2024) finds that large plans are more likely to invest in private equity, but less likely to delegate investments in alternative assets to funds-of-funds as compared to smaller plans. Andonov, Hochberg and Rauh (2018) find that pension plans with politicians on their board tend to allocate more to infrastructure. In turn, Dyck, Manoel and Morse (2022) and Lu, Mullally and Ray (2023) find that CIO compensation is tightly linked to higher allocations to private equity and infrastructure.<sup>11</sup>

Our analysis generalizes existing findings in several ways. First, we build a model that generalizes the analysis in Gârleanu and Pedersen (2018) which is foundational in predicting the effect of institutional scale on investment strategy and performance. This model clearly captures the tradeoffs imposed, for example, by fixed cost differences between public and private investment management, as well as internal vs. external management.

Second, our empirical analysis accounts for plans' joint decisions on investment style across both the active/passive and the internal/external dimensions of management decisions by plan sponsors. To this end, our theoretical model allows for cost economies of scale, internal active management, and both private and public (risky) asset classes, and establishes conditions under which an equilibrium can exist in which all four investment management styles potentially co-exist.

Third, we provide a more comprehensive analysis of cost economies of scale within different asset classes and across different investment management styles, and conduct formal tests of the dimensions along which these differ. We exploit the sub-asset class granularity of our data and document a power-law relation between size and investment management costs (within a sub-asset class) which more precisely indicates economies of scale in all asset classes, as well as at the plan level. Fourth, we show that economies of scale in costs differ significantly across passive and active mandates, while they are similar for internally and externally managed accounts. Finally, we conduct a detailed analysis of plans' gross and net return performance across different asset classes and investment management styles that comports to the predictions of our theoretical model.

The remainder of the paper proceeds as follows. Section 2 introduces the main features of our data from CEM with additional details provided in Appendix B. Section 3 develops a set of hypotheses on scale economies in investment management costs, while

<sup>&</sup>lt;sup>11</sup>Fang, Ivashina and Lerner (2015) use proprietary data to examine institutional investors' private equity holdings. They find that direct investments perform better than public market indices but find no evidence that direct investments outperform private equity fund benchmarks. Lerner et al. (2022) show that alternative vehicles on average match PE market returns.

Section 4 develops our equilibrium asset pricing framework and describes the associated implications for investment management styles and return performance. Section 5 provides a detailed analysis of the cost data, and Section 6 covers the determinants of internal versus external and active versus passive investment management decisions. Section 7 analyzes gross and net-of-cost return performance and how it relates to plan characteristics. Finally, Section 8 concludes.

# 2 Data and Summary Statistics

We obtain our data from CEM Benchmarking, a Toronto-based company that uses detailed annual surveys to collect data on public and private pension sponsors domiciled both in the U.S. and in a number of other developed-market countries. A key advantage of this dataset is its highly detailed fee/cost data, separated by sub-asset class, as well as by active vs. passive mandates and by internal vs. external management within each sub-asset class. In total, the CEM Benchmarking database covers 613 U.S. and 524 non-U.S. plans (CEM "PlanIDs") that participated in the survey at some point during our 29-year sample period from 1991 to 2019.<sup>12</sup>

CEM plan surveys in the U.S. and the U.K. are primarily collected from defined benefit (henceforth, DB) pension plans and other similar capital investment pools. Apart from these regions, the type of plans for which the survey is collected is country-specific, such as industry-based DB pools in the Netherlands, buffer funds in Sweden, insurance-backed retirement funds in Finland, or defined contribution plans in Australia. Even though reporting to CEM is voluntary, previous research has found no evidence of self-reporting bias related to performance (Bauer, Cremers and Frehen, 2010).<sup>13</sup> The self-reported data are checked by CEM for internal (same year) consistency, year-over-year consistency, and outlier reporting. CEM data is biased toward larger plans, yet plans contained in the database are broadly distributed across size (total plan AUM). The aggregate AUM covered by CEM in 2019 is \$10.32 trillion, with U.S. plans accounting for \$3.79 trillion,

<sup>&</sup>lt;sup>12</sup>The CEM dataset has further been studied by French (2008) who shows a shift from active to passive management over time while Andonov, Kok and Eichholtz (2013) document scale-economies for pension plan costs in real estate investments, and Andonov, Bauer and Cremers (2017) find that U.S. public pension funds invest more in risky assets. Broeders, van Oord and Rijsbergen (2016) look at scale benefits for Dutch pension plans, using different proprietary data.

<sup>&</sup>lt;sup>13</sup>From discussions with CEM, the primary reason for funds to leave the survey is turnover in direct contacts with clients, i.e., the personnel of a particular pension plan changes. High-fee plans, predominantly small plans, are less likely to participate in the survey which can be very labor intensive to complete.

and non-U.S. plans holding the remaining \$6.53 trillion (using 2019 exchange rates). Some plans only report results for a few years—in some cases only for a single year. However, while roughly 500 plans report to CEM for three or fewer years, 317 plans report to CEM for at least 10 years. This fact, coupled with the large cross-section of plans surveyed by CEM each year (at least since 1999), allows us to analyze a representative sample of worldwide pension plans.<sup>14</sup> Further details on the CEM database, and the mechanism used to collect data from plans, are contained in the Appendix.<sup>15</sup>

The CEM survey collects data on four categories of variables, separately for passively vs. actively managed, and, in turn, for internally vs. externally managed assets within each of six major asset classes (and their corresponding sub-asset classes), namely: stocks, fixed income, hedge funds and multi-asset class (jointly), private equity, private debt, and real assets. Included for each of four potential mandate choices within each asset class (e.g., internal active) is the dollar value of assets (using exchange rates for foreign plans), internal management costs or external management fees (AUM-based as well as performance-related), and asset returns, measured both gross and net of fees.<sup>16</sup> A full list of variables is contained in Appendices B.2—D.

Appendix B.3 examines the time-series evolution in plans' allocation to asset classes (Figure A.1) and sub-asset classes (Figure A.2). We identify two major shifts in the asset allocation of U.S. pension plans. First, the share of (publicly-traded) stocks and fixed income assets has declined from nearly 90% in the early 1990s to 70% at the end of our sample (2019), while allocations to non-traditional asset classes such as private equity, hedge funds, and real assets increase significantly over time.<sup>17</sup> Second, within traditional asset classes such as equity and bonds, we see large shifts toward more specialized mandates. For instance, there has been a transition from broad or all U.S. equities to funds focusing on large, medium, and small market capitalization segments in the equity space.

<sup>&</sup>lt;sup>14</sup>Details are provided in Appendix Table A.1. That said, our sample is especially reflective of North American plans. In our empirical results, we point out when differences exist between the early years of our sample and later years—which contain a higher proportion (relative to early years) of plans domiciled outside of North America.

<sup>&</sup>lt;sup>15</sup>For comparison, according to the Investment Company Institute (2021), in 2019, there were \$54.9 trillion of total net assets invested in worldwide regulated open-end funds, with the U.S. accounting for \$25.9 trillion, or nearly half, of these investments. The Center for Retirement Research at Boston College (CRR) estimates that U.S. public pension plans held \$4.1 trillion of assets in 2019. See https://publicplansdata.org/.

<sup>&</sup>lt;sup>16</sup>For each asset class, data is subdivided into several sub-asset classes such as U.S. large cap stocks or emerging market stocks, as shown in, for example, Appendix Table A.4.

<sup>&</sup>lt;sup>17</sup>Hedge fund holdings, on average across plans, increase from 1% in 2003 to 6% in 2019. Private equity holdings also increase to 9% in 2019 from 4% in 2000; allocations to real assets increase to 10% in 2019 from 4% in the early 1990s.

Similarly, we observe a move from general U.S. bond allocations towards more specialized strategies targeting high-yield and credit objectives in the fixed-income sector. By far the biggest shift is toward international and global assets, which become more prominent over time, particularly in stock allocations.

We present results for small and large pension plans, defined as plans below the 30th and above the 70th percentile in total plan AUM each year, in Figure 1. This figure includes bar charts for the asset allocation by management mandate within asset classes for the year 2019, with similar results in 1999 and 2009. The three asset classes, stocks, fixed income, and real assets, encompass all four management mandates: internal passive (IP), external passive (EP), internal active (IA), and external active (EA). Passive mandates are not available for the remaining alternative asset classes: private debt, private equity, and hedge funds. Large plans exhibit a higher fraction of internally managed assets, both for active and passive mandates, particularly in publicly-traded fixed income and stocks. These asset classes are associated with the lowest fixed and variable internal management costs, making them more conducive for setting up internal asset management.

Table 1 reports small and large plans' choice of investment management mandate in the form of the share of plans' AUM within individual sub-asset classes allocated to each of the four management mandates (IP, EP, IA, and EA). Large plans make far greater use of internal active management than small plans both in public asset classes and even more so among the four private asset classes. Differences can be very large, e.g., with 58% of large plans' assets in global equity being managed internally and actively, versus only 1% for small plans. Small plans also make far greater use of external active investment management than large plans. These are of course only summary statistics; in the next section, we develop a model for understanding plans' choice of investment mandates.

Appendix C.2 further discusses time trends in asset management costs for different mandates. We document that external and internal passive management costs have converged over time, while external active management fees have remained persistently higher than internal active management costs.

# 3 Economies of Scale in Investment Management Costs

Our paper examines the choice by pension plans of investment management style (internal vs. external and active vs. passive), investment management costs, and return performance as a function of pension plan scale. To this end, we seek to understand how economies of scale affect investment costs, specifically the fixed costs associated with different allocations, such as those to active or passive management, as well as internal or external management.<sup>18</sup> We highlight the bargaining power that large plans gain because of their ability to manage investments internally, potentially avoiding the higher costs associated with external managers.

Economies of scale matter in investment management because many costs, such as legal, data, and computing expenses, are either fixed or do not increase proportionally with assets under management. This suggests an inverse relation between a plan's holdings in a specific asset class and the average costs of managing that asset (or, sub-asset) class, meaning that larger plans typically experience lower costs and fees per dollar invested compared to smaller plans. Still, larger plans may also face higher costs due to the need for additional personnel and increased transaction expenses when dealing with larger pools of capital. Investment management costs can also vary depending on the labor-intensity of different sub-asset classes, influenced by factors such as liquidity and transparency.

To better understand scale economies in investment management costs, we examine the power law framework developed by Gabaix (2009, 2016), positing that dollar management costs, Cost<sup>\$</sup>, follow a power law as a function of AUM:<sup>19</sup>

$$\operatorname{Cost}^{\$} \propto \operatorname{AUM}^{\beta}.$$
 (3.1)

Power law coefficients  $\beta < 1$  are consistent with economies of scale in investment management costs, and the smaller is  $\beta$ , the bigger the cost economies of scale. Conversely,  $\beta > 1$  suggests diseconomies of scale since increasing AUM by a certain factor leads to disproportionately higher management costs.

We use the posited relation in (3.1) to formulate a set of hypotheses on economies of scale in investment management. Our most basic hypothesis is that costs grow less than proportionately with assets under management, i.e.,  $\beta < 1$ . Our next cost hypothesis is that investment management costs vary systematically across public and private asset classes. Specifically, we would expect greater cost economies of scale for public asset classes such as stocks and fixed income ( $\beta^{public}$ ) that are traded in transparent

<sup>&</sup>lt;sup>18</sup>Fixed costs include the costs of setting up a management "shop", such as the costs of office space, datasets, and human capital, both for internal and external management—but, also, the search costs of plans in locating skilled active external managers.

<sup>&</sup>lt;sup>19</sup>Two variables X and Y are said to be related via a power law if  $Y = cX^{\beta}$ , where c is an arbitrary constant. Gabaix (2009, 2016) suggests that power laws are ubiquitous among economic variables such as firm or city size, income, and wealth. While these power laws typically hold primarily in the tails of the distribution, we find the assumption plausible across the entire distribution (see Figure 3).

and liquid markets than for private asset classes  $(\beta^{private})$  which typically involve more labor-intensive (less computerized) processes that are harder to scale up.

Scale economies in costs are also likely to be linked to management mandate, so we analyze the cost-size relation at the asset class level for the four different mandates, namely, Internal Passive (IP), Internal Active (IA), External Passive (EP), and External Active (EA).<sup>20</sup> Passive investment management has largely become commoditized in a way that facilitates scaling more easily than the labor intensive active investment management process consistent with the conjecture of Berk and Green (2004). Moreover, besides lower per-dollar human-capital costs, large passive management funds can implement trading strategies that enhance their returns, such as securities lending and favorable per-dollar trading terms with prime brokers, relative to smaller passive funds. Hence, our third cost hypothesis is that passive investment management lends itself more easily to scaling than active management, in part because it is associated with lower market impact.

For both internal and external management to coexist within a specific asset class, we propose our fourth cost-scale hypothesis, namely that economies of scale are the same for these management mandates as a consequence of identical scaling technologies being applied in both internal and external asset management.

**Hypothesis I** (Economies of scale in investment management costs). In the context of the power law relation in (3.1), the following holds:

- (i) Pension plans' investment management costs display significant economies of scale and exhibit a concave relation to AUM:  $\beta < 1$ .
- (ii) Economies of scale in the cost of investment management are greater for publicly traded assets than for private asset classes:  $\beta^{public} < \beta^{private}$ .
- (iii) For each asset class, and for both internally and externally managed accounts, passive investment management offers better economies of scale than active management:  $\beta^{IP} \leq \beta^{IA}$  and  $\beta^{EP} \leq \beta^{EA}$ .
- (iv) For each asset class and management mandate (active or passive), the economies of scale cost parameter is identical for internally and externally managed assets:  $\beta^{IP} = \beta^{EP}$ , and  $\beta^{IA} = \beta^{EA}$ .

<sup>&</sup>lt;sup>20</sup>For private assets, we focus on active management mandates only, since the vast majority of such assets are actively managed.

# 4 An Equilibrium Model for Plans' Choice of Asset Management Style

In this section, we formulate testable hypotheses drawing from a model of asset management, considering scale economies, the cost of information acquisition, and heterogeneity in investors' abilities to identify skilled managers. We begin by examining how investment management costs depend on plan size which will guide the statement of our hypotheses on plans' choice of asset management style and their return performance.

## 4.1 Model Setup

Building on Gârleanu and Pedersen (2018), henceforth GP, we develop a general equilibrium model for assets and delegated asset management in the presence of fixed costs that pose a friction for all investors (in our setting, for DB plans). The GP model introduces delegated investment management with uninformed and informed managers. The true manager type (informed vs. uninformed) is unobserved by investors, and a fixed search cost must be paid to help identify skilled investment managers.<sup>21</sup>

In our setting, we observe wide heterogeneity in asset allocations among pension plans impacting their capacity and motivation to cover fixed costs associated with external manager search or internal management setup. Large plans with billions of dollars to invest and many experienced professionals can better handle the fixed costs of internal management, and are expected to be more capable of identifying skilled managers.<sup>22</sup> Conversely, small plans will neither have the incentive to undertake costly search, nor to establish internal management, leading to distinct choices between external and internal management. Thus, the choice between external and internal management will be indicative of the fixed costs of internal vs. external management, especially among large pension plans. Small plans can be expected to choose the "corner solution" of no internal management.

GP assume that investors forego the option of directly acquiring the signal and manage

<sup>&</sup>lt;sup>21</sup>Investors have the option of either investing their money directly (passively) and, thus, foregoing the search cost, or searching for an informed manager who will charge a fixed investment fee for actively managing investor assets. The size of this fee is modeled through Nash bargaining between the manager and investor. This feature of the GP model suggests that investors' bargaining power should matter to their choice of investment mandate as well as to investment alphas and fees.

<sup>&</sup>lt;sup>22</sup>To be sure, large plans are more likely to have access to the most skilled managers due to the greater fee income that they potentially bring, which can compound the advantages that their greater manager search capabilities bring. We focus on the bargaining power possessed by large plans due to their enhanced ability to "internalize" investment management.

their assets internally - a natural assumption for retail investors but not for the large pension plans on which we focus. To accommodate this and other salient features of our pension plan data, we generalize their model in three ways:

- First, consistent with Hypothesis I, we incorporate economies of scale in investors' cost functions (an assumption that we will verify with our dataset). This assumption is highly relevant for institutional investors and is not part of the GP model that is tailored toward retail investors.
- Second, we explicitly allow investors to manage assets internally and model their choice among four alternative investment styles s: Internal Passive (IP), Internal Active (IA), External Passive (EP), and External Active (EA).
- Third, in a further generalization of the GP model, we introduce two risky asset classes, labeled public and private assets, each characterized by different levels of search costs, competition among managers, and risk-return trade-offs.

#### 4.1.1 Information acquisition and Utility maximization

We next provide a high-level description of our generalization of the GP model, with details provided in Appendix A. Specifically, the GP model assumes a single risky asset whose unknown value v is normally distributed with mean  $\bar{v}$  and variance  $\sigma_v^2$ ,  $N(\bar{v}, \sigma_v^2)$ . Each investor (in our case, a pension plan) can pay a fee to purchase a noisy signal,  $\zeta$ , of  $v, \zeta = v + \varepsilon$ , where  $\varepsilon \sim N(0, \sigma_{\varepsilon}^2)$ . Plans also observe the asset price,  $p.^{23}$  Plans acquiring the signal for a fee are labeled active while those that do not are labeled passive.<sup>24</sup>

Let  $u_i^P(W)$  and  $u_i^A(W)$  denote the certainty-equivalent wealth of a passively or actively managed plan *i*, respectively, given wealth level *W*. Assuming CARA utility with riskaversion parameter  $\gamma_i$  and AUM  $W_i$ , we arrive at the following certainty equivalents for

<sup>&</sup>lt;sup>23</sup>To prevent the price from fully revealing investors' signals, the asset's supply, q, is stochastic and  $q \sim N(\bar{q}, \sigma_q^2)$ .

<sup>&</sup>lt;sup>24</sup>Following GP, we assume there is a mass  $N \ge 0$  of noise allocators that pay the signal fee, but do not necessarily become informed. These noise allocators are introduced to make it difficult to assess whether a manager is informed by looking at its clientele. We always assume that noise allocators manage their assets externally. Hence, they pay an active manager fee, but optimally choose an uninformed passive manager.

passive and active management, with holdings  $x^P$  and  $x^A$ , respectively:

$$u_i^P(W_i) = -\frac{1}{\gamma_i} \log \left[ \mathbb{E} \left[ \max_{x^P} \mathbb{E} \left( e^{-\gamma_i (W_i + x^P (v - p))} | p \right) \right] \right] = W_i + u_i^P(0) \equiv W_i + u_i^P,$$
  
$$u_i^A(W_i) = -\frac{1}{\gamma_i} \log \left[ \mathbb{E} \left[ \max_{x^A} \mathbb{E} \left( e^{-\gamma_i (W_i + x^A (v - p))} | p, \zeta \right) \right] \right] = W_i + u_i^A(0) \equiv W_i + u_i^A.$$

The rightmost equalities define the wealth-independent components of utility  $(u_i^P, u_i^A)$ , which determine the optimal behavior. In addition to managing the portfolio actively (A) or passively (P), a plan can further decide between internal (I) and external management (E), leading to four management styles  $s \in \{IA, IP, EA, EP\}$ . The choice between internal and external management affects only cost, not the certainty-equivalent of wealth. However, this choice still influences the optimal management style (A vs. P), as plans maximize the certainty-equivalent wealth, net of cost (see Section 4.1.2 below).

The model assumes a market with  $\overline{M}$  external managers, of which  $M^A$  are active and  $\overline{M} - M^A$  are passive. Active managers pay a search cost to acquire the signal with the expectation of collecting higher fees than passive managers (see Appendix A.2). In an equilibrium without corner solutions, managers are indifferent between active or passive management. In public asset markets where competition among managers is fierce, we expect  $\overline{M}$  to be high; however, we expect it to be much smaller in the more specialized private asset markets with higher costs of entry.

#### 4.1.2 Cost Functions

Cost functions play an important role in our analysis. We specify these as follows:

Internal Passive : 
$$c_i^{IP}$$
 External Passive :  $c_i^{EP}$   
Internal Active :  $c_i^{IA} + k$  External Active :  $c_i^{EA} + f_i$ 

Under active management, the plan incurs a search cost k for internally managed assets or pays a manager fee,  $f_i$ , for externally managed assets. This manager fee is determined by Nash bargaining between the plan and an external active manager. Consistent with the setup in Hypothesis I, we assume that cost functions follow a power law with coefficients that are higher for active ( $\beta^A$ ) than for passive ( $\beta^P$ ) mandates (i.e.,  $\beta^P < \beta^A$ ), as passively managed investments are easier to scale up than actively managed ones. Further, we assume that the scaling coefficients are the same for internally and externally managed assets. This leads us to the following specification of the costs for each management style

$$c_i^{IP}(W_i) = FC + \bar{c}^{IP} W_i^{\beta^{\rm P}} \qquad c_i^{EP}(W_i) = \bar{c}^{EP} W_i^{\beta^{\rm P}}$$
(4.1)

$$c_i^{IA}(W_i) = FC + \bar{c}^{IA} W_i^{\beta^{A}} \qquad c_i^{EA}(W_i) = \bar{c}^{EA} W_i^{\beta^{A}}.$$
(4.2)

The FC term is included for internal management to reflect the fixed cost associated with this management style. For simplicity, we assume that the fixed cost of active or passive management are equal.<sup>25</sup> In equilibrium, a plan's decision to adopt a certain management style is determined by the certainty equivalent of wealth, net of cost.

An asset market equilibrium is then defined by a number of active (external) fund managers  $M^A$ , a number of internal passive, external passive, internal active, and external active plans investing in that single asset class, an asset price, and an asset manager fee,  $f_i$ , such that: (1) no external manager has an incentive to change manager style from active to passive (or vice-versa); (2) no plan has an incentive to change management style; (3) the asset price clears the market; (4) the asset manager fee is determined by Nash bargaining.

## 4.2 Economies of Scale and Management Styles in Equilibrium

In Appendix A, we explicitly solve for the market equilibrium with parameters calibrated to our data sample. Figure 2a shows the outcome of this analysis, plotting the optimal investment style as a function of plan size (AUM). For the smallest plans, external active management is optimal; with growth in AUM, external passive, internal active, and, finally, internal passive management for the largest plans is optimal. External active management is optimal for the smallest investors who cannot overcome the fixed cost of setting up an internal team. They prefer active over passive management due to its higher alpha, which offsets the bargaining fee. As plan size increases, investors switch to external passive management to benefit from economies of scale. With further growth, plans transition increasingly from external to internal management and, again, from active to passive management to exploit larger economies of scale. Larger plans adopt internal management as they can absorb the fixed costs of establishing an internal team. The initial shift from external passive to internal active management is driven by a higher net alpha, despite the initially higher cost, as shown in Figure 2b.

 $<sup>^{25}</sup>$ This assumption makes our model simpler, and is consistent with the variable costs of IP vs. IC capturing the majority of cost differences due to, e.g., human capital, data, or technology expenditures (which are plausibly related to the scale of investment).

We emphasize that the economies of scale assumption in the cost functions is important for the coexistence of all four management styles in equilibrium. If costs were constant, as in the basic GP model, plans would simply choose between active and passive management, always preferring the cheaper option. This is because switching from passive to active management increases gross alpha (utility gain), whereas switching between internal and external management has no impact on alpha if the passive/active choice remains fixed. As a result, at most two management styles would emerge in equilibrium, always involving both active and passive management.

Similarly, differences in economies of scale and fixed costs between active and passive management are necessary. If both fixed costs and economies of scale were identical, plans would always prefer either external passive or internal passive management, eliminating the potential equilibrium coexistence of both. When fixed costs differ but economies of scale remain the same between passive and active management, all four management styles can arise in equilibrium—but only under fairly stringent parameter restrictions. We summarize these results in the following proposition (proved in Appendix A.4.)

**Proposition 4.1.** The following points hold for the generalized GP model:

- In the absence of economies-of-scale in management costs (i.e., constant costs, β<sup>IP</sup> = β<sup>EP</sup> = β<sup>IA</sup> = β<sup>EA</sup> = 0), at most two management styles can be observed in equilibrium, assuming costs for each management style are different. Furthermore, internal and external management can co-exist only when both passive and active management are observed.
- 2. If economies of scale and fixed costs for active and passive management are the same  $(\beta^{IP} = \beta^{EP} = \beta^{IA} = \beta^{EA}, \Delta FC = 0)$ , an equilibrium with all four management styles does not exist.
- 3. If economies of scale are identical for active and passive management, but fixed costs are different (β<sup>IP</sup> = β<sup>EP</sup> = β<sup>IA</sup> = β<sup>EA</sup>, ΔFC ≠ 0), either a market equilibrium with all four management styles (a) does not exist; or (b) exists and, ranked by AUM, is given by EA → EP → IP → IA, provided the market is highly efficient; or (c) exists and, ranked by AUM, is given by EA → EP → IP, provided the market is "mildly efficient."
- 4. In the model calibration of Figure 2a, an asset market equilibrium with all four management styles does not exist if economies of scale are equal, i.e. all parameters are kept the same except that  $\beta^{IP} = \beta^{EP} = \beta^{IA} = \beta^{EA}$ .

The "mildly efficient" market requirement in part 3 refers to the information gain from switching from passive to active management, and plays a key role in the GP model. In Appendix A, we characterize the level of market efficiency required for all four management styles to coexist in equilibrium when there are no economies of scale. When an equilibrium with all four management styles exists, part 3 makes it clear that external (internal) management is preferred by small (large) plans, and EA is preferred by the smallest plans over the EP management style. Only the ordering of IA versus IP as a function of AUM depends on the degree of market efficiency.

This analysis suggests the following hypotheses:

Hypothesis II (Plan size and investment management styles).

- (i) Large plans manage a greater fraction of their assets using internal management than small plans which, conversely, rely more on external asset management.
- (ii) Large plans manage a greater fraction of their passively managed assets internally than small plans.
- (iii) Large plans manage a greater fraction of their actively managed assets internally than small plans.

Points (ii) and (iii) do not follow automatically from point (i). For example, consider a large plan that manages 20% of its assets actively, of which 20% are internally managed, and 80% passively (10% managed internally). In total, this plan would manage 12% of its assets internally. Now, consider a small plan that manages 80% of its assets actively (15% internally) and 20% passively (5% internally). Overall, this plan manages 13% of its assets internally even though, for active and passive assets, separately, the large plan manages a greater fraction of its assets internally than the small plan.

## 4.3 Effect of Management Style on Cost

The equilibrium in Figure 2a and the associated costs in Figure 2b imply that costs can jump discretely when plans switch management style due to a change in AUM. Specifically, the model predicts that switching from passive to active management increases cost, and vice-versa, when controlling for size and external management. In contrast, switching from internal to external management is predicted to have no effect, after controlling for size and whether management is active or passive.<sup>26</sup> Furthermore, the model implies that plans increase their AUM in a (sub-)asset class when switching from external to internal management, and vice versa. We summarize these cost-based implications in the following hypothesis:

Hypothesis III (Cost and asset allocation when switching management style).

- (i) Controlling for AUM and active/passive management, switching from internal to external management has no effect on cost.
- (ii) Controlling for AUM and internal/external management, a switch from passive to active management increases cost, and vice versa.
- (iii) Plans tend to increase their AUM in a sub-asset class when switching from external to internal management, and decrease AUM when switching from internal to external management.

## 4.4 Plan Size and Return Performance

Our final set of hypotheses is concerned with how return performance, both gross and net of fees, varies across plan size, investment mandate, and asset class.

In formulating our hypotheses, we emphasize the difference between the markets for managing public and private asset classes. For public asset classes with a highly competitive market for asset management, as indicated by small values of k and  $\bar{c}^{EA}$ , plans have more bargaining power and fees are competed down to a point where the difference in net returns is only marginally higher for actively managed than for passively managed accounts. In our model, active management yields higher gross returns than passive management. Conditional on choosing active management, the model implies that plan size has no effect on gross returns, but does influence net returns due to economies of scale in costs. The model also suggests that internal versus external management has no impact on gross return performance but may affect net returns, since the cost function depends on the internal/external management decision. However, we expect this effect to be of second-order importance relative to the passive/active management decision, as the latter affects the extent of scale economies (Hypotheses I(iii) and I(iv)). Overall,

 $<sup>^{26}</sup>$ Even though the model is static, we can interpret a plan as switching management style upon growing in AUM, while the AUM of other plans remains unchanged—so the equilibrium outcome is unaffected by this individual change.

we expect size to be a significant determinant of net returns only, once we control for passive/active and internal/external management.

Markets for managing private assets are very different in that they are more specialized with a higher cost of entry, as captured by higher values of k and  $\bar{c}^{EA}$  in the GP model. Moreover, the market is characterized by less price transparency, illiquidity, and informational asymmetry, so that passive management may not be observed in equilibrium due to the large reduction in alpha. To accommodate this difference, in Appendix A.5, we generalize the GP model to allow for two risky asset classes. Both the original and generalized GP model suggest a positive gross alpha for active management (to cover the manager fee). As before, the model implies that the internal/external management decision has no impact on gross returns, but may have a second-order effect on net return performance. When calibrated to the data, the equilibrium in the private market suggests that plans solely employ active management (see Figure 2c). Larger plans opt for internal active management which enhances their net return performance due to cost savings. Therefore, only net-of-cost returns are strictly increasing in plan AUM in private assets, once we control for internal/external management. In sum, we propose the following hypotheses on plan size, and gross and net return performance across public and private asset classes:

Hypothesis IV (Plan size and return performance).

- (i) Plan size (AUM) has no impact on gross returns, controlling for plans' choice of active vs. passive management. In contrast, plan size has a positive effect on net returns in both public and private asset classes.
- (ii) Plans' choice of internal vs. external management has no impact on their gross returns in public and private asset classes, controlling for plan size and plan choice of active vs. passive management.
- (iii) Plan size has a stronger effect on net returns in private than in public asset markets, controlling for active vs. passive management.

We next set out to test these hypotheses empirically, beginning with plans' investment management costs (Section 5), moving on to their choice of investment management styles (Section 6), and finishing with return performance (Section 7).

## 5 Investment Management Costs

Hypothesis I implies that plan size is a key determinant of investment management fees/costs, as larger plans benefit from internal management scale economies and possess greater bargaining power to negotiate external management fees. Scale economies are likely to vary across different asset classes so in this section we explore the role of plan size in determining investment management costs across different asset classes and investment management managemen

## 5.1 Estimates of Power Law Coefficients

The power law equation in (3.1) implies a linear relation between log-cost and log-AUM whose slope measures the economies of scale coefficient,  $\beta$ . To see if this is a suitable characterization of the cost-size relation in our data, Figure 3 provides log-log plots of AUM versus costs for stocks and fixed income portfolios across the four investment management mandates. These plots suggest that the power law provides a good approximation to the cost-size relation. The slope is notably flatter for passively managed portfolios than for active ones consistent with larger economies of scale (lower  $\beta$ ) for passive than for active management of both stock and fixed income accounts.

Investment management costs depend on variables other than plan size, so we generalize the power law relation in (3.1) to allow for additional determinants of costs:<sup>27</sup>

$$\operatorname{Cost}_{iats}^{\$} = (\operatorname{AUM}_{iats})^{\beta_{As}} \exp\left(c_{As} + \lambda_{Ats} + \gamma_{1,As} \operatorname{Private}_{i} + \gamma_{2,As} \operatorname{nonUS}_{i}\right) \exp(\varepsilon_{iats}), \quad (5.1)$$

where  $\text{Cost}_{iats}^{\$}$  (AUM<sub>iats</sub>) is the dollar cost (AUM) of plan *i* in sub-asset class *a* at time *t* for mandate *s*,  $c_{As}$  is a constant that varies across asset classes *A* and mandate *s*,  $\lambda_{Ats}$  is a time fixed effect for asset class *A* and mandate *s*, Private<sub>*i*</sub> is a dummy equal to one if plan *i* is private and nonUS<sub>*i*</sub> is a dummy equal to one if plan *i* is domiciled outside the U.S. Taking logs in (5.1), we obtain the following panel model which allows us to estimate the power law coefficient,  $\beta_{As}$ :<sup>28</sup>

 $<sup>^{27}</sup>$ Bikker (2017) uses different cost functions to show that average costs are decreasing in size and that investment costs are *U*-shaped. Related to this, Alserda, Bikker and Lecq (2018) find large economies of scale for administrative costs, and diseconomies of scale for investment costs.

 $<sup>^{28}</sup>$ We include time fixed effects but not plan fixed effects in (5.2). Because AUM varies a lot across plans and is highly persistent, including plan fixed effects would make it difficult to estimate the size-cost relationship. For example, a high-profile pension plan with hundreds of billions of dollars in AUM is likely to face very different investment costs compared to a much smaller plan with a few hundred million dollars in AUM and plan fixed effects are likely to capture this.

$$\log(\operatorname{Cost}_{iats}^{\$}) = c_{As} + \lambda_{Ats} + \beta_{As}\log(\operatorname{AUM}_{iats}) + \gamma_{1,As}\operatorname{Private}_{i} + \gamma_{2,As}\operatorname{nonUS}_{i} + \varepsilon_{iats}.$$
 (5.2)

We estimate this model at the sub-asset class level to leverage the granularity of the data provided by CEM. Further, we impose homogeneity in the power-law coefficient within each asset class (across its sub-asset classes) so that information from all sub-asset classes is used to estimate the economies of scale parameter for the associated asset class.

The top panel in Table 2 shows estimates of (5.2) obtained for the different management mandates at the asset class level. First, consider the two public asset classes, stocks and fixed income, for which we have sufficient data to consider all four management mandates. Across both asset classes and for all four management mandates, our estimates of  $\beta$  are less than unity and, consistent with Hypothesis I(i), we reject the null hypothesis of no economies of scale,  $\beta_{1,As} = 1$ .

Our estimates of  $\beta_{As}$  are around 0.75 for passively managed stocks and fixed income assets, but are closer to 0.90 for actively managed accounts in these asset classes. This suggests that economies of scale are much higher for passively managed than for actively managed public assets. Our finding that passive management lends itself better to scaling than active management is consistent with Hypothesis I(iii) and seems highly plausible.<sup>29</sup> Our estimates of the power law coefficients are very similar within active or within passive management, regardless of whether assets are managed internally or externally. The choice of passive versus active management is thus more important to economies of scale than is the decision for whether to manage assets internally or externally.

Passive management is uncommon for the four alternative asset classes, so for these we only report estimates for internal active and external active mandates.<sup>30</sup> Table 2 shows that the estimates of  $\beta$  are generally higher than those obtained for stocks and fixed income, averaging 0.95 and ranging from 0.92 to 1.01. This finding is consistent with Hypothesis I(ii), suggesting somewhat *lower* scale advantages in unit investment costs for alternative asset classes, compared with publicly traded assets.<sup>31</sup>

<sup>&</sup>lt;sup>29</sup>Passive investment management relies heavily on computer algorithms that are easy to scale up. Passive portfolios may venture into more sub-asset classes as they grow in size in order to limit any adverse market impact, but this is unlikely to raise costs by much. Conversely, active investment management is more labor intensive and more adversely affected by the market impact of trading concentrated positions and, thus, more difficult to scale up.

<sup>&</sup>lt;sup>30</sup>For hedge funds and multi assets, there are only 140 observations of internal active management, so we do not report IA estimates for this case.

<sup>&</sup>lt;sup>31</sup>This finding is consistent with the far more labor-intensive process of managing specialized asset classes such as private equity. For these asset classes, there is generally no reliable public price that aggregates market information in the same way as for stocks and fixed income, making scaling more difficult and passive management infeasible. The main exception is REITS within the real asset class,

We finally consider, in columns two and three of Table 2, investment management cost differences between private vs. public, and U.S. vs. non-U.S. plans, respectively. There is evidence that private plans incur higher costs than public plans in the internal and external active management of stocks and fixed income assets; we find very little evidence of notable differences for passively managed stocks or fixed-income, as well as alternative assets, whether internally or externally managed. Non-U.S. plans pay significantly higher costs, on average, than U.S. plans for both internal and external passive management of stocks and fixed income assets, but pay lower fees for management of these asset classes in external active accounts. Among the alternative asset classes, non-U.S. plans pay significantly higher fees for internal active management of private debt and real assets but they incur significantly lower costs for external active management of private debt as compared to their U.S. peers.

We also estimate (5.2) separately for each sub-asset class, using only those sub-asset classes that contain a sufficiently large number of observations to allow us to obtain accurate estimates. In Appendix Table A.11, we find that the cost economy of scale estimates are in line with those obtained for the broader asset classes. Economies of scale are notably larger (i.e.,  $\beta$  estimates are lower) for passive management of EAFE and U.S. broad stock mandates, as well as for inflation-indexed bonds. In turn, scale economies are much lower for diversified private equity, real estate, and REIT accounts.

## 5.2 Formal Tests of Scale Economies

To formally test Hypothesis I that scale economies are the same for internal and external management (part (iv)) but differ for passive versus active management (part (iii)), we estimate a model that pools observations across the four management mandates s:

$$\log(\text{Cost}_{iats}^{\$}) = c_{As} + \lambda_{Ats} + \beta_{1,As} \text{Dummy}_{s} + \beta_{2,As} \log(\text{AUM}_{iats}) + \beta_{3,As} \text{Dummy}_{s} \times \log(\text{AUM}_{iats}) + \beta_{4,As} \text{Private}_{i} + \beta_{5,As} \text{nonUS}_{i} + \varepsilon_{iats},$$
(5.3)

where each of the dummy variables  $\text{Dummy}_s$  equals one if  $s \in \{\text{IA, EA, EP}\}$ . The fourth investment management mandate (IP) is treated as the benchmark with all effects measured relative to this case.<sup>32</sup> We test the null hypothesis of no scale differences

but again we do not have a sufficient number of data points on this sub-asset class to conduct a meaningful analysis.

 $<sup>^{32}</sup>$ For example, for internally managed assets Dummy<sub>s</sub> = 1 if s = IA and zero otherwise so this dummy allows us to estimate the differential impact of internal active management on cost relative to

between internal passive and internal active management by examining the significance of  $\beta_{3,As}$ .

We present the results of these tests in the bottom three rows of Table 2. For stocks and fixed income, we cannot reject the null hypothesis of equal returns to scale for internal and external passive management, in line with Hypothesis I(iv). Moreover, we cannot reject the null hypothesis that cost economies of scale are identical across internal and and external active mandates for three of five asset classes, the two exceptions being fixed income and real assets. For fixed income assets, internal active management is associated with significantly higher scale economies than external active management ( $\beta^{IA} = 0.84$ versus  $\beta^{EA} = 0.94$ ), while for real assets internal active management has weaker scale economies than external asset management ( $\beta^{IA} = 1.01$  versus  $\beta^{EA} = 0.92$ ). Hence the empirical evidence is mixed in relation to Hypothesis I(iv). This conclusion also holds for the economies of scale estimates in the same product market, as shown in Table 3, where we find support for Hypothesis I(iv) in stocks but not in fixed income.

Finally, in the bottom row of Tables 2 and 3, we report p-values for a one-sided test of equal economies of scale in passive and active management for stock and fixed income portfolios against the alternative that cost economies are bigger for passively managed than for actively managed accounts. Consistent with Hypothesis I(iii) we reject the null hypothesis for both stocks and fixed income, which indicates that larger plans, in particular, can achieve significant cost economies by switching from active to passive management.

In summary, our results demonstrate that scale economies in asset management costs vary along two important margins: (i) management mandate (IP, EP, IA, EA); and (ii) asset class. To help quantify the economic importance of variation in costs along these margins, the right panel of Table 2 reports management costs for small, medium, and large plans, represented by the 10<sup>th</sup>, 50<sup>th</sup>, and 90<sup>th</sup> percentiles of the (2019) AUM distribution for a given mandate and asset class combination. These columns summarize the economic effect on costs of the full set of coefficient estimates from our analysis.

Several important points emerge. First, internal passive management leads to substantial cost savings for both stocks and fixed income investments, with external passive management being roughly twice as costly as internal passive management. Second, internal active management costs are lower than external active management costs by an order of magnitude both for publicly traded assets (stocks and fixed income) and also for private asset classes, especially private equity.

the benchmark of internal passive management.

Third, there are particularly strong economies of scale across stocks and fixed income accounts, as demonstrated by the significantly lower per-dollar unit cost of plans in the 90th percentile, compared with plans in the 10th percentile of the size distribution. Economies of scale are generally far smaller for actively managed private asset classes, regardless of whether these are managed internally or externally.

## 5.3 Power Law Estimates for the Same Product Market

Even at the sub-asset class level, large and small plans may invest in different products, potentially biasing our estimates in Table 2. To address this point and control for such heterogeneity, we re-estimate the economies of scale parameter using a restricted sub-sample that only includes investments in the same product. We identify cases where different plans invest in the same product by selecting observations with identical gross and policy-adjusted gross returns within the same sub-asset class and year.<sup>33</sup> In this setting, any cost differences can be attributed solely to differences in a plan's ability to negotiate better deals. Specifically, we estimate the model

$$\log(\text{Cost}_{iats}^{\$}) = c_a + \lambda_{At} + \beta_{1,A} \log(\text{AUM}_{iats}) + \beta_{2,A} \log(\text{AUM}_{iats}) \times \text{Active}_{iats}$$
(5.4)  
+  $\beta_{3,A} \log(\text{AUM}_{iats}) \times \text{External}_{iats} + \beta_{4,A} \log(\text{AUM}_{iats}) \times \text{Active}_{iats} \times \text{External}_{iats}$   
+  $\beta_{5,A} \text{Active}_{iats} + \beta_{6,A} \text{External}_{iats} + \beta_{7,A} \text{Private}_i + \beta_{8,A} \text{nonUS}_i + \varepsilon_{iats}.$ 

The variables are defined as in (5.2), and Active<sub>*iats*</sub> and External<sub>*iats*</sub> are dummy variables equal to one if the investment is managed actively or externally, respectively. Interaction terms are included to allow economies of scale to vary across the four mandates. The sub-asset class fixed effect accounts for cost variation at the sub-asset class level.

Table 3 shows that the estimated economies of scale parameters are qualitatively similar to those reported in Table 2, reinforcing our main finding of economies of scale in management costs, but with some interesting differences: our estimates of economies of scale in internal passive management, at close to 0.68 for stocks and 0.63 for fixed income, are even stronger in this case. In both asset classes, active management is associated with significantly higher costs. For stocks, internal active management costs are 146% higher than internal passive costs, while external active costs are 250% higher than external passive costs (evaluated at the mean AUM in our sample). Similarly, for fixed income

 $<sup>^{33}</sup>$ To address the possibility that identical returns occur by chance, we filter out observations reported with two or fewer decimal places. We also filter based on the policy benchmark name, which is very granular (see Appendix D).

accounts, we find proportional cost increases of 205% and 181%, respectively.

This evidence is consistent with larger plans exercising greater bargaining power, resulting in lower fees for the same underlying product. Our analysis thus illustrates that economies of scale in asset management arise not only from differential access to investment products, but also from more favorable fee terms negotiated by larger plans within a common product market.<sup>34</sup>

## 5.4 Fixed Costs for External Active Mandates

In our data, there is no distinction between fixed and variable costs, except for external active mandates. For these mandates, we observe the base fee that a plan pays in a sub-asset class, defined as the fixed portion of the external management cost. To examine how this base fee varies with plan size, and to see if our cost assumptions in Section 4.1.2 are empirically valid, we define  $c_{iat}^{base}$  as the manager base fee (the fixed portion of the external cost of management), expressed as a share in basis points (bps) of sub-asset class AUM (AUM<sub>iat</sub>). We regress this variable on the log of plan-level AUM (log AUM<sub>it</sub>), as well as on Private<sub>i</sub> and nonUS<sub>i</sub>, which proxy for plan governance and regional effects, respectively. Since the dependent variable is a fraction, we use the fractional regression approach of Papke and Wooldridge (2008) to estimate the parameters and average partial effects. The specification also includes sub-asset class and time fixed effects.

The results are reported in Table 4. We find that the average partial effect of plan size is generally negative and statistically significant for the public asset classes, as well as for private equity. Specifically, a doubling of plan-level AUM is associated with a reduction in the base fee share of 1.45 and 3.15 bps/year in stocks and fixed income, respectively, while the effect is larger at 14 bps/year in private equity. These results are consistent with our theoretical model, where the equilibrium manager fee, expressed as a fraction of size, decreases with AUM (see Appendix A.1).

## 5.5 Cost Estimates from Changes in Management Style

Pension plans' decisions to manage their investments within a given sub-asset class internally or externally and actively or passively reflect a variety of plan characteristics such as plan size (AUM) and sub-asset class, with some sub-asset classes lending themselves more easily to passive and internal management than others.

<sup>&</sup>lt;sup>34</sup>This evidence is also consistent with Begenau and Siriwardane (2024), who document a size advantage in common product markets among U.S. public pension funds investing in private equity.

It is clear from Hypothesis II and the underlying theoretical analysis that plans' decisions on management style and, hence, their costs, is "endogenous" and is driven by, inter alia, plan AUM. In fact, our analysis suggests that there are jumps in cost when a plan switches management style (Figure 2b), so the effect on cost can be approximated by comparing the cost of a plan that switches management style due to a small increase in AUM with that of an otherwise identical plan whose AUM remains unchanged, and thus does not switch management style.

To gauge the magnitude of the effect of changes in management style on cost, we use the matching estimator of Imai, Kim and Wang (2021).<sup>35</sup> The idea is to compare the costs in a given sub-asset class of two otherwise similar plans where one plan switches from, say, external to internal management, while the other plan continues to manage its assets externally. The key requirements for this estimator are, first, obtaining accurate matches and, second, having a sufficient number of switches to estimate performance differences reliably.

First consider the effect of switching to internal management on the cost (in bps) of plan i in sub-asset class a at time t,  $\text{Cost}_{iat}$ . Using the potential outcomes framework of Imbens and Rubin (2015), define the average effect of switching from external to internal management on costs

$$\Delta C^{ex \to in} \coloneqq \mathbb{E} \bigg( \text{Cost}_{iat}(\text{Internal}_{iat} = 1, \text{Internal}_{iat-1} = 0) \\ - \text{Cost}_{iat}(\text{Internal}_{iat} = 0, \text{Internal}_{iat-1} = 0) |\text{Internal}_{iat} = 1, \text{Internal}_{iat-1} = 0 \bigg), \quad (5.5)$$

where  $\text{Cost}_{iat}(\text{Internal}_{iat} = 1, \text{Internal}_{iat-1} = 0)$  is the potential cost outcome of a plan switching from external management at time t - 1 to internal management at time t, whereas  $\text{Cost}_{iat}(\text{Internal}_{iat} = 0, \text{Internal}_{iat-1} = 0)$  denotes the potential cost for the same plan not switching management style. Under a parallel trends assumption that we spell out in Appendix C.3.2, we can estimate the effect of switching management style on cost. In doing so we also need to specify a set of control variables that we use to match plans in the treatment and control group: (i)  $\text{AUM}_{iat}$ , total AUM allocated by plan *i* to subasset class *a* at time *t*; (ii)  $\text{Active}_{iat}$ , indicator for whether plan *i* is private; (iv) nonUS<sub>i</sub>,

<sup>&</sup>lt;sup>35</sup>The chief advantage of this estimator is that it can handle unbalanced panels such as ours and datasets with a small time-series dimension. It also allows units to switch treatment status over time. All of these are features we observe in the CEM data. Finally, the estimator does not rely on the strong functional form assumptions and extrapolation imposed by two-way fixed effects regression.

indicator for whether plan i is domiciled in the U.S.; (v) sub-asset class a at time t.

Intuitively, our matching approach can be thought of as providing an estimate of the effect on cost of choosing internal management as opposed to external management after controlling for plan size, differences across sub-asset class, and other plan characteristics. We also estimate the reverse effect of a switch from internal to external management, and the effect of a switch from active to passive management and vice versa.

Results from the matching estimator are shown in Table 5. Switching from external to internal management (top row) is associated with substantial cost savings, especially in private asset classes. For stocks and fixed income, a change from external to internal management leads to a decrease in cost of 3 bps/year and 5 bps/year, respectively, while, in private markets, cost savings are on average 56 bps/year.<sup>36</sup> Although these estimates do not directly measure scale economies, they are not fully consistent with Hypothesis III(i). For external and internal management to co-exist when the latter offers cost savings, there would have to be some unmodeled advantages from external management such as, for example, key man risk. The substantial cost savings we estimate in private markets may also be driven by the fact that internal and external asset mandates can differ significantly in private equity, which we document in more detail in Section 7.1.

In the data, there are also a number of plans that switch from internal to external management. We analyze the effect on cost of this reverse switch using the same methodology. Table 5 shows that costs significantly increase when plans switch from internal to external management. Management costs increase by 7 bps/year for stocks, 5 bps/year for fixed income, and by 54 bps/year in the alternative asset classes, mirroring the cost savings estimate (56 bps/year) for the reverse external-to-internal switch. The bottom rows of Table 5 also show that, in the majority of cases, a switch from external to internal management is accompanied by an increase in AUM, while plans tend to decrease their AUM holdings when switching from internal to external management, in line with Hypothesis III(iii).

In summary, our matching estimates indicate that switching from external to internal asset management is associated with modest cost savings for public asset classes but large cost savings for private asset classes, while the reverse shift from internal to external asset management is associated with modestly higher costs for stocks and bonds and significantly higher management costs for alternative assets. We note that the smaller cost savings for public asset classes are multiplied by the large allocations of DB plans to

 $<sup>^{36}</sup>$ We omit hedge funds and multi-assets since our sample contains too few plans in these asset classes that switch between external and internal management.

them.

We finally consider the effect on costs of switching between active and passive management. We limit our analysis to the three asset classes (stocks, fixed income, and real assets) for which we have a sufficiently large number of transitions to facilitate accurate estimation. Our estimates are shown in the three rightmost columns of Table 5.<sup>37</sup> We find that switching from active to passive management reduces costs by around 9 bps/year for stocks and real assets and by 2 bps/year for fixed income, consistent with the low overall level of fees for this asset class. All estimates are statistically significant. Conversely, a switch from passive to active management is associated with a significant increase in costs. As before, the estimated effect is most pronounced for stocks (15 bps/year) and real assets (16 bps/year), and smaller for fixed income (5 bps/year). These results are consistent with Hypothesis III(ii).

# 6 Choice of Investment Management Mandate

To test empirically whether Hypothesis II is supported by our data, we next examine the impact of plan, manager, and asset characteristics, including plan size (AUM), investment management costs, and plan domicile, on the choice of investment management mandate ("style"). Specifically, we assess whether plans opt for internal or external asset management, and whether they favor active or passive investment management. Our analysis performs a set of regressions that use, as the dependent variable, the proportion of investment in asset class A, in a given year, t, that is managed by plan i in a certain style, s, denoted  $\omega_{iAt}^s$  and defined in more detail below. We regress this proportion on a set of covariates,  $x_{iAt}$ , as well as asset-class and time fixed effects,  $c_A$  and  $\lambda_{At}$ :

$$\omega_{iAt}^s = c_A + \lambda_{At} + \beta'_A x_{iAt} + \epsilon_{iAt}^s. \tag{6.1}$$

In practice, internal management involves substantial fixed-cost investments, including hiring compliance staff and traders, IT system setup, database subscriptions, and hiring skilled investment analysts. In this light, it is easy to understand why many plans, especially smaller ones, allocate zero assets to internal management. Similarly, it is uncommon for plans or external managers to manage alternative asset classes passively.

<sup>&</sup>lt;sup>37</sup>We use the same set of potentially confounding variables  $x_{iat}$  as for the internal/external estimates, except we replace Active<sub>iat</sub> with External<sub>iat</sub> to control for heterogeneity in costs associated with external management.

The panel regression in (6.1) does not account for the presence of many "zeros" in the data, and focuses on estimating plan choices between management mandates (internal vs. external, or passive vs. active) at the intensive margin. This approach may introduce model misspecification because variables like plan size and management costs likely influence both the *extent* to which a plan manages assets internally and whether it chooses internal management for *any* of its assets.

To deal with the large number of zeros and to obtain an estimate that accounts for plans' choice along both the intensive and extensive margins, we use the Cragg (1971) estimator. This estimator consists of two equations, namely (i) a selection equation that estimates the probability that a plan's allocation choice lies on the boundary (e.g., zero internal management); and (ii) an outcome equation that estimates the effect of a variable on the proportion of assets managed internally for plans with at least some internal management in that asset class:

$$\omega_{iAt}^s = \mathcal{S}_{iAt} h_{iAt}^*,$$

$$\mathcal{S}_{iAt} = 1 \left[ \gamma' x_{\mathcal{S}, iAt} + \varepsilon_{iAt} > 0 \right], \tag{6.2a}$$

$$h_{iAt}^* = \exp\left(\lambda_{At} + \beta' x_{o,iAt} + e_{iAt}\right). \tag{6.2b}$$

Here  $S_{iAt}$  is a selection indicator that depends on  $x_{S,iAt}$  (covariates influencing selection) and  $h_{iAt}^*$  denotes the choice or outcome variable that depends on  $x_{o,iAt}$ . If the selection indicator equals zero, the dependent variable  $\omega_{iAt}^s$  will also take a value of zero and, hence, lie on the boundary.<sup>38</sup>

Assuming that the error terms  $\varepsilon_{iAt}$  and  $e_{iAt}$  in (6.2a) and (6.2b) are independent normal random variables with marginal distributions  $\varepsilon_{iAt} \sim N(0, 1)$  and  $e_{iAt}|x_{o,iAt} \sim N(0, \sigma^2)$ , the conditional expectation of  $\omega_{iAt}$  given the variables  $x_{S,iAt}, x_{o,iAt}$  simplifies to

$$\mathbb{E}\left(\omega_{iAt}^{s}|x_{\mathcal{S},iAt},x_{o,iAt}\right) = \Phi\left(\gamma'x_{\mathcal{S},iAt}\right)\exp\left(\lambda_{At} + \beta'x_{o,iAt} + \frac{\sigma^{2}}{2}\right),\tag{6.3}$$

where  $\Phi(\cdot)$  is the CDF of the standard normal distribution.

To gauge the effect of changing a single variable, x, on the expected value of  $\omega_{iAt}^{s}$ , we

<sup>&</sup>lt;sup>38</sup>This model is more flexible than a standard Tobin (1958) model, since the variables determining selection (extensive margin) can be different from the variables driving the outcome (intensive margin) equation. Moreover, since  $\gamma$  and  $\beta$  are decoupled, the effect of a variable on the selection and outcome equations can also be different.

examine the average partial effect (APE) of x:

$$\operatorname{APE}_{x}(x_{\mathcal{S},iAt}, x_{o,iAt}; \gamma, \beta) = \frac{\partial \mathbb{E}\left(\omega | x_{\mathcal{S}}, x_{o}\right)}{\partial x} \bigg|_{x_{\mathcal{S}} = x_{\mathcal{S},iAt}, x_{o} = x_{o,iAt}}.$$
(6.4)

Since the expectation in (6.3) depends on both the selection and outcome equations, the APE in (6.4) accounts for both the intensive and extensive margin effects of changing x and so depends on both  $\gamma$  and  $\beta$ . Letting  $\hat{\gamma}$  and  $\hat{\beta}$  denote the maximum likelihood estimates, we can compute the sample APE as

$$\widehat{APE}_x = \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} APE_x(x_{\mathcal{S},iAt}, x_{o,iAt}; \widehat{\gamma}, \widehat{\beta}).$$
(6.5)

Intuitively,  $\widehat{APE}_x$  captures the average effect of changing x while holding all other variables constant.

#### 6.1 Internal versus External Management

To examine the determinants of plans' decision on managing investments in a given asset class internally (I) or externally (E), we estimate models for the proportion of plan *i*'s allocation to asset class *A* that is internally managed in year t,  $\omega_{iAt}^{I} := \text{AUM}_{iAt}^{I}/\text{AUM}_{iAt}$ , where  $\text{AUM}_{iAt}^{I}$  and  $\text{AUM}_{iAt}$  refer to the internally managed and total AUM of plan *i* in asset class *A* of year *t*.

We consider the following variables. First, to capture plan size, we include  $\log(AUM_{it-1})$ , the logarithm of the total dollar value of plan *i*'s assets under management (AUM) in year t-1.<sup>39</sup> Second, we include the lagged spread in the cost of external versus internal management in asset class *A* measured in basis points (CostSpread<sup>E-I</sup><sub>iAt-1</sub>). Third, we include a dummy that takes a value of one for non-U.S. plans and is zero otherwise (nonUS<sub>i</sub>) and a dummy that takes a value of one for private plans and is zero otherwise (Private<sub>i</sub>). Finally, we include asset class fixed effects,  $c_A$ , and year fixed effects:

$$\omega_{iAt}^{I} = c_{A} + \lambda_{At} + \beta_{1,A} \log(\text{AUM})_{it-1} + \beta_{2,A} \text{CostSpread}_{iAt-1}^{E-I} + \beta_{3,A} \text{Private}_{i} + \beta_{4,A} \text{nonUS}_{i} + \epsilon_{iAt}.$$
(6.6)

Table 6 reports our regression results. To retain a parsimonious specification for the Cragg estimator, we include only the log-size and cost spread between external and

<sup>&</sup>lt;sup>39</sup>Plan AUM is typically measured at the end of the year.

internal in the selection equation (6.2a) whereas in the outcome equation (6.2b) we further include time fixed effects and the dummies for whether a plan is private or public and domiciled inside or outside the U.S.

Across all asset classes, our estimates show that larger plans employ internal management to a significantly greater extent than smaller plans, consistent with Hypothesis II(i). For instance, our APE estimates in Panel A of Table 6 indicate that a 10 percent increase in plan size is associated with roughly a one percent increase in the proportion of the plan's stock portfolio that is managed internally. A 10 percent increase in plan size is associated with a comparable but slightly bigger increase in the proportion of the plan's fixed income portfolio that is internally managed (1.8 percent). For the alternative asset classes, we continue to find a significant relationship between plan size and the share managed internally, though the effects are generally weaker. An exception is private debt, where the relationship is comparable to stocks.

Plan size increases both the proportion of assets managed internally for plans already using internal investment management (intensive margin) and the likelihood of plans transitioning from *no* internal management to *some* internal management (extensive margin). This highlights the importance of explicitly accounting for selection effects.

Panel A examines if the plan size - management style choice relation in Hypothesis II holds at the intensive margin. However, a notable feature of our generalized GP model is that plans are expected to switch management styles as they grow larger which is a hypothesis about the extensive margin. To test this implication, Panel B in Table 6 examines this point by reporting estimates from the Cragg selection regression. The table quantifies the effect of lagged AUM and the cost spread on the probability that plans manage at least some of their investments in a given asset class internally. The first row of estimates shows that plan AUM in a given asset class is a highly significant determinant of the probability that a plan manages some of its assets internally within the asset class. All coefficient estimates on log-size are positive, so larger plans are significantly more likely to manage some of their assets internally, regardless of asset class. In contrast, the external-minus-internal cost spread appears to be a far less important determinant of plans' decision on whether to employ internal asset management and this variable is only statistically significant for one asset class (Hedge funds and multi assets).

The lower part of Panel B in Table 6 illustrates the importance of these estimates by reporting the probability that a plan manages some of its assets internally as we vary the plan size from the 10th through the 50th and 90th percentiles of the 2019 AUM distribution. We keep the cost spread at its average value in these calculations, though this is not important given that the cost spread does not have a big effect on the results. For stock holdings, we find that small plans (in the 10th percentile of the AUM distribution) have a 13 percent chance of managing some of their stock portfolio internally. This rises to 35 percent for medium-sized plans and to 67 percent for plans in the 90th percentile of the size distribution. Hence, large plans are five times more likely to manage some of their stock holdings internally than small plans. Similarly, large plans are almost three times more likely to manage some of their fixed income holdings internally than small plans (73 percent versus 29 percent).

Small plans rarely manage private assets internally. Specifically, the Cragg probability estimates vary from 0.58 percent to 12.76 percent for plans located at the 10th percentile of the size distribution. These probability estimates rise notably to between one-tenth (11.58 percent for hedge funds) to one-half (52.13 percent for private debt) for the largest plans, i.e., those in the 90th percentile of the size distribution.<sup>40</sup>

These estimates are all consistent with Hypothesis II(i) and suggestive of relatively modest fixed costs of setting up internal management shops in stocks and bonds, as compared to doing so for alternative asset classes (such as private equity) that require more specialized skills and knowledge, as well as more costly connections to external sources of information. Consequently, it is rare for small plans to manage their alternative assets internally.

To summarize, our findings suggest that plans' decision to overcome the hurdle of managing at least some of their investments in a given asset class internally is mainly determined by plan size, whereas the cost spread (external versus internal) is not as important (of course, interpreted with caution due to the endogeneity of internal management as a function of costs). Conversely, the cost spread does not appear to be an important factor in the decision of bringing an asset class in-house.<sup>41</sup>

 $<sup>^{40}</sup>$ Andonov, Bauer and Cremers (2017) show that plan size is not significant in determining management style after controlling for liabilities due to retirees. We provide a robustness check in Appendix Table A.8 including liabilities due to retirees. We find that coefficient estimates on liabilities due to retirees are insignificant in the outcome and selection equations, whereas the coefficient on plan size remains statistically significant.

 $<sup>^{41}</sup>$ For all asset classes, except for fixed income, the cost spread is insignificant at the intensive margin. For fixed income a 100 bps increase is associated with a 0.03 percent increase in internal management. However, the choice of internal management is endogenous to cost differences, and the composition of externally managed assets can change when internal management is employed, thus making a clean interpretation of the cost spread coefficient difficult.

# 6.2 Passive and Active Management in Internal vs. External Management

We next use Cragg regressions to formally test Hypothesis II(ii)-(iii). Let  $\omega_{iAt}^{IP} := \text{AUM}_{iAt}^{IP}/(\text{AUM}_{iAt}^{IP} + \text{AUM}_{iAt}^{IP})$  and  $\omega_{iAt}^{IA} := \text{AUM}_{iAt}^{IA}/(\text{AUM}_{iAt}^{IA} + \text{AUM}_{iAt}^{EA})$ , where  $\omega_{iAt}^{IP}$  measures the fraction of passively managed assets that are managed internally by plan *i* in year *t*, and  $\omega_{iAt}^{IA}$  measures the fraction of actively managed assets that are managed internally. Consistent with prior specifications, we model  $\omega_{iAt}^{IP}$  and  $\omega_{iAt}^{IA}$  as follows:

$$\omega_{iAt}^{IP} = c_A + \lambda_{At} + \beta_{1,A} \log(\text{AUM})_{it-1} + \beta_{2,A} \text{CostSpread}_{iAt-1}^{EP-IP} + \beta_{3,A} \text{Private}_i + \beta_{4,A} \text{NonUS}_i + \epsilon_{iAt}, \quad (6.7)$$

$$\omega_{iAt}^{IA} = c_A + \lambda_{At} + \beta_{1,A} \log(\text{AUM})_{it-1} + \beta_{2,A} \text{CostSpread}_{iAt-1}^{EA-IA} + \beta_{3,A} \text{Private}_i + \beta_{4,A} \text{NonUS}_i + \epsilon_{iAt}, \quad (6.8)$$

with variables previously defined, except CostSpread<sup>EP-IP</sup> and CostSpread<sup>EA-IA</sup>. The former denotes the basis point spread between the cost of external and internal passive management for plan *i* in asset class *A* at time t - 1, and the latter refers to the basis point spread between the cost of external and internal active management. Because the vast majority of plans do not use passive management in alternative asset classes, we only report estimates for stocks and fixed income for equation (6.7).

APE estimates in Panel A1 of Table 7 provide direct support for our hypothesis that larger plans manage a greater share of their passively managed assets internally as the coefficients on plan AUM are positive and statistically significant. For example, a 10 percent increase in plan size is associated with a 1.1 percent increase in passive equities managed internally and a 0.8 percent increase in passive fixed income assets managed internally.<sup>42</sup> In line with these results, Panel B1 shows that plans in the 90<sup>th</sup> percentile of the size distribution manage approximately 60 percent of their passively managed equity and 50 percent of their passively managed fixed income portfolios internally versus only 6% and 16%, respectively, for plans in the 10<sup>th</sup> percentile of the size distribution.

A similar pattern holds for actively managed assets. As shown in Panel A2 of Table 7, larger plans allocate a greater share of their actively managed portfolios to internal management. A one percent increase in plan size is associated with increases in internal

 $<sup>^{42}</sup>$ We exclude estimates for alternative asset classes in Panel A1 of Table 7 because passive internal management is rare for those asset classes.

management of 0.8, 1.7, and 0.4 percent for equity, fixed income, and alternative asset portfolios, respectively.<sup>43</sup>

Panel B2 provides additional evidence, indicating that plans in the 90<sup>th</sup> percentile of the size distribution manage 55 percent of their actively managed equity portfolios internally, along with 71 percent of fixed income and 33 percent of alternatives versus only 9%, 26%, and 9%, respectively, for plans in the 10<sup>th</sup> percentile of the size distribution.

Overall, the empirical evidence is fully consistent with Hypothesis II(ii)-(iii). Larger plans tend to manage a larger share of their passively and actively managed assets internally. Cost spreads have a smaller effect and influence this decision mostly on the intensive margin. These findings suggest that larger plans benefit from economics of scale, allowing them to internalize asset management for public and private asset classes.

# 7 Investment Performance and Plan Characteristics

Finally, We examine how plan characteristics, such as plan size, affects investment performance. As we have seen, plan size is a key determinant of costs. In this section, we explore whether plan size also influences the ability of plans to identify the best-performing asset managers and their bargaining power for net return performance after costs – a crucial question for plan beneficiaries.

A unique feature of our data is that it contains "policy returns" for each plan/subasset class/mandate (e.g., an internal active mandate) combination. Policy returns are negotiated targets between fund managers and plan sponsors, and can be used as a simple form of risk-adjustment.<sup>44</sup> Specifically, let  $r_{iats}$  be the return of plan *i* in sub-asset class *a* during year *t* with mandate *s*, while  $r_{iats}^P$  is the associated policy return for the same plan, sub-asset class, time period, and mandate. The policy-adjusted return,  $\tilde{r}_{iats}$ , is then<sup>45</sup>

$$\widetilde{r}_{iats} = r_{iats} - r_{iats}^P.$$
(7.1)

<sup>&</sup>lt;sup>43</sup>We pool alternative asset classes (private equity and debt, hedge funds, and real assets) to ensure a sufficiently large sample for the Cragg regression.

<sup>&</sup>lt;sup>44</sup>This simple, but powerful method for risk-adjusting is especially important for our sample, where many plans are represented for only one or a few years. In Appendix D.7, we explore robustness of our results to using a more conventional risk-adjustment approach based on plans' exposure to a set of common risk factors.

<sup>&</sup>lt;sup>45</sup>Appendix D reports summary statistics for raw returns and policy-adjusted returns.

## 7.1 Return Regressions

We examine the relation between plan characteristics and investment performance using a set of panel regressions, with policy-adjusted returns as the dependent variable. Hypothesis IV posits that plan size is an important determinant of net returns – but not gross returns – once we control for active management. Moreover, active management is conjectured to affect both gross and net returns, whereas external management only has a second-order impact on net returns. Motivated by these hypotheses, we estimate the following regressions separately for each asset class:

$$\widetilde{r}_{iats} = c_a + \lambda_{At} + \beta_{1,A} \log(\text{AUM}_{iat-1,s}) + \beta_{2,A} \text{Active}_{iats} + \beta_{3,A} \text{External}_{iats} + \beta_{4,A} \text{Perform}_{iats} + \beta_{5,A} \text{Private}_i + \beta_{6,A} \text{nonUS}_i + \epsilon_{iats},$$
(7.2)

where  $\tilde{r}_{iats}$  denotes the policy-adjusted gross or net return,  $c_a$  denotes a sub-asset class fixed effect,  $\lambda_{At}$  is an asset-class time fixed effect,  $\log(\text{AUM}_{iat-1,s})$  is plan *i*'s log AUM in sub-asset class *a* at time t-1 for mandate *s*, Active<sub>iats</sub> is a dummy equal to one if plan *i* manages sub-asset class *a* actively at time *t* for mandate *s*, External<sub>iats</sub> is a dummy equal to one if external management is employed, Perform<sub>iats</sub> is a dummy equal to one if a performance fee is paid, Private<sub>i</sub> is a dummy equal to one if plan *i* is private, and nonUS<sub>i</sub> is a dummy equal to one if plan *i* is domiciled outside the U.S. The latter two controls are included because Andonov, Bauer and Cremers (2017) find that U.S. public pension funds underperform relative to their private-sector peers. To the extent that using policy-adjusted returns does not fully capture a plan's exposures to risk factors within a particular asset class, the asset-class fixed effect  $\lambda_{At}$  can help absorb some of this variation provided its impact is relatively homogeneous across plans.

Table 8 presents our estimates from regression (7.2), applied separately to gross returns (top) and net returns (bottom), allowing us to examine whether differences in investment performance are explained by differences across plans in costs and fees, as well as differences in pre-fee alphas.

First, consider the relation between plan size and gross return performance. Consistent with Hypothesis IV(i), we find no relation between plan size and gross returns across all asset classes, except for private equity. Also consistent with Hypothesis IV(i), the active management dummy is positive and significant for stocks and bonds, and is positive, though not significant, for alternative asset classes. Economically, the gains from active management are substantial, increasing returns by 40-60 bps/year in public markets.

Plan size is positively and significantly correlated with net return performance for stocks, hedge funds and multi-assets, private equity, real assets, and alternative assets as a whole. This finding is consistent with larger plans being better at identifying skilled managers and using their bargaining power (or lower management cost) to capture part of the alpha, as implied by Hypothesis IV(i). These results contradict the findings of Andonov, Bauer and Cremers (2017), who report no significant effect of plan size on net return performance. Part of this difference may be due to the fact that Andonov, Bauer and Cremers (2017) do not use lagged AUM, which introduces bias in the estimated coefficient due to reverse causality. In addition, they evaluate performance at the plan level rather than at the plan/sub-asset-class level, which can dilute the size effect—for example, larger plans allocate to different asset classes than smaller plans, as we have shown above, and this can change the potential for alpha generation.

Consistent with Hypothesis IV(ii), plans' choice of internal versus external management has no significant effect on return performance for any of the asset classes. A notable exception is private equity, where external management is estimated to shift gross returns by nearly 4.6 percentage points. We conjecture that this result is driven by plans with an external mandate investing in different funds or products than those with an internal mandate. Empirically, internal private equity returns are much less correlated than external returns, relative to other asset classes. In addition, the benchmark return names most frequently associated with internal and external mandates show little overlap, further suggesting that the underlying investments differ substantially between internal and external management.

Net return performance is more strongly correlated with plan size for the private than for the public asset classes, with all of the individual asset class estimates being higher for the private than for the public asset classes and the overall estimate for alternative asset classes (0.38) also exceeding the estimates for stocks and fixed income (0.07 and 0.04) by a considerable margin.<sup>46</sup> These findings strongly support Hypothesis IV(iii).

Given the significantly positive association between policy-adjusted net returns and log-size observed for four out of six asset classes, we would also expect to find a positive and significant association between log-AUM and plans' total portfolio performance (i.e., the overall performance of a pension plan). We explore whether this relation holds by

 $<sup>^{46}</sup>$ For robustness, we also add a plan fixed effect in unreported regressions. We find results that are consistent with the results shown, albeit with less statistical significance in some cases. This can be expected, due to the loss of degrees-of-freedom when adding plan fixed effects. In addition, it is far from clear that investment skill is a plan-level quality across all assets rather than a quality common to all plans having a certain scale in a given asset class.

estimating the following panel model for plan-level total portfolio returns:

$$\widetilde{r}_{it} = \lambda_t + \beta_1 \log(\text{AUM}_{it-1}) + \beta_2 \omega_{it}^{\text{Active}} + \beta_3 \omega_{it}^{\text{External}} + \beta_4 \text{Perform}_{it} + \beta_5 \text{Private}_i + \beta_6 \text{nonUS}_i + \epsilon_{it},$$
(7.3)

where  $\tilde{r}_{it}$  is the policy-adjusted return on plan *i*'s total assets in year *t*, gross or net of costs.  $\omega_{it}^{\text{Active}}$  and  $\omega_{it}^{\text{External}}$  are defined as weighted averages of their corresponding subasset class dummy variables, where the weights are given by sub-asset class AUM. The "Total portfolio" column in Table 8 shows that larger plans obtain modestly higher policyadjusted gross and net returns. For example, moving from the 10th to the 90th percentile plan as ranked by total AUM is associated with an increase in policy-adjusted net totalportfolio returns of 25 bps per annum. In both return regressions, active management is an important control variable, whereas external management is insignificant.

# 8 Conclusion

This paper explores the relation between pension plan size and allocations to active vs. passive management, internal vs. external management, and public vs. private market investments. Consistent with fixed costs being important in setting up internal investment management capabilities, large plans *internally* manage a significantly greater proportion of assets than their smaller peers. Similarly, taking advantage of their greater ability to identify internal and external investment opportunities in the less transparent markets for private assets, large plans also allocate more of their holdings to asset classes such as private equity and real assets and less to (public) stocks and fixed income.

Our results indicate a strong role for economic scale in pension plan fees and investment performance: investment management costs follow a power law with cost economies being particularly strong for passively managed accounts and public asset classes. Hence, large plans pay significantly lower fees per dollar invested than their smaller peers. While large plans' better ability to identify skilled external managers and negotiate lower fees has only translated into modestly higher net-of-cost return performance in the highly competitive public asset markets (stocks and fixed income), we find strong evidence that larger plans earn economically large and significant abnormal returns in the markets for private assets (again, compared to their smaller peers). Private markets are less transparent and so allow the largest plans to benefit from their comparative advantage in searching for skilled managers. The scale disadvantages in investment management costs that we identify for smaller plans indicate that these plans may perform best when they embrace passive management which is widely available in public asset markets. For private asset classes, passive management is generally not an option (other than for special cases such as REITS) and fixed costs are too high to be covered by small plans which, consequently, rely almost entirely on external active management and have to accept the higher management fees typically charged for this service. Conversely, large plans have the ability to manage private assets internally and negotiate lower external investment management fees. This helps explain why plan size (scale) is particularly important in determining investment performance in private asset markets and why private asset classes have become particularly important for large plans in recent years.

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	Ç	Small Pl	ans (in 9	%)	Large Plans (in %)			
Stocks	IP	EP	IA	EA	IP	EP	IA	EA
ACWI x. U.S. EAFE Emerging Global Other U.S. Broad U.S. Large Cap U.S. Mid Cap U.S. Small Cap	1.66	$\begin{array}{c} 27.51 \\ 19.95 \\ 13.50 \\ 24.74 \\ 57.90 \\ 51.88 \\ 34.60 \\ 18.50 \end{array}$	1.44 1.14 2.06 11.45	$\begin{array}{c} 70.82 \\ 78.62 \\ 86.50 \\ 74.12 \\ 25.87 \\ 36.67 \\ 65.40 \\ 81.50 \end{array}$	$\begin{array}{r} 2.77\\ 18.53\\ 15.02\\ 15.19\\ 25.74\\ 34.06\\ 32.05\\ 27.54\\ 19.66\end{array}$	$\begin{array}{c} 31.00\\ 14.94\\ 8.65\\ 6.00\\ 0.62\\ 32.08\\ 31.53\\ 6.15\\ 4.87 \end{array}$	$\begin{array}{c} 2.77\\ 11.99\\ 13.54\\ 58.51\\ 26.75\\ 8.55\\ 20.02\\ 25.06\\ 13.25\\ \end{array}$	$\begin{array}{c} 63.45\\ 54.55\\ 62.79\\ 20.29\\ 46.90\\ 25.31\\ 16.40\\ 41.25\\ 62.22\\ \end{array}$
Fixed Income								
Bundled LDI Cash Convertibles		1.61	$37.56 \\ 54.70$	$60.83 \\ 45.30 \\ 100.00$	28.22	45.20	2.66	$\begin{array}{c} 23.92 \\ 100.00 \\ 100.00 \\ 12.12 \end{array}$
EAFE Emerging Global High Yield Inflation Indexed	24 63	0.60	5.87 9.87	100.00 99.40 94.13 16.77	86.88 7.51 8.84 40.47	$\begin{array}{c} 6.21 \\ 0.63 \\ 3.59 \\ 11.61 \end{array}$	$23.91 \\ 82.76 \\ 23.03 \\ 41.33$	$ \begin{array}{r} 13.12 \\ 62.37 \\ 7.77 \\ 73.37 \\ 6.60 \\ \end{array} $
Long Bonds Other U.S.	0.32	$ \begin{array}{r}     10.14 \\     21.33 \\     14.44 \\     13.18 \end{array} $	5.46 14.54 2.75	$72.88 \\71.02 \\84.07$	$     18.54 \\     72.48 \\     6.27 $	$\begin{array}{c} 0.58 \\ 0.88 \\ 10.37 \end{array}$	$   \begin{array}{r}     11.00 \\     14.46 \\     7.01 \\     46.22   \end{array} $	$66.43 \\ 19.63 \\ 37.14$
Hedge & multi ass.								
Funded TAA Hedge Fund Risk Parity			6.05	$93.95 \\ 100.00 \\ 100.00$			58.27 28.19	$\begin{array}{c} 41.73 \\ 100.00 \\ 71.81 \end{array}$
Private Equity								
Div. Private Eq. LBO Other Venture Capital			0.08	$\begin{array}{c} 99.92 \\ 100.00 \\ 100.00 \\ 100.00 \end{array}$			$18.86 \\ 0.27 \\ 26.81 \\ 0.70$	81.14 99.73 73.19 99.30
Private Credit								
Mortgages Credit			$\begin{array}{c} 1.98\\ 10.49 \end{array}$	$98.02 \\ 89.51$			$\begin{array}{c} 67.24 \\ 31.45 \end{array}$	$32.76 \\ 68.55$
Real Assets								
Commodities Infrastructure Nat. Resource Other Real Estate		18.43	2.62	$\begin{array}{r} 81.57\\ 100.00\\ 100.00\\ 100.00\\ 97.38\end{array}$	19.70	1.82	$58.20 \\ 61.39 \\ 46.70 \\ 28.42 \\ 39.67$	$20.28 \\ 38.61 \\ 53.30 \\ 71.58 \\ 60.33$
REIT		6.60		93.40	2.53	3.59	77.54	16.33

Table 1: Small and large plans' investment allocation by sub-asset class and management structure in 2019. This table shows the share (in %) of AUM allocated to the four management mandates: Internal Passive (IP), External Passive (EP), Internal Active (IA), and External Active (EA) for the given sub-asset classes. The share is calculated as follows:  $\omega_{ats} = \frac{AUM_{ats}}{AUM_{at}}$ , where AUM<sub>ats</sub> =  $\sum_i AUM_{iats}$ , and AUM<sub>at</sub> =  $\sum_s \sum_i AUM_{iats}$ , where *i* denotes plan *i*, *a* indicates the sub-asset class, *t* denotes the year 2019, and *s* denotes one of the four mandates. The shares are calculated separately for small and large plans, defined by the bottom and top 30th percentile of AUM in 2019 respectively. For small and large plans, rows sum up to 100%.

	Regression						Siz	ze percent	tile
	$\log(AUM_{iats})$	$Private_i$	$\mathrm{nonUS}_i$	Obs	$\mathbb{R}^2$		10%	50%	90%
<u>Stocks</u> IP	0.76	0.25	0.93	2294	0.70		2.67	1.48	0.85
EP	(0.037) <b>0.75</b>	(0.157) -0.01	(0.120) <b>0.23</b>	11253	0.62		5.39	2.94	1.65
IA	(0.015) <b>0.88</b>	(0.051) <b>0.46</b>	(0.055) 0.22	3602	0.71		9.35	7.21	5.53
EA	(0.026) <b>0.88</b> (0.007)	(0.167) <b>0.04</b> (0.021)	(0.146) -0.28 (0.023)	25839	0.86		62.49	49.92	39.10
Fixed Income		· /	· · · ·						
IP	0.80	-0.09	0.39	1269	0.69		2.94	1.51	1.00
EP	<b>0.79</b> (0.024)	0.11	<b>0.26</b> (0.074)	4127	0.63		4.57	2.84	1.92
IA	<b>0.84</b> (0.020)	<b>0.51</b> (0.124)	<b>0.25</b> (0.102)	5338	0.73		4.08	2.78	2.03
EA	<b>0.94</b> (0.010)	(0.00) (0.036)	<b>-0.18</b> (0.040)	17571	0.76		27.75	23.98	20.92
Hedge & Multi ass.									
EA	<b>0.95</b> (0.018)	$\underset{(0.062)}{0.09}$	-0.03 (0.064)	4801	0.78		146.87	133.21	120.66
Private Equity	4.04	0.10	a a <b>-</b>	- 20			10.00	10.10	10.00
IA	$\underset{(0.035)}{1.01}$	$\underset{(0.215)}{0.19}$	$\underset{(0.241)}{0.37}$	768	0.78		18.00	18.49	19.02
EA	(0.93)	<b>-0.08</b> (0.039)	(0.02)	8480	0.86		382.93	312.52	268.04
$\frac{\text{Private Debt}}{\text{IA}}$	0.05	0.30	0 76	411	0.70		19.95	10.12	8.64
FΛ	(0.93) (0.064) 0.94	(0.274) 0.18	(0.286)	$\frac{411}{1377}$	0.75		12.20	165.01	146.75
EA	(0.036)	(0.147)	(0.139)	1011	0.15		100.05	105.31	140.75
$\frac{\text{Real Assets}}{\text{IA}}$	1.01	0.00	0.49	2222	0.75		11.32	11.50	11.67
EA	(0.031) <b>0.92</b>	(0.138) -0.06	(0.135) -0.07	12117	0.79		161.87	136.15	115.65
	(0.011)	(0.036)	(0.037)						
Alternative IA	0.97	-0.02	0.47	3543	0.75		13.56	12.38	11.50
EA	(0.026) <b>0.92</b>	(0.139) -0.05	(0.132) - <b>0.15</b>	26775	0.75		215.09	177.48	149.01
	(0.011)	(0.036)	(0.042)					111110	110101
	Hy	pothesis T	esting (p-v	ralue)					
Null hypothesis	Stocks	Fixed Income	Private Equity	Private Debt	Real Assets	Alternati	ve		
$\beta^{\mathrm{IP}}_{\ \ \mathrm{old}} = \beta^{\mathrm{EP}}_{\ \ \mathrm{oEA}}$	0.90	0.46	0.99	0.70	0.01	0.10			
$\beta^{\rm P} = \beta^{\rm P}$ $\beta^{\rm P} = \beta^{\rm A}$	0.16 <b>0.00</b>	0.00 0.00	0.33	0.79	0.01	0.10			

Table 2: Economies of scale for cost among different investment mandates. The regression panel of this table shows estimates of the model (5.2):  $\log(\text{Cost}_{iats}^{\$}) = c_{As} + \lambda_{Ats} + \beta_{As} \log(\text{AUM}_{iats}) + \gamma_{1,As} \text{Private}_i + \gamma_{2,As} \text{nonUS}_i + \varepsilon_{iats}$ , where  $\text{Cost}_{iats}^{\$}$  is the cost (in dollars) of plan *i* in sub-asset class a at time t for mandate s,  $c_{As}$  is a constant that varies with asset class A and mandate s,  $\lambda_{Ats}$  is the time fixed effect for asset class A and mandate s,  $\log(AUM_{iats})$  is the log of total AUM of plan i in sub-asset class a at time t for mandate s, Private<sub>i</sub> is a dummy equal to one if plan i is private and nonUS<sub>i</sub> is a dummy equal to one if plan i is located outside the U.S. The alternative asset class pools observations from Hedge & multi assets, private equity, private debt, and real assets. For stocks and fixed income, we estimate the panel separately for the following mandates s: Internal Passive (IP), Internal Active (IA), External Passive (EP) and External Active (EA). The boldface coefficients on log(AUM) are significantly different from one at the 5% level and boldface coefficients on the other coefficients are significantly different from zero. Robust standard errors are reported in parentheses and are clustered by plan. The size percentile columns show  $\widehat{\text{Cost}}_{iats}^{*}/\text{AUM}_{iats}$  in bps, where  $\widehat{\text{Cost}}_{iats}^{*}$  is predicted based on the regression panel. We set  $Private_i$  and  $nonUS_i$  equal to zero and use the  $10^{th}$ ,  $50^{\text{th}}$  and  $90^{\text{th}}$  percentile of AUM<sub>iats</sub> in 2019 to obtain the fraction of cost relative to AUM. The bottom panel shows p-values of the null hypotheses that returns to scale are the same for different mandates, where a boldface *p*-value indicates a rejection of the null hypothesis.

	Stocks	Fixed Income							
$\log(AUM_{iats})$	0.68	0.63							
	(0.074)	(0.072)							
$\log(AUM_{iats}) \times Active_{iats}$	(0.18)	0.13							
$\log(AUM_{inte}) \times External_{inter}$	(0.020)	0.12							
log(lie)liquis) × Enternarquis	(0.072)	(0.055)							
$\log(AUM_{iats}) \times Act_{iats} \times Ext_{iats}$	0.05	-0.01							
A	(0.015)	(0.019)							
Active <sub>iats</sub>	-2.20	-0.40 (0.958)							
Externalizeta	0.29	-1.05							
Lincollianfaits	(1.543)	(1.002)							
$Private_i$	0.09	0.07							
110	(0.044)	(0.058)							
$\operatorname{nonUS}_i$	-0.05	-0.05							
	(0.072)	(0.110)							
Obs	1872	2046							
$R^2$	0.89	0.80							
APE of active ma	nagemen	ıt							
$IP \rightarrow IA$	1.46	2.05							
$EP \to EA$	2.58	1.81							
Hypothesis te	Hypothesis testing								
Null hypothesis	<i>p</i> -value								
$\beta^{\rm IP} = \beta^{\rm EP}$	0.83	0.04							
$\tilde{\beta}^{\mathrm{IA}} = \tilde{\beta}^{\mathrm{EA}}$	0.14	0.00							
$\beta = \beta$ $\beta P = \beta A$	0.14	0.00							
$\rho = \rho^{-1}$	0.00	0.00							

Table 3: Economies of scale for cost in the same product market. This table shows estimates of scale economies in cost, conditional on plans investing in the same product. The estimated model is:  $\log(\text{Cost}_{iats}^{\$}) = c_a + \lambda_{At} + \beta_{1,A} \log(\text{AUM}_{iats}) + \beta_{2,A} \log(\text{AUM}_{iats}) \times \beta_{2,A} \log(\text{AUM}_{iats}) + \beta_{2,A} \log($  $Active_{iats} + \beta_{3,A} \log(AUM_{iats}) \times External_{iats} + \beta_{4,A} \log(AUM_{iats}) \times Active_{iats} \times External_{iats} + \beta_{4,A} \log(AUM_$  $\beta_{5,A}$ Active<sub>*iats*</sub> +  $\beta_{6,A}$ External<sub>*iats*</sub> +  $\beta_{7,A}$ Private<sub>*i*</sub> +  $\beta_{8,A}$ nonUS<sub>*i*</sub> +  $\varepsilon_{$ *iats* $}$ , where Cost<sup>\$</sup><sub>*iat*</sub> is the cost (in dollars) of plan i in sub-asset class a at time t with mandate s,  $c_a$  is a sub-asset class fixed effect,  $\lambda_{At}$  is a time fixed effect, Active<sub>iats</sub> is a dummy equal to one if plan i manages sub-asset class a at time t actively, External<sub>iats</sub> is a dummy equal to one if plan i manages sub-asset class a externally at time t,  $Private_i$  is a dummy equal to one if plan i is private, and nonUS<sub>i</sub> is a dummy equal to one if plan i is located outside the U.S. The boldface coefficients on log(AUM) are significantly different from one at the 5% level and boldface coefficients on the other coefficients are significantly different from zero. Robust standard errors are reported in parentheses and are clustered by plan. The middle rows denote the average partial effect of active management at the mean AUM in our sample. The bottom rows show p-values of the null hypotheses that returns to scale are the same for different mandates, where a boldface *p*-value indicates a rejection of the null hypothesis.

	$\log(AUM_{it})$	$Private_i$	$\operatorname{nonUS}_i$	Obs
Stocks	-1.45 (0.697)	4.44 (1.984)	-4.97 (2.280)	3326
Fixed Income	<b>-3.15</b> (0.946)	0.79 (2.488)	-0.27 (3.056)	1753
Hedge & Multi ass.	-0.14(0.966)	0.37 (4.406)	-1.39 (3.913)	3832
Private Equity	-13.85 $(3.421)$	-74.04 (12.262)	-3.57 (11.393)	8185
Real Assets	-0.65 (1.400)	$\textbf{-15.77}_{(5.975)}$	-21.42 (5.877)	10218

Table 4: Regression of manager base fee share on plan characteristics. This table reports estimates of the average partial effect of plan characteristics on  $c_{iat}^{\text{base}}$ , defined as the manager base fee, expressed as a share in bps of sub-asset class AUM (AUM<sub>iat</sub>). The model is estimated using fractional regression with a probit link function (Papke and Wooldridge, 2008), and includes sub-asset class and time fixed effects. Boldface coefficients are significant at the 5% level. Robust standard errors, clustered at the plan level, are reported in parentheses. The sample is restricted to externally actively managed mandates.

Cost (in bps)	Stocks	Fixed income	Alt.	All		Stocks	Fixed income	Real assets
Cost (m bps)								
Internal	-2.76 (0.569)	-4.88 (1.056)	<b>-55.69</b> (11.003)	-4.40 (1.571)	Passive	-9.24 (0.520)	<b>-2.23</b> (0.392)	<b>-8.68</b> (0.861)
External	<b>7.35</b> (0.482)	<b>5.01</b> (0.669)	<b>54.29</b> (2.694)	<b>17.60</b> (0.768)	Active	14.48 (0.612)	<b>4.88</b> (0.341)	16.12 (1.365)
Obs	25240	19141	16562	60944		25240	19141	9817
	Treated units							
Internal	214	187	145	548	Passive	720	299	44
External	210	181	133	526	Active	555	261	28
			% of sv	vitchers th	at increase	AUM		
Internal	0.721	0.695	0.776	0.726	Passive	0.670	0.722	0.667
External	0.264	0.273	0.464	0.321	Active	0.232	0.318	0.348

Table 5: Effect of asset management style on cost using matching. This table shows the effect of switching from external to internal management (Internal), internal to external management (External), active to passive management (Passive) and passive to active management (Active) on cost (in bps). The asset classes "Alt" and "All" pool observations across the alternative asset classes and all asset classes respectively. The effect is estimated using the following controls:  $AUM_{iat}$ , total AUM allocated by plan i to sub-asset class a at time t; Private<sub>i</sub>, an indicator denoting whether plan i is private;  $nonUS_i$ , an indicator denoting whether plan *i* is domiciled in the U.S.; and sub-asset class a at time t to ensure that plans in the treated group are matched with plans in the control group that invest in the same sub-asset class. To estimate the effect of internal/external (passive/active) management, we also use the control: Active<sub>*iat*</sub> (External<sub>*iat*</sub>), an indicator denoting if plan i manages sub-asset class a actively (externally) at time t. Robust standard errors are reported in parentheses and boldface coefficients are significant at the 5% level. "Treated units" denotes the number of plans that switch management style by asset class. The bottom rows denote the number of plans that increase their AUM in a sub-asset class when switching management style.

	Panel A: Cragg APE Estimates								
	Stocks	Fixed income	Hedge & multi ass.	Private equity	Private debt	Real assets			
$\log(AUM_{it-1})$	11.4	<b>17.91</b>	0.68	2.32	<b>13.29</b>	6.58			
$\text{CostSpread}_{iAt-1}$	(2.453) 12.55 (7.094)	(2.624) <b>30.48</b> (8.664)	(0.455) 0.20 (0.420)	(0.825) -0.23 (0.240)	(4.396) 0.11 (1.250)	(1.507) 2.57 (1.528)			
$Private_i$	1.54	2.21	-0.89	3.50	12.04	2.31			
$NonUS_i$	(4.346) <b>13.49</b> (4.708)	(6.912) <b>22.47</b> (5.444)	(1.376) -0.84 (1.196)	(2.909) <b>11.92</b> (4.493)	(10.626) 1.57 (7.758)	(3.202) <b>17.70</b> (3.727)			
Obs	7205	7222	1944	4322	1055	5676			
	Panel B: Cragg Selection Estimates								
	Stocks	Fixed income	Hedge & multi ass.	Private equity	Private debt	Real assets			
$\log(AUM_{it-1})$	38.67	28.87	33.01	23.58	34.60	28.33			
$\mathrm{CostSpread}_{iAt-1}$	(3.987) 37.90 (24.409)	(3.282) 21.31 (18.474)	(8.801) - <b>13.09</b> (5.635)	(5.710) -2.29 (1.711)	(8.934) -2.34 (4.076)	(4.186) 0.16 (2.618)			
	$\Pr(\omega_{iAt}^{internal} > 0   X = x)$								
<u>Plan Size</u>									
$10^{\rm th}$ percentile	13.31	28.82	0.58	5.65	9.08	12.76			
$50^{\text{th}}$ percentile	34.84	49.22	2.84	12.61	24.52	27.14			
$90^{\text{tn}}$ percentile	67.04	72.60	11.58	26.17	52.13	50.00			

Table 6: Asset allocation regression for internal vs. external management. **Panel A** of this table reports the average partial effects as shown in (6.5) of the regression (6.6):  $\omega_{iAt}^{internal} = c_A + \lambda_{At} + \beta_{1,A} \log(\text{AUM})_{it-1} + \beta_{2,A} \text{CostSpread}_{iAt-1} + \beta_{3,A} \text{Private}_i + \beta_{4,A} \text{nonUS}_i + \epsilon_{iAt}$ .  $\omega_{iAt}^{internal}$  indicates the share of AUM that is internally managed by plan *i* in asset class *A* at time *t* (AUM\_{i,A,t}^{Internal} / (AUM\_{i,A,t}^{Internal} + AUM\_{i,A,t}^{External})),  $\lambda_{At}$  is a time fixed effect, AUM\_{it-1} denotes the lagged AUM of plan *i*, CostSpread\_{iAt-1} is plan *i*'s cost spread between external and internal management in asset class A at time t-1, Private<sub>i</sub> is a dummy equal to one if plan i is private, and nonUS<sub>i</sub> is a dummy equal to one if the plan is domiciled outside the U.S. In case a plan is fully internal (external) we impute the external (internal) cost as the median cost from plans that are similar in size, where size in a given year is either small (bottom 30th percentile), medium (between 30th and 70th percentile), or large (top 70th percentile) of total AUM. Robust standard errors are reported in parentheses and are clustered by plan. Boldface coefficients are statistically significant at the 5% level. The asset class "Private Debt" does not include time fixed effects due to the small sample size, and estimation for "Hedge Funds" start in 2000 due to lack observation prior to 2000. Panel B presents the results of the Cragg selection equation (6.2a). The bottom part of panel B shows the probability of allocating at least some portion of investments internally. We fix the cost spread at the mean cost spread across time and sponsors, and show the different probabilities based on size, using the 10th, 50th, and 90th percentile of AUM in 2019. All coefficients and standard errors are multiplied by 100.

	Panel A: Cragg APE Estimates							
	A1: I	P vs. EP	А	2: IA vs. E.	A			
	Stocks	Fixed income	Stocks	Fixed income	Alt.			
$\log(AUM_{it-1})$	10.94	7.76	8.54	17.14	<b>4.41</b>			
$\mathrm{CostSpread}_{iAt-1}$	(1.420) <b>36.59</b> (18.416)	-3.25	(2.340) 1.43 (5.119)	(2.072) 27.89 (8.011)	0.00			
$Private_i$	1.48	-1.01	3.56	-0.61	3.22			
$NonUS_i$	(3.270) -2.27 (3.010)	(3.850) -2.40 (2.685)	$(4.825) \\ 16.98 \\ (6.219)$	(6.796) <b>25.27</b> (5.298)	(2.129) <b>13.79</b> (3.413)			
Obs	5044	2992	7045	7123	13073			
	Panel B: Cragg Selection Estimates							
	B1: I	P vs. EP	B2: IA vs. EA					
	Stocks	Fixed income	Stocks	Fixed income	Alt.			
$\log(AUM_{it-1})$	43.61	24.50	36.76	30.07	23.32			
$\mathrm{CostSpread}_{iAt-1}$	(4.038) 79.62 (89.284)	(3.233) -58.18 (36.059)	(4.313) -23.11 (20.663)	(3.407) 12.80 (15.125)	(0.133) (0.136)			
	$\overline{\Pr(\omega_{iAt}^{IP} > 0   X = x)}$		$\Pr(\omega_{iAt}^{IA} > 0   X = x)$					
<u>Plan Size</u>								
10 <sup>th</sup> percentile	6.43	16.02	8.90	25.59	8.52			
50 <sup>th</sup> percentile	24.04	29.59	25.45	46.23	17.48			
90 <sup>°</sup> percentile	59.16	49.60	55.14	70.93	33.19			

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Table 7: Asset allocation regression for internal passive (IP) vs. external passive (EP) and internal active (IA) vs. external active (EA). Panel A of this table reports the average partial effects as shown in (6.5) of the following two specifications: A1: IP vs EP -  $\omega_{iAt}^{IP} = c_A + \lambda_{At} + \beta_{1,A} \log(AUM)_{it-1} + \beta_{2,A} CostSpread_{iAt-1} + \beta_{2,A} CostSpread_{iAt-1}$  $\beta_{3,A}$ Private<sub>i</sub>+ $\beta_{4,A}$ nonUS<sub>i</sub>+ $\epsilon_{iAt}$  and A2: IA vs EA -  $\omega_{iAt}^{IA} = c_A + \lambda_{At} + \beta_{1,A} \log(AUM)_{it-1} + \beta_{1,A} \log(AUM)_{it-1}$  $\beta_{2,A}$ CostSpread<sub>*i*At-1</sub> +  $\beta_{3,A}$ Private<sub>*i*</sub> +  $\beta_{4,A}$ nonUS<sub>*i*</sub> +  $\epsilon_{iAt}$ . In A1 and B1,  $\omega_{iAt}^{IP}$  indicates the share of internally managed assets that are managed passively. In A2 and B2,  $\omega_{iAt}^{IA}$  indicates the share of internally managed assets that are managed actively.  $\lambda_{At}$  is a time fixed effect,  $AUM_{it-1}$  denotes the lagged AUM of plan *i*,  $CostSpread_{iAt-1}$  is plan *i*'s cost spread between external and internal management in asset class A at time t-1, Private<sub>i</sub> is a dummy equal to one if plan i is private, and nonUS<sub>i</sub> is a dummy equal to one if the plan is domiciled outside the U.S. In case a plan is fully internal passive (internal active) in an asset class we impute the external passive (external active) cost as the median cost from plans that are similar in size, where size in a given year is either small (bottom 30th percentile), medium (between 30th and 70th percentile), or large (top 70th percentile) of total AUM. Robust standard errors are reported in parentheses and are clustered by plan. Boldface coefficients are statistically significant at the 5% level. **Panel B** presents the results of the Cragg selection equation (6.2a) for both specifications (IP vs. EP and IA vs. EA). The bottom part of B1 and B2 show the probability of allocating at least some portion of investments internal and passively (B1) or internally and actively (B2). We fix the cost spread at the mean cost spread across time and sponsors, and show the different probabilities based on size, using the 10th, 50th, and 90th percentile of AUM in 2019. All coefficients and standard errors are multiplied by 100.

	Stocks	Fixed income	Hedge & multi ass.	Private equity	Private debt	Real assets	Alt.	Total portfolio
Gross								
$\overline{\log(\mathrm{AUM}_{iat-1,s})}$	0.04 (0.026)	0.01 (0.029)	0.15 (0.110)	0.48 (0.153)	$\begin{array}{c} 0.19 \\ (0.139) \end{array}$	$\begin{array}{c} 0.11 \\ (0.084) \end{array}$	0.22 (0.070)	0.05 (0.021)
$Active_{iats}$	<b>0.59</b> (0.062)	<b>0.39</b> (0.083)		. ,		0.91 (0.522)	0.74 (0.540)	<b>0.65</b> (0.136)
$External_{iats}$	0.15 (0.111)	0.08 (0.107)	-0.83 (0.722)	<b>4.56</b> (1.043)	$\begin{array}{c} 0.77 \\ (0.459) \end{array}$	0.16 (0.351)	<b>1.13</b> (0.339)	0.04 (0.110)
$\operatorname{Perform}_{iats}$	<b>0.28</b> (0.127)	-0.02 (0.117)		× /	. ,		~ /	<b>0.44</b> (0.150)
$Private_i$	<b>0.22</b> (0.077)	0.06 (0.071)	0.55 (0.318)	-0.36 (0.535)	-0.82 (0.514)	0.33 (0.260)	0.09 (0.234)	<b>0.12</b> (0.053)
$\mathrm{nonUS}_i$	-0.13 (0.096)	-0.14 (0.102)	<b>-0.89</b> (0.314)	<b>2.33</b> (0.576)	0.83 (0.535)	0.08 (0.265)	<b>0.57</b> (0.237)	-0.03 (0.063)
Obs	30877	20683	3309	6300	1128	10377	21114	7214
$R^2$	0.05	0.04	0.20	0.20	0.17	0.07	0.08	0.20
Net								
$\overline{\log(\text{AUM}_{iat-1,s})}$	0.07 (0.026)	0.04	0.25 (0.111)	0.74 (0.149)	0.20 (0.135)	0.23 (0.091)	0.38 (0.074)	<b>0.06</b> (0.020)
$Active_{iats}$	<b>0.24</b> (0.063)	<b>0.26</b> (0.081)	× ,	~ /	· · /	0.65	0.53'	<b>0.33</b> (0.131)
$External_{iats}$	-0.03 (0.113)	-0.02	-1.18	2.70 $(1.016)$	0.28 (0.430)	-0.48 (0.350)	0.27 (0.324)	-0.10 (0.106)
$\operatorname{Perform}_{iats}$	<b>0.25</b> (0.129)	-0.15 (0.114)	× ,	~ /	· · /	· · ·	~ /	-0.07 (0.141)
$Private_i$	<b>0.20</b> (0.076)	0.06	$\begin{array}{c} 0.50 \\ (0.318) \end{array}$	0.11	-0.66	0.45	0.28 (0.239)	<b>0.11</b> (0.052)
$\mathrm{nonUS}_i$	-0.09 (0.097)	-0.14 (0.101)	<b>-0.79</b> (0.316)	2.17 (0.558)	$\begin{array}{c} 0.94\\ (0.503) \end{array}$	$\begin{array}{c} 0.24 \\ (0.269) \end{array}$	<b>0.63</b> (0.235)	$\begin{array}{c} 0.09\\ (0.060) \end{array}$
Obs	30877	20683	3309	6303	1128	10376	21116	7214
$R^2$	0.04	0.03	0.14	0.18	0.14	0.05	0.06	0.14

Table 8: Regression of policy-adjusted returns on plan characteristics. This table shows estimates of model (7.2):  $\tilde{r}_{iats} = c_a + \lambda_{At} + \beta_{1,A} \log(\text{AUM}_{iat-1,s}) + \beta_{2,A} \text{Active}_{iats} + \beta_{3,A} \text{External}_{iats} + \beta_{4,A} \text{Perform}_{iats} + \beta_{5,A} \text{Private}_i + \beta_{6,A} \text{nonUS}_i + \epsilon_{iats}$ , where  $\tilde{r}_{iats}$  denotes the policy-adjusted gross (top) and net (bottom) return. The column "Alt." pools observations from the alternative asset classes: Hedge & multi assets, Private equity, Private debt and Real assets. The column *Total portfolio* uses plan-level aggregate returns  $r_{it}$  from portfolios and estimates (7.3). Portfolios are constructed as weighted averages (by AUM) of asset class investments per sponsor in a given year. Robust standard errors are reported in parentheses and clustered by sponsor. Boldface coefficients are statistically significant at the 5% level.



Figure 1: Asset allocation by management style and plan size. This figure shows the share of total AUM allocated to the four management styles: Internal Passive (IP), External Passive (EP), Internal Active (IA) and External Active (EA). The shares are calculated in 2019 for the asset classes: Stocks, Fixed Income and Real Assets. Within each year, we also distinguish by small and large plans, which are defined by the bottom 30 and top 70 percentile relative to the total AUM within an asset class.



Figure 2: Optimal management style and cost in public and private asset classes. The top panels show the model-implied optimal management style as a function of AUM (left), and the associated cost for each management style as a function of AUM (right), in the public asset class. The bottom panels present the corresponding results for the private asset class. The parameter calibration for the public asset class is described in Appendix A.3, while the calibration for the private asset class is given in Appendix A.5.



Figure 3: Relation between log Cost and log AUM. This figure shows a scatter plot of  $log(AUM_{iats})$  versus  $log(Cost_{iats}^{\$})$ , where  $AUM_{iats}$  (resp.  $Cost_{iats}^{\$}$ ) denotes the dollar AUM holdings (resp. dollar cost) of plan i in sub-asset class a at time t for asset management style s. The asset management styles we consider are: Internal Passive, Internal Active, External Passive and External Active. In each panel and for a given style, observations are pooled across plans, sub-asset classes, and years over the sample period 1991–2019.