Is Bigger Better?
Size and Performance in Pension Plan Management

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First draft: May, 2010
This version: July, 2011

Abstract

We document substantial positive scale economies in asset management using a defined benefit pension plan database. The largest plans outperform smaller ones by 43-50 basis points per year. Between a third and one half of these gains arise from cost savings related to internal management, where costs are at least three times lower than under external management. Most of the superior returns come from large plans' increased allocation to alternative investments and realizing greater returns in this asset class. In their private equity and real estate investments large plans have both lower costs and higher gross returns, yielding up to 6% per year improvement in returns. The ability to take advantages of scale depends on plan governance with better governed plans having higher scale economies.

JEL classification: G11, G20, G23.
Keywords: pension funds, investment management, economies of scale, size, alternative assets, private equity

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Market forces constantly push firms toward operating at an appropriate scale. Where such forces are absent, firms can destroy value by operating at a non-optimal scale for extended periods of time. Defined benefit pension plans are a perfect example where such inefficiencies might occur. Their scale is driven largely by the size and age of the workforce and by contractual commitments to the workers. Plan beneficiaries unhappy about performance cannot vote with their feet and move their funds to appropriately scaled plans. Moreover, beneficiaries often have weak incentives to act, as it is unclear whether they will be required to make up for performance losses, or whether losses will be borne by employers or the public more generally.

The potential existence of scale-related inefficiencies in pension plans is a significant issue. The assets in defined benefit plans are substantial on their own, accounting for $14 trillion globally (Watson Wyatt (2008)). In the US for example, these plans control $5.4 trillion or 65% of total pension assets tied to employers, and in many other countries they are the sole source for pension payments.[1] Poor asset management of pension plans has immediate social consequences, reducing the welfare of beneficiaries, organizations, or society more generally, depending on which group bears the costs of inefficient management.

Are there economies or diseconomies of scale in pension plan management? What do larger plans do differently? Do these differences affect performance? Does governance influence the economies of scale?

Because pension plans outsource the vast majority of their portfolios to external managers, in some cases directly to mutual funds, a starting point for predicting the impact of scale on performance at the pension plan level is to consider evidence from the mutual fund literature that we review in Section I.[2] A well-known stylized fact in the fund literature is that

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[1] E.g., in Canada defined benefit plans account for 97% of total occupational pension plan assets ($637 out of $655 billion). These and the US statistics are for 2008 and were obtained from the OECD Pension Statistics Database.

[2] Throughout the paper, we use "plan" to refer to pension plans (pension funds) and "fund" to refer to mutual, hedge, and private equity funds that might manage pension plans' assets.

there are diseconomies of scale arising from more severe price impact of trades, increased capital inflows leading managers to pursue poorer investment ideas, and/or growing hierarchies in an organization that slow down decision making and dampen incentives. These factors predict pension plans should face downward sloping or at best flat returns as a function of their size.

A competing hypothesis is that defined benefit pension plans will exploit their greater degrees of freedom to mitigate or delay the onset of these fund-level diseconomies of scale and, potentially, to find economies of scale. We predict one avenue available to larger plans is to seek cost savings from negotiating power with external managers or from the ability to replace expensive external management with more cost effective internal management (that may be close enough in the ability to generate returns). We further predict that larger plans will exploit their power over resource allocation to shift assets from areas where diseconomies are more likely to areas where they are minimal or where there may even be scale-related benefits in returns.[3] Larger plans, for example, may get preferential access to private equity or real estate deals with attractive return-risk relationship. Successfully developing these two avenues would at a minimum extend the flat region of the relationship between size and performance or possibly even lead to upward sloping performance relationship over certain plan sizes.[4]

To determine whether the diseconomies at the fund level dominate, or alternatively whether plan managers exploit alternative strategies and benefit from these to a sufficient degree to offset fund level diseconomies, we turn to a recently available international dataset of multi-class defined benefit pension plans from CEM Benchmarking Inc. (CEM), a Toronto-based global benchmarking firm. This proprietary database has many advantages for exploring the relationship between scale and performance. The database has a large number of plans, with

[3] Note that such reallocation may be difficult or even impossible at the fund level (see Pollet and Wilson (2008) for mutual fund evidence).

[4] For very large plans even these avenues will inevitably be tempered and offset by organizational and other costs – in other words, a natural monopoly with a single pension plan would not be an optimal outcome. The key question is where existing plans are on the size-performance relationship.

842 separate plans. Appropriate for our research question, the sample is skewed towards the largest plans that have the resources and incentives to pay for the benchmarking service, for example including in 2007 57 of the top 100 plans in the US. In 2008, the plans in the database have about US$6 trillion in assets under management, the US plans account for 40% of US defined benefit assets, Canadian plans capture 65% of Canadian defined benefit assets, and the database covers plans that account for $1.46 trillion in European assets, as well as 11 Australian/New Zealand plans. The database also has a reasonably long period of coverage, with firms reporting to the benchmarking service over the years 1990 to 2008.

We offer four main findings. First and most strikingly, we find increasing returns to scale for pension plans. Bigger is better when it comes to pension plans. Larger plans outperform smaller plans by 43-50 basis points per year in terms of their net abnormal returns, which we define as gross returns minus actual costs minus plan-specific benchmarks for each detailed asset class. This gain is similar in magnitude to the reported benefits of passive management in US equities (French (2008)). The estimates imply that savings of participants in one of the largest plans (the average 5^{th} quintile plan has assets of $33 billion), *ceteris paribus*, would be 13% larger at retirement than savings in a plan with $1B in assets.[5]

What accounts for the positive rather than negative economies of scale? Our second main finding is to isolate and quantify the likelihood and importance of using approaches other than external active management. This is a particular advantage of our dataset as it has detailed information on the use and performance of internal management and on the costs associated with internal and external management for each asset class. Compared to first quintile, the largest quintile plans deploy 39% more of their assets using approaches other than external active management. The use of passive management is perhaps unsurprising as this approach is less size-sensitive. More interesting is that large plans manage 13 times more of their

[5] This calculation assumes a worker who saves the same amount every year for 40 years, and earns the return of 6% (6.50%) per year in the smaller (larger) plan.

active assets internally (2.7% in the 1st quintile versus 35.4% in the 5th quintile). This leads to substantial cost savings. While delivering similar gross returns, external active management is at least 3 times more expensive than internal active management, and in alternatives it is 5 times more expensive. Accounting for greater use of internal management and the performance benefits this brings still leaves more than half of the positive economies of scale to be explained by other factors.

Third, we find that larger plans shift towards asset classes where scale and negotiating power matter most and obtain superior performance in these asset classes. Larger plans devote significantly more assets to alternatives, where costs are high and where there is substantial variation in costs across plans. Our regression estimates suggest that the greatest impact of size comes from the private equity and real estate components of alternatives, where a move from the 1st to the 5th size quintile is associated with 6% and 4% increase in net abnormal returns per annum, respectively. Surprisingly, for both private equity and real estate, we document positive economies of scale in both gross returns and costs. This is consistent with larger plans having access to and taking advantage of co-investment opportunities (i.e. the ability to buy a share of portfolio companies without fees) and/or better ability to identify the better performing private equity funds.

Finally, we present suggestive evidence that plan governance affects performance and the ability to fight scale diseconomies. Long standing concerns about plan governance (e.g., Lakonishok, Shleifer, and Vishny (1992)) are likely greater in the public than in the private sector, particularly where public plans have severe limits on pay for internal managers and where their spending on oversight and board composition has been heavily influenced by politics. Given this, we use as proxies for governance plan corporate status, and (for reasons discussed below) whether the public plan is US or not. We find that stronger governance provides higher returns and a greater ability to take advantage of scale economies.

What are the implications? Our results contribute most directly to the theoretical and empirical literatures that explore scale in asset management (e.g. Chen, Hong, Huang and Kubik (2004)). We identify practices that can delay and in cases even more than offset scale related diseconomies at the fund level, quantifying scale advantages in negotiating costs with external managers, and more importantly the widespread practice amongst larger plans of substituting internal for external management that delivers substantial cost savings. Further, we show the importance of looking at the full range of assets under management to understand scale economies, as the majority of the advantages of scale come from expanding into asset classes like alternatives where scale offers a comparative advantage. These findings are likely to generalize to other larger multi-asset-class managers such as endowments, foundations and sovereign wealth funds. The pension results have policy implications as many countries, such as the United Kingdom, the Netherlands and Canada, are experimenting with or considering pension reforms that ease the ability of plan members (and plans) to allocate their pension contributions to appropriately scaled multi-asset-class pension plans.[6]

The rest of the paper is organized as follows. In Section I we briefly review insights and findings from the existing literature on the economics of asset management. In Section II we describe our data. Section III reports results on overall performance at the plan level. We then test whether economies of scale arise from investment approach within an asset class (Section IV) or from asset allocation choice (Section V). We explore limits to scale economies, focusing on governance in Section VI, and conclude in Section VII.

[6] In the UK, the National Employment Savings Trust (NEST) presents one effort to create a scaled investment vehicle. In the Netherlands and Canada there are efforts to allow existing pension plans to open themselves up to other members, and large plans that have moved to take advantage of this opportunity include APG (Netherlands), Ontario Teachers Pension Plan (Canada), and OMERS (Canada). See, for example, http://www.omers.com/About_OMERS/OMERS_Investment_Management_Services_available_to_third_parties.htm)

I. The Economics of Asset Management

I.1. Asset Management at the Fund Level

As we will show below, pension plans outsource the vast majority of their portfolios to external managers, in some cases directly to mutual funds. Thus, a starting point for predicting the impact of scale on performance at the pension plan level is to consider theoretical and empirical results from the mutual fund literature. A well-known stylized fact in the fund literature is of diseconomies of scale. Absent significant efforts by plans to combat such diseconomies at the fund level, or to find offsetting economies of scale, pension plans seem destined to the same problems.

Theoretical models capture factors that produce decreasing returns in asset management, from more severe price impact of trades, to increased capital inflows leading managers to pursue poorer investment ideas, and/or to growing hierarchies in an organization that slow down decision making and dampen incentives (e.g. Berk and Green (2004), Stein (2002)). These theoretical concerns are borne out in the data. The diminishing returns to scale at the fund level have been found in mutual funds (e.g., Chen, Hong, Huang, and Kubik (2004)). Further, Pollet and Wilson (2008) find that mutual fund inflows predominantly inflate existing position rather than lead to new and diversifying investments, consistent with the diseconomies argument.[7] Christoffersen, Keim, and Musto (2006) and Edelen, Evans, and Kadlec (2007) show that the negative economies of scale are driven by large funds' larger transaction sizes and higher transaction costs. Similar results have been found at the fund level in other asset classes, including hedge funds (e.g., Fung, Hsieh, Naik, and Ramadorai (2008)) and private equity funds, where Lopez-de-Silanes, Phalippou, and Gottschalg (2010) have found that the more assets managed in parallel in a fund, the worse that fund's performance.

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[7] Other recent papers that specifically address (dis)economies of scale in mutual funds include Yan (2008) and Reuter and Zitzewitz (2010).

I.2 Asset Management at the Family and Multi-Asset-Class Plan Levels

What the above analysis ignores is that asset managers that sit above the fund level have additional degrees of freedom. If plans are aware of the diseconomies at the fund level, we hypothesize that they will attempt to counteract these pressures. There may be scale-related cost savings in negotiating with external management, often ignored by the literature.[8] Plans are also predicted to increase the number of external managers they employ, to switch towards less size-sensitive passive investment approaches within an asset class, and, perhaps most interestingly, to substitute internal for external management that may produce significant cost savings. The fixed costs of establishing the physical and human resource infrastructure to support internal management will vary across asset classes, with for example greater costs in alternatives than in fixed income. Economic theory thus suggests the ability to move towards internal management will depend on the scale of the firm as larger plans can spread the fixed costs of setting up internal management over a larger asset base, and that the comparative advantage for larger plans will be greatest in asset classes with the greatest fixed costs.

We also predict that larger pension plans will fight fund-level diseconomies by taking advantage of their freedom to reallocate assets from classes where scale-related diseconomies are large to areas where they are weaker or where there may even be positive scale economies. Cost savings arising from negotiating power are more likely in asset classes where costs are higher and that are less competitive so that there are rents to be shared. There might also be scale economies on the return side if larger plans are given special access to attractive deals, are able to attract and retain more skillful managers, or are treated differently from other investors and granted special co-investment opportunities or contractual protections.

Of course, as asset managers become more than virtual organizations that delegate all asset management, and become real organizations with their own internal staff that actively

[8] E.g., Berk and Green (2004) assume that external managers appropriate all surplus by charging higher fees.

manage assets, we predict that issues of governance and organizational diseconomies will become more important. Taking advantage of the potential scale economies requires the ability to hire and retain the right staff, the ability to provide the right incentives, and effective oversight structures that are focused on risk and performance rather than political and other factors. Stein's (2002) model predicts further that organizational diseconomies will develop and that these will be most pronounced for those activities requiring the transmission of soft information.

Below we will test these alternative predictions to see if they are pursued by plans and if they are sufficient to offset diseconomies at the fund level. Before doing so, we note that the existing literature provides indications that such additional degrees of freedom are beneficial. Chen, Hong, Huang, and Kubik (2004) in addition to providing evidence of diseconomies of scale at the fund level, find economies of scale at the family level that they attribute to larger families being able to negotiate lower trading commissions and to generate higher lending fees. By focusing just on equities, this result cannot speak to scale economies for multi-asset class asset managers. Closer to our research are endowment papers. Brown, Garlappi and Tiu (2010) use size as a control variable, but while they document its positive effect, they do not analyze its impact in more detail. Lerner, Schoar and Wang (2008) also find scale economies but, do not explore the channels through which size impacts asset management, either. More importantly, Lerner et al. (2008) do not emphasize this result as they report that size is only a proxy for whether an endowment is from an 'Ivy Plus' university and has access to the stronger alumni networks. This mechanism does not apply to other multi-asset-class managers (pension plans, sovereign wealth funds) for which alumni networks do not exist. Critically, it is difficult to generalize from the endowment results to the scale of pension plans. The average endowment size in the Lerner et al. (2008) sample is twenty times smaller than the average in our pension plan sample. For example, in 2007, even the largest US endowment, Harvard Management Company, had a scale of just 1/7 the size of the largest US pension plan (CalPERS).

Only a few papers have used pension data and looked at scale economies. Blake, Timmermann, Tonks, and Wermers (2010), look at UK plan returns in UK fixed income and in UK and international equity. They find diseconomies at the fund level, but positive economies of scale at the overall external manager level, similar to Chen et al. (2004). However, they cannot speak to plan-level economies as they do not have data on costs and on returns in other asset classes. Bauer, Cremers, and Frehen (2010) look at US plan returns in US equity and find that smaller plans do better on their investments in small cap stocks. These results again do not speak to overall plan performance as they do not cover other asset classes.

II – Data

II.1 Data Source and Key Performance Measures

To explore the relationship between pension plan size and performance we take advantage of data from an international sample of pension plans from 1990 to 2008 provided to us by CEM Benchmarking, Inc. (CEM), a Toronto-based global benchmarking firm. The data is based on survey responses of 842 distinct pension plans with 5008 plan-year observations. Plans report on their asset allocation, costs, gross returns, and benchmarks. Asset classes examined include equities (including US equities, EAFE equities, and emerging market equities), various fixed income categories, and alternatives (including hedge funds, private equity, and real assets, subdivided into real estate, REITs, natural resources, etc.). Within each of these detailed asset classes, we have performance and cost data broken down along two dimensions, internal versus external management, and active versus passive management.

The data is well suited to explore questions of the relationship between size and performance as it has data not only on gross returns, but also on sub-asset class specific costs and benchmarks. Lacking information on costs, other papers often focus solely on gross returns, or gross returns minus benchmarks (Goyal and Wahal (2008)) or approximate costs using pro forma fee schedules (Busse, Goyal and Wahal (2010)). Fortunately, the CEM database provides actual costs at the level of the detailed sub-asset class, including all costs directly related to that activity and the plan's activity-based allocation of fixed costs to that activity, with separate numbers for external active, external passive, internal active, and internal passive holdings of each asset class.[9] This is particularly important when the plan uses internal management, as is very common in large pension plans, and when plans use alternatives, as there is substantial cross-plan variation in alternative costs. The cost data explicitly exclude any liability-related costs such as benefit administration costs and insurance premiums.

The performance measure we focus on is net abnormal returns that we define as gross returns minus costs minus benchmarks. To construct plan level net abnormal returns we value weight net abnormal returns for each asset class (e.g., emerging market equity), and then subtract plan-level investment administration costs that are not associated with a specific asset class.[10] In our analyses, we also provide robustness checks with other performance measures.

We use the provided data as given, with the following changes. The holding and performance data are provided in each plan's local currency. To ensure comparability we express asset holdings in US dollars and transform all returns into US dollar returns using interbank exchange rates as of December 31 of each sample year and hence assuming that plan investments are held and returns are earned over the entire calendar year. (This assumption is only needed for non-US plans.) We winsorize costs and return the data at the 1st and the 99th

[9] Thus, external active management costs include "All fees paid to third-party managers including investment management fees, manager-of-managers fees, performance-based fees, commitment fees and hidden fees netted from the returns" and "other internal and external costs that can be directly attributed to specific externally managed holdings." For example, CEM directs respondents in the following way: "the costs of a trading system used by both internal domestic stock and fixed income managers should be allocated to both internal domestic stock and fixed income investment cost based on an estimate of usage. A simpler and acceptable alternative allocation method is to allocate overhead costs based on relative direct head count." Instruction and Footnotes, 2009 US Defined Benefit Pension Fund Survey. http://www.cembenchmarking.com/Surveys/SurveyDownload.aspx

[10] These administrative costs are defined to include oversight (e.g. director salaries, executives responsible for oversight of multiple asset classes), custodial, consulting and performance measurement, audit and legal costs, but do not include costs associated with liability or benefit administration.

percentile to avoid results being driven by a few extreme observations that remain even after the CEM vetting process.[11] We have a plan ID and a number of plan characteristics (country (e.g., US) or region (e.g., Euro zone) of the plan, ownership (corporate, public, other[12]), the fraction of liabilities that are due to current retirees, etc.). The terms of use of the dataset require us to preserve plan anonymity and do not allow us to match data with alternative data sets.

The dataset is an unbalanced panel. The mean (median) length of time a plan with a given ID is in the sample is 6 (4) years. The relatively short duration in the dataset arises from the increasing number of participants in the benchmarking service over time,[13] from the fact that CEM assigns new identifiers to plans following a substantial change in the structure of plan membership (e.g. a merger), and from other idiosyncratic reasons that lead plans to cease to participate in the benchmarking service.

Table I provides an overview of the data. Over our sample period, the average plan invests 54% of its portfolio in equity, 33% in fixed income and 6% in alternatives; the remaining 6% are in cash and tactical asset allocation. The most common style of management is active management through external managers, accounting for 68% of all assets at the mean and 77% at the median. The mean and median net return (gross returns minus costs) is 8.8% and 8.4%, while the mean and median net abnormal return (net returns minus benchmark return) is 0.22% and 0.12%. As a point of reference, the average net abnormal return in US equity is -0.06%.

II.2 Coverage, Representativeness and Potential Biases

[11] We repeated our main analyses with the data in local currencies with very similar results. Winsorizing does not change our plan-level results, but makes the within-asset class results stronger (this is because the most egregious outliers, e.g., reported costs in real estate that exceed 40%/year, occur for small plans).
[12] The 'other' category accounts for 600 plan-year observations and includes union pension plans, insurance funds, and a few endowments and sovereign wealth funds. Results are robust to excluding this category.
[13] E.g., 170 of the 842 plans appear in the data only in 2005 or later, so these plans can have at most 4 observations. The average plan appears in 57% of years following its addition year.

As with any new data source, there are questions about its coverage, representativeness, and potential biases. The CEM database is the most comprehensive database on international pension plan asset allocation, performance, and costs that we are familiar with.[14] As we indicated in the introduction, the database captures a significant percentage of the industry and is particularly comprehensive for US and Canadian plans, where in 2008 it captures 40% of US and 65% of Canadian defined benefits assets.

The database is particularly good in its coverage of very large plans, aided by the inclusion of international plans. While the cost of the benchmarking service is moderate, it is more easily covered by larger plans whose sponsors are more likely to demand the benchmarking as part of their governance of the plan. As we report, the average plan (time series average based on equal weighted average each year) has $9.2 billion in assets (Table I – plan characteristics), and plan sizes vary across quintiles from $340 million for the first quintile to $33,088 million for the fifth quintile (Table II – plan characteristics). Our data provider allowed us to compare the list of plans covered to the list of top 1,000 pension plans published by the trade journal "Pensions and Investments" for 2007. At least 200 (of the 215 CEM plans) are in the top 1000 list, with a higher percentage of CEM plans among the largest plans (172 plans in the top 500, 110 in the top 200 and 57 plans in the top 100). Public testimonials on the CEM website, and publicly available statements, show that the service is used by many of the largest plans in the world. [15]

[14] For example, Novy-Marx and Rauh (2010) rely on a sample of 116 state plans, Ferson and Khang (2002) use data on equity holdings of 60 pension plans between 1984 and 1994, Blake, Lehmann, and Timmerman (1999), have 9 years of data on 306 UK pension plans, Coggin, Fabozzi, and Rahman (1993) have 8 years of data on 71 US equity pension plan managers. In comparison, just our US sub-sample includes 171 public, 323 corporate, and 50 other (predominantly union) plans and spans the period 1990-2008. There are other papers that occasionally use more plans, but have much less data about each of the plans (e.g. Rauh (2006) uses a larger sample of 1,522 corporate plans from 1990 to 1998 where he could match with IRS data). Analyses of pension plans by aggregating up their external mandates (e.g. Goyal and Wahal (2008)) are limited in which asset classes they cover and miss the use of internal management which, as we will show, is particularly important for larger plans.

[15] Publicly available information from the CEM website and plan public disclosures show that the participants include the large American plans CalPERS ($199B in assets according to 2009 Pensions and Investment's Databook) and CalSTRS ($130B), the large Canadian plans CPPIB ($122B) and Ontario Teachers ($92B), and the large European plans PFZM (formerly known as PGGM, $124B) and ABP/APG ($300B).

While the database is quite comprehensive, it does not cover the universe of plans, raising questions whether the omitted plans might have different characteristics than the included ones. This would be a significant concern if, for example, the larger better performing plans were the only ones that took part in the service, or chose to participate only in years where they had strong performance, as this would skew the performance of the larger plans.

To explore these issues we first compared included firms with population characteristics in the United States, the region for which we have some population data. Specifically, we first compared asset allocation of the US plans in the CEM database with asset allocation in the Pensions and Investments 2007 top 200 Funds list (the sample for which they report asset allocation) and found statistically indistinguishable and economically small differences across the two samples.[16] We next looked at performance of pension plans of publicly-traded US firms that are required to report net plan returns in their annual statements and which Compustat reports since 1996. The time series averages of the equally-weighted cross sectional average (median) returns of the plans in the CEM database are 7.3% (7.0%) (CEM has on average 87 US corporate plans per year with the maximum of 123). There are many more plans reported by Compustat firms (2137 on average), the bulk of which are substantially smaller. The average return of these plans is 6.6% for the whole sample, 6.9% if we restrict plans to have at a minimum the size of the smallest CEM plan ($25m), and 7.4% if we restrict ourselves to the largest 200 corporate plans. Our interpretation of these comparisons is that our US sample is comparable with the population of plans in Compustat, but skewed towards larger plans. We do not have population data and cannot carry out similar analyses for non-US plans. However, the Canadian data is particularly comprehensive (in 2008 for example we capture 65% of all Canadian defined benefit plans), so there are fewer ex ante concerns of bias here.

[16] In 2007, the mean allocation to equities in our CEM sample is 58.3%, while it is 60.1% for the top 200 funds and 58.9% for the top 100 funds; for fixed income the average CEM fund has 28.2% allocation while the top 200 and top 100 fund have 26.2% and 27.3%; for alternatives CEM funds allocate 11.2% while the top 200 and top 100 allocate 11.8% and 12.3%, respectively.

Another potential bias would be if firms came in and out of the database based on their performance. One concern we can easily address is survivorship bias, as the plans that no longer report do remain in the database. We also compared the net abnormal returns of new plans (plans that enter the database in year *t*) and the performance of plans that have reported in the immediately preceding year (have reports in both year *t* and year *t*-1). The difference is essentially zero (-0.002%). Similarly, the difference in the performance of plans that skip a year (enter the database before year *t* and report in year *t*, but not in year *t*-1) and plans that continue reporting (report in both years *t* and *t*-1) is tiny (-0.05%).[17] These results suggest it is unlikely that plans strategically report only in years when their performance is superior.

III – Are There Scale Economies? Plan-level Evidence

III.1 Summary Statistics

Table II provides an indication of the interplay between scale and performance. For illustrative purposes we divide the data into five quintiles by size, and report the time-series averages of the cross-sectional averages computed in each sample year. As the far right columns in the table show, the difference in net returns between the largest plans (5th quintile, mean assets of $33 billion and median of $21 billion) and smaller plans (1st and 2nd quintiles, with mean assets of $342 and 994 million respectively) is 33 to 78 basis points. This simple comparison could mask very different exposure to risk, but the standard deviation of returns and the Sharpe ratio do not support this view. The Sharpe ratio is close to monotonic in size, and grows from 0.34 and 0.36 for the smallest to 0.43 for the largest plans. More importantly, we can control for risk more directly and use the asset class benchmarks reported by each plan

[17] Bauer et al. (2010) also use the CEM database and were allowed by the data provider to match the US corporate plans in the database to Compustat, matching 67% of the CEM firms. They find no significant difference in returns of plans that enter or leave the CEM database and plans that remain in the data.

to construct abnormal net returns. By this measure the difference between the largest quintile and the two smallest quintile plans is 33 to 36 basis points, which translates into an information ratio of 0.45 (0.05-0.07) for large (small) plans.

These results alone are insufficient to establish a relationship between size and performance. First, US and non-corporate plans are overrepresented among larger plans, so these results could be driven by plan type rather than scale. To address this, we will use corporate plan and non-US plan dummies in our regressions. Second, there might be a concern about risk adjustment. We use plan- and asset-class-specific benchmarks, which should pick up risk, but there might be a concern about potential benchmark manipulation. Thus, we also present results for benchmarks defined as the mean or median plan returns in a given class, as well as control for average performance in a given asset class via year fixed effects.

We do not take the more conventional asset pricing approach of estimating alphas after controlling for well-known factors. The CEM data is annual and has only an average of 6 observations per plan, and we lose one of these by using lagged size. Thus, estimating even a one-factor regression is challenging, and a reasonable risk correction in our context needs more than a few factors, since plans invest in multiple asset classes, including alternative assets, and in both domestic and international markets.[18] Given this, we feel the most appropriate approach is to use plan-reported benchmarks. At the very least they capture the appropriate market portfolio, and usually also additional geographical or market segment information.[19]

[18] The summary statistics in Table II should reduce concerns that larger plans are getting their returns by taking on greater risks, as they show that large pension plans have lower return standard deviations and hence have considerably larger Sharpe ratios. When we estimate CAPM, Fama-French, and Carhart alphas for the size quintile portfolios in untabulated regressions (we use portfolios to maximize the number of annual observations to 19), we again find that large plans outperform small ones with similar economic magnitude. However, we do not think this evidence is particularly persuasive because, as we argue above, commonly used asset pricing models are unlikely to capture all risks of the multi-asset-class investors in our sample.

[19] Benchmarks in the CEM data are more complex than those used by US mutual funds. For example, US equity benchmarks include composite benchmarks such as "34% Russell 2500/ 66% S&P 500," "Custom (0.4 R1000/ 0.3 R MidCap/ 0.3 S&P Citi Growth)," or "Custom (Russell 1000 Growth, S&P Barra Value, S&P 500)". EAFE equity benchmarks include "50% Europe, 25% Japan, 25% Pacific excluding Japan," "60%MSCI EAFE, 40%MSCI EAFE Small Cap," or "Custom(MSCI EAFE; EAFE Sm Cap; EAFE Value)." In private equity, a frequent variation is to

III.2 Regression Analysis

In Table III we test whether plan strategies allow them to offset fund level diseconomies. We begin with the sub-sample of US plans. In the univariate specification (1) we find that lagged plan size has a positive and statistically significant impact on plan-level performance. Its economic impact is substantial: Changing plan size from the smallest to the largest quintile average translates into performance improvement of 40 basis points per year. Since the average costs decline over time (French (2008)), we control for year fixed effects in (2) and find that this has only a negligible effect on our variable of interest. In (3) we add a corporate plan dummy and find an even stronger coefficient suggesting an economic impact of 45 basis points. This is because corporate plans have stronger performance but tend to be smaller than public plans. Not controlling for plan type then leads to a flattening out of the size relationship in (1) and (2), and is why going forward we will include this control in our preferred specifications. In columns (4) and (5) we repeat this analysis using first Canadian plans and then European, Australian, and New Zealand plans (we pool the last three categories given the small number of plans). Our results are very similar for US and for non-US plans. Given the similarity in economies of scale in (3), (4), and (5), we pool the data for most of our remaining tests. For the interested reader we report US-only results in the Appendix Table AI.

Thus we arrive at our core specification in column (6), where in addition to corporate status we include a dummy for non-US plans in case they behave differently. The coefficient on log of end of year *t*-1 plan size is a highly statistically significant 0.095 and as we report at the bottom of the table implies an increase in net abnormal returns of 43 basis points in moving from a small (first quintile) to a large (fifth quintile) plan. This positive effect of size on performance is very robust. We see this in part in column (7), where we include lagged net plan returns and find persistence in plan performance, but most importantly for our purposes this

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use the return of an index (e.g. S&P500, Russell 2000, a composite index (45% Russell 3000, 45% MSCI Europe, 10% Nasdaq) and to increase this by an amount that varies between 1% and 5% per year.

barely changes the size coefficient. We perform further robustness checks and report the results in Appendix Table AI Panel B, where we find significant and economically meaningful economies of scale for public and non-public plans, when we drop the largest or smallest quintile plans, or when we restrict ourselves to the first or the second half of the sample.

The above results are based on benchmarks reported to CEM, which at least partly control for differences in asset allocation between plans and likely differences in risk within each asset class. To address the potential concern that plans might be manipulating their benchmarks, we impose a common benchmark using average or median realized performance in each asset class and value weighting asset class results to construct plan-level abnormal performance. Panel B of Table III reports results using as a benchmark the average returns (1-2) and median returns (3-4). The results are of similar statistical significance and higher economic magnitude. For example, the analogues to our preferred specification from (6) are the similar specification in (2) and (4) of Panel B, where the estimated impact of a Q1 to Q5 change increases by more than 50% to 67 and 73 basis points, respectively. In (5) we use the percentile rank in performance. That is, each year we compute each plan's percentile ranking in each asset class the plan invests in. We next value weight these percentile ranks across asset classes to form a plan's overall percentile ranking.[20] The positive and significant coefficient on size in (5) shows that larger plans perform better by this measure as well.

Ideally, we would supplement this evidence, which relies largely on cross-sectional variance in size and performance, with time series evidence from changes in size of individual plans. Unfortunately, this is difficult with pension plans as they have fairly little variation in their size over time (and as noted earlier, our data provider assigns a new ID with any substantial change such as a merger). Added to this problem, we have a very short time series

[20] This approach was proposed in a similar context in Edelen, Evans, and Kadlec (2008).

for the typical plan. [21] We get more power in the time series in our within-asset class analysis below, as plans make more substantial changes at the asset class level over time, even if their overall size remains fairly constant.

III.3 Is the Relationship Between Size and Performance Log Linear?

To explore potential non-linearities between size and performance we first estimate regressions with log size directly, log size and its square, and then log size and its square and cube. We present the results graphically in Figure 1 Panel A. Including the squared term (insignificant) has little impact with a slight attenuation, while the inclusion of the squared and cubic term (again insignificant) suggests possibly greater scale effects. Importantly, we find no evidence that economies of scale abate even for the largest plans in our sample. This is not a weakness of our database. As we report in Section II, CEM captures 57 of the largest 100 pension plans in the US and many more large plans from around the world, including multiple plans that exceed $100 billion. Of course, we do expect that for sufficiently large plans the economies would dissipate and eventually turn negative, but the data suggest that this does not happen on average for the plans in our sample.

We next test for non-linearities by introducing a piecewise linear specification, again for convenience using quintiles. We include a dummy for the first four size quintiles in (8) in Table III Panel A, so that the point estimates directly tell the difference in performance relative to the largest quintile. We find that all four smaller quintiles dummies are negative, reflective of scale economies, with the implied cost of being a first and 2nd (3rd, 4th) quintile plan rather than a 5th quintile plan of 36 and 50 basis points (31, 27). Interestingly, the coefficient on the 2nd quintile exceeds that for the first quintile, which suggests an unreliable relationship between size and

[21] For example, we tried to explore within plan variation by identifying plans that increase by a substantial amount (for example by a third beyond their investment returns) and report to our database in the subsequent years. Unfortunately, this produced only 13 plans and variants of this approach did not yield substantially more plans. We do find consistent results using this sample, as on average, they experience a net abnormal return of -0.17% in the year before the change, and 0.49% in the year of the change and 0.47%, 0.76%, and 0.72% in the three subsequent years, but he limited sample size and the insignificance of these averages make this at best suggestive evidence.

performance in the first two size quintiles. We confirm this non-monotonic relationship in column (9) where we restrict our attention to solely the first two size quintiles and find a statistically and economically insignificant relationship between size and performance with a coefficient estimate of -0.001. To capture this lack of effect we include a first quintile dummy in (10), where it has a positive and significant coefficient. The relationship between size and performance is now even greater, with the estimated coefficient rising from 0.095 to 0.135. In Figure 1 Panel B we present the implied relationship between size and performance using column (6) and column (10), as well as the summary statistics for reference purposes.

In sum, Table III provides our first principal finding: there are statistically and economically significant economies of scale in the overall plan performance showing that plans are able to more than offset the diseconomies at the fund level. To understand better the channels through which size influences performance we now test whether these returns are accounted for by differences across plans in their investment approach within an asset class (Section IV), or from asset allocation choice (Section V). In section VI we return to the question of what limits scale economies. In the Appendix, we report the results of our test of an alternative hypothesis that plans act to avoid diseconomies of scale by spreading their assets across more investment vehicles. We find that they do increase the number of mandates to partially offset their size, but the increase is less than proportional, meaning that we need to look elsewhere to account for the finding of positive returns to scale.

IV - Size and the 'Make versus Buy' Option

Why do plans experience positive rather than decreasing returns to scale? As discussed in section I, unlike mutual funds that are contractually bound to do substantially the same thing when they receive inflows, pension plans face a 'make versus buy' decision. Instead of buying from external active managers they can 'make' a similar product in-house. Their cost savings here might be sizable and having this option might aid them in negotiations with external managers.[22] Thus, the first set of hypotheses we explore is that larger plans are more likely to use internal management in place of external management, that this reduces costs and/or improves returns, and that accounting for this substitution (partly) explains the observed positive relationship between size and performance.

Consistent with this hypothesis, we find that larger plans are far more likely to turn to approaches other than external active management. Figure 2, Panel A shows that the fraction of plans with some internal or passive management increases with size; in the largest decile virtually all plans go outside the external active management style in equities and fixed income. In terms of the summary statistics, 17% (56%) of assets of the average Q1 (Q5) plan are internal or passive. Part of this result is driven by the use of passive management, as we show in Panel B. More interesting is what we find in Panel C when we look at internal active management. Few plans smaller than the median have any internal active management, but more than half of top size decile plans manage a portion of their holdings in-house. Almost 40% of the largest decile plans also manage a portion of their private equity internally.[23]

These patterns in the likelihood of using active management across asset classes are in line with the economic intuition: Hiring an internal team to manage fixed income does not require as significant fixed cost investment in human resources and oversight as is required for more complex asset classes. Accordingly, almost regardless of size decile, fixed income is the most common asset class with internal active management. The greatest organizational challenge in setting up an internal group is likely that of assembling, rewarding, and monitoring

[22] A model such as Berk and Green (2004) shuts down another way for positive economies of scale to prevail by assuming that all of the bargaining power is held by the external asset managers and/ or there is no surplus. More generally, however, it is conceivable (and in less competitive asset classes also likely) that there is surplus and that buyers of external managers' services may have negotiating power to appropriate part of that surplus.
[23] We provide additional regression-based analysis of these phenomena in Appendix Table AIII.

an internal private equity or real estate team. Up to the 4th size decile there is no internal active management of private equity, and it only becomes sizable in the 9th and 10th size deciles.

These findings establish that larger plans use more internal management, but does this approach produce substantial savings, and does it affect gross returns? The summary statistics in Table II provide an indication of the cost savings. In the bottom portion of the table we report total management costs at the asset class level by size quintile, showing that costs decline monotonically from the first to the fifth quintile in both equities (from 37 to 16 bps) and fixed income (from 20 to 9 bps), consistent with the existence of negotiating power by larger players and their greater use of less costly passive and internal management. We then restrict our attention solely to active management and report the ratio of external to internal active costs to provide a cleaner estimate of the cost savings by controlling for style. External active managers are 2.6 to 3.5 times as expensive to use as internal managers for equities, 1.7 to 5.1 times more expensive in fixed income, and 3 to 6.9 times more expensive in alternatives, with broadly speaking more substantial savings from internal management for larger plans.[24]

We turn again to regression analysis to explore the impact of style of management on performance. In Table IV, we take as our core regression column (6) of Table III and add to this specification the fraction of holdings not invested using external active management. This is bound to take away from the straight impact of size on performance, as it picks up one of the channels that make size relevant. The positive and significant coefficient on 'not external active' in (1) shows that turning away from external active management improves net abnormal returns and that accounting for this variable reduces the coefficient on size by about one third, to 0.65. We look at costs and then gross returns separately in (3) and (5) and find that the benefit comes through statistically and economically significant cost savings and positive but

[24] To assess the robustness of these cost savings, in untabulated test we restrict our attention to plans that have at least 10% of their assets in a given asset class in both internal active and external active management, and look at the median ratios providing very similar results of ratios of 3 to 6 in equities, 2.5 to 8 in fixed income, and above 5.9 in alternatives, again with generally higher ratios for the larger quintile plans.

insignificant impact on gross returns. In these regressions larger plans continue to have lower costs (consistent with superior negotiating power) and insignificantly greater gross returns.

We gain further insight if we go one level deeper to identify the proportion of assets managed internally, and the proportion managed passively. Column 2 shows at the overall plan level that the use of internal management is the more important choice for overall performance. Breaking down the impact on costs (column 4) and gross returns (column 6) separately shows that internal and passive management have similar magnitude cost reductions, and neither has a statistically significant impact on gross returns. Importantly, while accounting for this channel that is used most extensively by larger pension plans reduces our scale coefficient by 42%, it still leaves a positive and significant coefficient on size and shows that the majority of the benefit needs to be accounted for by other factors.

V - Do Plans Realize Economies of Scale via Asset Allocation?

V.1 Size and Asset Allocation

We hypothesize that a second avenue through which plan managers will try to avoid diseconomies of scale is to expand the number of investment categories in the portfolio and to increase weights on categories where decreasing returns to scale are less likely or where there are more than offsetting positive economies of scale. This asset reallocation may also have diversification benefits,[25] but we are ignoring these and focusing only on whether it provides positive economies of scale in net abnormal returns.

An *ex ante* indicator of where skill and negotiating power should matter is the variance or perhaps better yet the interquartile range of performance (which is less driven by outliers).

[25] Return standard deviations in the 5th and 1st size quintiles are 0.122 and 0.133, respectively, in line with larger plans being better diversified.

With a bigger range of performance, there is a greater potential gain associated with strong management of that asset class. If plan size correlates with skill and negotiating power, the interquartile range should also provide an indication of where larger pension plans should focus their activities. The alternative asset class has the highest interquartile range in almost all performance categories and hence is likely to be an area where size matters. For example, as we show in Table I Panel B, the interquartile range for private equity in costs, gross returns and net abnormal returns is 181 basis points, 19%, and 17%, while similar numbers for public equities (and fixed income) are 21 basis points, 8.2% and 3% (14 basis points, 7.3% and 1.5%).

Figure 3 presents a summary of how size affects asset allocation. The smallest plans have little alternative holdings, but alternatives do become more important for largest plans. The mean (median) difference in the portfolio weight on alternatives between Q5 and Q1 plans is 6.3% (8.1%). Larger plans seem to substitute alternatives for both fixed income and equities.

We formally test whether larger plans allocate more to alternatives in Table V. The positive and significant coefficient in column (1) shows that they do. The estimate implies 7 percentage points greater allocation to alternatives in going from a Q1 to a Q5 plan. Of course, investments in alternative asset classes are usually associated with higher risk and lower liquidity, and differences in risk appetites or the demand for liquidity might correlate with plan size. Accordingly in (2) we also include the fraction of liabilities tied to current retirees and the corporate dummy as measures of the demand for liquidity/ risk appetite. The liabilities tied to retirees captures variation in the need for returns in the near term, and managers of corporate plans may have a greater incentive to avoid bankruptcy risk.[26] We include a dummy for a foreign plan as well to make results comparable with previous findings, although we have no strong prior on this variable. In line with economic intuition, we find in (2) that plans that likely have the greatest need for safety and liquidity (plans with a high fraction of current

[26] Unfortunately other potentially useful variables, such as plan underfunding, are not collected by the data provider.

retirees among plan members) indeed invest less in alternative assets, and the interaction shows that this has less of an effect on larger plans. The addition of these variables has no effect on our measure of size and asset allocation. In specifications (3-10) we analyze portfolio weights on the main alternative components. Size leads to greater weight on private equity in (5) and (6) and real estate in (7) and (8), but has no effect on allocations to hedge funds in (3) and (4) and REITs in (10).

V.2 Size and Performance in Alternatives

Do larger plans get superior returns on the asset classes they overweight relative to smaller plans? The summary statistics from Table II provide indications of such a relationship. In alternatives, the 1st and 2nd quintile have the lowest performance of -13 and -87 points respectively, while the 5th quintile has the highest net abnormal returns of 130 basis points. Thus, a move from the 1st or 2nd to the 5th quintile is associated with a performance improvement of 143 to 217 basis points. But this analysis may be too aggregate and may confound differences across different sub-categories of alternative assets.

In Table VI we analyze separately the most important alternative investment categories of private equity (27% of overall holdings of alternatives), real estate (47%), REITs (10%) and hedge funds (11%). We begin with private equity net abnormal returns in Panel A of Table VI.[27] We find a strong relationship between size and performance. In a univariate specification (1) and our base regression (2) we find a large, positive, and significant coefficient on size. The estimate in (2) implies that a move from the 1st to the 5th size quintile produces a substantial 6% increase in net abnormal returns. This premium is higher than half of the overall average gross return in that asset class. In (3) we include plan size outside of private equity to see if this return is driven by overall plan size or the PE allocation, and find that the sub-asset class

[27] CEM reports that prior to 2008 some plans had difficulty in identifying gross returns and costs separately. This introduces noise to our analysis when we separately look at gross returns and costs but does not affect the analysis in this section as we are looking at net abnormal returns (net returns less the benchmark).

allocation dominates with a slight increase in coefficient. In (4) we allow for small plans to be different by including a 1st quintile dummy and find no effect. In (5) we control for the percentage of private equity holdings managed internally, and in (6) we add the average mandate size, although this variable is only available for a small subset of our data. In all cases, the overall impact of size remains economically large and significant.

In Panel B we explore whether size has a similar effect on performance in real estate, REITs, and hedge funds. We find similar results for real estate as for private equity, with statistically and economically significant coefficients on size. The implied impact on performance of real estate investing as a large rather than a smaller plan is 3.68% per year. In untabulated tests we found this relationship in private equity and real estate is robust and effectively unaffected by including squared terms, and then squared and cubic terms. In contrast, for REITs and particularly hedge funds we find mostly insignificant results. For reference purposes we also include a similar analysis of equities, and fixed income, where we also fail to find a robust relationship with size.

The differences in economies of scale across the investment categories in Panel B align directly with patterns in portfolio weights of investment categories reported in section V.1 and in most cases follow the patterns in interquartile range in net abnormal returns. The only outlier here is hedge funds that have high interquartile range, but no scale economies.[28] These patterns consistent with large plans focusing on categories where scale benefits are largest.

Finally, the magnitudes we find for alternatives are consistent with our plan-level estimates from Section III. The difference in the allocation to alternatives between the smallest and the largest quintile is 6.3% and the Q1-Q5 economic effect is of the order of 5% per year

[28] This may be because hedge funds have lower capacity for accommodating large inflows, with flows inducing large price impact and forcing managers to exploit weaker ideas. This view is consistent with the evidence in Fung et al. (2008). In private equity and real estate the potential investment universe is much greater and less likely to suffer from such adverse effects.

private equity and real estate. These two subcategories account for 75% of alternatives, so the impact on overall plan net abnormal return is 0.063x0.05x0.75=24bps, more than half of the effect we estimated in our baseline regression (6) in Table III.[29] Thus, while the within-asset-class channel from Section IV accounts for up to a half of the overall economies of scale, more than half is due to the across-asset-class channel of Section V.

V.3 Robustness of Economies of Scale in Alternatives

There are potential concerns with these results as there are omitted variables that could be driving returns. Three such variables, highlighted by Lerner, Schoar, and Wang (2007), are experience, access, and timing. Perhaps larger pension plans simply have been investing for a longer period of time in the asset class, have greater experience, and have established connections with the persistently strong private equity performers identified in previous papers (e.g. Kaplan and Schoar (2005)) that have closed their funds to new investors. In such a case the positive relationship between allocations to alternatives and net abnormal returns is more of a historical accident than a robust relationship between size and performance.

To address this concern we run two additional specifications. First, in column (7) we include the lagged net abnormal returns, again finding a robust relationship between size and performance. In line with the earlier studies, e.g., Kaplan and Schoar (2005), we find strong persistence in net abnormal returns to private equity. Second, in (8) and (9) we include plan fixed effects so that the size effect comes solely off the within-plan variation. This is possible as there are often significant changes to asset allocation a given plan even if the overall plan size does not change much. The estimated relationship is even stronger with a higher value to the size coefficient and remains statistically significant. Thus, our findings are not driven by pension plans invested in private equity funds with high recent performance or by the access of larger

[29] This back-on-the-envelope calculation ignores that large plans overweight private equity and real estate relative to small funds (see Table V), which makes the overall effect even larger.

plans to the best PE managers, to the extent that such access is constant over the sample period and is subsumed in plan fixed effects.

This analysis does not address the concern about timing arising from both the vintage effect (some years are better for returns than others) and the j-curve effect (it takes time for PE investments to yield returns). If larger plans invested earlier than smaller ones, then we may simply be seeing the effect of the timing of the investments. Such concerns are greatest for private equity. It is comforting, but not fully convincing, that we see similar results for real estate investments, where there is less likely to be a j-curve to investment returns. To tackle this issue directly we went back to the data provider. We asked for and were provided some measures of timing for a subset of the plans in our sample, based on a survey CEM conducted in early 2009. Specifically, we obtained for 15% of plans that invested in private equity in the year 2008 (and which account for 18% of the dollars in private equity) the fraction of private equity investments that were still in the commitment period in 2008 and the average vintage year of their PE portfolios (weighted by the amount invested in each LP position). These are admittedly crude measures to capture differences in both vintage year and j-curve, but are all that is possible given our data.

In Table VII we examine how these measures of PE investment timing influence our estimates of the impact of size on returns. For these regressions we use contemporaneous size rather than lagged size to maximize our number of observations.[30] In columns 1-4 we use just the 2008 data, while in columns 5-8 we pool the 2006-2008 data and assume that the cross sectional variation in timing found for 2008 also applies to these earlier years.[31] In (1) and (5) we establish a baseline and show that our prior finding of positive returns to scale in private

[30] We only have data on 30 plans and using lagged size would reduce the number of observations by 15% in regressions 5-8. We verified that using contemporaneous rather than lagged size has only a small impact on results in the previous tables. If we used lagged size in Table VII, we would still find positive, although a little lower effect (e.g., 1.621 instead of 1.818 in (5)) with somewhat lower t-stats (e.g., 1.62 versus 1.83 in (5)).

[31] If a plan has PE investments that are, on average, 5 years old in 2008, we assume they were 4 (3) years old in 2007 (2006). We cannot similarly extrapolate the fraction of assets in the commitment period and we assume that that variable does not change in the last three years of the sample.

equity is also found in this sub-sample of plans. Not surprisingly, given the small sample size, this is not significant for 2008, but we do find significance in the pooled data. In (2-4) and (6-8) we include the timing variables. They have the predicted signs, with more assets in the commitment period reducing returns and older portfolios producing greater returns. Importantly, the inclusion of these variables only slightly reduces the coefficient on size.

V.4 What Drives Superior Returns in Alternatives?

Are these patterns of substantially greater returns in private equity and real estate plausible? To address this question we first turn to an example and some survey evidence. We then follow this by using our data to test for channels suggested by these examples.

A notable public example of a large plan that has had success in private equity and sees its success contingent upon its large size is the Canada Pension Plan Investment Board (CPPIB).[32] Two areas where they report scale to be an advantage are the Principal Investing group (which accounts for about $4 billion) and their secondaries division (with about $2 billion in commitments). The CPPIB undertakes direct investments through the exercise of co-investment rights, through co-sponsored deals where the plan works directly with GPs to identify attractive investment opportunities, or by investing directly in companies. All of these mechanisms allow investments without typical LP fees, lowering average costs for the plans' private equity funds. They could also lead to superior returns and if the pension plan has the ability to select the more promising of the opportunities presented to them. A recent example is the successful purchase and sale of Skype that CPPIB co-sponsored with the GP Silverlake where CPPIB Executive Vice President Mark Wiseman stated, "We have the ability to write a $300 million cheque into a transaction, which makes us the first call, in some cases, the only

[32] This account is based on HBS case on CPPIB (case #9-809-073) and on our interviews with CPPIB management and private equity group.

call."[33] In the secondaries market CPPIB buys LP positions, usually at a significant discount. Since such secondary transactions can be vetoed by GPs, it is important for the purchasing plan to be viewed favorably by GPs – and plans as large as CPPIB usually are.

There is suggestive evidence from a recent survey of large investors that CPPIB's experience is not unique but shared by large investors. DaRin and Phalippou (2010) confirms that size correlates strongly with co-investment invitations, as well as a range of mechanisms that shield LPs from problems of opacity and complexity highlighted by Metrick and Yasuda (2010) and Phalippou (2009). DaRin and Phalippou (2010) for example show that larger investors are significantly more likely to: spend more time on due diligence, receive side letters that essentially detail favors for that investor, obtain most preferred nation status that guarantees that no other investor receives better terms in their side letter, get advisory board seats, etc.

Can we go further using our data to identify the channels through which large investors get superior returns in private equity and real estate? One thing we can distinguish is whether the benefit comes solely through cost savings, or also comes from superior performance in gross returns. The cost data provides indirect evidence of the importance of factors such as negotiating power and co-investments where pension plans are given the option of investing alongside the private equity fund. In column (1) of Panel A, Table VIII we introduce our base specification and in (2) our preferred specification, finding a highly significant coefficient on costs of -32. In (3) we test to see whether this effect is driven by the use of internal management. While the estimate is negative, significant, and suggests substantial cost savings (189 basis points if a plan were entirely internal as opposed to 100% external), this reduces the coefficient on size by only about 10%. The economic magnitude in specification (3) implies a 138

[33] *Globe and Mail*, September 2, 2009. CPPIB invested $300M into the transaction directly along with a $50m investment as an LP in Silverlake, and exited with a sale in April of 2011.

basis point difference in moving from 1st quintile allocation to private equity to the 5th quintile allocation.[34]

More surprising is our evidence on gross returns. We find a statistically and economically strong relationship between size and gross returns. We see this in column (4) without controls, in (5) with our main controls and also in (6), where we add the percentage of the allocation that is internally managed. The coefficient of 1.08 in (6) implies that moving from the 1st to the 5th size quintile would improve gross returns by 5.14 percentage points. This is most easily interpretable as a superior ability to screen and monitor private equity and real estate funds or being provided superior access to the best opportunities. Larger plans may also have more clout with policy makers, which may help funds in regulatory arbitrage or, say, in winning contracts.

We also find this same pattern of cost and gross returns both driving positive net abnormal returns in real estate, with somewhat smaller magnitudes. Real estate funds, like private equity funds, often offer co-investment opportunities where skill is important. In hedge funds and REITs, in contrast, we find cost savings with no robust relationship in gross returns and, as reported earlier, no statistically significant benefit in net abnormal returns.

As a final test, we try to see whether there are spillovers between internal investing (which is essentially only pursued in private equity by the largest pension plans) and returns from investing as an LP (i.e., external holdings). Specifically, in Table IX we focus on returns on external private equity and include as a right hand side variable the returns on internal private equity, restricting our attention to plans that invest both internally and externally. The positive and significant coefficient on internal active return in (1) suggests a positive spillover.

[34] A potential concern brought to our attention by the data provider is that for a few plans CEM has introduced default private equity costs, as the reported costs were inconsistent with those of other plans. That is, CEM replaced reported costs for these plans with default costs that they calculated. We think this reduces the noise in our data, but since we were concerned about how this may affect our results, we also asked for and were provided a list of plan identifiers where default costs were used. We re-examined our findings excluding these observations and found that they had no quantitative or qualitative impact on these results, or those reported previously in earlier tables.

In (2) and (3) we repeat the analysis for real estate and for alternatives as a whole, finding similarly positive spillovers. In (4) and (5) we show that such spillovers do not appear to exist in public equities and fixed income. One interpretation here is that teams with the ability to identify good internal opportunities (e.g. to screen co-investment opportunities) also have skill and experience that improves external manager selection and monitoring.

VI Limits to Economies of Scale

VI.1 Scale Economies correlated with Governance

To exploit their additional opportunities larger plans have to have the ability to attract, retain and motivate internal and external managers. They also need an oversight structure that allows them to focus on economic rather than other objectives. In short, governance could play an important role in taking advantage of scale. We test for the impact of governance by using two crude proxies available in our data set: a dummy variable for corporate plans and a dummy variable identifying US public plans. The corporate dummy is a proxy for superior governance. Corporate status is likely associated with fewer politically-driven resource constraints (which could limit the ability to attract, retain, and motivate internal and external managers) and more oversight since returns on pension plans do impact corporate bottom lines. The US public dummy is intended to proxy for poor governance. These plans are often suggested to have the greatest resource constraints in their internal management and the weakest oversight. [35]

In Table X we find evidence consistent with the importance of governance: Corporate plans have both stronger overall performance and stronger scale economies and US public plans

[35] Ambachtsheer (2011) presents suggestive evidence of differences in the ability to compensate managers in US public plans, relative to plans elsewhere. There have been greater recent concerns about governance structures and corruption in US public plans, e.g., "New York Tightens Pension Rules," Wall Street Journal, 9/24/2009, "At Calpers, a Revolving Door of Fees for Influence," Wall Street Journal, 1/15/2010, o "Illinois Confirms Inquiry by SEC," Wall Street Journal, 1/25/2011 and for New Jersey, "A Gold-Plated Burden," The Economist, Oct 14, 2010.

have poorer overall performance. In column (1) we add to our core specification an interaction of corporate status with de-meaned size and find that corporate plans deliver statistically stronger overall performance (16 basis points higher) and that they have significantly greater scale economies. In (2) we repeat this analysis introducing a US public plan dummy so that the omitted category includes corporate plans and non-US public plans. The negative and significant coefficient on US public indicates that these plans have the weakest overall performance (29 basis points lower) and the negative coefficient on de-meaned size is consistent with lower scale economies but is not significant. Columns (3) and (4) repeat this analysis including a control for percentage of holdings that are not external active and the results are essentially unaltered. If the results are driven by constraints on resources and the ability to attract and motivate the right managers, then plans with fewer constraints should have higher returns *and* costs. This is what we see in (5) and (7), where the corporate dummy indicates 61 basis points improvement in gross returns, with a positive but insignificant coefficient on the interaction with size, more than enough to cover the 4 basis points cost increase. US public plans have particularly bad returns, with column (8) implying a performance drop of 1.47%, a loss that is only partially offset by lower costs in (6).[36]

VI.2 Lack of Scale Economies in Smaller Plans

Finally, we return to a finding from Section III (e.g., regression (9) in Table III) where we reported no evidence of scale economies when we restricted our attention to smaller plans, and some evidence of superior returns for the smallest quintile plans. Our interpretation is that this evidence is consistent with diseconomies of scale at the fund (asset class) level that are not sufficiently offset by positive economies of scale at the plan level in this size range. First, in

[36] In untabulated tests we found additional evidence of resource constraints of US public plans in that they rely more on outsiders for investment advice (rather than generate advice internally). US public plans pay more to consultants, both in terms of the overall level of consulting costs and as the fraction of their overall investment administration expenditures. These results are not driven by public plans' higher portfolio complexity, as proxied by the portfolio weight on alternative assets.

Table II we report weakly stronger returns in equities for first quintile plans compared to second quintile plans. Bauer, Cremers, and Frehen (2010) explore this more fully for US plans investing in US equities and find that smaller plans do particularly well in US small cap equities, where diseconomies are more likely. Second, we find that second quintile plans shift resources to alternatives almost as aggressively as larger plans, but have particularly poor returns in that asset class. In contrast, first quintile plans scarcely invest in alternatives, devoting half as much of their portfolio to this category (3% for Q1 versus 6% for Q2). Their performance in alternatives is not as bad, with Table II showing a return of -13 rather than -87 basis points, and the coefficient on Q1 dummy being positive (but insignificant) in Table VI column (4). The behavior of second quintile plans is consistent with them believing they are big enough to play the alternatives game, but in reality not being equipped to deliver. In contrast, the smallest plans understand their limitations and stay out of the game or only play at the margins.

VII Conclusions

We use a novel proprietary dataset to examine the relationship between size and performance in asset management in defined benefit pension plans. We document that pension plans are operating in a region where there are *positive* economies to scale: Larger plan size is associated with better performance of the entire pension plan portfolio. The effect is economically sizeable: Returns on the largest plans are higher by 43-50 basis points/ year.

To explain this finding, we hypothesize and find that plans react to changes in size by exploiting their freedom of action by using more internal management (exploiting their "make versus buy" option) and by shifting resources to where larger plans have a comparative advantage (alternatives, particularly private equity and real estate). A third to a half of the benefits of size come through cost savings realized by larger plans, primarily via internal management. Up to two thirds of the economies come from substantial gains in *both* gross and net returns on alternatives. For example, the movement from 1st to 5th size quintile improves net abnormal returns in real estate and private equity by as much as 6% per year. We interpret this as being driven both by cost savings and by superior monitoring/screening of managers. We also find that the ability to take advantage of scale is conditioned by plan governance, with better governed plans having higher scale economies.

The results contribute most directly to the theoretical and empirical literatures that explore scale in asset management and likely generalize to other larger multi-asset-class asset managers such as endowments, foundations and sovereign wealth funds. The findings suggest the importance of practices that can delay and in cases even more than offset scale-related diseconomies at the fund level, particularly highlighting the widespread practice and growing importance of larger plans substituting internal for external management and the particular importance of alternatives to these large investors. Our finding that the benefits of scale accrue mainly to well governed plans helps in part to reconcile our results with Stein's (2002) concerns about organizational diseconomies, but more work is needed to understand how the hypothesized organizational diseconomies are addressed in practice in these pension plans. This remains a topic for our future research.

Finally, our results suggest welfare costs to the current pension system. Many defined benefit pension plans are currently facing significant opportunity costs arising solely from their size. This produces costs for plan members and their firms, and the society at large. It also suggests opportunity costs for members of defined contribution plans, to the extent that they lack access to large plans with enough degrees of freedom to capture positive economies of scale.

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Figure 1. Do larger plans have higher performance? This figure presents the relationship between the overall plan size and net abnormal plan returns, with size ranging from the 5th to the 95th percentile (from the 5th percentile to \$10B) in the graph on the left (right). The graphs in the top row exhibit fitted values for specification (6) from Table III (solid line) and its variants with quadratic (dotted line) and quadratic and cubic (dash-dotted line) terms for log size. The graphs in the bottom row exhibit fitted values for two specifications from Table III: (6) (solid line) and (10) (dash-dotted line). We superimpose the average net abnormal returns for size quintiles based on the raw data (from Table II) on all graphs.

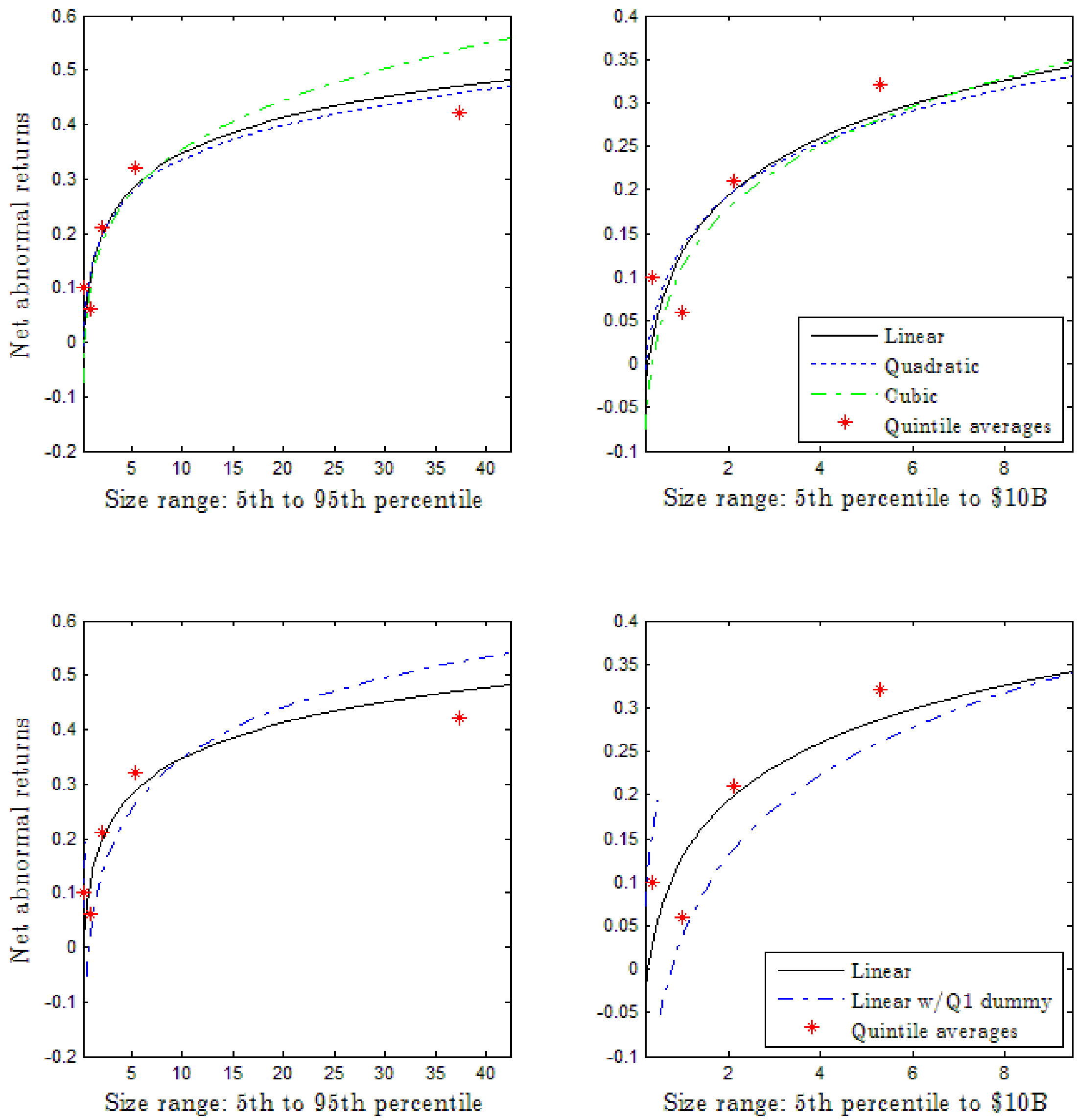

Figure 2. Do larger plans manage their holdings differently? The top (middle, bottom) panel presents the fraction of plans that have any non-external-active (any passive, any internal) holdings in public equities, fixed income, private equity, and real estate. Each point corresponds to the average fraction of plans within a given size decile, where decile 1 (10) is comprised of the smallest (largest) plans. This graph is constructed using the data on the cross-section of plans in 2007.

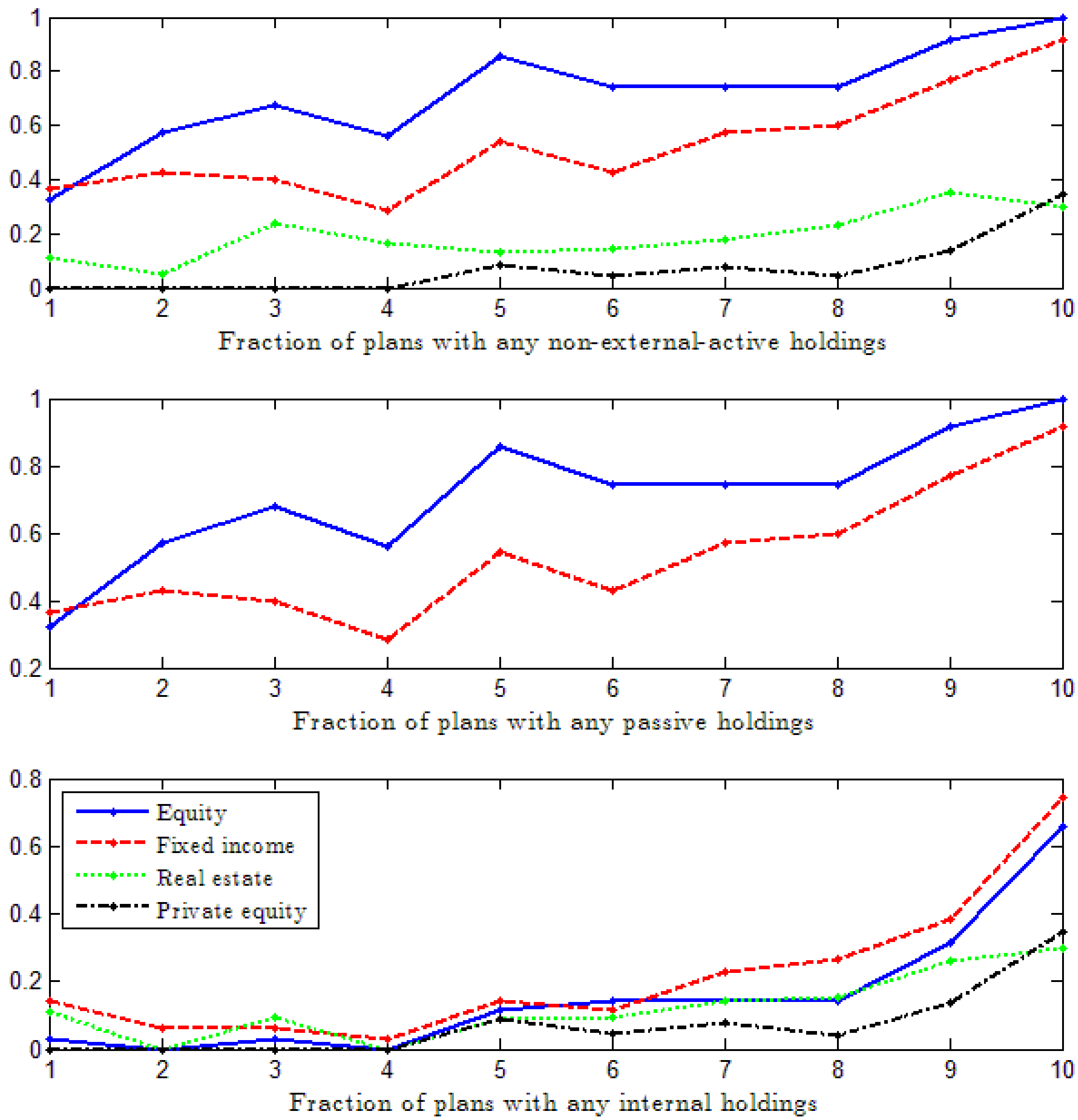

Figure 3. Do larger plans allocate more to alternatives? This figure presents portfolio weights of fixed income, public equities, and alternative assets for plans sorted into deciles based on their size. The graph depicts values estimated using the Fama-MacBeth method: Each sample year, size deciles are redefined and the average portfolio weights are computed within each decile. The final estimate for each decile is the time-series average of the cross-sectional averages.

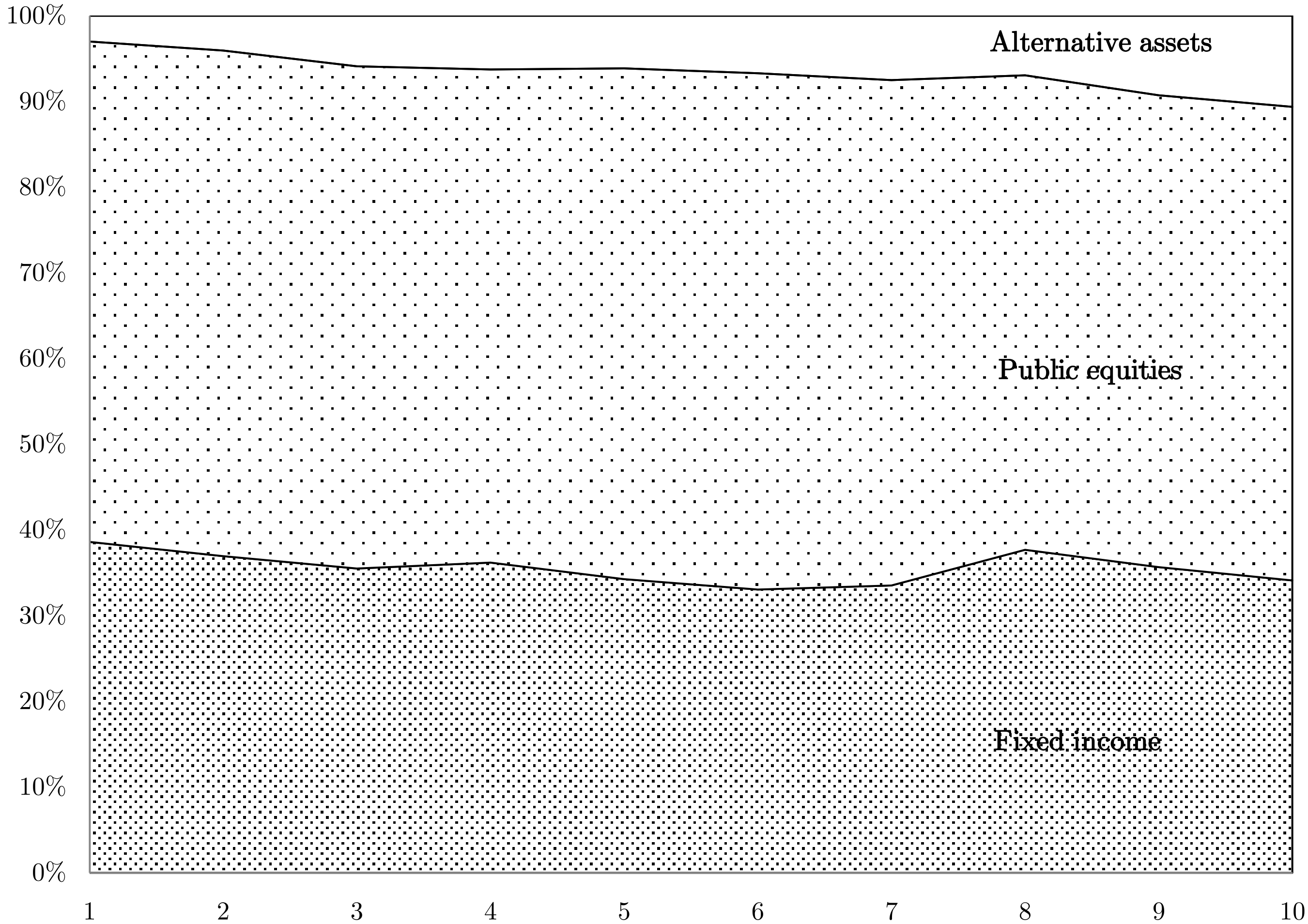

Table I. Summary statistics. This table presents summary statistics from the CEM Benchmarking, Inc. database of defined benefit pension plans. Panel A provides key summary characteristics at the plan level. Panel B presents performance data by asset class, with different asset classes ranked by interquartile range in performance. In Panel A, "Sample characteristics" are time series statistics based on 19 years of data. The remaining numbers in the table are estimated using the Fama-MacBeth approach: In each year, cross-sectional statistics are computed for the plans/ asset classes with data in that year; the table presents time-series averages of these cross-sectional estimates. Net returns (net abnormal returns) are defined as gross returns minus costs (net returns minus benchmark returns) and are computed for each asset class and value-weighted to a plan-level measure. Net returns and costs in Panel A include both asset-class-level costs and plan-level costs of investment administration. Net returns and costs in Panel B only include asset-class-level costs.

Panel A: Summary statistics for plans.

	# obs	Mean	St.dev.	25th %	Median	75th%
Sample characteristics						
# plans/ year	19	263.6	67.9	269	285	296
Total dollars (US $ billion)/ year	19	2576.6	1671.2	1018.1	2595.4	4118.9
Plan characteristics						
# observations/ plan	842	5.95	5.40	1	4	10
% liabilities due to current retirees	18	46.56%	15.46%	37.40%	46.54%	55.65%
Overall plan size (US$M)	19	9158.6	21764.4	779.8	2023.7	6375.1
Asset allocation						
% in equities	19	54%	12%	48%	55%	61%
% in fixed income	19	33%	12%	26%	33%	39%
% in alternatives	19	6%	6%	1%	5%	10%
Style of management						
% passively or internally managed	19	32%	30%	6%	23%	51%
% passively managed	19	19%	20%	1%	12%	29%
% internally managed	19	17%	29%	0%	0%	18%
Overall plan performance						
Gross returns (in %)	19	9.2	4.9	5.5	8.9	12.7
Net returns (gross-cost, in %)	19	8.8	4.9	5.2	8.4	12.3
Net abnormal returns (gross-cost-benchmark, in %)	19	0.22	2.13	-0.94	0.12	1.24

Table I, Panel B: Summary statistics for asset classes.

	Costs (in bps)				Gross returns (in %)				Net abnormal returns (in %)			
	Mean	St.dev.	Median	avg x-plan IQR	Mean	St.dev.	Median	avg x-plan IQR	Mean	St.dev.	Median	avg x-plan IQR
Fixed income												
Total	16	3	17	14	8.2	6.9	7.4	7.3	0.04	0.80	0.24	1.46
Public equities												
Total	29	6	30	21	9.1	19.4	14.0	8.2	0.38	1.42	0.26	2.96
Alternative assets												
Real estate	76	10	76	60	7.5	9.1	8.0	10.2	-0.78	1.35	-0.78	7.08
REITs	35	11	35	46	8.1	15.5	8.0	12.4	1.08	4.57	0.15	6.13
Hedge funds	188	13	188	132	4.7	10.9	7.1	12.3	-1.66	4.89	-0.96	8.77
Private equity	252	116	218	181	12.8	14.2	18.5	19.3	0.10	8.27	-0.31	17.10

Table II. Summary statistics for plans sorted on size. Each year we sort plans based on their size (overall pension plan holdings) into quintiles and summarize main plan characteristics within each quintile (each value is the time-series average of cross-sectional means, computed across 19 years of data in our sample). For each asset class, net returns (net abnormal returns) are defined as gross returns minus costs (net returns minus plan-specific benchmark returns for a given asset class). Plan-level net returns are value-weighted averages of asset-class returns and also include plan-level costs of investment administration. Asset class level net (abnormal) returns and costs only include asset class level costs. Standard deviation of returns, Sharpe ratios (average excess net returns over standard deviation of returns), and information ratios (average net abnormal returns over standard deviation of net abnormal returns) are computed using annual returns on equal-weighted portfolios of plans in each quintile.

	smallest Q1	Q2	Q3	Q4	largest Q5	Q5-Q1	Q5-Q2
Plan characteristics							
Plan size ($US million)	342	994	2101	5300	33088	32745	32094
% US plans	24%	52%	64%	75%	72%	47%	20%
% corporate plans	64%	57%	65%	52%	31%	-34%	-26%
% liabilities due to current retirees	46	47	47	47	48	2	2
Overall plan performance							
Net returns (%)	8.84	8.39	8.88	9.01	9.17	0.33	0.78
Net abnormal returns (%)	0.10	0.06	0.21	0.32	0.42	0.33	0.36
Standard deviation of net returns	13.32	12.66	13.00	12.32	12.28	-1.04	-0.37
Sharpe ratio (using net returns)	0.36	0.34	0.37	0.40	0.42	0.06	0.07
Information ratio	0.07	0.05	0.18	0.31	0.45	0.38	0.40
Gross plan returns (%)	9.27	8.82	9.28	9.34	9.42	0.15	0.60
Overall asset-class-level costs (bps)	45	43	39	33	25	-20	-19
Plan-level administrative costs (bps)	12	8	6	4	3	-9	-5
Costs and performance by asset class							
Net abnormal equity returns (%)	0.41	0.35	0.32	0.48	0.35	-0.06	0.004
Overall equity costs (bps)	37	36	31	27	16	-20	-20
Net abnormal fixed income returns (%)	-0.14	-0.13	0.09	0.20	0.21	0.35	0.34
Overall fixed income costs (bps)	20	19	18	14	9	-11	-10
Net abnormal alternative assets returns (%)	-0.13	-0.87	0.11	0.08	1.30	1.43	2.17
Overall alternatives costs (bps)	93	130	119	120	115	23	-15
Ratio of costs of external active management to costs of internal active management							
Equity	2.8	2.6	3.4	3.5	3.2	0.4	0.6
Fixed income	1.7	2.5	3.0	3.9	5.1	3.4	2.6
Alternatives	3.0	5.7	4.5	5.0	6.9	3.8	1.1

Table III: Do larger plans achieve higher performance? The dependent variable is the overall plan net abnormal return in year *t*, computed as the value-weighted average of net abnormal returns on each of the asset classes the plan invests in, minus the plan-level investment administration costs (including audit, oversight, custodial, and consulting costs). For each asset class, we compute net abnormal returns as gross returns minus costs minus benchmark for a given asset class. The main independent variable is log of plan size at the end of year *t*-1. In Panel A, benchmarks are as reported in our data. In Panel B columns 1-8 we compute abnormal performance using benchmarks defined as the average or the median plan performance in a given asset class. For Panel B columns 9 and 10, each year and for each asset class, plan net abnormal returns are ranked into percentiles (the lowest rank is the inverse of the number of plans active in a given asset class in a given year, the highest rank is 1). The overall performance measure is the value-weighted average percentile performance rank. In Panel A, regressions 1-3 are estimated over the sample of US plans, 4 – Canadian plans, 5 – European and Australian/ New Zealand plans, 6-9 and 10 over the pooled sample, and 7 over plans in the two smallest size quintiles. In Panel B, all regressions are estimated over the full sample. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table III, Panel A: Abnormal net performance computed using benchmarks reported in the CEM database.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample:	US	US	US	Can	Euro&Aus	All	All	All	Q1,Q2	All
Log of end of year *t*-1 plan size	0.087**	0.080**	0.098***	0.096**	0.183**	0.095***	0.086***		-0.001	0.135***
	(2.45)	(2.26)	(2.76)	(2.25)	(2.14)	(3.75)	(3.64)		(-0.01)	(4.46)
Corporate plan dummy			0.245**	0.025	0.128	0.147*	0.140*	0.142*	-0.028	0.156**
			(2.33)	(0.20)	(0.45)	(1.84)	(1.86)	(1.77)	(-0.22)	(1.98)
Non-US plan dummy						0.091	0.107	0.052	0.154	0.059
						(1.07)	(1.32)	(0.61)	(1.02)	(0.69)
Net abnormal return in year *t*-1							0.081***			
							(2.64)			
Plan size in Q1								-0.357***		0.260*
								(-2.74)		(1.92)
Plan size in Q2								-0.499***		
								(-4.32)		
Plan size in Q3								-0.310***		
								(-2.71)		
Plan size in Q4								-0.273**		
								(-2.56)		
Observations	2185	2185	2185	1431	213	3829	3789	3829	1537	3829
R-squared	0.002	0.231	0.233	0.259	0.256	0.182	0.189	0.183	0.230	0.183
Year FE	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Economic effects:										
Effect of Q1 to Q5 change	0.40	0.37	0.45	0.44	0.84	0.43	0.39		-0.005	0.62
Effect of Q2 to Q5 change	0.30	0.28	0.34	0.34	0.64	0.33	0.30		-0.004	0.47

Table III, Panel B: Abnormal performance computed using benchmarks defined as the average or the median plan return in each asset class in each year (regressions (1) through (8)), or computed as the value-weighted percentile ranking of a plan's performance within each asset class (regressions (9) and (10)).

	(1)	(2)	(3)	(4)	(5)
Performance correction:	Benchmark=average return		Benchmark=median return		Rank-based measure
Log of end of year *t*-1 plan size	0.129***	0.147***	0.163***	0.159***	0.008***
	(4.76)	(5.13)	(5.93)	(5.52)	(3.73)
Corporate plan dummy	0.332***	0.346***	0.323***	0.369***	0.003
	(3.88)	(4.02)	(3.69)	(4.24)	(0.47)
Non-US plan dummy	0.158*	0.187*	0.160*	0.146	-0.006
	(1.70)	(1.96)	(1.70)	(1.53)	(-0.85)
Observations	3,829	3,829	3,828	3,828	3,829
R-squared	0.007	0.015	0.009	0.036	0.009
Year FE	NO	YES	NO	YES	YES
Economic effects:					
Effect of Q1 to Q5 change	0.59	0.67	0.75	0.73	
Effect of Q2 to Q5 change	0.45	0.52	0.57	0.56	

Table IV. Does avoiding external active management generate returns? The dependent variable is year t plan-level net abnormal returns (in %) in (1) through (4); plan-level costs (in basis points) in (5) and (6); and plan-level gross returns (in %) in (7) and (8). The main independent variables are the fraction of plan holdings that are not external active and the log of plan size in year t-1. Plan-level returns and costs are computed as the value-weighted average of returns and costs on each of the asset classes the plan invests in. Net abnormal returns are computed as in Table III. Regressions are estimated over the pooled sample with year fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Net abnormal returns		Costs		Gross returns	
% holdings that are not external active	0.325**		-26.17***		0.051	
	(2.15)		(-13.43)		(0.12)	
% holdings that are internally managed		0.411***		-16.27***		-0.225
		(2.71)		(-7.71)		(-0.52)
% holdings that are passively managed		0.047		-20.71***		0.410
		(0.31)		(-5.21)		(1.12)
Log of end of year t-1 plan size	0.065**	0.055*	-2.90***	-3.24***	0.081	0.095
	(2.25)	(1.80)	(-7.41)	(-7.91)	(1.17)	(1.28)
Corporate plan dummy	0.154*	0.159**	4.53***	4.34***	0.594***	0.593***
	(1.93)	(2.01)	(3.82)	(3.62)	(3.53)	(3.53)
Non-US plan dummy	0.040	0.012	-9.88***	-10.77***	0.701***	0.752***
	(0.46)	(0.13)	(-7.72)	(-7.89)	(3.63)	(3.73)
Observations	3,829	3,829	4,950	4,950	3,829	3,829
R-squared	0.183	0.184	0.405	0.380	0.867	0.867

Table V. Do larger plans invest more in alternative assets? The dependent variable is the portfolio weight on overall alternative assets (holdings of alternative assets over plan size, regressions 1 and 2) and on portfolio weight on components of alternative assets (holdings of hedge funds, private equity, and real assets over plan size, regressions 3 to 10). Regressions are estimated over the pooled sample with year fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable: weight on	All alternatives		Hedge funds		Private equity		Real estate		REITs	
Log plan size	0.014***	0.011***	0.001	-0.001	0.006***	0.003*	0.006***	0.008***	0.001***	0.001
	(8.99)	(2.92)	(0.79)	(-1.03)	(7.55)	(1.71)	(6.10)	(3.09)	(3.63)	(1.24)
% liabilities due to retirees		-0.087**		-0.039*		-0.058***		0.018		-0.006
		(-1.99)		(-1.78)		(-2.79)		(0.60)		(-0.49)
% liabilities due to retirees * size		0.011*		0.005		0.008***		-0.002		0.001
		(1.80)		(1.51)		(2.64)		(-0.48)		(0.46)
Corporate plan dummy		-0.000		0.002		0.007***		-0.006**		-0.002**
		(-0.11)		(0.72)		(3.41)		(-1.99)		(-2.34)
Non-US plan dummy		-0.005		-0.005*		-0.010***		0.005		0.000
		(-1.03)		(-1.66)		(-5.63)		(1.40)		(0.30)
Observations	5008	4202	2683	2440	5008	4202	5008	4202	5008	4202
R-squared	0.200	0.251	0.045	0.055	0.114	0.205	0.090	0.111	0.073	0.083

Table VI. Do larger plans have greater returns in asset classes they overweight? In Panel A the dependent variable is net abnormal return on private equity (in %) in year t and the main independent variable is log of year t-1 private equity holdings. Panel B summarizes regressions with the same controls as in Panel A for other asset classes and reports the coefficients on log holdings of these asset classes. Regressions are estimated over the pooled sample and, where indicated, with year and plan fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Regressions of net abnormal returns on private equity on holdings of private equity and controls.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log of end of year t-1 holdings	1.254***	1.289***	1.346***	1.337***	1.237***	1.159	1.094***	1.778**	1.842**
	(5.27)	(5.14)	(3.69)	(4.98)	(4.79)	(1.60)	(4.90)	(2.41)	(2.48)
Log (plan size-holdings)			-0.114						
			(-0.24)						
Corporate plan dummy		2.490**	2.430**	2.467**	2.377**	2.311	2.230**		
		(2.35)	(2.31)	(2.33)	(2.22)	(0.97)	(2.28)		
Non-US plan dummy		-0.235	-0.225	-0.309	-1.158	-4.745**	-0.280		
		(-0.21)	(-0.20)	(-0.28)	(-1.00)	(-2.01)	(-0.28)		
Plan size in Q1				1.409					
				(0.64)					
% holdings internally managed					3.206*				
					(1.66)				
Average mandate size						0.009**			
						(2.37)			
Net abnormal return in year t-1							0.110***		-0.024
							(3.36)		(-0.53)
Observations	1,897	1,897	1,897	1,897	1,897	195	1,844	1,897	1,844
R-squared	0.166	0.169	0.169	0.169	0.170	0.135	0.176	0.335	0.334
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Plan FE	NO	NO	NO	NO	NO	NO	NO	YES	YES
Economic effects:									
Effect of Q1 to Q5 change	5.97	6.13	6.41	6.36	5.89	5.52	5.21	8.46	8.77
Effect of Q2 to Q5 change	4.60	4.73	4.94	4.90	4.54	4.25	4.01	6.52	6.76

Table VI, Panel B: Size coefficients in regressions of net abnormal returns on holdings of other asset classes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Private equity	1.254***	1.289***	1.346***	1.337***	1.237***	1.159	1.094***	1.778**	1.842**
	(5.27)	(5.14)	(3.69)	(4.98)	(4.79)	(1.60)	(4.90)	(2.41)	(2.48)
Real estate	0.695***	0.783***	0.832***	0.863***	0.725***	1.013**	0.582***	0.412	0.343
	(5.82)	(6.18)	(3.49)	(6.22)	(5.67)	(2.48)	(5.49)	(0.94)	(0.79)
REITs	0.712*	0.652*	1.055*	0.751**	0.891**	-0.032	0.543	0.047	0.210
	(1.95)	(1.76)	(1.92)	(1.98)	(2.33)	(-0.03)	(1.56)	(0.04)	(0.17)
Hedge funds	0.099	0.059	-0.399	0.099	0.059	-0.209	-0.011	-1.283	-1.240
	(0.32)	(0.19)	(-1.08)	(0.36)	(0.19)	(-0.20)	(-0.04)	(-1.15)	(-1.10)
Public equities	-0.021	0.019	0.184	0.045	-0.016	-0.115**	0.012	-0.238	-0.291
	(-0.65)	(0.53)	(1.51)	(1.11)	(-0.39)	(-1.99)	(0.36)	(-0.97)	(-1.16)
Fixed income	0.060***	0.052**	-0.005	0.057*	0.028	0.059	0.046**	0.287	0.284
	(2.89)	(2.18)	(-0.06)	(1.94)	(0.95)	(1.00)	(1.98)	(1.40)	(1.41)

Note: regression (5) cannot be estimated for hedge funds as hedge funds are exclusively externally managed.

Table VII. Economies of scale in private equity: controlling for vintage and j-curve effects. This table presents regressions of net abnormal returns in externally managed private equity on log of size of external holdings of private equity and controls for the vintage of the investments: the fraction of assets still in the commitment period and the average age of the investment, computed as the invested-amount-weighted average age (current year minus the vintage year of a particular LP position). The vintage data are only available for 30 plans for the year 2008. We estimate the regressions on the cross-section of plans in 2008, as well as on the panel of plans in years 2006 to 2008 (plans with the average investment age of less than one (two) years are not included in the regressions that use 2006 (2007) data). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample:	2008 data only				2006-2008 data (3 years of data)			
log external private equity holdings	2.110	1.629	1.265	1.408	1.818*	1.775*	1.493	1.506
	(1.13)	(0.99)	(0.70)	(0.83)	(1.83)	(1.76)	(1.38)	(1.39)
% assets in commitment period		-25.207**		-22.940**		-3.252		-2.102
		(-2.23)		(-2.06)		(-0.45)		(-0.26)
Avg. age of private equity investment			2.417	0.755			1.365	1.286
			(1.04)	(0.34)			(1.01)	(0.93)
Constant	-6.560	14.333	-8.399	11.879	-8.936	-6.343	-9.868	-8.283
	(-0.59)	(1.07)	(-0.79)	(0.83)	(-1.46)	(-0.72)	(-1.44)	(-0.88)
Observations	30	30	30	30	78	78	71	71
R-squared	0.050	0.188	0.103	0.192	0.047	0.050	0.072	0.073

Table VIII. What drives the economies of scale in alternative assets? Panel A presents regressions of private equity year t costs (in bps) and gross returns (in %) on log of year t-1 holdings of private equity and controls. Panel B summarizes similar regressions for other components of alternative assets: real estate, REITs, and hedge funds, and reports the coefficients on log holdings of these asset classes from regressions with the same controls as those in Panel A. Regressions are estimated over the pooled sample with year plan fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Regressions of private equity costs (in bps) and gross returns (in %) on holdings of private equity and controls.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:		Costs			Gross returns	
Log of end of year t-1 holdings	-24.848***	-32.121***	-29.034***	1.237***	1.079***	1.081***
	(-4.20)	(-5.31)	(-5.01)	(4.47)	(3.82)	(3.79)
Corporate plan dummy		-108.334***	-101.645***		0.906	0.911
		(-4.91)	(-4.71)		(0.87)	(0.86)
Non-US plan dummy		-76.347***	-22.033		-2.683**	-2.641**
		(-3.02)	(-0.72)		(-2.31)	(-2.15)
% holdings internally managed			-188.624***			-0.143
			(-6.18)			(-0.05)
Observations	1897	1897	1897	1897	1897	1897
R-squared	0.135	0.178	0.207	0.361	0.364	0.364
Year FE	YES	YES	YES	YES	YES	YES
Plan FE	NO	NO	NO	NO	NO	NO
Economic effects:						
Effect of Q1 to Q5 change	-118.25	-152.86	-138.17	5.89	5.13	5.14
Effect of Q2 to Q5 change	-91.13	-117.80	-106.48	4.54	3.96	3.96

Table VIII, Panel B: Size coefficients in regressions of costs and gross returns on holdings of other alternative asset classes.

	(1)	(2)	(3)	(4)	(5)	(6)
	Costs			Gross returns		
Private equity	-24.848***	-32.121***	-29.034***	1.237***	1.079***	1.081***
	(-4.20)	(-5.31)	(-5.01)	(4.47)	(3.82)	(3.79)
Real estate	-4.921***	-7.025***	-5.719***	0.548***	0.579***	0.559***
	(-5.02)	(-7.82)	(-6.44)	(4.13)	(4.26)	(4.02)
REITs	-8.715***	-8.438***	-4.880***	0.631*	0.557	0.597
	(-4.68)	(-4.31)	(-2.64)	(1.66)	(1.51)	(1.49)
Hedge funds	-12.965***	-12.611***	N/A	-0.051	-0.073	N/A
	(-3.01)	(-3.10)	N/A	(-0.17)	(-0.24)	N/A

Note: regressions (3) and (6) cannot be estimated for hedge funds as hedge funds are exclusively externally managed.

Table IX. Is there evidence consistent with learning/monitoring? Regressions in this table illustrate spillovers between internally and externally managed investments. The dependent variable is year *t* net abnormal return on external active holdings of overall alternatives, private equity, real estate, overall public equities, and overall fixed income. The main independent variables are log of year *t*-1 external active holdings of a given asset class and year *t* net abnormal return on internal active holdings of the same asset class. Regressions are estimated only for plans that have both internally and externally managed holdings in the given asset class. Additional controls include corporate and non-US plan indicators and year fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Asset class:	(1) Private equity	(2) Real estate	(3) Alternatives	(4) Public equities	(5) Fixed income
Log end of year *t*-1 holdings	1.326*	-0.256	0.334	0.677***	-0.148
	(1.93)	(-0.53)	(1.05)	(3.32)	(-0.92)
Internal active net abnormal return	0.334***	0.190	0.095*	0.022	0.007
	(4.09)	(1.51)	(1.84)	(0.35)	(0.15)
Corporate plan dummy	2.551	4.339**	0.750	-0.041	0.931**
	(0.90)	(2.64)	(0.65)	(-0.08)	(2.27)
Non-US plan dummy	1.305	-2.887	-1.139	0.532	-1.533***
	(0.42)	(-1.23)	(-1.00)	(0.80)	(-3.26)
Observations	158	129	491	646	517
R-squared	0.356	0.409	0.139	0.197	0.272

Table X. Does governance influence economies of scale? This table reproduces the main regressions from Tables III and IV, with interaction terms between plan size and proxies for plan governance (an indicator for US public plans and an indicator for corporate plans). Returns are in percentages, costs are in basis points. All regressions include year fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	Net abnormal returns				Costs		Gross returns	
Log of end of year *t*-1 plan size	0.058**	0.104***	0.019	0.081***	-2.183***	-1.094**	0.009	0.100
	(2.13)	(3.63)	(0.63)	(2.67)	(-3.79)	(-2.57)	(0.12)	(1.43)
Corporate plan dummy	0.156**		0.164**		3.793***		0.611***	
	(1.98)		(2.09)		(2.73)		(3.62)	
Corporate dummy * de-meaned size	0.101**		0.114**		-0.876		0.181	
	(2.19)		(2.45)		(-1.28)		(1.64)	
US public dummy		-0.294***		-0.269***		-0.276		-1.471***
		(-3.01)		(-2.74)		(-0.19)		(-7.33)
US public dummy * de-meaned size		-0.014		-0.024		-1.431**		-0.050
		(-0.29)		(-0.49)		(-2.00)		(-0.45)
Non-US plan dummy	0.116		0.062		-9.387***		0.735***	
	(1.36)		(0.71)		(-6.34)		(3.77)	
% holdings that are not external active			0.366**	0.292**	-26.977***	-31.766***	0.116	0.139
			(2.43)	(1.97)	(-11.72)	(-14.00)	(0.28)	(0.35)
Observations	3829	3829	3829	3829	3829	3829	3829	3829
R-squared	0.183	0.183	0.184	0.184	0.387	0.334	0.867	0.868

Table AI. Relationship between net abnormal returns and size: robustness checks. This table re-estimates the main specifications from Tables III and VII for subsamples of the data. Panel A presents estimation results for the subsample of US plans. Panel B summarizes the estimates on plan and holdings size for similar specifications for various other subsamples of the data. All regressions include year fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Key specifications estimated for US plans only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Asset class	Overall plan		Private equity		Real estate		REITs		Hedge funds	
Log of end of year *t*-1 plan size	0.10***	0.12***	1.11***	1.16***	0.71***	0.77***	0.07	0.19	-0.30	-0.03
	(2.76)	(3.28)	(3.09)	(3.11)	(4.52)	(4.66)	(0.13)	(0.38)	(-0.61)	(-0.06)
Corporate plan dummy	0.25**	0.25**	3.08**	3.04**	0.98*	0.96*	-0.32	-0.43	1.58	1.35
	(2.33)	(2.43)	(2.43)	(2.41)	(1.86)	(1.83)	(-0.28)	(-0.38)	(1.20)	(1.04)
Plan size in Q1		0.28		2.33		1.64		3.55		7.25
		(1.14)		(0.51)		(1.45)		(1.27)		(1.42)
Observations	2,185	2,185	1,281	1,281	1,522	1,522	426	426	247	247
R-squared	0.233	0.234	0.218	0.219	0.076	0.078	0.036	0.039	0.220	0.238

Table AI, Panel B: Coefficients on plan size and holdings size for various sub-samples of the data.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Asset class:	Overall plan		Private equity		Real estate		REITs		Hedge funds	
Benchmark -- all plans	0.09***	0.13***	1.29***	1.34***	0.78***	0.86***	0.65*	0.75**	0.06	0.10
(as in the paper)	(3.75)	(4.46)	(5.14)	(4.98)	(6.18)	(6.22)	(1.76)	(1.98)	(0.19)	(0.36)
US plans only	0.10***	0.12***	1.11***	1.16***	0.71***	0.77***	0.07	0.19	-0.30	-0.03
	(2.76)	(3.28)	(3.09)	(3.11)	(4.52)	(4.66)	(0.13)	(0.38)	(-0.61)	(-0.06)
Canadian plans only	0.10**	0.15**	1.32***	1.43***	1.06***	1.24***	1.83	1.81	-0.002	-0.40
	(2.25)	(2.46)	(3.73)	(3.66)	(4.37)	(4.29)	(1.55)	(1.45)	(-0.004)	(-1.24)
European & Australian/	0.18**	0.20*	1.74**	1.74**	0.89	0.80	0.85	0.96	0.46	0.46
New Zealand plans only	(2.14)	(1.87)	(2.55)	(2.55)	(0.99)	(0.87)	(1.45)	(1.63)	(0.96)	(0.96)
Public only	0.06**	0.11***	1.82***	1.85***	0.77***	0.88***	0.30	0.29	-0.18	-0.17
	(2.11)	(2.96)	(6.09)	(6.04)	(3.64)	(3.80)	(0.55)	(0.52)	(-0.41)	(-0.40)
Non-public only	0.07**	0.13***	1.77***	1.80***	0.79***	0.90***	0.73*	0.83*	0.21	0.05
	(2.43)	(3.79)	(6.40)	(6.10)	(4.35)	(4.46)	(1.71)	(1.91)	(0.52)	(0.14)
Excluding Q1	0.14***	0.14***	1.33***	1.33***	0.81***	0.81***	0.80**	0.80**	0.11	0.11
(plans in the smallest size quintile)	(4.57)	(4.57)	(4.82)	(4.82)	(5.78)	(5.78)	(2.14)	(2.14)	(0.41)	(0.41)
Excluding Q2	0.08***	0.12***	1.40***	1.44***	0.76***	0.85***	0.46	0.56	0.26	0.33
(plans in the second size quintile)	(2.92)	(3.27)	(6.12)	(6.08)	(5.50)	(5.44)	(1.25)	(1.48)	(0.70)	(0.84)
Excluding Q1 & Q2	0.14***	0.14***	1.52***	1.52***	0.87***	0.87***	0.63*	0.63*	0.14	0.14
(plans in the two smallest size quintiles)	(3.47)	(3.47)	(6.17)	(6.17)	(5.33)	(5.33)	(1.66)	(1.66)	(0.37)	(0.37)
Excluding Q5	0.04	0.11*	0.62*	0.64*	0.32**	0.33**	0.14	0.19	-0.07	-0.02
(plans in the largest size quintile)	(1.01)	(1.75)	(1.81)	(1.81)	(2.23)	(2.19)	(0.31)	(0.41)	(-0.22)	(-0.08)
Year<1999	0.18***	0.19***	1.13**	1.37***	0.65***	0.73***	0.08	2.54*		
(first half of the sample)	(5.57)	(4.34)	(2.46)	(3.00)	(4.08)	(4.34)	(0.04)	(1.88)		
Year>1998	0.05	0.10**	1.21***	1.14***	0.85***	0.92***	0.84**	0.83**	0.06	0.10
(second half of the sample)	(1.49)	(2.57)	(3.91)	(3.54)	(4.98)	(4.89)	(2.23)	(2.12)	(0.19)	(0.36)

Table AII. Do larger plans use more mandates? This table shows that larger plan increase the number of mandates, which may help them to postpone diseconomies of scale at the fund level, but that the increase in mandates is less than proportional to the increase in size. The dependent variable is the log of the number of external mandates in a given asset class in year *t*. The main independent variable is the log of the externally managed holdings of a given asset class in year *t*-1. Thus, the coefficient on log holdings can be interpreted as the elasticity. "Equities" ["Fixed income"] regression uses observations on all equity [fixed income] sub-classes (e.g., US equity, EAFE equity) that have data on the number of mandates; number of mandates on each equity [fixed income] subclass enters the regression as a separate observation. The last two rows report the F-test for the null hypothesis that the coefficient on log holdings is equal to one. Regressions are estimated over the pooled sample and include year and plan fixed effects, as indicated. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
						Alternative assets:		
Asset class:	Equities	US equity	US equity	Fixed income	Hedge funds	Private equity	Real estate	REITs
log holdings	0.353***	0.282***	0.168***	0.345***	0.431***	0.502***	0.282***	0.361***
	(22.18)	(12.41)	(3.64)	(14.91)	(7.76)	(8.15)	(5.73)	(5.03)
Corporate plan dummy	0.033	0.092		0.261***	-0.146	-0.210	-0.163	0.075
	(0.70)	(1.55)		(3.92)	(-0.84)	(-0.84)	(-0.95)	(0.66)
Non-US plan dummy	-0.081	-0.624***		0.165	-0.276	-0.162	-0.837***	0.040
	(-1.61)	(-8.28)		(1.09)	(-1.63)	(-0.69)	(-4.35)	(0.22)
Observations	5575	1965	1965	1590	164	222	316	131
R-squared	0.523	0.575	0.890	0.505	0.411	0.406	0.321	0.440
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Plan FE	NO	NO	YES	NO	NO	NO	NO	NO
F-test (H0: log holdings = 1)	1652.88	999.44	327.1	800.4	105.15	65.52	213.59	79.45
p-value	0	0	0	0	0	0	0	0

Table AIII. Do larger plans focus on less size-sensitive investment approaches? This table provides regression evidence consistent with the results reported in Figure 2: Larger plans devote a greater percentage of assets to approaches that do not involve hiring external active managers. The dependent variable is the fraction of plan assets that are not external active (i.e., that are managed internally or passively), at the level of the overall plan (specifications 1 and 2) or in a specific asset class (overall equities in 3-5, overall fixed income in 6-8, alternative assets in 9-11). The main dependent variables are the log of a plan's overall size and log of a plan's holdings in a given asset class. Regressions are estimated over the pooled sample with year fixed effects. T-statistics based on robust standard errors (clustered at the plan level) are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Asset class:	Overall plan		Equities			Fixed income			Alternative assets		
Log plan size	0.081***	0.093***	0.091***	0.097***		0.078***	0.099***		0.032***	0.055***	
	(11.56)	(13.19)	(13.86)	(13.72)		(7.58)	(10.31)		(2.92)	(5.62)	
Log holdings of asset class					0.055***			0.105***			0.007
					(2.88)			(3.01)			(0.69)
log (plan size - holdings)					0.041**			-0.005			0.045***
					(2.17)			(-0.14)			(3.08)
Corporate plan dummy		-0.022		-0.003	-0.003		-0.044	-0.033		-0.003	0.001
		(-1.00)		(-0.12)	(-0.15)		(-1.55)	(-1.13)		(-0.12)	(0.03)
Non-US plan dummy		0.145***		0.060***	0.061***		0.256***	0.236***		0.298***	0.292***
		(6.52)		(2.68)	(2.63)		(8.85)	(8.25)		(9.27)	(8.91)
Observations	5,008	5,008	4,989	4,989	4,978	4,990	4,990	4,981	3,976	3,976	3,971
R-squared	0.200	0.256	0.238	0.247	0.244	0.106	0.206	0.215	0.029	0.207	0.210