Scale Economies, Bargaining Power, and Investment Performance: Evidence from Pension Plans*

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Abstract

This paper uses a unique proprietary database with granular cross-sectional fee, asset allocation, investment management style, and performance data to explore the relation between the structure and size of defined benefit pension plans and their choice of (1) active vs. passive management, (2) internal vs. external management, and (3) allocation to public vs. private markets. Our results indicate a strong role for economic scale in pension plan investments: large plans have stronger bargaining power over their external managers in negotiating fees as well as access to better-performing funds, relative to small plans. They use this power to produce higher gross and net-of-fee return performance, particularly in private asset classes. Economies of scale in investment costs are particularly large for passively managed accounts and for publicly traded assets and are significantly lower for actively managed accounts and alternative (private) asset classes.

Key words: 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 structure of the professional asset management industry—and the asset classes that it covers—have changed substantially. As key examples of structural change, competition among and between passive and active managers has substantially reduced fees—certainly partly due to the decreasing costs of technology and information—and both types of managers have become more specialized in their investment offerings (Blake et al. (2013)). In parallel, alternative asset classes have become more widely accepted among major institutional investors such as pension plans and endowments in their allocations to hedge funds, private debt and equity, and real asset investments.

Defined-benefit (DB) pensions continue to hold a large share of the market portfolio of worldwide financial assets, and the total AUM of DB pensions has grown substantially—especially state and local government plans. Accordingly, these pensions both impact the well-being of the average household and the pricing of such assets–both public and private–in financial markets. Specifically, the AUM of U.S. state and local government DB plans has grown from $1.4 to 5.1 trillion from year-end 1995 to 2020, while U.S. private-sector DB plans have grown from $1.5 to 3.4 trillion over the same period (Investment Company Institute, 2021, p. 177). Further, the current landscape consists of several very large pension plans.[1]

The confluence of the above-noted shifts in the asset management industry with the increased bulk of DB assets brings several new issues to light, such as the potential increase in the bargaining power of DB plans in their interactions with money managers. Our study is designed to conduct a granular analysis of the DB industry, with an emphasis on the interaction of DB plan size with fees and investment performance. For example, one economically important trend is that large DB plans are increasingly managing assets "in-house," to cut fees while potentially maintaining a reasonable level of performance (Beath et al., 2022).[2] A key issue that we explore is whether such in-house management brings greater bargaining power to plans when they negotiate fees for external management services—and, whether such bargaining power mainly resides with the largest pension plans due to the fixed costs of setting up and maintaining internal management.

In retail markets, individual investors are usually considered as "atomistic" agents who have no individual (or collective) bargaining power. The seminal paper of Berk and Green (2004) (henceforth, BG) presents a model based on this assumption as well as the usual assumption that "alpha" generation by fund managers exhibits diseconomies-of-scale. Predictions from their model include that (1) skilled investment managers collect all of the rents from their alpha-generating efforts, (2) flows from atomistic

[1] For example, one of the biggest pension funds in the world—CalSTRS—contains total assets in excess of $314.8 billion, as of May 31, 2022. See https://www.calstrs.com/investment-portfolio.

[2] As an important example, CalSTRS recently stated that in-house management is instrumental to their cost savings. See https://www.pionline.com/pension-funds/calstrs-costs-falling-despite-alternatives-rich-portfolio?utm_source=p-i-plan-sponsor-topical-email&utm_medium=email&utm_campaign=20221116&utm_content=hero-headline&CSAuthResp=1668636734799%3A0%3A387174%3A391%3A24%3Asuccess%3A4E2D0C348F5479E9C209DA7057327EC4#cci_r=

investors occur at each period (in reaction to updated information about manager skills)—either into or out of each fund until management fees equal expected pre-fee alphas, and (3) all investors, being atomistic, obtain the exact same zero expected alpha, net-of-fees.

In the pension plan market that we study, the only major assumption of the BG model that can be assumed to hold—without further inquiry—is that of pre-fee scale diseconomies in fund alpha generation. While managers retain all bargaining power in retail markets, it is far from clear that the largest pension plans have no power to extract net-of-fee alpha from their external managers—since plans are not of a trivial scale, and, thus, their ability to invest in funds with low fees and high alphas cannot be assumed away. Further, we might expect the economics of large plans to deviate the most from the zero expected-alpha (net-of-fee) BG model, since these large plans realize greater bargaining power—at least in part due to having more favorable economies-of-scale to overcome the fixed costs of setting up an internal management shop to "compete" with external managers in the same asset-class/strategy. Our study, thus, investigates how bargaining power is associated with plan size as well as how that power is related to the ability of larger plans to capture some of the rents created by external managers (through lower fees and/or higher alpha generation by such external managers).[3]

We further explore other implications of scale in pension plans, including trends in asset allocation. For example, it is unclear whether the bargaining power of large plans results in a greater use of external active managers (presumably at lower fee levels) or a greater tendency to internally (either actively or passively) manage assets. And, as large plans move assets to internal management, it is interesting to determine whether their internal active skills outweigh the savings from internally managing passively—or, whether this depends on the asset class.[4] Thus, our paper provides a unique view into scale economies of plans—and the associated bargaining power—at the level of plan asset classes.[5]

The modeling framework proposed by Gârleanu and Pedersen (2018); GP, match more closely the empirical setting of our analysis. In their model, investors must 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) matters for fees as well as net-of-fee return performance when some investors are not atomistic in size. 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

[3]Of course, for internal management to pose a "threat" to external managers, there must be a large mass of plans that stand ready to manage internally—and, a finite mass of smaller plans such that external managers do not retain all bargaining power, unlike the infinite supply of capital assumed in BG. While some large plans may choose not to spend the fixed costs of setting up internal management, the mere ability to do so gives them negotiating power.

[4]That is, an important issue is whether internally managing a greater share of a plan's assets in a particular asset class leads to a different mix of active vs. passive management in that asset class, as well as other asset classes held by the plan. The role of pension plan scale in internalizing active vs. passive management can be expected to depend on the relative fixed costs of creating an internal management organization for each, within a given asset class.

[5]For example, large pension plans may be more capable of actively managing private asset classes, where they can directly exert their size to obtain more favorable investments.

in which investment management costs are relatively high in private asset markets and the largest plans benefit disproportionately from their better ability to search for skilled managers and negotiate lower investment management fees.

We note that two major trends drive our interest in these questions. First, pensions have increasingly moved toward passive management of their public market exposures in both equities and (to a lesser extent) fixed-income. Second, pensions have increasingly turned to private equity funds or to direct investments in real assets as a source of diversification and higher long-term returns. These developments can be partially attributed to the shrinking number of publicly traded stocks that are available in the U.S. In the face of these trends, many pensions have assigned a greater role to internal asset management. Both of these trends are consistent with a shrinking level of fixed costs in setting up an internal asset management organization across all asset classes, but especially so in public market securities.

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 large cross-section of pension plans, each year, on their asset allocations (in percent) to each major asset class (e.g., public equities, hedge funds, private equity, public debt, private debt, and real assets), to asset subclasses (e.g., small-capitalization U.S. equities or infrastructure investments), and–within each of these subclasses–to active vs. passive management and to internal vs. external management. Importantly, the CEM database contains information on AUM, gross return, and investment costs for each of these subclass/active-passive combinations; in addition, the CEM staff routinely apply a battery of checks to obtain the most precise data possible.[6] We believe that the CEM data allows a closer look at the above questions than has been possible with prior studies.

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 market where scale-related bargaining power can be expected to be especially important in achieving net-of-fee alphas, such as private equity investments (see also Dyck and Pomorski (2016)). Further, large plans tend to use internal management to a greater degree, particularly in the public asset classes where the cost of setting up internal investment management is lower.

Further, we identify two major shifts in the asset allocation of U.S. pension plans. First, while stocks and fixed income assets continue to account for a little over 70% of AUM at the end of our sample (2019), this share has declined from nearly 90% in the early 1990s, with non-traditional asset classes such as private equity, hedge funds, and real assets increasing significantly over time.[7] Second, even within traditional asset classes, such as equity and bonds, we see large shifts toward more specialized

[6] 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 data integrity.

[7] 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.

mandates, e.g., from Broad/All U.S. equities to large, medium, and small market capitalization funds in the equity space, and from U.S. bonds toward high yield and credit objectives in the fixed income area. By far the biggest shift is toward international and global assets, which become far more prominent over time, particularly in stock portfolios.

These shifts in asset allocation are consistent with a decrease in fixed costs of managing investments, with this decrease varying widely across asset classes (as well as within an asset class, between active and passive management). When we examine the tendency to manage assets internally, we find that plan size greatly matters. Specifically, we find that larger plans are more likely to manage assets internally. On further examination, we see that larger plans are more likely to internally manage fixed income and private debt allocations. Non-U.S. plans, in general, have a higher tendency to internally manage allocations relative to U.S. plans. Private plans allocate larger portions to internal management in stocks, private debt, and private equity.

Examining more closely allocations to active versus passive management, we find that, as a pension plan becomes larger, its likelihood of employing active management for equities decreases, but chiefly for public securities. That is, large pensions exploit the huge and increasing economies-of-scale in passive management of public securities, and increasingly do so over time as the fixed costs of passive management have rapidly decreased. For the share of equities and fixed income that are managed actively, large plans are more likely to manage equities internally and actively, and are less likely to manage fixed income internally.[8]

Subsequently, we examine investment costs for our sample of pension plans by investment management mandate. Here, we find that the median cost of internally and passively managing stocks is 1-3 bps per year throughout the sample period, while internally and actively managed stocks bear a medium cost that fluctuates between 5-11 bps per year. The medium cost for externally and passively managed stocks hovers between 4-8 bps, while the medium cost of external active management is noticeably higher – between 32-48 bps. For fixed income holdings, we observe similar patterns. Moreover, we find that external passive management costs have been decreasing over time for stocks and fixed income, converging toward the lower level of internal passive management costs. In contrast, there is no signs of convergence in the costs of internal and external active management costs for these asset classes or, indeed, for the private asset classes.

Finally, we find strong evidence of strong 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 holds for public as

[8]We also find that private pension plans have a higher probability in managing fixed income internally and actively, and tend to actively and externally manage equities. For the share of actively and internally managed assets, non-U.S. plans favor active and internal management for equities, relative to their U.S. counterparts. For the share of actively and externally managed assets, non-U.S. plans favor active and external management compared to U.S. plans, and are less likely to favor active and external management for fixed income.

well as private asset classes. Specifically, large plans benefit from economies-of-scale and pay considerably less for the management of alternative assets. Comparing a small plan versus a large plan (bottom 10% versus top 10% of the size distribution), we find cost reductions of 14 bps/year in stocks, 13 bps/year in fixed income, 34 bps/year for hedge funds, 110 bps/year for private equity, and 68 bps/year for real assets. Active management, is more costly with an additional 37 bps/year for stocks, 14 bps/year for fixed income, and 26 bps/year for real assets. Private plans enjoy lower costs for managing private equity and real assets with a reduction of 42 and 18 bps, respectively. However, they pay higher costs for managing stocks and hedge funds of 2 and 8 bps/year, respectively.

Our paper relates to Dyck and Pomorski (2011), who find a positive relation between *total* plan size and performance, partially due to large plans' greater ability to manage assets internally at lower cost. They also document that larger plans allocate larger amounts of their holdings to asset classes where their scale is more likely to provide bargaining power with respect to the fees charged by external asset managers, specifically private equity and real estate. Our analysis generalizes these findings in several ways. First, we focus on the endogenous choice of plans between internal and external management, as well as active versus passive management. Our results account for selection effects in a plan's choice to employ internal (or active) management, which has a significant impact on the magnitude of the size effect on plans' choice of investment management mandate. Second, exploiting the sub-asset class granularity of our data, we document a power-law relation between size and investment management costs which indicates economies of scale in all asset classes, not just private equity. We further show that economies of scale in costs differ significantly across passive and active mandates while they are similar for internally and externally managed accounts. Third, relative to Dyck and Pomorski (2011), we have ten more years of data, which allows us to explore the time-trend of management choices that crucially depend on the growth in scale of DB plans relative to the markets in which they invest, as well as time-series changes in the fixed costs required to set up internal management.

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 A. Section 3 develops a set of hypotheses that we set out to test empirically in the subsequent analysis. Section 4 covers internal versus external and active versus passive investment management decisions. Section 5 provides a detailed analysis of the cost data, and Section 6 analyzes gross and net-of-cost return performance and how it relates to plans' management mandate. Section 7 concludes.

2 Data and Summary Statistics

In this section, we introduce our data set and provide summary statistics on its coverage of pension plans, as well as plans' asset allocation decisions, management costs, and investment performance. A key advantage of this data set is its highly detailed fee/cost data by sub-asset class, active vs. passive mandates, and internal vs. external management. Such granular data allow us to implement very precise hypothesis tests in several important investment dimensions, as we describe further in Section 3.

2.1 Data Source

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. 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.

CEM plan surveys in the U.S. and the U.K. are primarily collected from defined benefit (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 et al., 2010).[9] 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 \$9.04 trillion, with U.S. plans accounting for \$3.81 trillion, and non-U.S. plans holding the remaining \$5.23 trillion (using 2019 exchange rates). Further details on the CEM database, and the mechanism used to collect data from plans, are contained in the Appendix.[10]

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.[11]

2.2 Variables

The CEM survey collects data on four categories of variables: (i) total plan assets (AUM), as well as plan AUM within six major asset classes (and their corresponding sub-asset classes, e.g., small-cap U.S.

[9]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 fill out.

[10]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/

[11]Details are provided in Appendix Table D.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.

equities), namely: stocks, fixed income, hedge funds and multi-asset class (joint), private equity, private debt, and real assets; (ii) management structures, including whether assets are managed internally or externally, and whether the investment mandate is passive or active; (iii) management fees (AUM-based as well as performance-related) within sub-asset classes; and (iv) asset returns within sub-asset classes, measured both gross and net of fees.[12] A full list of variables is contained in Appendix A.2 – D. To help identify important trends and economic mechanisms at work, we next provide a brief overview of the time-series evolution in the four categories of variables.

2.3 Assets Under Management and Portfolio Allocations

Figure 1 shows the proportion of investments allocated to each of the six major asset classes for U.S. (top panel) and non-U.S. (bottom panel) plans. For U.S. plans, the average plan allocation to public equities (stocks) varies between 50 and 60% from the beginning of our sample (1991) until the Global Financial Crisis (2007-2008), after which it drops below 50% of portfolio holdings. Initially, U.S. plans allocate chiefly between stocks and bonds, but they increasingly allocate to alternative asset classes by the end of our sample (2019)—from less than 8% in 1991 to almost 28% in 2019. Non-U.S. plans show a similar pattern of asset allocation over time, albeit with lower levels of stocks relative to other asset classes, as compared to U.S. plans.

Even larger shifts have taken place during our sample period in the sub-asset classes that comprise the six main asset classes. Consider how mandates for U.S. plans have changed for allocations to public-equity subclasses. Figure 2a shows that the allocation to broad-based U.S. stock strategies (U.S. Broad/All) was 86% at the beginning of our sample, dropping to 18% by 2019. In turn, U.S. plans allocated more to international stock strategies, such as ACWI ex U.S., EAFE, emerging markets, and global (12% in 1991 versus 58% in 2019), and allocated more to specialized market capitalization strategies (small, medium and large cap stocks). For fixed income, while the "broad U.S." mandate comprised nearly 90% of total AUM in 1991, it accounts for less than half in 2019, being replaced by categories such as high yield, global, inflation indexed, and long bonds (Figure 2b). Allocations between alternative sub-asset classes also show substantial variation, with a trend toward greater allocations to hedge funds (Figure 2c), LBOs (Figure 2d), private credit (Figure 2e), and natural resources and infrastructure (Figure 2f).

To summarize, the pension plans in our database show a decided trend toward less liquid asset classes and sub-asset classes, as well as toward more specialized (i.e., more narrow) sub-asset classes over time.

[12] 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 D.4.

2.4 Investment Management Internalization and Mandate Choice

As described in further detail in the Appendix, the CEM data contains detailed information on plan management structures, i.e., a measurement of the percentage of the total AUM, for each plan, that is managed internally (I) or externally (E), and—within internal and external management, the AUM dedicated to active (A) vs. passive (P) management—giving us precise fee and asset allocation information for four different investment mandates, that is, IA, IP, EA, and EP. Because total plan AUM is an important determinant of the allocation to these four mandate types, as shown previously, we separately present results for small vs. large pension plans, defined as plans below the 30th and above the 70th percentile of the total plan AUM distribution, each year, respectively. For these left- and right-tail sets of plans, Figure 3 shows bar charts for the fraction of assets by management mandate within a given asset class in 2009 and 2019.[13] We present results for the three asset classes (stocks, fixed income, and real assets) that have all four management mandates (IP, EP, IA, EA); that is, passive investment mandates are not offered for the three remaining alternative asset classes (private debt, private equity, and hedge funds).

Large plans manage a far bigger fraction of their assets internally than externally, as compared to small plans, both for actively and passively managed assets, and particularly in publicly-traded fixed income and stocks. These are the two asset classes for which we would expect the lowest frictions of setting up internal asset management, i.e., they have the lowest fixed internal management costs as well as variable/operating costs. External active management accounts for a very large proportion of all investment mandates for small plans, with close to three-quarters of small plan assets being managed in this manner. In sharp contrast, large plans exhibit a much greater tendency to trade off internal vs. external management for stocks, fixed-income, and real assets.

Our granular data allows us to examine plans' deployment of different investment management mandates (defined as the choice between internal vs. external management, as well as the choice between active and passive mandate) at the sub-asset class level. Specifically, using 2019 data, 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.

Several patterns emerge from this table. First, with the partial exception of U.S. Broad and inflation indexed, small plans make almost no use of internal passive management in any of the sub-asset classes. In contrast, large plans manage a sizeable portion of their assets internally and passively across most stock and fixed income sub-asset classes, as well as for commodity and REIT accounts. Second, large plans make far greater use of internal active management than small plans. This holds both in public asset classes and (even more so) for 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%

[13] Similar conclusions are obtained if, instead of 2009, we use 1999 as the initial year.

for small plans. Third, small plans make far greater use of external active investment management than large plans. In particular, large plans allocate less of their holdings to active external management in more liquid sub-asset classes, such as U.S. large cap (16% for large plans versus 37% for small plans).

These differences point to important mechanisms affecting plans' decisions to manage assets internally. Sub-asset classes differ widely in how costly and simple they are to manage. The more specialized subasset classes are harder to recruit in and expose the plan to key man risk if an important manager leaves the plan and cannot be replaced. This is particularly important for small plans with small teams where one person leaving can have a disproportionately negative effect. Thus, the scale of the subasset class matters for the decision to manage assets internally. Coupled with fixed costs of setting up internal management, we would expect smaller plans to engage in internal management far less often than larger plans, consistent with what we see.

2.5 Investment Management Costs

The CEM data set contains uniquely detailed data on the asset management costs incurred by pension plans within different asset classes, as well as within internal versus external and active versus passive mandates and combinations of these mandate dimensions. In the investment management industry, differences in investment management costs and performance fees tend to be far more persistent than differences in (gross) return performance and, thus, have a significant impact on cumulative, multi-year return performance (see, for example, Carhart (1997)). This point is particularly salient to our analysis, since pension plans generally have long investment horizons; i.e., fee differences tend to cumulate more persistently than (pre-fee) return differences. Despite their economic importance, the academic literature on pension plan investment fees and costs and their determinants is relatively sparse.[14]

We measure the aggregate investment management cost in an asset or sub-asset class as the sum of AUM-based fees and performance-related fees and report it as a percentage of AUM within that asset or sub-asset class during a particular year. Further, we scale the median value of this cost by the "grand average" cost averaged across asset classes, plans and years in our data.[15] This generates a new measure of cost, *scaled cost.* which is expressed in percent of the average cost. While this scaling does not show the cost level in bps, it allows us to interpret time trends in management cost as well as compare costs across different asset classes and management mandates.[16,17] Because active and passive management costs tend to be quite different, as are the cost of internal versus external management, we display these costs separately for the four management mandates in Figure 4—which shows the scaled median costs by year for investments in stocks and fixed income across the four management mandates, as well as the

[14] We describe the CEM cost data in further detail in Appendix B.

[15] We use this transformation to preserve confidentiality of cost *levels* as requested by CEM.

[16] For example, a *scaled cost* of 100% implies that the median costs are equal to the average costs in our sample while a value of 50% implies a median cost of half the average cost.

[17] Appendix Table D.8 reports scaled costs by asset class and country-of-domicile for plans for selected years.

cost of internal and external active management for the four alternative asset classes.

First, consider investment management costs for stock holdings (Figures 4a and 4c). For passively managed accounts (Figure 4a), median costs increase over time from around 5% to 8% of average costs when internally managed, yet decline from 18% to 9% of of average costs, when externally managed. Hence, by the end of our sample, the cost of internal and external passive management has essentially converged, suggesting that passive management has increasingly become a "commoditized" investment management service. Active equity management costs are far higher, at just below 22% of average costs for internally managed accounts, and rising from just above 67% to nearly 110% of average costs for externally managed accounts. In this case we do not find any evidence of convergence in costs. We conjecture that part of the reason for this non-convergence is that plans choose to internalize the active management of the least specialized, lower-cost subasset classes (e.g., small cap US stocks) and conversely externalize the high-cost segments (e.g., emerging market stocks) which require more specialized knowledge to manage actively.

External active investment management costs for our sample of institutional pension plan accounts do not display the same systematic downward trend experienced by retail stock accounts over the same period. We conjecture that there are two explanations for the absence of such a trend. First, as we show subsequently, external fund managers generated positive net-of-fee return performance especially for the largest pension plans in our sample, serving to reduce any pressures on funds to lower active management fees. Second, a shift towards high-cost specialized sub-asset classes during our sample (a composition effect) would have mitigated any declines in average investment costs.

For fixed income accounts (Figures 4b and 4d), passive management costs fluctuate around 4% of average costs for internal accounts, while declining from 16% to 9% of average costs for externally managed accounts. As with stocks, the difference in management costs between external and internal passive management declines over our sample period. Once again, active management costs are far higher, averaging 49% of average costs for external fixed income accounts, versus 8% of average costs for internal accounts. And, again, external active fees are durably higher than internal costs.

For private asset classes, passive management mandates either do not exist or, in the few cases where they do (e.g., REIT funds), they comprise a very small fraction of overall investments. We therefore only compare active external to active internal management for these asset classes (Figures 4e-4h). External asset management costs are noticeably higher for all four private asset classes, and remain so throughout our sample. Specifically, fees of externally-managed hedge fund accounts decline from just below 700% of average costs at the beginning of our sample period to 400% of average costs at the end, while internal management costs in this asset class decline from over 330% to 440% of average costs—indicating that pension plans have seen great cost reductions in internalizing hedge fund and multi-asset management. For private equity, external active management fees rise from just under 700% to just under 900% of average costs . In contrast, internal active management costs are much lower, and fluctuate around 67% of average costs. The cost of private debt management rises from 40-90% of average costs in the early years of our sample to over 220% of average costs at the end, as compared to internal management costs which rise modestly to about 40% of average costs per year. As shown in Figure 2, part of this trend in cost can be attributed to shifts from sub-asset classes with low management cost into more specialized (high-cost) sub-asset classes. Finally, real asset fees in externally managed active accounts hover in the range 270-360% of average costs throughout the sample, while internally managed real asset accounts incur a far steadier cost of 20-40% of average costs.

To summarize these results, passively managed assets have become largely commoditized, and plans—specifically large plans—have reduced their costs in this asset class through increasingly internalizing management (as shown in Figure 3). Small plans remain dependent on external passive management, but at lower fees due to the increase in scale economies in passive management—and, thus, the effect on competition in passive investment management. External active management fees have, in general, remained durably higher than internal active management costs, due to an increasing specialization of external active managers and the alpha benefits such specialization brings to pension plans.

3 Empirical Hypotheses

Our paper is chiefly concerned with investment management costs and return performance, as a function of pension plan scale (or, more precisely, as a function of individual plan invested assets within each sub-asset class, e.g., the allocation of CALSTRS to small-cap U.S. equities or to commodities). We seek to understand the role of economies-of-scale in investment costs, with a focus on the fixed costs of investment management for allocations of pension plans, large and small, to active vs. passive management, as well as to internal vs. external management (both active and passive). Fixed costs can include the costs in setting up a management "shop", such as the costs of office space and human capital, both for internal and external management—but, also, the potential search costs of plans in locating skilled active external managers. Such fixed costs, we believe, are key in understanding investment allocations, performance, and investment costs or fees—and their differences—between large and small plans.[18]

That is, a key theme of our paper is the role of fixed-costs of investment management in creating economies-of-scale for pension plans, and the resulting bargaining power that (large) plans possess with their external investment managers. We emphasize the bargaining power that plans retain due to their potential to internally manage investment assets rather than to employ potentially more costly external

[18]Yearly salaries and subscriptions to data sets, as well as office space, can be reasonably considered to be fixed costs (that have little sensitivity to the level of AUM that is managed) that are paid each year and can be discontinued at any time. In this framework, the plan decides, each year, whether to continue paying the fixed cost, or to simply outsource investment management. Search costs can also be considered as fixed costs paid each year, as plans can be expected to expend a search cost every year to estimate the skills of their hired external manager as well as to determine whether more skilled external managers at a comparable fee level.

managers. Accordingly, in this section, we develop testable hypotheses that draw from some key theories of asset management in the presence of scale economies (either positive or negative), as well as uncertainty in active management skills among investors, costly information acquisition by investment managers, and heterogeneity in investors' ability to identify skilled investment managers.

3.1 Theories of Asset Management

A useful starting point for our inquiry is the seminal paper of Berk and Green (2004); BG. In mutual fund markets, BG propose an equilibrium model that starts with the assumption of homogeneous diseconomies-of-scale among funds in their investments in financial markets. Given the implied absence of any differential bargaining power of (atomistic) mutual fund investors in their model, mutual funds—in equilibrium—grow to a size at which their diseconomies result in zero expected net-of-fee alphas.[19]

BG assume the presence of a set of skilled investment managers with the ability to generate abnormal returns (expected "alpha"), subject to decreasing returns-to-scale, as well as an infinite (i.e., "competitive") amount of investment capital. In our setting that includes some very large pension plans, as well as competition for all plans between low-cost passive and high-cost active management, we can expect some deviations from this idealized BG no-frictions equilibrium outcome.

Specifically, the differential bargaining power of individual plans cannot be dismissed, and brings many interesting features to the competitive market for investment managers who cater to such plans.[20] That is, the industrial organization of the market for delegated investment management in the pension fund industry is far more complex than that modeled by BG for the mutual fund industry, with outcomes depending on issues such as the relative bargaining power of plans and managers.[21]

Addressing some of these shortcomings, Gârleanu and Pedersen (2018); GP, develop a general equilibrium model for assets and asset management in the presence of fixed costs that pose a friction for all investors (in our setting, for plan sponsors). The GP model introduces delegated investment management with uninformed and informed managers, where the latter receive a signal that is correlated with returns on a risky asset, as in Grossman and Stiglitz (1980). Importantly, the true manager type (informed vs. uninformed) is unobserved by investors, and a fixed search cost must be paid to help identify skilled

[19]That is, open-end mutual fund managers allow their funds to grow to a size that leaves zero expected alphas, net-of-fees, to rational atomistic investors in their funds—but that maximizes fund manager fee income. So, in BG's setting of a limited number of truly skilled asset managers, all of the expected rents (ex-ante alphas) accrue to investment managers, since the infinite pool of investors (supply of capital) competes away any net-of-fee performance through their inflows to funds rationally inferred to be overseen by skilled managers. All individual investors commonly receive zero (expected) rents, since they are homogeneous and atomistic—and, thus, have no collective bargaining power.

[20]To be clear, BG allow for a very limited role for the fixed costs of active investment managers—i.e., in modeling the decision of such managers to continue operations or to shut down (i.e., the external margin of asset manager choice). In our setting, fixed-costs of investment management, both active and passive, as well as internal vs. external management, are central to the ongoing choices made by pension plans (i.e., the internal margin of asset manager choice). This distinction implies that there exist scale economies—at the plan level—which affect both investment costs and allocations to external vs. internal management, abstracting from the choice of investment managers to discontinue their operations.

[21]Prior papers on pension plan choice of investment managers (and their dismissal) do not focus on the role of plan scale in such manager choice and negotiated fees (see, e.g., Blake et al. (2013), Rossi et al. (2018) and Beath et al. (2022)).

investment managers.[22]

Our setting with pension plans shares some similarities with the GP deviation from the idealized BG setting. Most importantly, there is a wide heterogeneity in the level of assets allocated to different asset classes (and sub-asset classes) across pension plans and, thus, in their ability and willingness to pay the fixed costs of either searching for a skilled external manager or in establishing and maintaining an internal management shop. Large pension plans with billions of dollars to invest and dozens of experienced investment professionals can be expected to be far more capable of scanning the universe of external fund managers and identifying those that are most likely to be informed.[23] In concert, large pension plans will be better able to overcome the fixed costs of setting up an internal management shop. Conversely, small plans will neither have the incentive to undertake costly search, nor to establish 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 (i.e., small plans can be expected to choose the "corner solution" of no internal management).

Another important feature of pension plans is their potential bargaining power with investment managers through the ability to "make-or-buy" their investment management services. This bargaining power, which is enhanced for large pension plans, contrasts with the lack of such power of atomistic uninformed retail investors with their mutual fund managers. We believe that this make-or-buy threat is a central mechanism through which large pension plans generate higher risk-adjusted performance. For instance, several plans manage public equities and fixed income (both actively and passively) through groups set up in their internal organizations, and others (predominantly large plans) manage real assets internally.[24]

It is useful to think of the implications of such bargaining power within a "modified BG model", as applied to the pension plan landscape. Here, a plan faces potential diseconomies-of-scale in pre-fee investment returns, as well as non-trivial fixed costs in setting up an internal management organization.[25] As a result, large plans are more likely to arrange internal management and to extract both lower fees within an asset class and better investment opportunities from external managers to combat these diseconomies-of-scale. Large plans, consequently, are likely to obtain higher net-of-fee alphas

[22]Investors have the option of either investing their money directly (passively) and, thus, forgoing 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 (active vs. passive) as well as to investment alphas and fees.

[23]To be sure, large plans are more likely to have access to the most skilled managers (i.e., bargaining power) due to the greater fee income that they potentially bring, which can compound the advantages that their greater manager search capabilities bring. In this paper, we focus on the bargaining power possessed by large plans due to their enhanced ability to "internalize" investment management, as described below.

[24]As of 2019, 28.9% of plans in the CEM database manage U.S. stocks at least partially through their internal teams, up from 24.3% in 2009. This ability to bring management—either passive or active—"in-house" presents a threat to external managers, bringing increased bargaining power to those plans that can most economically set up internal investment management (which are generally large pension plans).

[25]As mentioned previously, BG allow for fixed costs of investment management in Section II.B of their model. However, in their environment of competitive (atomistic) capital, adding fixed costs only serves to model the non-survival of small mutual funds.

from both their internally managed and externally managed assets, since the fixed costs of both internal management and the search for external skilled managers are of diminishing importance as a function of investment scale.

The BG model assumes decreasing returns to scale in asset management and a perfectly elastic supply of investment capital such that, in equilibrium, managers grow their funds to the point where the marginal return on an extra dollar under management equals the investment fee charged to investors. The BG model does not address the role of cost economies-of-scale, and only models fees as a function of expected manager skills (which are assumed to be drawn from the same distribution, and are independent of mutual fund size). Conversely, an implication of the analysis in GP is that costs (or fess) per dollar of assets under management is decreasing in fund size. If the cost of managing assets, as well as any scale economies, depends on the size of assets under management and varies by investment mandate (passive versus active) and asset class (private versus public assets)—as we document in our empirical analysis—then we should expect to find rich patterns of variation in our data set in return performance, both gross and net of fees—especially along the dimension of plan size. Such cross-sectional variation across plan size may be different for active vs. passive mandates, as well as for different (sub-) asset classes having differing levels of fixed costs of investment. These are the dimensions that we explore in our study.

3.1.1 Economies of Scale

As we have indicated above, a key feature of the pension plan landscape is the widely varying size of plans—ranging from small plans with tens of millions of dollars in AUM to ultra-large plans that oversee hundreds of billions of dollars. For example, the median plan in the CEM database (based on U.S. equity dollar allocations), in 2019, contains U.S. equity investments totalling $1.01 billion, while the 10th and 90th percentile plans oversee $107.0 million and $9.25 billion, respectively. While U.S.-domiciled equity mutual funds exhibit a similar dispersion in size, most investors in mutual funds have a relatively small investment and can be considered "atomistic"—that is, they have an insufficient ownership fraction to incentivize or to empower them to negotiate fees with their fund managers.[26]

Thus, while net-of-fee scale diseconomies may be relatively homogeneous among mutual fund investors, mostly due to their limited negotiating power, such diseconomies can be expected to be much more diverse among pension plans. Small plans might be expected to hold little power to negotiate with their investment managers due to their high fixed costs of search and internal management (per unit of AUM), and, accordingly, may face qualitatively similar net-of-fee diseconomies-of-scale as investors

[26] Among U.S.-domiciled domestic equity mutual funds, the median fund manages $514 million, while funds at the 10th and 90th percentiles, respectively, manage $38.7 million and $6.8 billion, respectively, at the end of December 2020. For comparison, the median amount invested in mutual funds by U.S. households was $200,000 in 2021 (Investment Company Institute, 2021). We recognize that fiduciaries of large defined contribution (DC) plans—some of which hold greater than $1 billion in AUM—might hold some bargaining power with their investment managers (see, for example, Sialm et al. (2015)). However, large DC plans hold levels of AUM that tend to pale in comparison with that of large DB plans.

in mutual funds; in contrast, large plans might use their bulk to reduce diseconomies, or to potentially reverse them and to realize positive scale economies in investment management fees.

3.1.2 Public versus Private Asset Markets

The model of Gârleanu and Pedersen (2018) can be used to compare outcomes in private asset markets, such as real estate and private equity, which display high search and information costs, versus more transparent and lower information-cost asset markets for publicly traded securities, such as stocks and bonds.

Specifically, in asset markets with lower search costs for locating skilled active managers, as well as lower information acquisition costs for such managers, the increased competition among active managers both reduces the average active "alpha" (before fees; i.e., a more efficient investment market), and applies pressure on active managers to reduce fees. In the face of these shrinking fees, we can expect to see more specialization in active management—e.g., actively managed funds that specialize in small-cap equities rather than in a broad-capitalization equity style, or funds that invest in emerging markets rather than in global markets—as an attempt by active managers to protect their fee levels. With these developments, it naturally follows that passive management gains market share, relative to active management when search costs are low and information acquisition is less costly. We should expect these trends to especially occur in developed public market equities and fixed-income.

Conversely, search costs tend to be much higher in the market for managing private assets, as well as less efficient public-market assets, and only investors with the capacity for undertaking a sophisticated search process (i.e., low search costs, relative to AUM) should hire active managers in these markets. Information acquisition costs (paid by active investment managers) also tend to be higher in these markets, and prices are less efficient due to the higher cost of entry and the resulting weaker competition among informed managers. To cover their higher information acquisition fixed costs, investment managers also charge larger fees in private asset markets. In equilibrium, we would expect larger pension plans to be more willing to engage with skilled managers in private markets, in part because of the enhanced ability of large plans to locate skilled managers as well as the negotiating power that large plans possess. That is, the market for private investments can be expected to be much less important for small pension plans.

In turn, informed managers in private asset markets will tend to earn higher fees due to the high fixed-costs of search and internalization by pension plans. Similarly, to compensate investors for the higher cost of searching for managers of private asset classes, we expect to find higher abnormal returns, net of fees in private markets.

Based on this discussion of the key factors determining pension plans' choice of investment management mandate, asset allocation decisions, and investment performance as well as costs, we next set out a set of hypotheses that discipline our subsequent empirical analysis.

3.2 Choice of Investment Management Mandate

Our first hypothesis involves plan size and the corresponding choice of investment management mandate (internal vs. external management, and active vs. passive management). Large plans have greater incentives to develop internal investment management, beyond that of small plans—given the often sizeable fixed costs involved in setting up and operating internal investment teams. Moreover, due to these fixed costs, we expect that large plans will, in general, allocate a greater proportion of assets to internal management within asset classes where their investments are commensurately larger, and for which the cost spread between external and internal management is particularly high.

A second dimension is the choice of active vs. passive management. In the Gârleanu and Pedersen (2018) model, small investors with high manager search costs rationally choose not to pay the fixed cost of searching for a skilled manager and, so, remain uninformed, i.e., invest passively. In contrast, large investors with a higher capacity for searching and more assets to invest optimally choose to search for informed, active managers, as the (fixed) search cost is small relative to the value of their investable assets. An implication of this is that we would expect small plans to invest more of their assets passively compared to large plans which, conversely, are expected to invest a larger portion of their assets actively.

As plans grow in size, they exhaust profitable investment opportunities in the densely populated public equity and fixed income space, and, so, increasingly move into alternative asset classes. Plan size may also affect the available options within each asset class. In particular, larger plans can use their size to negotiate better deals (lower fees, relative to the pre-fee alphas generated) in alternative asset classes that are not as easily attainable for small plans. We expect that this translates into a positive relation between plan size and portfolio allocations to private asset classes and, conversely, a negative relation between plan size and holdings in public stocks and bonds. We summarize these relations between investment choices and plan size in the following hypothesis:

Hypothesis I (Plan size and investment management mandate)**.** *Large pension plans, relative to other plans:*

(i) manage a bigger fraction of their assets internally both in passive and active accounts, and across all asset classes.

(ii) allocate a larger fraction of their portfolios to private asset classes and, correspondingly, a smaller fraction of their portfolios to public assets (stocks, bonds).

Our second hypothesis is related to how investment management costs affect plans' choice of investment management mandate (internal vs. external management as well as active vs. passive management). The investment management mandate is, of course, an important determinant of investment performance. Active investment management is more costly than passive investment, and may not be as easily scalable. However, if investors have the ability to identify the best-performing active managers and have sufficient bargaining power to share at least part of any abnormal returns generated by the manager, this investment management mandate holds the promise of better performance than passive investment management. Conversely, active asset management is not as attractive if active management fees are high and investors have limited ability to search for and to select top-performing managers.

Similarly, internal investment management has the potential to substantially reduce investment costs compared to external investment management. This is particularly true for private asset classes where active asset management fees tend to be very high. Internal asset management also solves the coordination problem associated with delegated asset management across multiple managers and asset classes, see, e.g., van Binsbergen et al. (2012).

Pension plans will optimally choose between internal and external management of assets, and, given the fixed-costs of investment management, external managers will retain market power and their (percent of AUM) fees, particularly if the fixed costs of setting up internal management are large and durable over time—especially for smaller pension plans that find it more costly to overcome the fixed costs of interally managing investments. In particular, external management fees, as well as allocations by pension plans to external managers, in private markets will remain significantly higher than those in public markets over time—even for large plans—given that internal fixed costs may be durably higher in private market investing for a similar level of pre-cost "alpha".

We summarize this discussion in our second hypothesis:

Hypothesis II (Costs and choice of investment management mandate)**.** *Investment management costs are a significant determinant of plans' choice of investment management mandates. Specifically, across all asset classes:*

(i) a larger spread between the cost of external and internal investment management leads plans to manage a greater fraction of their assets internally.

(ii) a larger spread between the costs of active and passive management leads plans to allocate more to passive management. Within an asset class, we expect this spread to be much larger for small pension plans.

Competition in the market for managing public equity and fixed income assets is fierce, as the market ecosphere for these assets is mature. This competition has brought down management fees considerably over time, and has reduced the spread in fees being charged. Higher management fees in these asset classes are, therefore, likely to be associated with a bigger outflow toward other managers and/or other management structures or asset classes. In contrast, management of alternative asset classes typically requires more specialized skills and these markets are not nearly as mature. We would therefore expect plans' allocation to publicly traded assets such as stocks and fixed income to be more sensitive to costs than their allocation to private asset classes.

We would also expect fees for managing public assets to be lower than fees for managing private assets. The model proposed by Gârleanu and Pedersen (2018) implies that active management fees should be larger in markets with high information acquisition costs (for the manager) and high search costs (for plans) and depend on the bargaining power of investors and managers.

Hypothesis III (Investment management costs and asset allocation.)**.**

(i) Plans' allocations to publicly traded asset classes such as stocks and fixed income are more sensitive to costs than that of their allocation to private (alternative) asset classes.

(ii) External managers are able to charge higher fees and retain a higher asset allocation share for private asset classes than for public assets.

3.3 Scale economies in investment management costs

Economies of scale play an important role in many areas of economics and are also likely to matter in investment management since many types of costs (e.g., legal, data, computing) are either fixed or do not grow in proportion with the asset under management. This suggests that there should be an inverse relation between a plan's holdings in a given asset and the average costs of managing it, i.e., bigger plans incur lower costs and fees per dollar invested than smaller plans. Still, larger plans will incur greater costs due to their need to hire more personnel and the greater transaction costs associated with trading bigger lots. Investment management costs are also likely to depend on how labor-intensive investments are which will depend on the liquidity and transparency of the asset class.

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 follow a power law as a function of AUM:[27]

$$\text{Cost} \propto \text{AUM}^{\beta}. \tag{3.1}$$

Power law coefficients $\beta < 1$ are consistent with economies of scale in investment management costs, and the smaller is β, 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

[27]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.

scale for public asset classes such as stocks and fixed income (β^{public}) that are traded in transparent 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.

How investment management costs scale is also likely to be tightly linked to management mandate, so we analyze the cost-size relation at the asset class level for the four different mandates (s), namely Internal Passive (IP), Internal Active (IA), External Passive (EP), and External Active (EA).[28]

Passive investment management has largely become commoditized in a way that facilitates scaling more easily than the labor intensive active investment management process. 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 internal and external management to co-exist in a given asset class and to match the empirical observation that that not all plans exclusively manage their assets internally nor externally, the economies-of-scale parameters of the two management mandates must be the same, which is our fourth cost-scale hypothesis. This hypothesis must hold in an equilibrium in which pension plans optimally choose whether to use internal or external investment management in a given asset class.

Hypothesis IV (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, such as public equities and fixed income, than for private asset classes, such as private equity and real assets: $\beta^{public} < \beta^{private}$.

(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* $\beta^{IA} = \beta^{EA}$.

3.4 Investment performance

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

[28]For private assets, we focus on active management mandates only.

Plan size can have both a positive and a negative impact on investment performance. Plan size will impact investment performance net of fees positively if there are sizeable economies-of-scale in the cost of investment management. That is, the existence of significant fixed costs in asset management—especially in active management and in private asset classes—gives large plans a distinct advantage. In particular, large plans have more resources to search for skilled managers and monitor their return performance on a continual basis. They can also be assumed to possess more bargaining power which they can use to negotiate more favorable terms with external managers. Moreover, because large plans are more likely to have internal asset management capabilities, they can use this as a credible "threat" or reservation point in negotiations with external managers.

Conversely, consistent with the BG modeling framework, AUM can have a negative effect on pre-fee (gross) returns as managers with more money to invest run out of ideas. Importantly, though, this mechanism is most relevant at the asset manager level, i.e., for externally managed assets.

In asset classes such as stocks and fixed income, plans can choose between employing active managers at a higher cost versus passive managers at a lower cost. Moreover, manager performance is easily measured and is largely a matter of public record which significantly reduces search costs. To justify their higher fees, active investment managers must generate higher gross returns than passive investment managers. However, if demand for skilled investment managers is perfectly elastic (as assumed in the Berk and Green (2004) model) and pension plans possess no bargaining power, then the informed active managers set their fees so that they fully extract any abnormal returns, leaving net-of-fee abnormal returns that equal zero in expectation:

Hypothesis V (Active management and return performance)**.** *Actively managed investments in public equity and fixed income markets:*

(i) outperform passively managed investments, gross of fees.

(ii) offer the same return performance, net of fees, as passive investments.

An alternative hypothesis is large plans have greater bargaining power and resources to monitor actively managed accounts, pick skilled external managers, and negotiate better deals. Stock and fixed income markets are highly transparent and competitive so it is unclear how feasible it is for even the largest plans to exploit their bargaining power in these markets. We would, therefore, expect higher net-of-fee return performance to predominantly appear in the management of private asset classes which have both the highest cost of information acquisition and pose the greatest challenges for identifying manager talent (higher search costs).[29]

[29] Search and information costs are much higher for assets in private markets. For example, benchmarking return performance—which can be considered a component of search costs—is far more difficult compared to the markets for public assets. The model of Gârleanu and Pedersen (2018) implies that only those investors with the greatest resources will search for skilled managers in these markets.

For example, the model of Gârleanu and Pedersen (2018) is consistent with an equilibrium in which informed managers outperform, net of fees. This, in turn, has implications for the returns earned by investors. Because the largest, most sophisticated investors are better able to identify informed (skilled) managers than smaller investors and have more bargaining power, these investors are expected to earn higher returns than smaller investors, i.e., gross and net-of-fee return performance should both be increasing functions of plan size.

Asset classes matter to this relation because of the large differences in acquiring information and managing investments in public and private asset classes and even within these broad categories. Information costs are generally much higher for private assets such as real estate, private equity, and venture capital. Competition among managers of private assets is also not as fierce as that for public asset classes such as stocks and fixed income which offer passive investment products that help bound how high investment management fees can go.

We summarize this discussion in Hypothesis VI which is an alternative to the earlier Hypothesis V:

Hypothesis VI (Plan size and return performance)**.**

(i) The largest plans earn positive investment returns both before and after fees, i.e., gross and net return performance is an increasing function of plan size.

(ii) Net-of-fee returns are particularly strongly positively related to plan size for private asset classes.

We next set out to test these hypotheses more formally, beginning with plans' choice of investment management styles (Section 4), moving on to investment management costs (Section 5), and finishing with investment performance (Section 6).

4 Investment Management Mandates

This section explores empirically how plan, manager, and asset characteristics such as plan size (AUM), investment management costs, or plan domicile affect plans' choice of investment management mandate, i.e., the extent to which plans manage their assets internally or externally and whether they prefer active or passive investment management mandates.

4.1 Methodology

Our analysis performs a set of regressions that use as our dependent variable the proportion of investments in asset class A, in a given year, t, that is managed by plan i in a certain way, denoted ω_{iAt} and defined in more detail below. For example, ω_{iAt} can denote the proportion of investments in asset class a that are managed internally. We regress this proportion on a set of covariates, x_{iAt}, as well as asset-class and time fixed effects, c_A and λ_{At}:

$$\omega_{iAt} = c_A + \lambda_{At} + \beta_A' x_{iAt} + \epsilon_{iAt}. \tag{4.1}$$

Controlling for sample selection. As discussed in the introduction, in practice internal management involves considerable fixed-cost investments ranging from hiring back-office compliance staff and traders to setting up IT systems and acquiring subscriptions to databases used to determine allocations, as well as hiring highly-skilled investment analysts and portfolio managers. Consistent with such fixed costs, many plans in our dataset, especially smaller ones, choose a zero allocation to internal management. Similarly, it is uncommon for plans or external managers to manage alternative asset classes passively. The panel regression in (4.1) ignores the effect of having a large number of "zeros", as it is designed to estimate how plans choose between different management mandates (internal versus external or passive versus active) at the intensive margin. This effect introduces model misspecification that could be important here because variables such as plan size and management costs are likely to affect both *how much* a particular plan manages, e.g., internally and *whether* the plan manages *any* of its assets internally.

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, which 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. More formally, the regression model we estimate takes the form:

$$\omega_{iAt} = s_{iAt} h^*_{iAt},$$

$$s_{iAt} = 1\left[\gamma' x_{s,iAt} + \varepsilon_{iAt} > 0\right], \tag{4.2a}$$

$$h^*_{iAt} = \exp\left(\lambda_t + \beta' x_{o,iAt} + e_{iAt}\right), \tag{4.2b}$$

where s_{iAt} is a selection indicator that depends on $x_{s,iAt}$ and h^*_{iAt} denotes the choice or outcome variable that depends on $x_{o,iAt}$. If the selection indicator equals zero, the dependent variable ω_{iAt} will also take a value of zero and, hence, lie on the boundary. 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 γ and β are decoupled, the effect of a variable on the selection and outcome equations can also be different.

Assuming that the error terms ε_{iAt} and e_{iAt} in (4.2a) and (4.2b) 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 ω_{iAt} given the variables $x_{s,iAt}, x_{o,iAt}$ is given by

$$\mathbb{E}\left(\omega_{iAt}|x_{s,iAt}, x_{o,iAt}\right) = \Phi\left(\gamma' x_{s,iAt}\right)\exp\left(\beta' x_{o,iAt} + \frac{\sigma^2}{2}\right), \tag{4.3}$$

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 ω_{iAt}, we examine the average partial effect (APE) of x:

$$\text{APE}_x(x_{s,iAt}, x_{o,iAt}; \gamma, \beta) = \left.\frac{\partial \mathbb{E}\left(\omega|x_s, x_o\right)}{\partial x}\right|_{x_s = x_{s,iAt}, x_o = x_{o,iAt}}. \tag{4.4}$$

Since the expectation in (4.3) depends on both the selection and outcome equations, the APE in (4.4) accounts for both the intensive and extensive margin effects of changing x and so depends on both γ and β. Letting $\widehat{\gamma}$ and $\widehat{\beta}$ denote the MLE estimates, we can compute the average sample APE as[30]

$$\widehat{\text{APE}}_x = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\text{APE}_x(x_{s,iAt}, x_{o,iAt}; \widehat{\gamma}, \widehat{\beta}). \tag{4.5}$$

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

4.2 Internal versus External Management

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

Our vector of regressors includes the following variables. First, to capture plan size, we include $\log(\text{AUM}_{it-1})$, the logarithm of the total dollar value of plan i's assets under management (AUM) in year $t-1$.[31] Second, we include the lagged spread in the cost of external versus internal management in asset class A measured in basis points ($\text{CostSpread}_{iAt-1}$). Third, we include a dummy that takes a value of one for non-U.S. plans and is zero otherwise (nonUS_i) and a dummy that takes a value of one for private plans and is zero otherwise (Private_i). Finally, we include asset class fixed effects, c_A, and year fixed effects, λ_{At}:

[30] We compute the parameters in (4.2a) and (4.2b) by maximum likelihood estimation. Specifically, the likelihood function for an individual observation is given by (Wooldridge, 2010, Equation (17.54)):

$$f(\omega_{iAt}|x_{s,iAt}, x_{o,iAt}) = \left[1 - \Phi\left(x_{s,iAt}\gamma\right)\right]^{1(\omega_{iAt}=0)}\left\{\Phi\left(x_{s,iAt}\gamma\right)\phi\left(\frac{\log(\omega_{iAt}) - x_{o,iAt}\beta}{\sigma}\right)\frac{1}{\omega_{iAt}\sigma}\right\}^{1(\omega_{iAt}>0)},$$

where $\phi(\cdot)$ is the pdf of a standard normal distribution.

[31] Plan AUM is typically measured at the end of the year.

$$\omega_{iAt}^{internal} = c_A + \lambda_{At} + \beta_{1,A}\log(\text{AUM})_{it-1} + \beta_{2,A}\text{CostSpread}_{iAt-1} + \beta_{3,A}\text{Private}_i + \beta_{4,A}\text{nonUS}_i + \epsilon_{iAt}. \tag{4.6}$$

4.2.1 Empirical results

Table 2 reports our empirical results. To retain a parsimonious specification for the Cragg estimator, we include only the log-size and cost spread between external and internal in the selection equation (4.2a) whereas in the outcome equation (4.2b) 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. Our estimates of average partial effects are shown in columns to the right of the panel estimates in Table 2.

Across all asset classes, our estimates show that, consistent with Hypothesis I(i), larger plans employ internal management to a significantly greater extent, as compared to smaller plans. For instance, our panel estimates in the top portion of Table 2 indicate that a 10% increase in a plan's stock portfolio is associated with roughly a one percent increase (0.83% and 1.14% for the panel and Cragg estimates, respectively) in the proportion of the plan's stock portfolio that gets managed internally. A 10% increase in a plan's fixed income portfolio is associated with a comparable but slightly bigger (1.1% and 1.77%) increase in the proportion of this portfolio that is internally managed.

For alternative asset classes we continue to see a significant association between investments within an asset class and the proportion of that asset class that is managed internally, but the effects are generally not as strong as for stocks or fixed income, with the exception of private debt.

Our Cragg estimates on log-size are notably larger than the corresponding panel estimates for both stocks and fixed income. The reason for this finding is that plan size tends to increase both the proportion of internally managed assets for those plans already employing internal investment management and also increases the propensity for plans for switching from not managing *any* assets internally to having *some* assets managed internally. This finding highlights the importance of explicitly accounting for selection effects.

Panel B in Table 2 verifies 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 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 & multi assets).

The lower panel in Table 2 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 for each asset class. We keep the cost spread at its average value in these calculations, although 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 12% chance of managing some of their stock portfolio internally. This rises to 33% for plans with medium-sized stock holdings and to nearly 65% for plans in the 90th percentile of the distribution of stock holdings. Hence, large plans are five times more likely to manage some of their stock holdings internally than small plans. Similarly, large plans are approximately three times more likely to manage some of their fixed income holdings internally than small plans (71% versus 28%).

For the private asset classes, the smallest plans almost never manage any assets internally except for real assets (12.13%). Specifically, the Cragg probability estimates vary from 0.52% to 8% for plans located at the 10th percentile of the size distribution of these asset classes. These probability estimates rise notably to between one-tenth (10.79% for hedge funds) to one-half (50.37% for private debt) for the largest plans, i.e., those in the 90th percentile of the asset-class size distribution.

These estimates are consistent with 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 very rare for small plans to manage their alternative assets internally. Our finding that plan size matters more than the proportional cost spread variable on the extensive margin also suggests that AUM matters most to overcoming the hurdle of establishing internal management expertise within an asset class.

Consistent with Hypothesis II(i), the spread in cost between external and internal management is highly significant for the degree to which plans utilize internal management for stocks, and fixed income. For stocks, as the cost spread increases by 100 bps, the proportional allocation to internal management is predicted to increase by 12.2% (15.3%) based on the Cragg (panel) estimates. For fixed income this effect is bigger at 30.3% (23.8%). The estimated coefficients on the cost spread have the wrong sign and fail to be significant for private equity, and private debt. Conversely, the effect is positive for hedge funds and real assets, but insignificant. These findings are all consistent with Hypothesis III.

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. Conversely, for plans that have decided to manage some of their assets internally, the cost spread is important for how large a proportion of their assets they manage internally.

Equation (4.3) shows that the average partial effect is a nonlinear function of the variables. This means that the effect of changing plan size or the cost spread depends on the initial value from which the variable is changed. Specifically, consider the APE when x takes on a value ξ:

$$\widehat{\mathrm{APE}}_x(\xi) = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\mathrm{APE}_x(\widetilde{x}_{s,iAt}, \widetilde{x}_{o,iAt}; \widehat{\gamma}, \widehat{\beta}), \tag{4.7}$$

where $\widetilde{x}_{o,iAt} = [x_{o,iAt} \backslash x_{iAt}, \xi]$ is the vector of variables in the outcome equation with $x_{iAt} = \xi$ and $\widetilde{x}_{s,iAt}$ defined similarly. For example, to calculate the APE when size is set at the 10^{th} percentile, we use (4.7) and set $\log(\mathrm{AUM})_{it-1}$ at its 10^{th} percentile. To examine if this is economically important, we evaluate partial effects at the 10th and 90th percentiles and test if the difference between the two estimates is statistically significant.

Results from this analysis applied to the size and cost spread variables are presented in Panel A of Table 3. For the size variable, the average partial effect is larger by an order of magnitude for the largest plans (90th percentile) than for the smaller ones (10th percentile). For example, going from a plan with a small stock portfolio (10^{th} percentile) to a plan with a large stock portfolio (90^{th} percentile), our estimates suggest that the two plans will increase the proportion of their internally managed stocks by 0.34% and 3.05%, respectively. Moreover, these differences are statistically significant across the public asset classes, and positive for all private asset classes. Hence, big plans are disproportionately more likely to move public assets from external to internal management as they grow larger.

For the cost spread, plans that pay the highest costs (90th percentile) for management of their fixed income are significantly more likely to move assets from external to internal management than are the plans that pay the lowest costs (10th percentile). This makes good sense since the low-cost group has a weaker incentive to switch from external to internal management as they already pay relatively low costs. For the other asset classes, the APE of the cost differential fails to be significant.

4.3 Active versus Passive Management

To formally test Hypothesis I, we next use our framework to examine the determinants of plans' decisions to use active or passive management in different asset classes. Let $\omega_{iAt}^{active} := \mathrm{AUM}_{iAt}^{active}/\mathrm{AUM}_{iAt}$ be the fraction of investments in asset class A that is actively managed by plan i in year t. We use this as our dependent variable in a set of panel regressions

$$\begin{aligned}\omega_{iAt}^{active} = c_A + \lambda_{At} + \beta_{1,A}\log(\mathrm{AUM})_{it-1} \\ + \beta_{2,A}\mathrm{CostSpread}_{iAt-1} + \beta_{3,A}\mathrm{Private}_i + \beta_{4,A}\mathrm{NonUS}_i + \epsilon_{iAt},\end{aligned} \tag{4.8}$$

where $\log(\mathrm{AUM})_{it-1}$ denotes the logarithm of plan i's asset under management in year $t-1$ (*size effect*), $\mathrm{CostSpread}_{iAt-1}$ denotes the basis point spread between the cost of active and passive management in asset class A, $\mathrm{Private}_i$ is a dummy that takes the value of 1 for private plans and zero otherwise, and

NonUS$_i$ is a dummy that takes the value of 1 for non-U.S. plans and zero otherwise. We also include asset class fixed effects, c_A, and time fixed effects, λ_{At}. Because the vast majority of plans do not use passive management in the alternative asset classes, we only have sufficient data to report estimates for stocks, fixed income and real assets.

4.3.1 Results

Table 4 reports estimates from the panel regressions in (4.8) as well as for the Cragg estimator using the same format as in the previous subsection. For stock portfolios, we find that larger plans manage a significantly higher proportion of their stock holdings passively as both the panel and Cragg estimates of the coefficients on log-size are negative and statistically significant. For every 10% increase in plan size, the proportion of stock holdings managed passively increases by about 0.4%. Moreover, consistent with Hypothesis II(ii), a higher spread in the cost of managing stocks actively rather than passively is associated with a large and highly significant negative effect on the proportion of stock holdings managed actively. Specifically, the Cragg estimate suggests that raising this cost spread by 100 bps is associated with a 32% increase in the proportion of plans' stock holdings that are passively managed. Private plans also appear to manage significantly more of their stock portfolios actively than public plans do.

For fixed income holdings, we find some evidence that larger plans manage a slightly higher proportion of their assets actively as the Cragg APE estimate of log-size is significantly positive. However, the effect is small and the panel estimate is insignificant. The Cragg APE estimate on the cost spread is highly significant and negative, suggesting that higher active management costs, measured relative to passive management costs, lead plans to significantly increase the proportion of their passively managed fixed income holdings, again in line with Hypothesis II. A 100 bps increase in this spread is associated with an increase in the proportion of passively managed fixed income holdings of 22%. Public plans domiciled in the US also appear to manage a higher proportion of their fixed income portfolios actively than their public and non-US peers.

For real assets, we find a negative relation between investment size (AUM) and the proportion of actively managed assets, but the estimated effect is very small and insignificant. The estimated effect of the cost spread between active and passive management is essentially zero for panel estimates and is negative and insignificant when estimated with Cragg. Both results reflect that very few plans in our dataset manage real assets passively and, for those that do, predominantly in one sub-asset class, namely REITs.

Trade-offs between the costs and benefits of active versus passive management are likely to differ depending on whether assets are managed internally or externally. To explore if this is indeed the case, the middle and right panels in Table 4 consider active management separately for externally managed (middle panel) and internally managed (right panel) assets.

Beginning with stock holdings, we find that the estimated coefficient on log-size is bigger for external stock allocations than for internal ones. Hence following an increase in stock portfolios, plans reduce the proportion of their actively managed external stock holdings significantly more than they reduce the proportion of their actively managed internal stock holdings. Conversely, an increase in the active-passive cost spread is associated with a much larger decrease in the externally managed stock holdings that are actively managed. This makes sense since external active management fees are far higher than external passive management fees compared to their internal management counterparts and so the cost savings are much bigger for the externally managed accounts.

For fixed income holdings, our estimates show that as plans grow larger, they tend to increase the proportion of their externally managed fixed income holdings that they manage actively more than the proportion of their internally managed fixed income holdings. Moreover, the Cragg APE estimates show that higher cost spreads (active minus passive) are associated with higher allocations to active external management in fixed income, but negatively affects active internal management. However, the APE estimates fail to be significant.

Finally, we consider again the APE estimates evaluated at different percentiles of the size and cost spread distribution. Our estimates are presented in Panel B of Table 3. Most of the differences in APE estimates are statistically insignificant. Interestingly, larger plans (90th percentile) are significantly more likely to move stock investments from internal active management to internal passive management than their smaller peers. Moreover, plans paying the highest costs for active equity management (90th percentile) are more likely to move their stock holdings from active to passive management than are plans paying the lowest costs (10th percentile) - a point that is driven by externally managed holdings.

In summary, our results suggest that as plans grow in AUM, they tend to increasingly manage their stock holdings passively, while we find a much smaller plan-size dependency for fixed income and real asset investments. Furthermore, the largest plans tend to emphasize cost savings more when hiring external equity managers, consistent with their ability to adopt passive stock index strategies.

Table 4 also reports estimates on dummies for whether a plan is private or public and whether a plan resides in the U.S. or outside the U.S.. Our Cragg estimates show that private plans tend to allocate approximately 4.8% more of their stock holdings to active management than their public peers. Similarly, non-U.S. plans manage approximately 4.6% more of their stock holdings actively as compared to U.S. plans, when estimated with panel fixed effects regressions.[32] The opposite result holds for fixed income holdings as non-U.S. plans manage 9.8% less of their fixed income holdings actively than U.S. plans, when estimated with Cragg.

While many plans mix different management mandates at the asset class level (e.g., external active and external passive management of their stock portfolio), in most cases they choose just a single management

[32] This result becomes insignificant for the Cragg estimates.

mandate at the sub-asset class level. In other words, it is common to see asset managers that employ internal passive management for their US Large cap portfolio and external active management of their emerging market stock portfolios, but it is rare to see managers that simultaneous employ different management mandates for their US Large cap portfolio. In the rare cases where plans mix multiple management mandates for a particular sub-asset class, this tends to be done exclusively by the largest plans.

4.4 Asset Allocation Decisions

To examine if plans' asset allocation decisions are consistent with our empirical predictions in Section 3, we conduct a set of panel regressions that use as our dependent variable the weight of asset class A for plan i in year t, $\omega_{iAt} = \text{AUM}_{iAt}/\text{AUM}_{it}$:

$$\begin{aligned}\omega_{iAt} = c_A + \lambda_{At} + \beta_{1,A}\log(\text{AUM}_{it-1}) + \beta_{2,A}\text{Cost}_{iAt-1} \\ + \beta_{3,A}\text{Private}_i + \beta_{4,A}\text{nonUS}_i + \beta_{5,A}\text{LiabilityRetiree}_{it} + \epsilon_{iAt}.\end{aligned} \tag{4.9}$$

The list of regressors is similar to that adopted earlier with two exceptions. First, our cost variable (Cost_{iAt-1}) is now the lagged per-dollar cost for plan i in asset class A measured as a fraction of AUM and denoted in bps. Second, we also control for liability-related effects on asset allocation decisions by including $\text{LiabilityRetiree}_{it-1}$; the fraction of the plan's total liabilities owed to retirees. We do so because plans are likely to consider their liability structure when deciding how much to allocate to asset classes with different risk characteristics. For example, more mature plans may allocate a larger fraction of their portfolio to fixed income.

Estimates of the panel regression in (4.9) are reported in Table 5. Because only a subset of plans report data on liabilities, including this as a covariate results in a substantial decline in sample size. We therefore report results both with (Panel B) and without (Panel A) this variable included.

We find evidence largely consistent with Hypothesis I(ii) as larger plans allocate significantly less of their portfolios to stocks, fixed income, hedge funds, and private debt. Conversely, they allocate a significantly greater share of their investments toward private equity and real assets. These findings hold regardless of whether we estimate our panel regressions on the larger sample (top panel), or on the smaller sample that controls for plan liabilities (bottom panel).[33]

Moreover, our estimates imply economically meaningful effects of plan size on portfolio holdings. Moving from a (small) plan in the 10th percentile of the 2019 size distribution to a (large) plan in the 90th percentile entails a shift in an asset allocation of -8.4% for stocks, -3.5% for fixed income, -7.4% for hedge funds and multi-asset, 1.8% for private equity, -1.6% for private debt and 2.7% for real assets.

[33] Our estimates are also consistent with the findings reported in Dyck and Pomorski (2011).

Investment management costs are also an important driver of plans' asset allocation decisions. We obtain negative and highly significant estimates on the cost variable for five of the six asset classes with the sixth (private debt) being insignificant. Coefficient estimates vary greatly across asset classes; by far the highest estimate is obtained for fixed income (-20.16) and stocks (-7.14) with smaller estimates for hedge funds and multi assets (-1.66) and, in particular, real assets (-0.44) and private equity (-0.10). These results are consistent with our earlier findings on plans' choice of investment management mandate and, consistent with Hypothesis III(i) show that plan decisions on stock and fixed income allocations are far more sensitive to costs than their decisions on alternative asset classes.

The most likely explanation for why plans' allocations to alternative asset classes are less sensitive to costs than their allocations to publicly traded assets is the high level of competitiveness among public asset managers. This allows plans to easily switch managers of public asset classes and so forces the managers to reduce costs. Another possible explanation is that the best managers of alternative asset classes can charge higher fees because they still generate higher alphas which allows them to deliver higher net-of-fee return performance. We test this hypothesis in Section 6.

Turning to the liability variable, a plausible hypothesis is that plans with a higher proportion of retired members will hold portfolios with less exposure to the most volatile assets (stocks) and higher exposure to safer asset classes such as fixed income and private debt, and assets whose values are not marked to market and hence less volatile, including private equity and real assets.

Our estimates in the bottom panel in Table 5 are broadly consistent with this hypothesis. Going from a plan with no retired members to a plan whose members are all retired is associated with a 5% drop in the allocation to stocks, a 3% increase in the allocation to fixed income, a 1.2% increase in the allocation to private equity, and a 2% increase in the allocation to private debt, with all of these effects being statistically significant. In contrast, plans' allocations to hedge funds or real assets are not significantly correlated with the liability measure used in our analysis. While returns on real assets have relatively low volatility, these assets also have low liquidity which can make them less suited to more mature pension plans.

5 Investment Management Costs

Our results so far indicate that plan size plays an important role in determining plans' asset allocation decisions as well as their choice of investment management mandate.

Plan size is likely to also be a key determinant of management costs as larger plans can benefit more from economies of scale and have greater bargaining power with regards to negotiating external management fees. This section therefore sets out to explore the role of plan size as a key determinant of investment management costs across different asset classes and investment management mandates.

Our focus is on how larger plans can use the threat of establishing internal management to establish bargaining power with external managers, particularly in asset classes with relatively low fixed costs of setting up such management.

5.1 Plan-level Costs

We begin by providing a sense of the rich variation in investment management costs across pension plans, asset classes, and management mandates. For the same confidentiality concerns in Section 2.5, we express the bps cost in units of average cost in our sample, referred to as *scaled cost*.

Figure 5 presents box plots with the median and interquartile range of 2019 plan-level costs for the six asset classes and four management mandates represented in our sample, again scaled by the grand-average cost, i.e., costs averaged across asset classes, plans, and time. For stocks and fixed income, the cost ranges are both low and narrow for passively managed accounts (IP and EP). Internal active (IA) management costs are a little higher, on average, than passive management fees and slightly more dispersed among stock and fixed income accounts. Median costs grow notably bigger, and cost ranges wider, for external actively (EA) managed accounts which charge far higher fees than all other account types. We note that this holds across all sub-asset classes and throughout our sample.

All four alternative asset classes have sufficient data on internal active and external active accounts while only real assets have a sufficient number of passively managed accounts to enable us to examine the cost of passive management. For all four alternative asset classes, and consistent with Hypothesis III(ii), the median cost, as well as the interquartile range of costs, is far greater for external actively managed accounts than for internal actively managed accounts. Differences in median costs for external versus internal active accounts are, moreover, far bigger than those found for stock and fixed income accounts, exceeding 3.33 or even 8.89 in the case of private equity.

Examining the real asset class, we find that passively managed accounts charge far lower and more uniform fees than their actively managed counterparts, regardless of whether assets are managed internally or externally.[34]

5.2 Power Law of Investment Costs

Taking logs in the power law equation in (3.1), we obtain a linear relation between the log-cost and log-AUM whose slope measures the economies of scale coefficient, β. To see if this is a suitable characterization of the cost-size relation in our data, Figure 6 provides log-log plots of AUM versus costs for stocks and fixed income portfolios across the four management mandates. These plots suggest that the power law provides an excellent approximation to the cost-size relation. The slope is notably flatter for

[34] Similar plots are obtained for other years in the sample, highlighting the persistence in the heterogeneity of investment management costs.

passively managed portfolios than for active ones consistent with larger economies of scale (lower β) for passive than for active management of both stock and fixed income accounts.

Generalizing the power law relation in (3.1) to allow for additional determinants of costs, in our empirical work we examine the following model

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

where $\text{Cost}^{\$}_{iats}$ (AUM_{iats}) 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, λ_{Ats} is a time fixed effect for asset class A and management style s, Private_i is a dummy equal to one if plan i is private and nonUS_i is a dummy equal to one if plan i is domiciled outside the US. Taking logs in (5.1), we obtain the following panel model which allows us to estimate the power law coefficient, β_{As}:[35]

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

We estimate this model at the sub-asset class level to leverage on the granular data provided by CEM, significantly increasing the sample size compared to using asset class level data. Notice also that we impose homogeneity in the power-law coefficient within each asset class so that information from all sub-asset classes is used to estimate the economies of scale parameter for the associated asset class.[36]

5.3 Results

The top panel in Table 6 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, where we have sufficient data to consider all four management mandates. Across both asset classes and for all four management mandates, our estimates of β are less than unity and, consistent with Hypothesis IV(i), we reject the null hypothesis of no economies of scale $\beta_{1,As} = 1$.

Turning to the importance of investment mandate for scale economies, our estimates of β_{As} are around 0.75 for passively managed stocks and fixed income assets but closer to 0.90 for actively managed accounts in these asset classes. This suggests that economies of scale are higher for passively managed than for actively managed public assets.

Our estimates of the power law coefficients are very similar regardless of whether assets are managed internally or externally. In other words, our power law estimates are more similar for internal passive

[35]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.

[36]In Appendix Table D.7 we present results that allow the power-law coefficient to change by sub-asset class and find evidence consistent with the homogeneity assumption, i.e., scale economies are largely determined by the asset class rather than the subasset class.

and external passive managed accounts and for internal active and external active managed assets than they are for, say, internal passively and internal actively managed assets. The choice of passive versus active management is, thus, far more important to economies of scale than is the decision on whether to manage assets internally or externally.

Our finding that passive management lends itself better to scaling than active management is consistent with consistent with Hypothesis IV(iii) and seems highly plausible. 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 too much. Conversely, active investment management is more labor intensive and more adversely affected by market impact and, thus, more difficult to scale up.

Turning to the four alternative asset classes, passive management is uncommon, so we only report estimates for internal active and external active mandates.[37] Table 6 shows that the estimates of β are generally higher than those obtained for stocks and fixed income, averaging 0.95 and ranging from 0.91 to 1.01. This finding is consistent with Hypothesis IV(ii) and suggests somewhat *lower* scale advantages in unit investment costs for alternative asset classes compared with publicly traded assets, consistent with Hypothesis IV.

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.[38]

We next consider investment management cost differences across private and public and US versus non-US plans. There is evidence that private plans incur higher costs than public plans in internal management of stocks and fixed income assets and also in external active management of stocks. We find very little evidence of notable differences in private and public plans' costs of managing alternative assets internally or externally.

Non-US plans pay significantly higher costs, on average, than US 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-US 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 US peers.

To formally test Hypothesis IV and see if there are statistically significant differences in scale economies between internal/external and passive/active management, we estimate a model that pools observations across the four management mandates s:

[37] For hedge funds and multi assets, there are only 140 observations on internal active management, so we do not report IA estimates for this case.

[38] The only exception is REITS within the real asset class, but again we do not have a sufficient number of data points on this subasset class to conduct a meaningful analysis.

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

where each of the dummy variables Dummy_s equals one if $s \in \{\text{IA, EA, EP}\}$. The fourth investment management mandate (IP) is treated as the benchmark so all effects are measured relative to this case. For example, for internally managed assets $\text{Dummy}_s = 1$ if $s = \text{IA}$ and zero otherwise so this dummy allows us to estimate the differential impact of internal active management on cost relative to the benchmark of internal passive management. We can test the null hypothesis of no scale differences 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 6. 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 IV(iv). Moreover, we cannot reject the null hypothesis that cost economies of scale are identical across internal active and external active mandates for three of five asset classes. The two exceptions to this are fixed income and real assets. For fixed income assets, internal active management is associated with significantly higher scale economies than external active management ($\beta^{\text{IA}} = 0.84$ versus $\beta^{\text{EA}} = 0.94$), while for real assets internal active management has weaker scale economies than external asset management ($\beta^{\text{IA}} = 1.01$ versus $\beta^{\text{EA}} = 0.92$). Hence the empirical evidence is mixed in relation to Hypothesis IV(iv).

Finally, in the bottom row we report p-values for a test of identical economies of scale in passive and active management for stock and fixed income portfolios. We set this up as a one-sided test against the alternative that cost economies are bigger for passively managed than for actively managed accounts. Consistent with Hypothesis IV(iii) we reject the null hypothesis for both stocks and fixed income, which shows 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 of asset management costs vary along three important margins: (i) management mandate (IP, EP, IA, EA); (ii) asset class; and (iii) plan size. To help quantify the economic importance of variation in costs along these margins, the right panel of Table 6 reports management costs for small, medium, and large plans, represented by the 10^{th}, 50^{th}, and 90^{th} percentiles of the (2019) AUM distribution for a given mandate and sub-asset class combination. These columns therefore 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 the publicly traded assets (stocks and fixed income) and also for the private asset classes. Differences are particularly large for private equity for which a median-sized external actively managed portfolio pays 313 bps/year versus only 18 bps/year for an internal actively managed account. These notably higher external active management fees in the private asset classes is consistent with Hypothesis III.

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 the actively managed private asset class portfolios, regardless of whether these are managed internally or externally.

We also estimate (5.2) at the *sub-asset class* level for those sub-asset classes that contain sufficiently many number of observations to allow us to obtain accurate estimates. In Appendix Table D.7, 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 higher (i.e., β estimates lower) for passive management of EAFE and US broad stock mandates and for inflation-indexed bonds. In turn, scale economies are much lower for diversified private equity, real estate, and REIT accounts.

6 Investment performance and Management Structure

We complete our empirical analysis by examining how plans' choice of management structure affects their investment performance. We would expect that the same factors that determine plans' bargaining power when negotiating the fees of external investment management or internal asset management capabilities also influence the ability of plans to identify and get access to the best-performing asset managers.

6.1 Asset Class Returns

Table 7 reports summary statistics for raw returns grouped by asset class. Over our sample, 1991-2019, private equity holdings earned the highest mean return (15.9% per annum), followed by stock holdings (10.8%), real assets (8.4%), and private debt (7.8%). Hedge funds & multi assets (7.1%) and fixed income (7.0%) earned the lowest average sample returns. Volatility estimates, reported in the bottom panel of Table 7, show that private equity is by far the most volatile asset class (22.3% per annum), followed by stocks (16.3%), real assets (11.6%), hedge funds (10.5%) and private debt (9.7%). Fixed income holdings, unsurprisingly, record the lowest volatility (6.9%).

While expected return performance is clearly an important driver of plans' asset allocation decisions, it is by no means the only explanation for the increased importance of alternative asset classes over our sample. The possibility of reducing portfolio-level return volatility by diversifying across asset classes has also been a key determinant of these decisions.

To better understand the extent to which pension plans gained from diversification across asset classes, Panel B in Table 7 reports the average correlation across our six asset classes. Stock returns are positively correlated with returns on all other asset classes and have the lowest correlation with real assets (0.201) and fixed income (0.278) and the highest correlation with hedge funds and multi assets (0.858). Fixed income returns, on the other hand, are negatively correlated with returns on both real assets and private equity, though insignificantly so. The correlation between fixed income returns and returns on hedge funds and multi asset (0.547) or returns on private debt (0.598) is much stronger.

Overall, these correlation estimates are sufficiently low to imply clear diversification benefits from adding alternative asset classes to the plans' public asset holdings, with the possible exception of hedge funds and multi assets whose returns were highly correlated with both stock and fixed income returns during our sample.

6.2 Policy-Adjusted Returns

Our data on pension plan returns spans a relatively long sample period (29 years). However, observations are recorded at the annual frequency and many plans only have a short track record in the CEM database. Traditional risk-adjustment methods which require estimation of return sensitivities to a variety of risk factors are therefore of limited usage here since we cannot hope to accurately estimate individual plans' factor loadings (betas).

To address this limitation, we exploit a unique feature of our data, namely that all plans included in the CEM survey report, for each asset class as well as for their aggregate portfolio, a set of policy or benchmark returns. Policy returns are targets that are carefully established through negotiations between fund managers and plan sponsors. They are used to calculate performance-based fees and so are intended to be realistic benchmarks that are feasible yet difficult to outperform.

Policy returns are typically linked to observable and tradable indexes in a given asset class such as the Russell 3000, or the S&P 500 index for domestic stocks and therefore track annual variation in the underlying market performance. Policy returns in a given year also vary across plans because the specific choice of benchmarks used, as well as their weighting, is plan-specific. For example, a plan might emphasize small caps by assigning a bigger weight to an index that weighs small firms more heavily than, say, the S&P 500 index. The choice of benchmark is less of an issue for stock and fixed income portfolios for which the policy range tends to be quite narrow in most years but is very important for investments in the alternative asset classes whose sub indices are less liquid, more heterogeneous, and difficult to monitor.[39] The policy benchmarks have another key advantage when it comes to assessing plans' investment performance, namely that they reflect the plans' investment objectives. For example, the investment performance of a plan whose manager is tasked with overweighting small caps or tech

[39] Appendix Figure D.9 shows box-and-whisker plots for policy returns across all asset classes in our sample. Ranges are much wider for the alternative asset classes than for stocks and fixed income.

stocks will be measured against a benchmark that weights these types of stocks more heavily. Measuring returns relative to the policy benchmarks therefore implicitly adjusts for risk exposures in a way that does not require estimating any factor loadings and more accurately reflects the objectives and constraints on allocations that the plans' asset managers are operating under. This is an important advantage over conventional regression-based approaches which struggle keeping track of shifts in target weights. This concern is particularly important for the four alternative asset classes for which it is difficult to determine the best benchmarks to use absent more detailed information on plan mandates.

Taking advantage of the existence of these benchmarks, our main analysis uses policy-adjusted returns.[40] Specifically, let r_{iAt} be the return of plan i in asset class A during year t, while r^P_{iAt} is the associated policy return for the same plan, asset class, and time period. The policy-adjusted return, $\widetilde{r}_{iAt}$, is then

$$\widetilde{r}_{iAt} = r_{iAt} - r^P_{iAt}. \tag{6.1}$$

Figure 7 presents box-and-whisker plots of policy-adjusted gross returns at the plan-level for the individual asset classes in our data set. Square boxes span the interquartile ranges with whiskers covering the 5% and 95% of ranked policy-adjusted returns in a given year. The horizontal line inside the boxes represents the median policy-adjusted return.

First consider the performance of stock investments (Panel 7a). For all years in our sample, the median plan's policy-adjusted stock return performance falls within one or two percent of zero. The range of variation in policy-adjusted returns is wider during years with large price movements (e.g., 1999, 2000, and 2009) but becomes markedly narrower after 2010, with 90% of the plans typically earning returns within 4% of the policy target.

Fixed income investments (Panel 7b) show a similar pattern with large spreads in policy-adjusted returns during the Global Financial crisis in 2008 and 2009. For most of the remaining years, 90% of the plans perform within 2-3% of their policy benchmark – an even narrower range than that found for equity returns.

Policy-adjusted return ranges are wider by an order of magnitude for the four alternative asset classes. The policy benchmark seem to be correctly centered, however, and, with a few exceptions, the median fund's risk-adjusted performance is close to zero and the interquartile range includes zero in most years. Once again, policy-adjusted return ranges widen substantially in 2008 and 2009, highlighting the difficulty of accurately assessing the market value of private assets during periods of financial distress. During such periods, it becomes difficult to measure not only the value of individual plans' holdings but also the returns on the underlying benchmarks which often comprise illiquid assets that are not marked-to-market.

40 In subsection 6.4 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.

These results demonstrate two important points. First, policy benchmarks accurately track individual plans' target returns in asset classes such as stocks and fixed income with more than 90% of plans earning returns that generally fall within a margin of 2-4% of the benchmark. Second, market values are harder to establish for the four private asset classes and this introduces measurement errors when calculating abnormal returns. Differentials between plan and policy returns have narrowed considerably after the Global Financial Crisis, however, suggesting that plan sponsors and asset managers have become better at setting policy targets also for these iliquid asset classes.

6.3 Returns and Plan Characteristics

The CEM data is rich on details for the individual plans. These can be exploited to gain insights into how return performance depends on plan characteristics such as (i) the size of the plans' assets under management (AUM), (ii) the proportion of a plan's investments that are managed internally vs. externally, (iii) the proportion of the plan's assets managed actively vs. passively, and (iv) whether the plan is public or private and domiciled inside or outside the U.S.

We examine the relation between these characteristics and investment performance through a set of panel regressions that use policy-adjusted returns as the dependent variable. These regressions are estimated separately for each of our asset classes using plan-year sub-asset class returns as the unit of observation, and thus take the form:

$$\begin{aligned}\widetilde{r}_{iat} = c_a + \lambda_{At} + \beta_{1,A}\log(\text{AUM}_{iAt-1}) + \beta_{2,A}\omega^{External}_{iAt} \\ + \beta_{3,A}\omega^{Active}_{iAt} + \beta_{4,A}\text{Perform}_{iAt} + \beta_{5,A}\text{Private}_i + \beta_{6,A}\text{nonUS}_i + \epsilon_{iat},\end{aligned} \tag{6.2}$$

where $\widetilde{r}_{iat}$ denotes the policy-adjusted gross or net return on plan i's holdings in sub-asset class $a \in A$ in year t and c_a denotes the sub-asset class fixed effect. Although we use returns at the sub-asset class level, we impose that the time fixed effect (λ_{At}) and coefficient estimates (β_A) are the same within a particular asset class, A. The other regressors include: (i) $\log(\text{AUM}_{iAt-1})$, the logarithm of plan i's dollar holdings in asset class A in year $t-1$; (ii) $\omega^{External}_{iAt}$, the proportion of plan i's holdings in asset class A in year t that is externally managed; (iii) ω^{Active}_{iAt}, the proportion of plan i's holdings in asset class A in year t that is actively managed; (iv) Perform_{iAt}, a dummy for whether plan i pays a performance-based management fee in asset class A in year t; (v) Private_i, a dummy for whether a plan is private; (vi) nonUS_i, a dummy for whether plan i is domiciled in the U.S.

6.3.1 Return performance and plan size

Table 8 presents our estimates from regression (6.2) applied separately to gross returns (top panel) and net returns (bottom panel). This allows us to examine whether differences in investment performance are explained by differences across plans in costs and fees. It also allows us to test whether external investment managers adjust their fees to fully capture any abnormal performance they are able to generate as hypothesized by Berk and Green (2004). In this case, we would expect to see alpha estimates that are significantly positive for gross returns but equal to zero for net returns.

First consider the relation between plan size and return performance for the two public asset classes. Large plans fail to generate significantly higher policy-adjusted gross returns for stocks. However, because they pay lower costs than smaller plans, large plans generate significantly higher policy-adjusted net returns than their smaller peers. Specifically, going from a plan ranked in the 10th percentile to a plan ranked in the 90th percentile of the 2019 distribution of plans' stock holdings increases the expected policy-adjusted net returns by 0.37%. For fixed income investments we do not find a significant relation between policy-adjusted gross or net returns and plan size. These findings are largely consistent with Hypothesis V.

For the alternative asset classes, we only find a significantly positive relation between the size of a plan's investments and policy-adjusted gross returns for private equity. Examining policy-adjusted returns net of costs and fees (bottom panel), we see that larger plans deliver significantly better performance for all alternative asset classes, with the exception of private debt.

The size-return relation is particularly strong for private equity investments. Moreover, the coefficients on size are bigger for net returns than for gross returns, consistent with large plans not only earning higher gross returns than smaller plans, but also paying lower management costs. Differences in the performance of large and small plans are economically large. Specifically, going from a plan in the 10th percentile of the 2019 AUM asset class distribution to a plan in the 90th percentile is associated with increases in mean net returns of 1.05% (hedge funds and multi asset), 4.78% (private equity), 0.70% (private debt), and 1.30% (real assets).

Acknowledging that we have fewer data points on the alternative asset classes, We also explore a specification that pools return data across all plans, alternative asset classes and years and imposes homogeneous slope coefficients:

$$\begin{aligned}\widetilde{r}_{iat} = c_a + \lambda_t + \beta_1 \log(\text{AUM}_{iAt-1}) + \beta_2 \omega_{iAt}^{External} \\ + \beta_3 \omega_{iAt}^{Active} + \beta_4 \text{Private}_i + \beta_5 \text{Perform}_{iAt} + \beta_6 \text{nonUS}_i + \epsilon_{iat}.\end{aligned} \tag{6.3}$$

By assuming that the coefficients are the same across alternative asset classes, this specification uses far more data points which can increase the precision of our estimates. Results are shown in the "Alt" column of Table 8. Using this specification, we find a significantly positive relation between plans' log-AUM and policy-adjusted gross and net returns. Again, the coefficient on size is larger for net returns than for gross returns, consistent with some of the higher net returns earned by the largest plans stemming from their ability to better exploit economies of scale and reduce costs. These findings are consistent with Hypothesis VI(i)-(ii).

Given the significantly positive association between policy-adjusted net returns and log-size observed for five out of six asset classes, we would also expect to find a positive and significant association between log-AUM and plans' total portfolio performance. We explore if this relation holds by estimating the following panel model for plan-level total portfolio returns:

$$\widetilde{r}_{it} = \lambda_t + \beta_1 \log(\text{AUM}_{it-1}) + \beta_2 \omega_{it}^{External} + \beta_3 \omega_{it}^{Active} + \beta_4 \text{Private}_i + \beta_5 \text{Perform}_i + \beta_6 \text{nonUS}_i + \epsilon_{it}, \tag{6.4}$$

where $\widetilde{r}_{it}$ is the policy-adjusted return on plan i's total assets in year t, gross or net of costs. The "Total portfolio" column in Table 8 shows that larger plans obtain modestly higher policy-adjusted 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 total-portfolio returns of 0.32% per annum.

6.3.2 Active versus passive management

Table 8 shows that an increase in the proportion of plans' actively managed assets within a given asset class is associated with higher average policy-adjusted gross *and* net returns. Moreover, in the public asset classes, an increase in active management has less effect on return performance net of fees. For stocks, the policy-adjusted return performance is reduced from 53 to 17 bps, and for fixed income the reduction is from 37 to 25 bps, which is both substantial. This finding is consistent with Hypothesis V, even though the effect is still significant net of fees, which contradicts Hypothesis V(ii). Finally, for real assets we fail to find a significant relation between active management and return performance, both gross and net of fees.[41] This finding is inconsistent with Hypothesis V.

At the total portfolio level, switching from all-passive to all-active management is associated with a statistically significant and positive effect of 67 bps/year gross of fees and 27 bps/year net of fees. This suggests that active managers retain more than two-thirds of the amount by which they beat the total portfolio policy benchmark, but also that they do not raise fees by enough to entirely capture the outperformance. Conducting the analysis on the four alternative asset classes, we fail to find a significant coefficient on the active managed portfolio share both gross and net of fees.

6.3.3 External versus internal asset management

In Table 8, we find no significant relation at the asset class level between policy-adjusted net return performance and the fraction of assets managed externally for all asset classes, except private equity. A similar finding holds at the total portfolio level. For private equity investments we find a significantly

[41] Because nearly all assets are managed actively for the hedge fund, private equity and debt portfolios, we cannot estimate the impact on returns from changing the fraction of actively-managed assets for these asset classes.

positive association between external management and policy-adjusted gross and net returns. Moreover, the estimated effect is economically large with a switch from an all-internal to an all-external private equity portfolio estimated to raise mean returns net of costs by 524 bps per annum. While this is a large effect, approximately half of it is countered by the large negative estimate (-261 bps) of the performance-fee dummy since we would expect external active private equity managers to almost always earn a performance-based fee.

6.3.4 Private versus public plans

Our panel regressions include a private-plan dummy which can be used to estimate return differences between public and private plans. We find no significant difference in return performance between public and private plans, with the exception of stock investments (gross of fees). Moreover, the return performance of private versus non-private plans differs in sign and magnitude across the remaining five asset classes. The same conclusion obtains when we estimate the effect of private plans when pooling the alternative asset classes.

At the total portfolio level, private plans earn 12 bps/year gross and net returns above their public peers. While these estimates are statistically significant, they are economically small, suggesting only minor differences in the return performance of public and private plans.

Overall, we conclude that whether a plan is private or public has a modest impact on its policy-adjusted net return performance, especially compared to some of the other plan characteristics such as AUM and choice of active versus passive management.

6.3.5 U.S. versus Non-U.S. plans

Our estimates in Table 8 show that non-U.S. and U.S. plans have similar gross- and net-adjusted return performance in stocks and fixed income. Alternative asset classes may be more segmented, opening up for possible differences in U.S. and non-U.S. managers' investment performance. At the asset class level, we find two cases with significantly different returns. First, non-U.S. plans earn gross and net returns in private equity that exceed those of U.S. plans by more than 200 bps per year. Second non-U.S. plans earn 33 bps per year higher net policy-adjusted returns in real assets than U.S. plans. A more granular analysis reveals that this better performance originates from non-U.S. plans earning significantly higher net returns on real estate ex-REITs.

6.3.6 Performance Fees and Return

A subset of plans in our sample charge performance-related fees. Table 8 shows estimates of how the presence of these fees affects gross and net returns. For stocks, we find that performance fees increase both gross returns (28 bps) and net returns (22 bps) by a significantly positive amount.

Conversely, there is no significant relation between performance fees and gross or net returns for fixed income and real assets. Only for private equity do we find a significant negative association between performance fees and gross and net return performance. However, these estimates are confounded by the large positive estimates on the external manager dummy which largely coincides with the existence of a performance fee for this asset class. Effectively, this means that only the sum of the coefficients on the external manager and performance fee dummies is identified.

6.4 Risk-Adjusted Return Performance

Policy returns constitute a natural benchmark against which to measure individual plans' return performance. However, it is more common to measure investment performance by adjusting for plans' exposure to a small set of pervasive risk factors. Such an approach is not feasible here, however, because most plans have short return records in the CEM database.

As an alternative approach to conducting plan-level risk adjustments, for each asset class, we form equal-weighted portfolios that comprise up to 29 years of annual plan-level returns. We refer to this equal-weighted aggregate return for asset class A in year t as $\bar{r}_{At}$ and use it to estimate the following risk-adjustment regression:

$$\bar{r}_{At} - r_{ft} = \alpha_A + \beta_A' \mathrm{F}_{At} + \epsilon_{At}, \tag{6.5}$$

where r_{ft} is the risk-free rate and F_{At} refers to a set of risk factors used for asset class A. We consider both the Fama and French (1993) three-factor model and the seven-factor model of Fung and Hsieh (2001) which includes the market excess return, a bond trend, currency trend, commodity trend, size spread, bond market and credit spread. The risk factor regressions provide a very good fit particularly for stocks, fixed income, and hedge funds and a somewhat poorer fit for plans' returns in the three remaining alternative asset classes. Appendix D.3 provides further details.

Repeating the earlier analysis from Table 8 on the plan-year risk-adjusted returns, we find results that are broadly in line with those obtained for the policy-adjusted returns. The last four columns in Table 8) shows results for stocks, fixed income, alternative assets and the total portfolio. We find that the largest plans continue to produce significantly higher risk-adjusted returns on the alternative asset classes both on a gross and net of cost basis. Using risk-adjusted returns also leads to higher coefficient estimates on the size variable for fixed income and total portfolio returns.

7 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. Large plans, hence, 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 not translated into 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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	Small Plans (in %)				Large Plans (in %)			
Stocks	IP	EP	IA	EA	IP	EP	IA	EA
ACWI x. US	1.66	27.51		70.82	2.77	31.00	2.77	63.45
EAFE		19.95	1.44	78.62	18.53	14.94	11.99	54.55
Emerg		13.50		86.50	15.02	8.65	13.54	62.79
Glob		24.74	1.14	74.12	15.19	6.00	58.51	20.29
Other					25.74	0.62	26.75	46.90
US Broad	14.17	57.90	2.06	25.87	34.06	32.08	8.55	25.31
US Large Cap		51.88	11.45	36.67	32.05	31.53	20.02	16.40
US Mid Cap		34.60		65.40	27.54	6.15	25.06	41.25
US Small Cap		18.50		81.50	19.66	4.87	13.25	62.22
Fixed Income								
Bundled LDI		1.61	37.56	60.83	28.22	45.20	2.66	23.92
Cash			54.70	45.30				100.00
Convertibles				100.00				100.00
EAFE					86.88			13.12
Emerging				100.00	7.51	6.21	23.91	62.37
Global		0.60		99.40	8.84	0.63	82.76	7.77
High Yield			5.87	94.13		3.59	23.03	73.37
Inflation Indexed	24.63	48.74	9.87	16.77	40.47	11.61	41.33	6.60
Long Bonds	0.32	21.33	5.46	72.88	18.54	0.58	14.46	66.43
Other		14.44	14.54	71.02	72.48	0.88	7.01	19.63
US		13.18	2.75	84.07	6.27	10.37	46.22	37.14
Hedge & multi ass.								
Funded TAA			6.05	93.95			58.27	41.73
Hedge Fund				100.00				100.00
Risk Parity				100.00			28.19	71.81
Private Equity								
Div. Private Eq.			0.08	99.92			18.86	81.14
LBO				100.00			0.27	99.73
Other				100.00			26.81	73.19
Venture Capital				100.00			0.70	99.30
Private Credit								
Mortgages			1.98	98.02			67.24	32.76
Credit			10.49	89.51			31.45	68.55
Real Assets								
Commodities		18.43		81.57	19.70	1.82	58.20	20.28
Infrastructure				100.00			61.39	38.61
Nat. Resource				100.00			46.70	53.30
Other				100.00			28.42	71.58
Real Estate			2.62	97.38			39.67	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 structures: 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: $\omega_{ats} = \frac{\text{AUM}_{ats}}{\text{AUM}_{At}}$, where $\text{AUM}_{ats} = \sum_{i \in k}^{N} \text{AUM}_{iats}$, and $\text{AUM}_{At} = \sum_{i \in k}^{N} \text{AUM}_{iAt}$, where i denotes plan i, a indicates sub-asset class a in asset class A, $t = 2019$, s denotes one of the four management structures and k indicates either small percentile or large plans defined by the bottom and top 30^{th} percentile by AUM respectively. For small and large plans, rows sum up to 100%.

Panel A: Panel and Cragg Estimation

	Stocks		Fixed Income		Hedge & Multi ass.		Private Equity		Private Debt		Real Assets	
	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE
$\log(\text{AUM}_{it-1})$	**8.29**	**11.24**	**10.96**	**17.66**	**0.81**	0.68	**2.34**	**2.32**	**11.25**	**14.31**	**6.80**	**6.40**
	(0.824)	(2.461)	(0.997)	(2.647)	(0.397)	(0.454)	(0.787)	(0.825)	(2.36)	(5.034)	(0.99)	(1.54)
$\text{CostSpread}_{iAt-1}$	**15.25**	12.23	**23.81**	**30.29**	-0.00	0.17	-0.09	-0.23	-0.01	-0.95	1.03	2.66
	(5.245)	(6.946)	(4.784)	(8.660)	(0.189)	(0.420)	(0.061)	(0.240)	(0.087)	(1.729)	(0.623)	(1.576)
Private_i	-0.29	1.65	-3.36	2.36	0.43	-0.89	1.81	3.50	6.54	15.27	0.29	2.21
	(2.067)	(4.260)	(2.845)	(6.810)	(0.851)	(1.377)	(1.535)	(2.906)	(7.181)	(12.758)	(2.469)	(3.204)
NonUS_i	**13.99**	**13.06**	**23.60**	**21.91**	0.74	-0.83	**14.45**	**11.91**	**22.23**	1.88	**27.79**	**17.44**
	(2.097)	(4.596)	(2.759)	(5.387)	(1.232)	(1.196)	(2.512)	(4.490)	(7.275)	(9.156)	(2.964)	(3.814)
Obs	7205	7205	7222	7222	1944	1944	4322	4322	1055	1055	5676	5676
R^2	0.26		0.29		0.06		0.18		0.30		0.24	

Panel B: Cragg Selection Estimates

	Stocks	Fixed Income	Hedge & Multi ass.	Private Equity	Private Debt	Real Assets
$\log(\text{AUM}_{it-1})$	**38.19**	**28.49**	**33.07**	**23.59**	**34.59**	**28.08**
	(4.018)	(3.309)	(8.783)	(5.709)	(8.935)	(4.227)
$\text{CostSpread}_{iAt-1}$	36.77	21.52	**-13.33**	-2.30	-2.32	0.20
	(23.892)	(18.451)	(5.741)	(1.712)	(4.065)	(2.617)
	$\Pr(\omega_{iAt}^{internal} > 0 \mid X = x)$					
Plan size						
10^{th} percentile	12.38	27.68	0.52	5.33	8.42	12.13
50^{th} percentile	33.32	47.96	2.64	12.18	23.57	26.26
90^{th} percentile	64.58	70.87	10.79	25.19	50.37	48.28

Table 2: **Asset allocation regression for internal vs. external management**. Regression of the fraction of internally managed assets over total assets for each asset classes as shown in equation (4.6). For each asset class the regression specification is as follows. We include the log of year t - 1 AUM per sponsor/asset class (Size). We include the cost spread between external and internal at year $t-1$. We include a dummy that equals 1 if the plan is private ($Private_i$), a dummy that equals 1 if the plan is located outside of the U.S.. Lastly, we include time dummies to control for time effects. For each asset class we run two regressions. We run a panel fixed effects controlling for time effects, and we run a hurdle regression with a point mass at 0. We report the average partial (APE) effects of Cragg estimates in columns starting with "Cragg". For cases where a plan is fully internal (external) we impute the external (internal) cost as the median cost for plan that is similar size (small (30^{th} percentile in total AUM), medium (between 10^{th} and 70^{th} percentile in total AUM), or large (70^{th} percentile in total AUM)) in that given year. Robust standard errors are in parenthesis and 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 shows the results for (4.2a). The bottom part of panel B shows the probability of allocating at least some portion of the investments internally. We fix the the cost spread to be the mean cost spread across time and plans, and show the different probabilities based on size. We show the results for three different percentiles of log size in 2019 given a particular asset class: 10^{th}, 50^{th}, and 90^{th}. All coefficients and standard errors are multiplied by 100 for readability purposes.

Panel A: Internal vs. External Management						
	Stocks	Fixed Income	Hedge & multi ass.	Private Equity	Private Debt	Real Asset
log(AUM)						
Percentile: 10	**3.42**	**6.03**	0.42	0.39	**6.18**	**2.43**
	(0.826)	(1.020)	(0.239)	(0.197)	(1.910)	(0.477)
Percentile: 90	**30.5**	**41.70**	0.72	1.65	19.90	**6.16**
	(9.170)	(9.760)	(0.782)	(1.040)	(10.400)	(2.130)
Difference	**27.08**	**35.67**	0.29	1.26	13.72	3.73
Cost Spread						
Percentile: 10	**9.56**	**21.50**	0.19	-0.09	-0.96	**1.33**
	(4.800)	(5.240)	(0.296)	(0.102)	(1.770)	(0.540)
Percentile: 90	12.30	**28.00**	0.15	-0.08	-0.92	1.74
	(7.770)	(8.400)	(0.492)	(0.078)	(1.630)	(0.909)
Difference	2.74	**6.50**	-0.04	0.01	0.04	0.41
Obs	7205	7222	1944	4322	1055	5676

Panel B: Active vs. Passive Management							
	Active Overall			Active External		Active Internal	
	Stocks	Fixed Income	Real Asset	Stocks	Fixed Income	Stocks	Fixed Income
log(AUM)							
Percentile: 10	**-4.58**	2.78	-0.08	**-1.90**	**4.10**	-4.64	2.68
	(0.703)	(1.670)	(0.352)	(0.853)	(1.420)	(4.170)	(5.680)
Percentile: 90	**-4.18**	**2.10**	0.18	-2.01	**2.08**	2.09	2.60
	(1.320)	(0.646)	(0.238)	(1.180)	(0.326)	(3.120)	(2.770)
Difference	0.40	-0.68	0.25	-0.11	-2.02	**6.73**	-0.08
Cost Spread							
Percentile: 10	**-30.10**	**-19.30**	-0.11	**-16.20**	3.37	-13.80	-27.20
	(4.410)	(5.530)	(0.327)	(5.720)	(5.210)	(18.500)	(16.100)
Percentile: 90	**-39.20**	**-25.40**	-0.11	**-19.80**	3.81	-13.30	-29.90
	(8.050)	(9.480)	(0.372)	(8.510)	(5.140)	(17.800)	(19.100)
Difference	**-9.10**	-6.10	-0.01	-3.60	0.44	0.50	0.50
Obs	7206	7210	4395	7051	6637	1851	2762

Table 3: **Significance test for the difference of average partial effects for size and external less internal cost spread (Panel A), and for size and active less passive cost spread (Panel B)**. This table show the average partial effect (4.7) for size ($\log \text{AUM}_{it-1}$) and $\text{CostSpread}_{iAt-1}$. We set $\log(\text{AUM})_{it-1}$ and $\text{CostSpread}_{iAt-1}$ to their 10^{th} and 90^{th} percentile in 2019 respectively. Then, we test if the estimated APEs are equal using a χ^2-test. We report the difference of the calculated APEs. The columns show the calculation for each asset class. All coefficients and standard errors are multiplied by 100 for ease of readability. We compute the standard errors of the computed APEs using the Delta method and standard errors are reported in parenthesis. Boldface coefficients are significant at the 5% level.

	Active Allocation						Active External Allocation				Active Internal Allocation			
	Stocks		Fixed Income		Real Assets		Stocks		Fixed Income		Stocks		Fixed Income	
	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE	Panel	Cragg APE
$\log(\text{AUM}_{it-1})$	**-3.20**	**-4.27**	0.08	**2.45**	-0.11	0.04	-0.70	**-1.79**	**1.29**	**3.52**	-0.72	-0.36	-0.15	2.24
	(0.675)	(0.827)	(0.658)	(1.231)	(0.160)	(0.318)	(0.657)	(0.892)	(0.604)	(1.049)	(2.232)	(3.480)	(1.382)	(3.531)
$\text{CostSpread}_{iAt-1}$	**-20.47**	**-32.87**	**-7.36**	**-22.23**	-0.01	-0.11	-4.51	**-16.29**	6.96	3.44	-2.68	-12.87	-5.99	-24.45
	(4.019)	(5.663)	(3.586)	(9.363)	(0.193)	(0.349)	(4.054)	(6.387)	(4.230)	(5.077)	(3.955)	(17.181)	(13.362)	(14.749)
Private_i	3.13	**4.79**	-1.94	2.01	-0.15	0.18	1.31	2.21	-1.43	3.59	13.60	22.50	-9.66	**-16.88**
	(1.997)	(2.263)	(2.041)	(2.561)	(0.845)	(0.729)	(2.117)	(2.127)	(1.954)	(2.104)	(7.120)	(12.530)	(5.146)	(7.800)
NonUS_i	**4.64**	1.56	**-8.93**	**-9.75**	0.40	**1.47**	**6.55**	0.98	**-8.83**	**-9.55**	**31.96**	**20.37**	1.92	8.63
	(2.098)	(2.227)	(2.139)	(2.678)	(0.739)	(0.664)	(2.108)	(2.138)	(2.064)	(2.178)	(6.141)	(8.309)	(4.622)	(7.321)
Obs	7206	7206	7210	7210	4395	4395	7051	7051	6637	6637	1851	1851	2762	2762
R^2	0.10		0.04		0.01		0.05		0.06		0.15		0.02	

Table 4: **Asset allocation regression for passive vs. active management**. The left panel shows the regression of the fraction of actively managed assets over total assets for stocks, fixed income and real assets as shown in equation (4.8). In the middle panel the dependent variable is active external allocation $\omega^{a,e}_{iAt} = \text{AUM}^{Active,External}_{iAt}/\text{AUM}^{External}_{iAt}$, and for the right panel the dependent variable is defined as the active internal allocation $\omega^{a,i}_{iAt} = \text{AUM}^{Active,Internal}_{iAt}/\text{AUM}^{Internal}_{iAt}$. For each asset class the regression specification is as follows. We include the log of year t - 1 AUM per sponsor/asset class (Size). We include the cost spread between active and passive at year $t-1$. For cases where a plan is fully internal (external) we impute the external (internal) cost as the median cost for plan that is similar size (small (30^{th} percentile in total AUM), medium (between 10^{th} and 70^{th} percentile in total AUM), or large (70^{th} percentile in total AUM)) in that given year. We include a dummy that equals 1 if the plan is private ($Private_i$), a dummy that equals 1 if the plan is located outside of the U.S.. Lastly, we include time dummies to control for time effects. For each asset class we run two regressions. We run a time fixed effects panel regression and we run a hurdle regression with a point a mass at 1. The column heading "Panel" denotes the fixed effects regression estimates. We report the average partial effects (APE) of Cragg estimates in columns starting with "Cragg". Robust standard errors are in parenthesis and clustered by plan. Boldface coefficients are statistically significant at the 5% level. All coefficients and standard errors are multiplied by 100 for readability purposes.

Panel A	Stocks	Fixed Income	Hedge & multi ass.	Private Equity	Private Debt	Real Assets
$\log(\text{AUM}_{it-1})$	**-2.10**	**-0.88**	**-1.85**	**0.44**	**-0.39**	**0.64**
	(0.339)	(0.323)	(0.270)	(0.156)	(0.167)	(0.128)
Cost_{iAt-1}	**-7.14**	**-20.16**	**-1.66**	**-0.10**	0.01	**-0.44**
	(3.112)	(4.350)	(0.429)	(0.029)	(0.011)	(0.096)
Private_i	**-2.92**	**5.88**	-1.72	-0.33	-0.99	**-2.03**
	(0.920)	(0.856)	(0.935)	(0.431)	(0.585)	(0.293)
nonUS_i	**-3.39**	**2.65**	**-3.70**	**-2.09**	0.14	**1.65**
	(0.932)	(0.931)	(0.935)	(0.412)	(0.652)	(0.376)
Obs	7206	7219	2611	4413	1073	5677
R^2	0.24	0.12	0.15	0.20	0.10	0.31
Panel B						
$\log(\text{AUM}_{it-1})$	**-2.53**	-0.65	**-1.84**	**0.59**	**-0.42**	**0.71**
	(0.425)	(0.384)	(0.334)	(0.156)	(0.176)	(0.179)
Cost_{iAt-1}	**-8.96**	**-15.59**	**-1.37**	**-0.09**	0.01	**-0.58**
	(3.556)	(4.301)	(0.466)	(0.027)	(0.010)	(0.123)
Private_i	**-4.50**	**8.70**	-1.73	-0.43	-0.97	**-2.52**
	(1.090)	(0.973)	(1.056)	(0.438)	(0.627)	(0.369)
nonUS_i	**-2.50**	**2.54**	**-4.12**	**-2.19**	-0.03	**1.64**
	(1.214)	(1.162)	(1.121)	(0.405)	(0.680)	(0.488)
$\text{LiabilityRetiree}_{it}$	-5.88	2.71	1.61	1.12	1.95	-0.49
	(3.036)	(3.327)	(2.417)	(1.179)	(1.674)	(1.014)
Obs	4435	4440	1757	2774	782	3499
R^2	0.27	0.16	0.14	0.22	0.11	0.30

Table 5: **Asset allocation regression**. This table reports estimates of the regression (4.9): $\omega_{iAt} = \lambda_{At} + \beta_{1,A}\log(\text{AUM}_{it-1}) + \beta_{2,A}\text{Cost}_{iAt-1} + \beta_{3,A}\text{Private}_i + \beta_{4,A}\text{nonUS}_i + \beta_{5,A}\text{LiabilityRetiree}_{it} + \epsilon_{iAt}$, where ω_{iAt} denotes plan i's proportion of assets allocated to asset class A at time t, λ_{At} denotes the time fixed effect, $\log(\text{AUM}_{it-1})$ denotes the log of plan i's total AUM at time $t-1$, Cost_{iAt-1} denotes the cost (in bps) of plan i in asset class A at time $t-1$, Private_i denotes a dummy variable equal to one if plan i is not a public plan, nonUS_i is a dummy variable equal to one if the plan is domiciled outside the U.S., and $\text{LiabilityRetiree}_{it}$ denotes the fraction of plan i's total liabilities owed to retirees. **Panel A** excludes $\text{LiabilityRetiree}_{it}$ as a regressor. All coefficient estimates and standard errors are multiplied by 100. The robust standard errors are in parenthesis and clustered by plan. Boldface coefficients are statistically significant at the 5 percent level.

	Regression					Size percentile		
	$\log(\text{AUM}_{iats})$	Private_i	nonUS_i	Obs	R^2	10%	50%	90%
Stocks								
IP	**0.76**	0.25	**0.93**	2294	0.70	2.67	1.48	0.85
	(0.037)	(0.157)	(0.120)					
EP	**0.75**	-0.01	**0.24**	11239	0.62	5.39	2.94	1.65
	(0.015)	(0.051)	(0.055)					
IA	**0.89**	**0.46**	0.22	3552	0.70	9.36	7.25	5.62
	(0.027)	(0.167)	(0.148)					
EA	**0.88**	**0.04**	**-0.28**	25799	0.86	62.66	49.98	39.11
	(0.007)	(0.021)	(0.023)					
Fixed Income								
IP	**0.80**	-0.09	**0.39**	1269	0.69	2.94	1.51	1.00
	(0.047)	(0.210)	(0.175)					
EP	**0.79**	0.11	**0.26**	4125	0.63	4.57	2.84	1.92
	(0.024)	(0.071)	(0.074)					
IA	**0.84**	**0.51**	**0.25**	5293	0.72	4.09	2.77	2.03
	(0.021)	(0.124)	(0.103)					
EA	**0.94**	0.00	**-0.18**	17544	0.76	27.75	23.98	20.92
	(0.010)	(0.036)	(0.040)					
Hedge & Multi ass.								
EA	**0.95**	0.09	-0.03	4801	0.78	146.87	133.21	120.66
	(0.018)	(0.062)	(0.064)					
Private Equity								
IA	1.01	0.19	0.37	768	0.78	18.00	18.49	19.02
	(0.035)	(0.215)	(0.241)					
EA	**0.93**	**-0.08**	0.02	8480	0.86	382.93	312.52	268.04
	(0.015)	(0.039)	(0.050)					
Private Debt								
IA	0.95	-0.39	**0.76**	411	0.79	12.25	10.13	8.64
	(0.064)	(0.274)	(0.286)					
EA	0.94	-0.18	**-0.62**	1377	0.75	188.03	165.91	146.75
	(0.036)	(0.147)	(0.139)					
Real Assets								
IA	1.01	0.00	**0.49**	2211	0.74	11.58	11.79	11.98
	(0.032)	(0.138)	(0.135)					
EA	**0.92**	-0.06	-0.07	12117	0.79	161.87	136.15	115.65
	(0.011)	(0.036)	(0.037)					

Hypothesis Testing (p-value)

$\mathcal{H}_0$	Stocks	Fixed Income	Private Equity	Private Debt	Real Assets
$\beta^{\text{IP}} = \beta^{\text{EP}}$	0.90	0.46			
$\beta^{\text{IA}} = \beta^{\text{EA}}$	0.19	**0.00**	0.33	0.79	**0.01**
$\beta^{\text{P}} = \beta^{\text{A}}$	**0.00**	**0.00**			

Table 6: **Economies of scale for cost among different investment mandates**. The *regression* panel of this table shows estimates of the model: $\log(\text{Cost}^{\$}_{iats}) = c_{As} + \lambda_{Ats} + \beta_{1,As}\log(\text{AUM}_{iats}) + \beta_{2,As}\text{Private}_i + \beta_{3,As}\text{nonUS}_i + \varepsilon_{iats}$, where $\text{Cost}^{\$}_{iats}$ is the cost (in dollars) of plan i in sub-asset class a at time t for asset mandate s, c_{As} is a constant that varies with asset class A and mandate s, λ_{Ats} is the time fixed effect for asset style s, $\log(\text{AUM}_{iats})$ is the log of total AUM of plan i in sub-asset class a at time t for style s, Private_i is a dummy equal to one if plan i is private and nonUS_i is a dummy equal to one if plan i is located outside the US. For stock and fixed income, we estimate the panel separately for the following styles 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 covariates are significantly different from zero. Robust standard errors are reported in parenthesis and are clustered by plan. The *size percentile* panel shows $\widehat{\text{Cost}}^{\$}_{iats}/\text{AUM}_{iats}$ 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^{th} and 90^{th} percentile of AUM_{iats} 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 management styles, where boldface indicates a rejection of the null hypothesis.

Panel A: Descriptive Statistics						
	All		Passive		Active	
	Mean	Sharpe	Mean	Sharpe	Mean	Sharpe
Stocks	0.108	0.525	0.100	0.462	0.108	0.502
Fixed Income	0.070	0.671	0.067	0.602	0.065	0.569
Hedge & multi. ass.	0.071	0.544	0.129	1.239	0.068	0.45
Private Equity	0.159	0.624			0.156	0.638
Private Debt	0.077	0.646			0.078	0.559
Real Assets	0.084	0.538	0.054	0.220	0.086	0.533
Panel B: Correlation Matrix						
	Stocks	Fixed Income	Hedge & multi ass.	Private Equity	Private Debt	Real Assets
Stocks	0.163					
Fixed Income	0.278	0.069				
Hedge & multi ass.	**0.858**	**0.547**	0.105			
Private Equity	**0.412**	-0.050	**0.382**	0.223		
Private Debt	0.306	**0.598**	**0.528**	-0.006	0.097	
Real Assets	0.201	-0.161	0.124	**0.528**	0.204	0.116

Table 7: **Summary statistics for asset class returns**. This table reports summary measures for returns on the six asset classes. Panel A presents summary statistics of asset class returns. Mean Returns are computed as the average return of the asset class across years and plan sponsors: $\bar{r}_A = \frac{1}{NT}\sum_t^T \sum_i^N r_{iAt}$. Standard deviations of returns, reported on the diagonal in Panel B, are computed as follows: $\sigma_A = \sqrt{(1/T)\sum_t^T(\bar{r}_{At} - \bar{r}_A)^2}$, where $\bar{r}_{At} = (1/N)\sum_i^N r_{iAt}$. The Sharpe Ratio is computed as the ratio of the mean excess return over the standard deviation of returns. In panel A, summary statistics are reported separately for all plans ("All"), and for passively managed assets ("Passive") and actively managed assets ("Active"). Because all Private Equity and Private Debt assets are actively managed, we do not provide any summary statistics for them in the "Passive" subheading. The asset class "Hedge & multi ass." includes hedge funds and multi-assets, hence also includes passively managed assets. The lower triangle of Panel B presents pairwise correlations between mean returns across aggregate asset classes. The main diagonal presents the standard deviation of each asset class. Boldface coefficients are statistically significant at the 5% level.

	Policy Adjusted Returns								Risk Adjusted Returns			
	Stocks	Fixed income	Hedge & multi ass.	Private equity	Private debt	Real assets	Alt.	Total portfolio	Stocks	Fixed income	Alt.	Total portfolio
Gross												
$\log(\text{AUM}_{iAt-1})$	0.05	0.00	0.11	**0.70**	0.12	0.16	**0.29**	0.04	-0.03	**0.17**	**0.36**	**0.14**
	(0.027)	(0.032)	(0.098)	(0.138)	(0.125)	(0.083)	(0.062)	(0.022)	(0.048)	(0.054)	(0.127)	(0.039)
$\omega_{iAt}^{External}$	0.14	0.02	-0.82	**6.69**	-0.09	-0.24	0.45	0.06	-0.24	**0.55**		-0.02
	(0.148)	(0.112)	(0.683)	(1.630)	(0.392)	(0.437)	(0.365)	(0.111)	(0.286)	(0.236)		(0.249)
ω_{iAt}^{Active}	**0.53**	**0.37**				0.78	0.61	**0.67**	**0.54**	0.33		**0.62**
	(0.084)	(0.092)				(0.622)	(0.639)	(0.133)	(0.216)	(0.333)		(0.270)
Private_i	**0.17**	0.06	0.49	-0.16	-0.34	0.36	0.19	**0.12**	0.16	**1.22**	-0.63	**0.4**
	(0.075)	(0.068)	(0.327)	(0.505)	(0.387)	(0.243)	(0.211)	(0.055)	(0.129)	(0.141)	(0.400)	(0.103)
Perform_{iAt}	**0.28**	**0.33**	**1.68**	-2.27	**1.54**	0.35	**0.83**	**0.28**	0.08	-0.02	1.37	**-0.43**
	(0.110)	(0.162)	(0.525)	(1.343)	(0.675)	(0.334)	(0.300)	(0.083)	(0.141)	(0.235)	(1.490)	(0.210)
nonUS_i	-0.15	-0.17	**-0.65**	**2.28**	0.03	0.10	**0.49**	-0.02				
	(0.097)	(0.100)	(0.323)	(0.563)	(0.417)	(0.252)	(0.220)	(0.065)				
Obs	22879	18064	2762	4985	1016	8819	17582	7204	3897	3721	6298	4907
R^2	0.07	0.05	0.20	0.21	0.17	0.07	0.09	0.20	0	0.02	0.01	0.01
Net												
$\log(\text{AUM}_{iAt-1})$	**0.09**	0.02	**0.25**	**0.95**	0.15	**0.26**	**0.43**	**0.05**	-0.0	**0.19**	**0.46**	**0.16**
	(0.027)	(0.032)	(0.095)	(0.131)	(0.126)	(0.087)	(0.064)	(0.021)	(0.047)	(0.054)	(0.135)	(0.041)
$\omega_{iAt}^{External}$	-0.02	-0.08	-1.06	**5.24**	-0.32	-0.64	0.04	-0.14	-0.43	0.46		-0.23
	(0.150)	(0.113)	(0.670)	(1.608)	(0.383)	(0.435)	(0.354)	(0.107)	(0.292)	(0.233)		(0.255)
ω_{iAt}^{Active}	**0.17**	**0.25**				0.52	0.42	**0.27**	0.18	0.21		0.15
	(0.084)	(0.091)				(0.630)	(0.644)	(0.126)	(0.219)	(0.329)		(0.271)
Private_i	0.14	0.06	0.44	0.27	-0.26	0.46	0.37	**0.12**	0.13	**1.2**	-0.57	**0.37**
	(0.075)	(0.067)	(0.327)	(0.491)	(0.383)	(0.248)	(0.212)	(0.053)	(0.129)	(0.139)	(0.412)	(0.109)
Perform_{iAt}	**0.22**	0.13	0.77	-2.61	0.62	0.24	0.36	0.14	0.04	-0.09	0.42	**-0.85**
	(0.108)	(0.156)	(0.502)	(1.345)	(0.653)	(0.334)	(0.295)	(0.083)	(0.143)	(0.224)	(1.553)	(0.230)
nonUS_i	-0.11	-0.16	-0.62	**2.27**	0.18	0.33	**0.61**	0.10				
	(0.096)	(0.099)	(0.325)	(0.535)	(0.417)	(0.258)	(0.218)	(0.062)				
Obs	22878	18064	2762	4987	1016	8819	17584	7204	3897	3721	6300	4907
R^2	0.06	0.04	0.15	0.19	0.13	0.06	0.06	0.14	0	0.02	0.01	0.01

Table 8: **Regression of policy and risk adjusted returns on plan characteristics**. This table shows estimates of regression (6.2): $\widetilde{r}_{iat} = c_a + \lambda_{At} + \beta_{1,A}\log(\text{AUM}_{iAt-1}) + \beta_{2,A}\omega_{iAt}^{External} + \beta_{3,A}\omega_{iAt}^{Active} + \beta_{4,A}\text{Private}_i + \beta_{5,A}\text{Perform}_{iAt} + \beta_{6,A}\text{nonUS}_i + \epsilon_{iat}$, where $\widetilde{r}_{iat}$ denotes the policy adjusted **gross** (top) and **net** (bottom) return; $\log(\text{AUM}_{iAt-1})$ denotes plan i's total AUM in asset class A at time $t-1$; $\omega_{iAt}^{External}$ denotes the proportion of plan i's holdings in asset class A in year t that is externally managed; ω_{iAt}^{Active} denotes the proportion of plan i's holdings in asset class A in year t that is actively managed; Private_i is a dummy for whether a plan is private; Perform_{iAt} is a dummy for whether plan i pays a performance-based management fee in asset class A in year t; nonUS_i is a dummy for whether plan i is domiciled in the U.S. The first 6 columns denote estimates for the individual asset classes and control for asset- and time fixed effects. The column "Alt." estimates (6.3) and pools 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 (6.4). Portfolios are constructed as weighted averages (by AUM) of asset class investments per sponsor in a given year. The risk adjusted return estimates only include U.S. plans and are only shown for stocks, fixed income, alternative, and total portfolio. Risk adjusted returns are estimated at the asset class level instead of sub-asset class level. Robust standard errors are reported in parentheses and clustered by sponsor. Boldface coefficients are statistically significant at the 5% level.

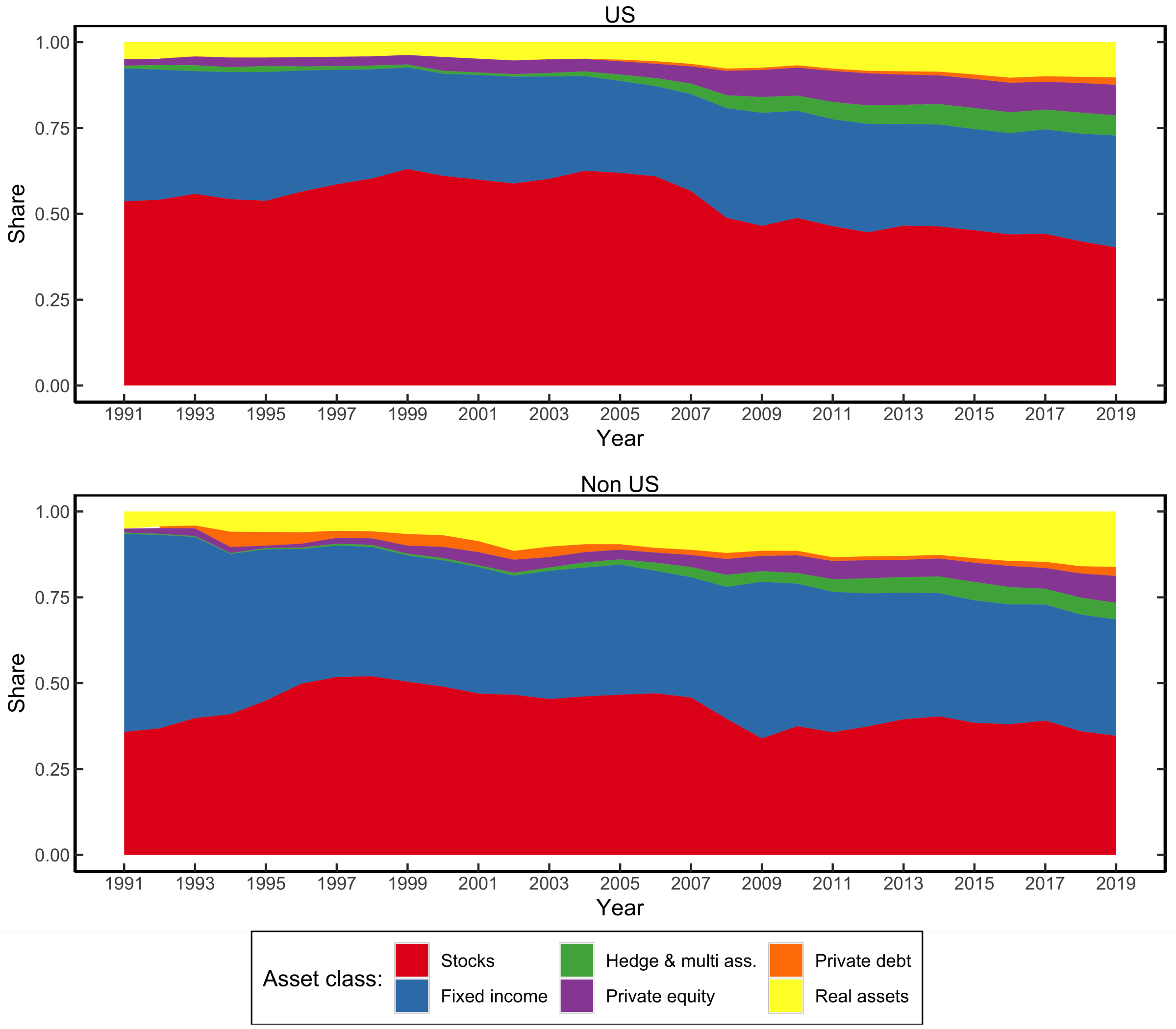


Figure 1: **Asset allocation over time**: This figure shows the share of total AUM dedicated to each of the six asset classes within a year. The shares are reported separately for US plans (top panel) and non US plans (bottom panel).

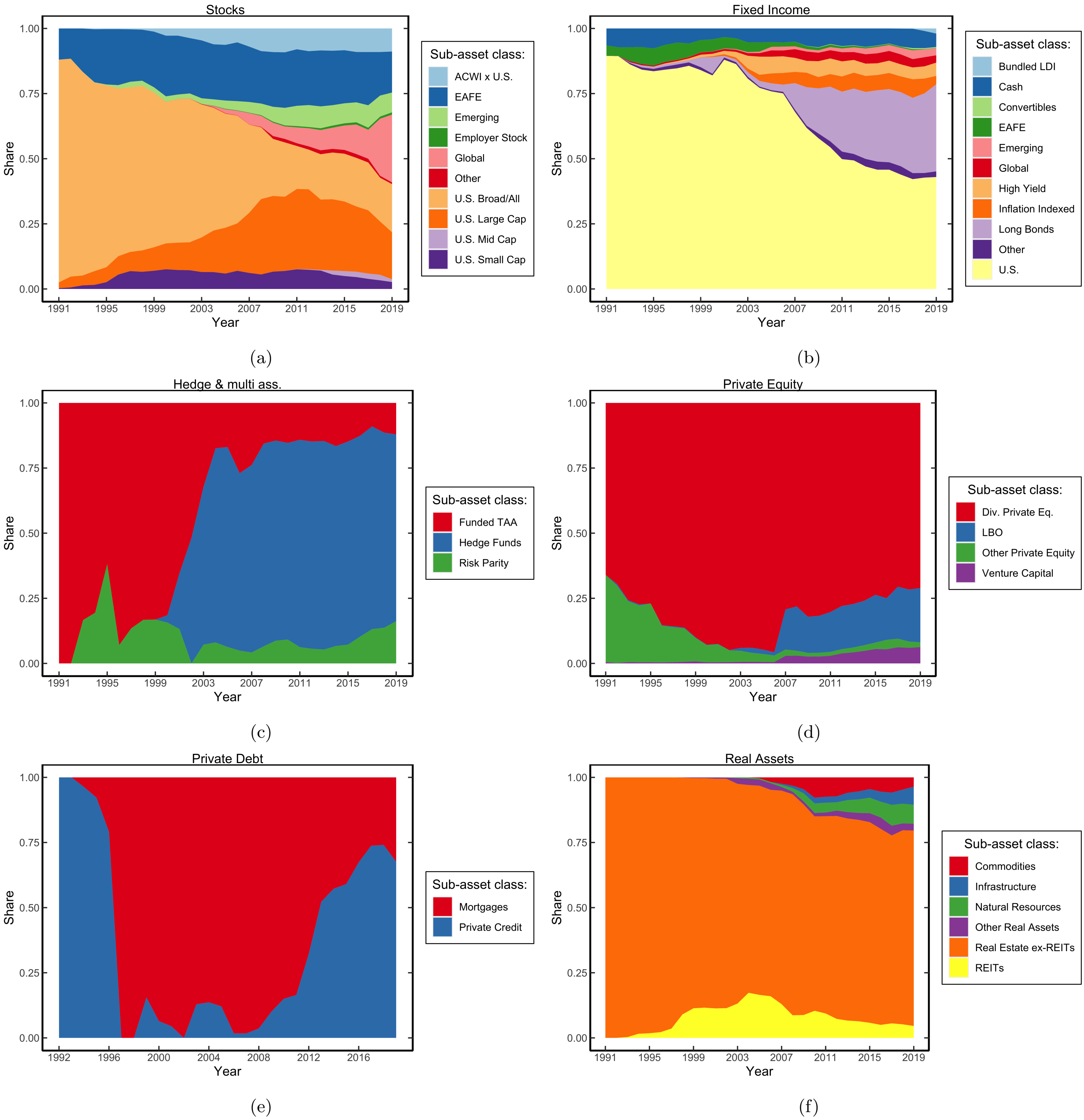


Figure 2: **Sub-asset class allocation over time for U.S. plans.** This figure shows the share of total AUM dedicated to each sub-asset class for a given year and asset class.

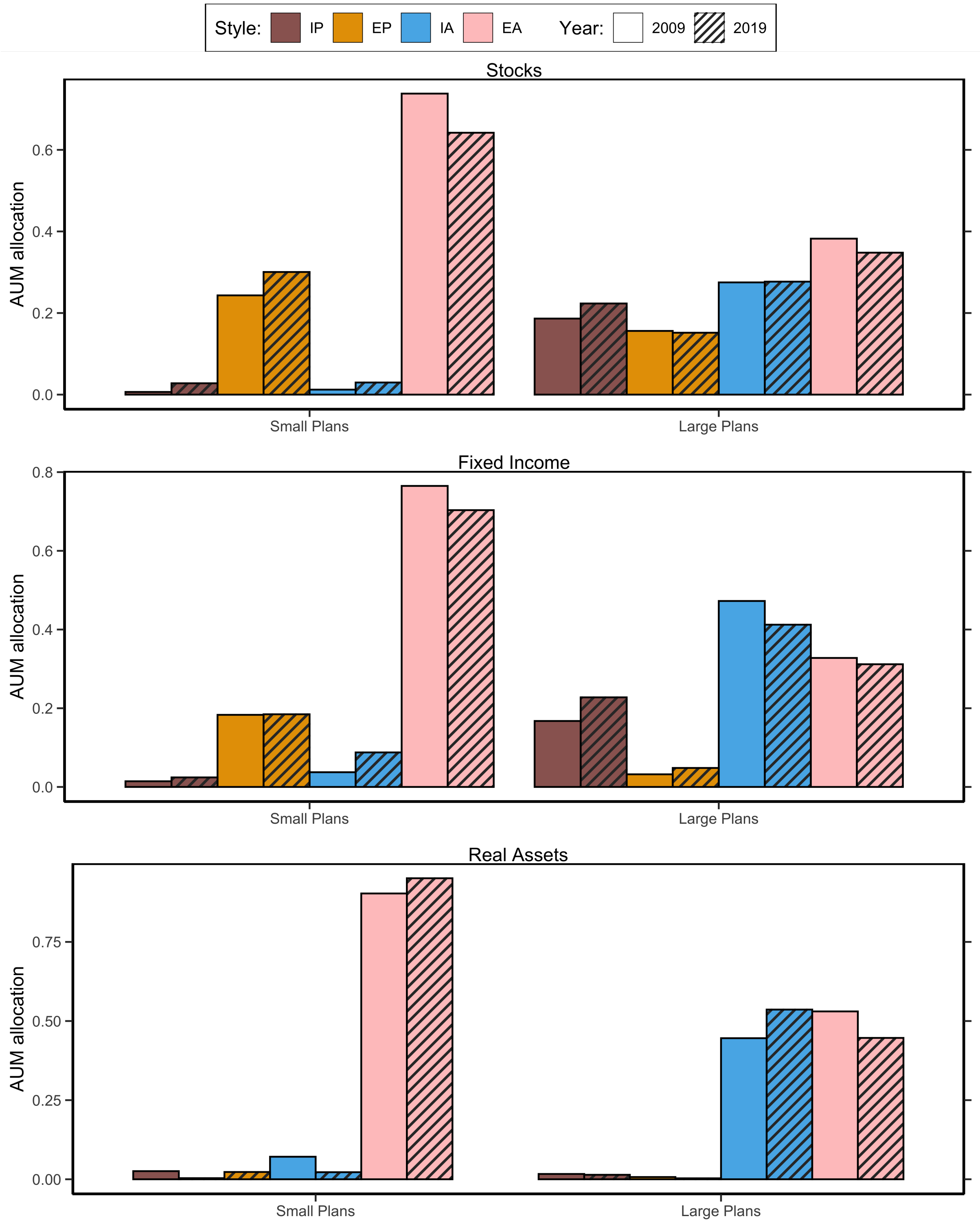


Figure 3: **Asset allocation by management style and plan size.** This figure shows the share of total AUM allocated to the four management styles: Internal Passive (IP), External Passive (EP), Internal Active (IA) and External Active (EA). The shares are calculated for the years 2009 and 2019 for the 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.

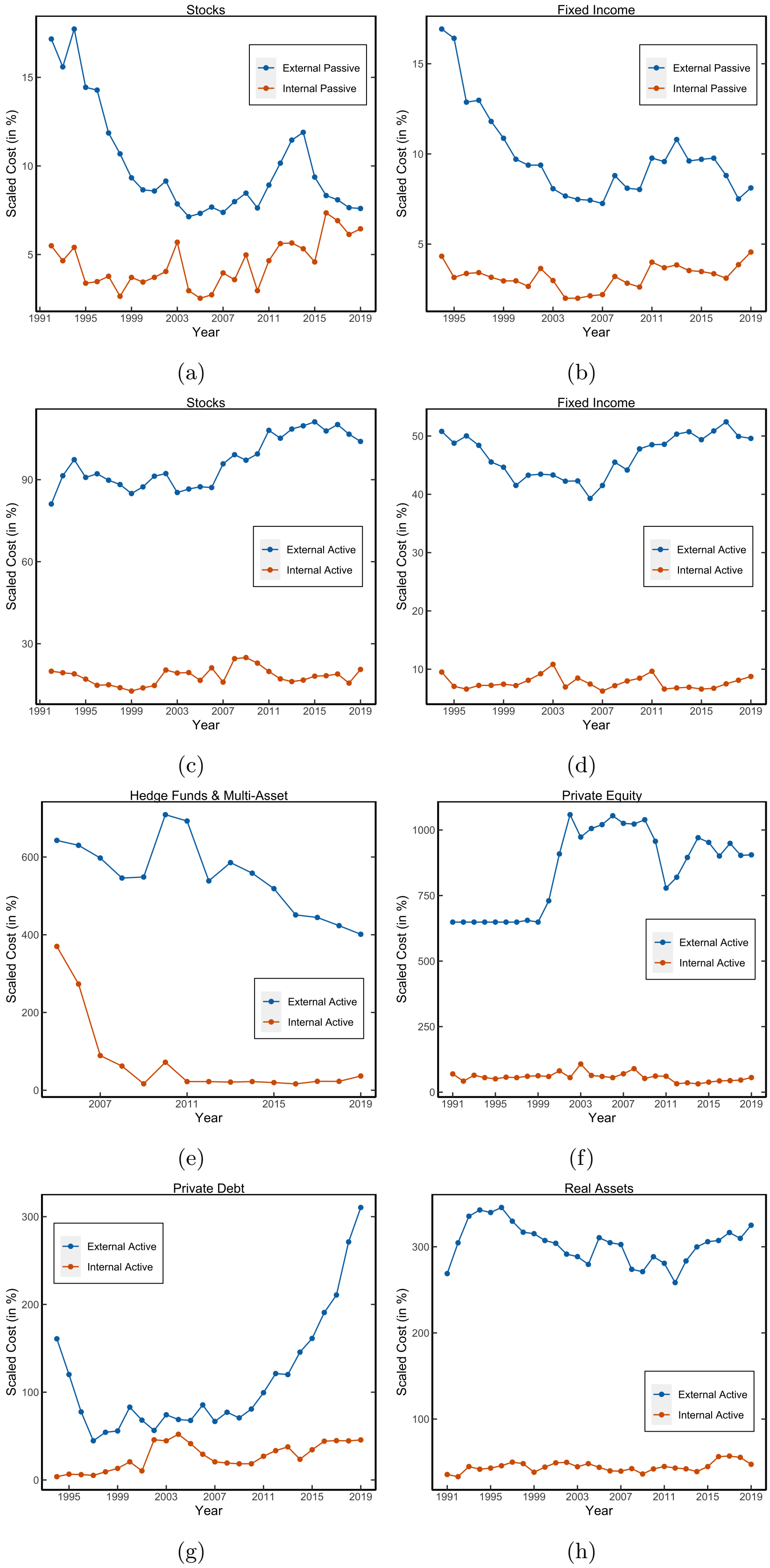


Figure 4: **Median cost by management style**. The figure shows a time series plot of the (scaled) median cost across plans by asset style for a given asset class. The figure only shows active cost for the alternative asset classes, since almost all investments are actively managed in these asset classes. We only present years that have enough plan observations for each asset class and style. Median cost are scaled by the average cost across years and plans.

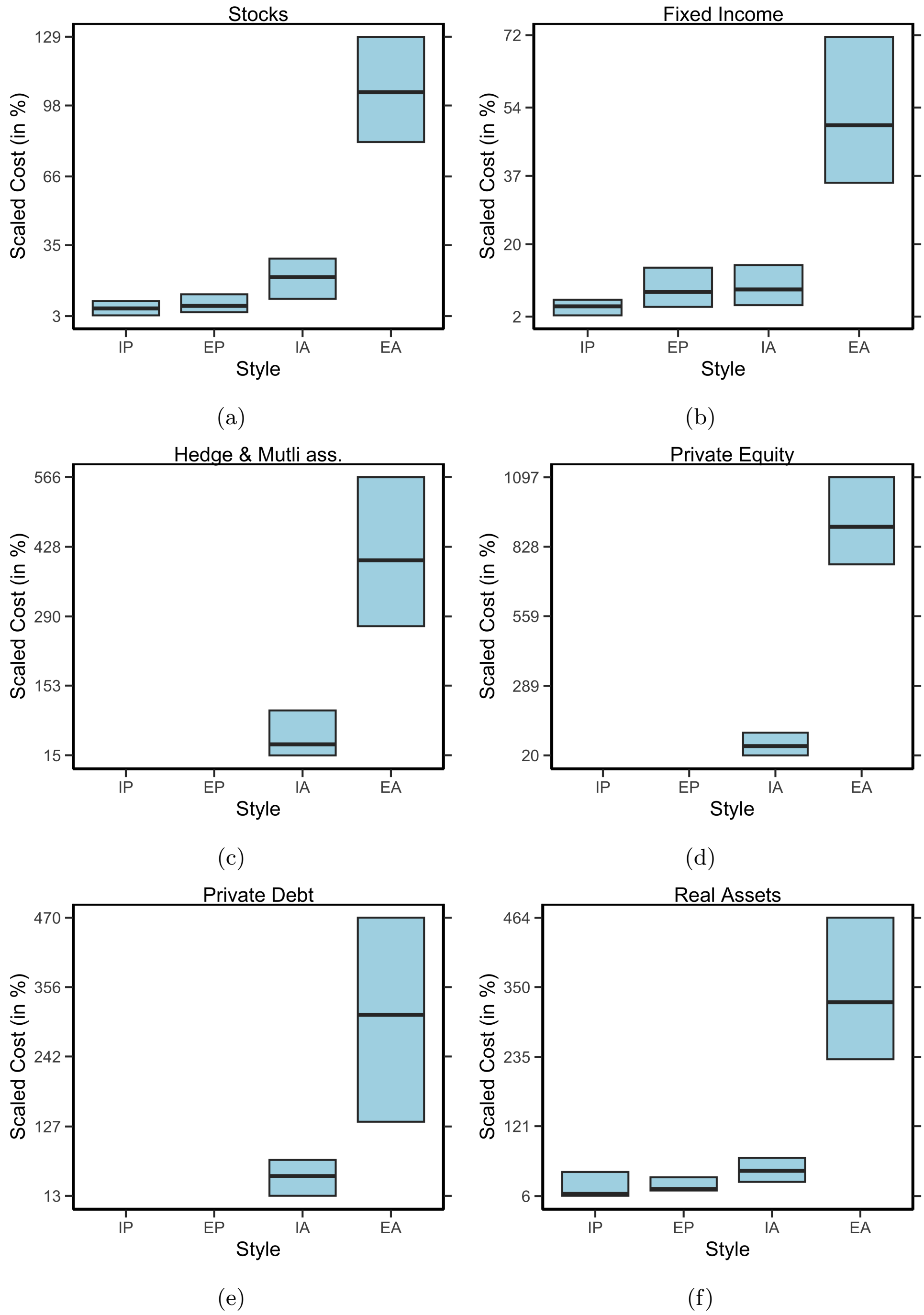
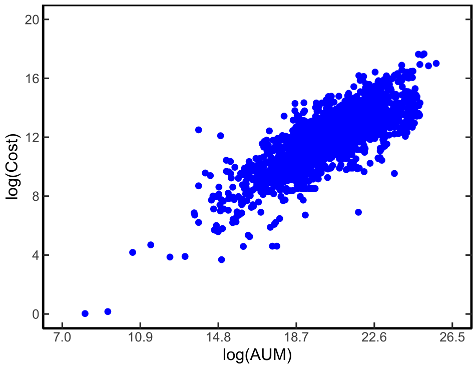
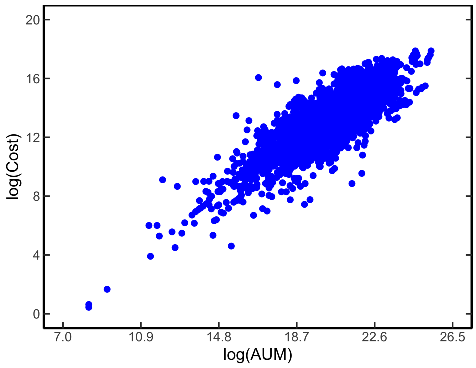


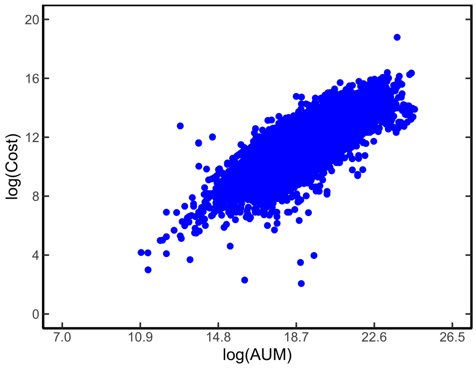
Figure 5: **Cost by management style in 2019.** The figure shows boxplots of scaled cost by management style for different asset classes in 2019. The different type of management styles include: Internal Passive (IP), External Passive (EP), Internal Active (IA) and External Active (EA). For the alternative asset classes we only consider active investments. Cost are scaled by the average cost across years and plans.



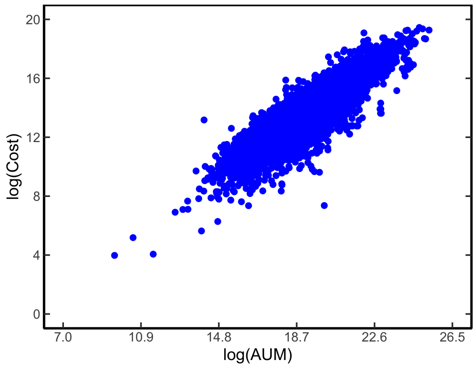
(a) Stocks, Internal Passive



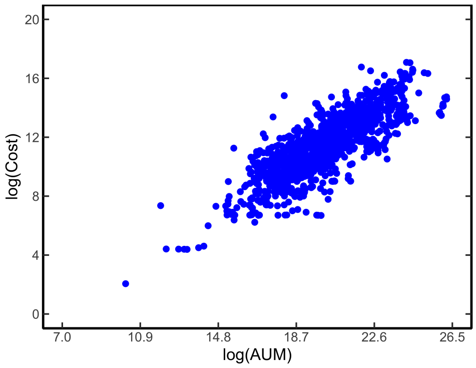
(b) Stocks, Internal Active



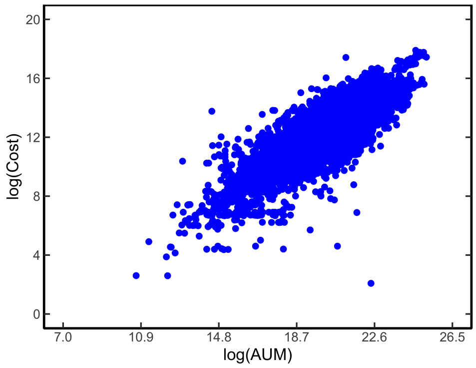
(c) Stocks, External Passive



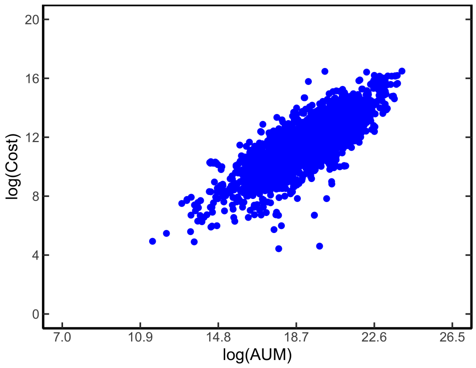
(d) Stocks, External Active



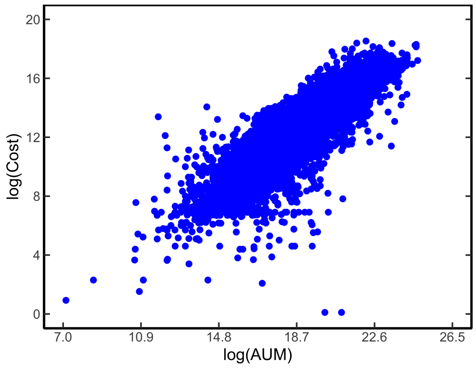
(e) Fixed income, Internal Passive



(f) Fixed income, Internal Active

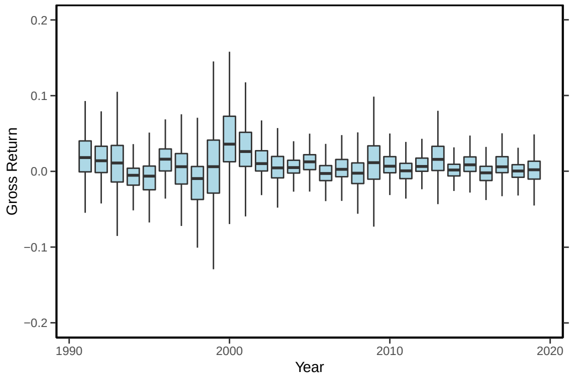


(g) Fixed income, External Passive

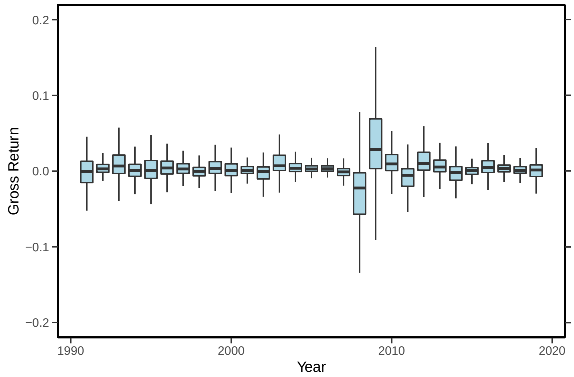


(h) Fixed income, External Active

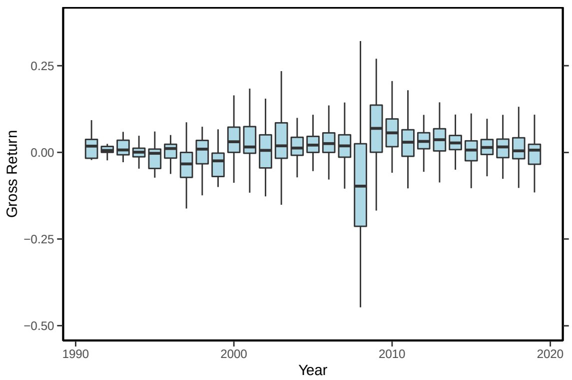
Figure 6: **Relation between log Cost and log AUM**. This figure shows a scatter plot of $\log(\text{AUM}_{iats})$ versus $\log(\text{Cost}^{\$}_{iats})$, where AUM_{iats} (resp. $\text{Cost}^{\$}_{iats}$) denotes the dollar AUM holdings (resp. dollar cost) of plan i in sub-asset class a at time t for implementation style s. For stocks and fixed income the figure shows the following implementation styles: 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.



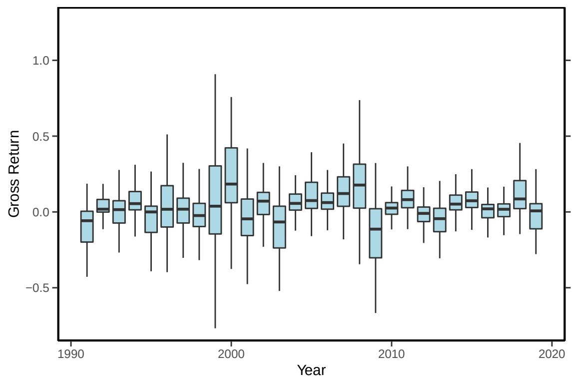
(a) Stocks



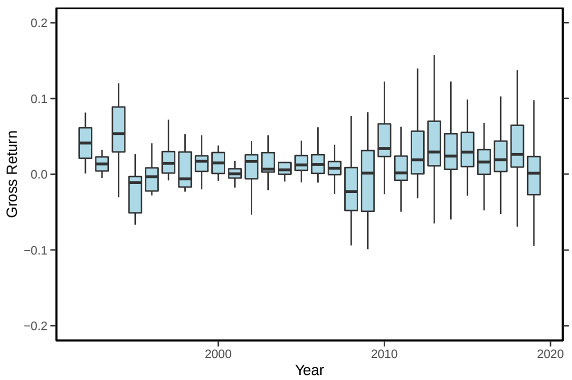
(b) Fixed Income



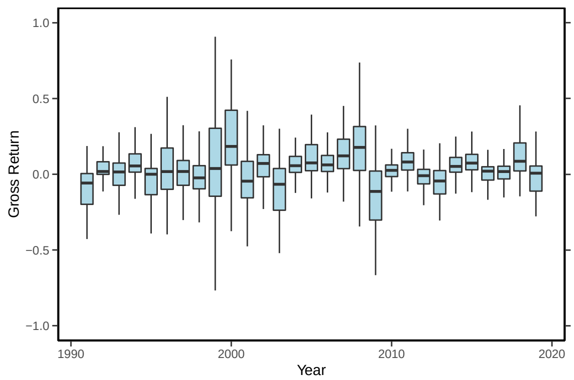
(c) Hedge Fund



(d) Private Equity



(e) Private Debt



(f) Real Assets

Figure 7: **Policy adjusted gross returns**. We show the boxplots of gross returns pooled across plans and year. We adjust gross returns by subtracting the self-declared policy returns.