Is Bigger Better?
Size and Performance in Pension Plan Management

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First draft: May, 2010
This version: February, 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 45-50 basis points per year on a risk-adjusted basis. 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 net returns. Poor governance reduces overall plan returns and attenuates 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 sub-optimal scale for extended periods of time. Defined benefit 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, they 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 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. The scale of defined benefit plans is an area of current policy interest stimulated by the shrinking of plans that are closed to new contributors and the calls for increased freedom of larger plans to seek and manage assets of smaller plans. Finally, any size-related efficiencies in pension plans likely translate to other important asset managers such as large endowments and sovereign wealth funds.

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?

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

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

At the same time, defined benefit pension plans have greater degrees of freedom that give them the potential to mitigate these diseconomies of scale at the fund level and to find other economies of scale. One factor that we know very little about is the potential extent of cost savings arising from either negotiating power with external managers or from substituting external management with internal management. A second factor that may be important is the ability of managers to shift resource allocation from areas where diseconomies are more likely to areas where they are minimal or where there are even scale-related benefits (e.g., large plans may have access to better private equity deals).

Whether diseconomies or economies dominate is ultimately an empirical question. We explore it by exploiting a recently available dataset of multi-class defined benefit pension plans from CEM Benchmarking Inc. (CEM), a Toronto-based global benchmarking firm.[3] The database includes a large number of plans of varying size in the years 1990 to 2008. In 2008, the database covers assets of about US$6 trillion, and represents approximately 40% of US defined benefit assets, 65% of Canadian defined benefit assets, $1.6 trillion in European assets,

[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.
[3] The US data was used by French (2008) in his exploration of the costs of active investing, and by Bauer, Cremers, and Frehen (2010), who investigate scale effects in equity investing for US plans in US equities.

as well as 11 Australian/New Zealand plans.[4] Our unbalanced panel includes 842 unique plans, with a mean plan size of \$8.9 billion, and a median size of \$2 billion. The dataset has annual information on holdings and performance by investment approach within detailed asset class categories, with separate information on costs, gross returns, and benchmarks.

We offer four main findings. First, we find strong evidence of increasing rather than decreasing returns to scale. Bigger is better when it comes to pension plans. Using net abnormal returns (net returns minus benchmark returns), where we take into account the risk in asset allocation by including plan-specific benchmarks for each detailed asset class, we find a 45-50 basis point performance improvement associated with a movement from a \$1 billion plan to a plan with \$37 billion in assets (average size of the 5th size quintile plan). This gain is similar in magnitude to the reported benefits of passive management in US equities (French (2008)). Savings of participants in one of the largest plans, ceteris paribus, would be 13% larger at retirement than savings in a plan with \$1B in assets.[5]

What accounts for these economies of scale? Our second main finding is that larger pension plans are much more likely to utilize internal management across all asset classes, which results in cost savings and improved plan performance. Compared to first quintile plans, 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 compared to smaller plans, large plans manage 13 times more of their active assets internally (2.7% in the 1st quintile versus 35.4% in the 5th quintile). Internal management substantially reduces costs: the ratio of external active to internal active costs averages 3 for equities and fixed income and 5 for alternatives. Empirically,

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[4] The total value of defined benefit assets in the US (\$T5.4) and Canada (\$T0.64) are from the OECD Pensions Statistics Database. Unfortunately, we do not have similar numbers for other regions.

[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.

these cost savings account for between a third and one half of the overall benefit of size on performance.

Our third key finding is that the most significant contributor to economies of scale comes from larger plans shifting towards asset classes for which scale and negotiating power matter and obtaining superior performance in these ‘overweighted’ asset classes. Larger plans devote significantly more assets to alternative asset classes, where costs are high and where there is substantial variation in costs across plans. This shift in allocation is associated with statistically and economically large positive economies of scale in performance. 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.

One source of this substantial performance improvement in private equity and real estate is the cost discount for larger plans. Larger pension plans have access to co-investment opportunities that provide potential returns with no additional fees, and better negotiating power or a more sophisticated approach to contracts. Part of these cost savings are also accounted for by the largest plans using internal management for a portion of their alternative portfolios. Even more important are positive economies of scale in gross returns. These scale economies cannot be explained solely by greater access of large pension plans to top performing private equity and real estate funds, as the effect persists after controlling for lagged returns and plan fixed effects. Consistent with the importance of co-investment opportunities and skill, we find that returns on externally and internally managed assets are positively correlated, but that these spillovers only arise in alternative asset classes in which barriers to building internal management teams are the highest and where the advantage of large plans is likely to be the most pronounced.

Finally, we find that plan governance affects performance and the ability to take advantage of economies of scale. Long standing concerns about plan governance (e.g., Lakonishok, Shleifer, and Vishny (1992)) are likely greater in the public than in the private sector. Public plans have traditionally had limits on pay, while their spending on oversight and board composition has been heavily influenced by politics. Moreover, it is often unclear who is responsible for performance problems, with an implicit belief that the government will pick up the tab for any shortfall, which leads to particularly weak incentives to improve performance.[6] In corporate plans, in contrast, the shareholders of the firm ultimately bear the risk of these contractual commitments, which strengthens incentive alignment, and they do not face politically-driven resource constraints stopping them from addressing such issues. We expect the differences between public and corporate plans to be greatest in the US because of the greater differences between compensation in the public and private sector.[7] Our evidence supports this view. Using US public plan status and corporate status as proxies for poor and good governance respectively, we find that weaker governance is associated with weaker economies of scale and weaker returns, while stronger governance provides stronger returns and a greater ability to take advantage of scale economies.

What are the implications? Our finding that firms are able to increase their size without sacrificing performance supports the neoclassical theory of the firm and its focus on technologically determined economies of scale. Larger firms both access cost-effective internal management in progressively more asset classes and shift resources to classes where scale-related negotiating power matters, revealing how important technology-based scale economies can be. In contrast, our findings that scale improves performance and that larger plans rely more on

[6] Particular weaknesses in government accounting for pension plans likely contribute to this problem, as reported in Novy-Marx and Rauh (2010).
[7] In addition, 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, September 24, 2009, "At Calpers, a Revolving Door of Fees for Influence," Wall Street Journal, January 15, 2010, or "Illinois Confirms Inquiry by SEC," Wall Street Journal, January 25, 2011.

internal management are more puzzling from the perspective of theories of the firm such as Stein (2002). In his model scale reduces performance by increasing the costs associated with using soft information inside larger hierarchies. What offsets these organizational diseconomies? We provide a partial answer in showing that governance influences performance and scale economies. However, a more detailed investigation of organizational structures is needed to understand how the hypothesized diseconomies are addressed in practice, particularly given larger plans' increased reliance on internal management, where such diseconomies are likely to be more important.

Our findings likely hold not only for the $14 trillion in assets held by defined benefit plans, but also for other large institutional investors with similar characteristics. For example, sovereign wealth funds also have significant size that is in large part driven by political and exogenous factors rather than by efficiency considerations. Political considerations have driven governments to split assets into multiple funds in countries such as Singapore, Abu Dhabi, and China, but our results suggest that, at least for funds of similar size to the pension plans in our database, this has a cost. Similar scale issues also likely affect endowments.

Regarding defined benefit pension plans specifically, our estimates suggest that absent significant additional governance or political concerns about larger plans, there are gains to removing restrictions on or even providing incentives for larger plans to open themselves to manage assets from smaller plans.[8] Our results imply that the greatest benefits arise from making smaller plans substantially larger, as we find scale economies are the strongest in and beyond the second size quintile and we do not find that the economies are exhausted at very large sizes. That is, growing from $300M to $1B is not enough – plans need to grow to multi-billion size for positive scale economies to arise.

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[8] This is already happening with a number of large European funds (e.g. APG of the Netherlands) and is being considered by large Canadian pension plans such as Ontario Teachers Pension Plan and OMERS (e.g. http://www.omers.com/About_OMERS/OMERS_Investment_Management_Services_available_to_third_parties.htm)

The results also suggest costs associated with the shift from defined benefit to defined contribution plans. The shrinking defined benefit plans are predicted to face increasing costs as they reduce their scale. Our results also suggest it is costly for defined contribution plan participants to be unable to access the scale and freedom of action of defined benefit plans. Traditional defined contribution vehicles are at the fund level and may find it harder to avoid diseconomies. Currently there are no multi-asset class vehicles within the defined contribution universe that would have the freedom to shift assets to alternatives and the scale-related ability to get higher returns in those classes.

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.

I. The Economics of Asset Management

Before getting to our evidence, we briefly review some of the main findings from the asset management literature on the relationship between scale and performance.

I.1. Asset Management at the Fund Level

Because pension plans outsource the vast majority of their portfolios to external managers, in some cases directly to mutual funds, a starting point for assessing economies of scale at the pension plan level is to consider mutual fund evidence. A well known stylized fact in the fund literature is of diseconomies of scale. 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.[9] 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.

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.

I.2 Multi-Asset Class Asset Management

What the above analysis ignores is that defined benefit pension plans have additional degrees of freedom that are unavailable to funds. If plans are aware of the diseconomies, they could counteract them at the asset class level by increasing the number of external managers they employ, by switching towards less size-sensitive passive investment approaches within an asset class, and, perhaps most interestingly, by substituting internal for external management that may produce significant cost savings. The ability to move towards internal management

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

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. There may also be scale-related cost savings in external management, often ignored by the literature.[10]

Pension plan managers can also take advantage of their freedom to reallocate assets from classes where scale-related diseconomies are likely to be largest 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 settings 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.

The mutual fund literature also provides some indications of the benefits of scale in lowering costs. Chen, Hong, Huang, and Kubik (2004) not only show evidence of diseconomies of scale at the fund level, but also 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. Some papers using endowment data similarly find positive economies of scale in returns but do not focus on quantifying the impact (e.g. Brown, Garlappi, and Tiu (2009)), while others (e.g. Lerner, Schoar, and Wang (2008)) do not find a strong size effect once they control for other factors.[11] While interesting, it is unclear to what extent the findings on scale economies from endowments translate to larger pension plans, given that typical endowments are much smaller in size (the average endowment size is $M483 in their sample versus $B8.9 in our pension plan sample).

[10] E.g., Berk and Green (2004) assume that external managers appropriate all surplus by charging higher fees.
[11] In particular, Lerner et al. do not find an effect after controlling for whether an endowment is from an 'Ivy Plus' university, interpreting this as arising from the stronger alumni networks in such schools. Since alumni networks do not exist for pension plans, size may play a similar role in attracting better talent and governance.

Few other papers have used pension data to examine scale economies, but where they have they have focused primarily on specific investments in equities and fixed income finding diseconomies (e.g. Blake, Timmermann, Tonks, and Wermers (2010), who look at UK plan returns on UK fixed income and on UK and international equity, and Bauer, Cremers, and Frehen (2010), who look at US plan returns on US equities). As we will show, doing so ignores other potential impacts of scale in alternatives and at the overall plan level.

II – Data

We use detailed data on pension plan size and performance from 1990 to 2008 provided to us by CEM Benchmarking, Inc. (CEM), a Toronto-based global benchmarking firm. The data is based on information pension plans report on their asset allocation, costs, gross returns, and benchmarks. CEM performs checks on the data and takes steps to confirm its accuracy and reliability, and produces reports used by management and boards. 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 asset classes, we have performance data broken down along two dimensions, internal versus external management, and active versus passive management.[12]

The performance variable we focus on is net abnormal returns. Net abnormal returns are defined as gross returns minus costs minus benchmarks. Benchmarks are self-reported by plans and are available at the level of each asset class. To construct plan level net abnormal returns we construct net abnormal returns for each asset class (e.g., emerging market equity),

[12] Hedge funds are exclusively externally managed. Alternative asset classes are always actively managed. Some management styles and asset classes are rarely used, e.g., we only have 20 plan-year observations of internally managed passive emerging market equity.

then aggregate them to the plan level based on value-weights, and subtract plan level investment administration costs (e.g., oversight and custodial costs), which are not included in the asset-class-specific cost figures. Note that when looking at an asset class the costs include all costs directly related to that activity and an activity-based allocation of fixed costs to that activity.[13] Oversight and custodial costs that are not associated with a specific asset class are reported separately and included in overall plan-level but not in asset class-level analyses. The costs used in the study do not include any liability related costs such as benefit administration costs and insurance premiums. The database also has additional information on other items of interest, e.g. the number of external mandates, although coverage of such items is less extensive.

We use the provided data as given, with the following changes. The holding and performance data is provided in each plan's local currency. To ensure comparability we express asset holdings in (millions of) 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. (Of course, this assumption is only needed for non-US plans.) We winsorize costs and return the data at the 1st and the 99th percentile to avoid results being driven by a few extreme observations that remain even after the CEM vetting process.[14] We have a plan ID and a number of plan characteristics (e.g. country (e.g., US) or region (e.g., Euro zone) of the plan, ownership (corporate, public,

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[13] 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

[14] 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 within-asset class results weaker (this is because the most egregious outliers, e.g., reported costs in real estate that exceed 40%/year, occur for small plans).

other[15]), the fraction of liabilities that are due to current retirees, etc.) but do not have information on specific plan names so we cannot match the data with alternative data sets.

We provide summary statistics of the database in Table I. The data we use in this paper is based on survey responses of 842 distinct pension plans with 5008 plan-year observations. Corporate plans account for 54% of the sample and US plans account for 57% of the sample. The mean (median) length of time a plan is in the sample is 6 (4) years. To construct Table I, in each year we calculate the basic summary statistics based on the cross section of plans we have data on in the given year. The table reports the time series averages of the cross sectional statistics. 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 actively managed 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) for plans over our sample period 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 another point of reference, the average net abnormal return in US equity is -0.06%.

As with any relatively new data source there are natural concerns about potential biases. One concern is that plans only report in years when they did well. This would produce a positively skewed description of performance and may impact our results if this reporting bias were further related to plan size. Fortunately, Bauer, Cremers and Frehen (2010) address this issue with CEM data using their sample of US plans. They were able to enlist CEM support to match the CEM plans with Compustat data and find no evidence of performance-related biases.[16] A second potential concern is that there might be a bias in the benchmarks plans report

[15] The 'other' category accounts for 600 plan-year observations and includes pension plans with unspecified 'other' ownership, insurance funds, endowments and sovereign wealth funds. Non-pension plans represent 1.5% of observations in our sample. Results are robust to excluding this category.

[16] Specifically, Bauer et al. (2010) find no evidence that plans start reporting to the database when they have good performance and/or stop reporting when they have bad performance.

to CEM. We address this concern directly in the paper by also presenting results for gross returns with year fixed effects, which act as a common benchmark for a given asset class. More generally though, we have no strong reason to believe that benchmarks are strategically misreported or that if they were, this would be related to plan size. The reports that CEM produces based on the survey data are typically used by top management and boards of directors, and plans would have little reason to misreport and make this service less informative. Finally, we regressed benchmark returns on size and did not find any evidence of size-related differences that may influence our findings.

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 have divided the data into five quintiles by size, and the table reports 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 \$37 billion and median of \$21 billion) and smaller plans (1st and 2nd quintiles, with mean assets of \$342 and 994 million respectively) is 35 to 80 basis points. This simple comparison could mask very different exposure to risk. The standard deviation of returns and the Sharpe ratio shows this does not drive the result. 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 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 (smaller) plans.

These results alone are insufficient to establish a relationship between size and performance for two main reasons. First, US and non-corporate plans are overrepresented among larger plans, so these results could be driven by plan type rather than scale. Second, there is a potential mechanical relationship in looking at contemporaneous size and performance, as plans that perform well will be larger. To address these two issues in all of our preferred specifications we will include controls for plan type and use lagged size, although the use of lagged size does come at the cost of reducing the number of usable observations. [17] In looking at costs we find a time trend in reducing costs, so to provide a more meaningful and comparable estimate of size over time it will be helpful to include year fixed effects.

III.2 Regression Analysis

In Table III we test for the presence of scale economies using as the dependent variable overall plan net abnormal return. We begin with the sub-sample of US plans, which, as shown in Bauer et al. (2010), is bias-free. In the univariate specification (1) we find 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 41 basis points per year. Since the average costs seem to decline over time, we control for year fixed effects in (2) and find that this has only a negligible effect on our variable of interest. Finally, with a corporate plan dummy in (3), we find an even stronger coefficient of positive economies of scale. 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.

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[17] Using lagged size reduces our sample size by more than 20%. We have re-estimated all tables using contemporaneous (same year) size as well, obtaining similar and slightly quantitatively stronger results.

In columns (4) and (5) we repeat this analysis using first Canadian plans and then European and Australian and New Zealand plans (we pool the last three categories given the small number of plans). For these plans we do not have the benefit of the analysis similar to that of Bauer et al. (2010). However, the Canadian data is particularly comprehensive (in 2008 for example, sample firms account for 65% of all Canadian defined benefit plans), so there are fewer ex ante concerns of bias here. 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.

In column (6) we provide our base specification where in addition to corporate status we include a dummy for non-US plans in case they behave differently and to capture the fact that such plans are on average smaller than US plans. The coefficient on log of end of year t-1 plan size is a highly statistically significant 0.095 and implies an increase in net abnormal returns of 45 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 barely changes the estimate of size on performance. We perform further robustness checks and report the results in Appendix Table A2 Panel B, where we find highly significant and economically meaningful coefficient estimates of scale for public and non-public plans, when we drop the largest or smaller quintile plans, when we restrict ourselves to the first (year<1999) or the second half of the sample.

The above results are based on benchmark-corrected returns. This correction is necessary given differences in asset allocation between plans and likely differences in risk within each asset class. We used benchmarks plans reported to CEM. An alternative approach would be to correct returns for well-known factors. However, our relatively short time series makes this approach very difficult. Our data only has 6 (4) annual returns for the average (median) plan, and one of these observations is lost since our regressions use lag size. Thus, estimating even a one-factor regression in these circumstances is essentially pointless for more than 50% of plans in our sample. Moreover, any reasonable risk correction would need more than a few factors. Our paper focuses on returns on alternative assets, such as private equity or hedge funds, and on the overall plan portfolio, which includes alternative assets. Literature on alternatives suggests using additional factors (e.g., Fung et al. (2008) use a seven factor model to study hedge fund returns), which would put a further strain on the data.[18]

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

The specifications so far relate net abnormal returns to log of lagged size. To explore potential non-linearities we first estimate regressions with log size directly, log size and its square, and log size and its square and cube, and present the results graphically in Figure 1 Panel A. The figure shows that 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. Of course, we do expect that for sufficiently large plans the economies should eventually dissipate and likely turn negative.[19] However, that critical threshold is outside the range of plan size in our sample.

We next test for non-linearities in our regression format by examining a piecewise linear specification, again for convenience using quintiles. We include a dummy for the first four size quintiles and omit the 5th size quintile in (8) in Table III. We find that all four smaller quintiles dummies are negative, reflective of scale economies, with the implied cost of being a first and 2nd

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[18] Readers concerned that large pension plans take on more risks can refer to Table II, which shows larger 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 again find that large funds outperform small ones. 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] In the extreme, if one plan accounts for the whole sector, we would still expect diseconomies of scale at the level of the overall pension asset management industry, as in Pastor and Stambaugh (2010).

(3^{rd}, 4^{th}) quintile size plan rather than a 5^{th} quintile plan of 36 and 50 basis points (31, 27). Interestingly, the coefficient on the 2^{nd} quintile exceeds that for the first quintile, which suggests an unreliable relationship between size and 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 relationship in the first and second quintile plans for the full sample in a similar regression to (6), 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.[20] 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 two of our principle findings. First, there are positive rather than negative returns to scale in pension plan performance. They are economically sizeable, as they imply about 45 basis points improvement from smallest to largest quintiles using a log-linear approach and 50 basis points improvement from second to largest quintiles when a Q1 dummy is included. Second, we find that the relationship is only monotonic starting in the second size quintile suggesting limits to scale economies in smaller plans.

To understand better the channels through which size influences performance we now test whether these returns derive from the 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.

[20] When we interact size and the smallest quintile dummy, the interaction has a positive sign but is insignificant.

IV - Do Plans Realize Economies of Scale within Asset Class?

IV.1 Size and the Average Mandate Size

Table I shows that pension plans outsource the vast majority of their investment management to external active managers that are either mutual funds or whose investment opportunities closely resemble those of mutual funds. The stylized fact is that these funds face diseconomies of scale. Do pension plans try to mitigate these diseconomies? In this section we test a simple hypothesis that plans act to avoid diseconomies of scale by spreading their assets across more investment vehicles. Doing so will reduce the price impact in a given external fund or reduce the chance that the external fund will shift their assets towards less attractive investment ideas. For pension plans we can measure the number of investment vehicles using the number of their external active mandates.

Our data includes information on the number of external active mandates for a subset of plans. If a plan turns to one provider for asset management in a number of areas, each is supposed to be counted as a separate mandate. Combining this information with data on the overall assets managed actively by external managers in that sub-asset class (i.e. for US equities, EAFE equities, etc.), we produce average mandate size. We treat this quantity as a proxy for the size of the external fund that invests on behalf of a pension plan. This is an admittedly imperfect proxy. It is more meaningful if large and small plans interact similarly with external fund managers and if larger average mandate size means the fund receiving the mandate takes larger positions in existing investments, as Pollet and Wilson (2008) have found. It will be less meaningful if plans with larger mandates can require funds to limit other investors in the fund.

Table IV shows that plans do act as if they are aware of the diseconomies of scale at the fund level. In the regressions in this table we focus just on the external active assets. The dependent variable is the log of the number of mandates and the main independent variable is the log of the external holdings in that asset class, with controls for plan attributes that correlate with size. The coefficient on the log of holdings can be interpreted as an elasticity.

Table IV indicates that larger plans do increase their number of mandates, but this increase is far from proportional. In columns 1-3 we focus on equities with the coefficient of 0.34 in (1) indicating when plans double their equity holdings in a sub-asset class (e.g. US equities, EAFE equities, emerging market equities) they increase the number of mandates by 34%. If we look just at US equities the elasticity is 27%, and if we use plan fixed effects we find just 17% (column 3). Magnitudes are similar in fixed income, real estate and REITs and slightly higher in hedge funds and private equity (with elasticities of 42% and 49%).

The fact that the increase in mandates is less than proportional to the increase in size results in substantially larger mandate sizes, something revealed most clearly in Figure 2, which shows a monotonic relationship between plan size and average mandate size that is persistent over time for equities and the most important sub-components of alternatives. Existing evidence in the mutual fund and private equity literature suggests that such dramatic increases of allocations to a manager may be harmful for performance, making our findings from the previous section even more surprising: Large plans are able to generate better net performance in spite of the fact that they have substantially larger mandate sizes.[21]

IV.2 Size and the 'Make versus Buy' Option

Unlike mutual funds that are contractually bound to do substantially the same thing when they receive fund inflows, pension plans face a 'make versus buy' decision. Instead of buying from external active managers they can 'make' a similar product in-house and their cost

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[21] An alternative possibility (that we do not have the data to test) is that larger plans are able to write different contracts in their mandates, aligning incentives better and limiting the ability of the manager to access additional funds. Canada Pension Plan Investment Board, one of the largest asset managers in Canada, has developed and successfully used a performance contract that substantially differs from industry standards (see Raymond (2008)). CPP IB's success in implementing this contract is related to its size and importance; it is unlikely that a small plan would be able to entice external managers to accept a contract that markedly differs from the usual fee structure.

savings here might be sufficient to produce positive net abnormal returns, or they can 'buy something different' and shift to passive management that produces returns that are less scale-sensitive.[22] Internal active management would expose plans to the same concern about decreasing scale economies in returns, but there may be sufficiently great offsetting scale economies in costs not available with external managers to make this an attractive strategy.

We show in Figure 3 that larger plans buy much less from external active managers. Panel A shows that in the smallest decile less than 40% of plans use internal or passive management, implying that more than 60% of plans in this decile exclusively use external active management. 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, something we expect of larger plans interested in avoiding becoming a closet indexer. We indeed see substantially greater use of passive management (either internal or external) as plan size grows 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 50 percent of plans in the top decile manage a portion of their holdings in house. Almost 40% of the largest decile plans also manage private equity internally. This is in line with the economic intuition: hiring an internal team (or an individual) 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 commonly asset class with internal active management. The greatest organizational

[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.

challenge in setting up an internal group is likely that of assembling, rewarding, and monitoring an internal private equity or real estate team. Up to the 4th size decile there is no internal active management of private equity, and this only becomes sizable in the 9th and 10th size deciles. Overall, the average fraction of internally managed alternative assets ranges from 13% for Q1 plans to 25% for Q5 plans.[23]

In Table II we provide indications of the cost advantages that come from these choices, and whether these cost advantages depend upon scale by reporting time series averages of cross-sectional averages across five size quintiles. Plan-level administrative costs decline monotonically in Table II, from 12 basis points in the 1st quintile to just 3 basis points in the 5th quintile.[24] More interesting, 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 bps 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. To illustrate the cost savings with internal management we also report internal costs separately in equities (fixed income) declining from 12 bps (7bps) in the smallest size quintile to 7 bps (3bps) in the largest. This data is likely an underestimate of the cost savings for larger plans since it is at the aggregated level of asset class, and larger plans use more complex and costly categories within these asset classes (e.g. emerging markets equities within equities and private equity within alternatives).

At the bottom of Table II we restrict our attention solely to active management and report the ratio of external to internal active costs in this category to provide a cleaner estimate of the cost savings. Costs of internal management are on average 3 times cheaper in public equities and fixed income and 5 times cheaper in alternatives. Moreover, these ratios are close

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[23] We provide additional regression-based analysis of these phenomena in the Appendix.

[24] 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.

to monotonic in the size quintiles, with the largest quintile plans having cost savings of 3.2 times in equities of 5.1 in fixed income and 6.9 in alternatives.

There are a few potential concerns with these economically important cost advantages. First, they could be driven by outliers such as plans with extremely low internal active costs but also low levels of internal active management. Second, low internal costs may misrepresent potential costs as they could come solely from those efficient plans that pursue internal management.[25] To address these concerns we use firm fixed effects and look at the median ratios for plans that have substantial internal and external active management, which we define as managing at least 10% of assets using internal active management and at least 10% using external active management in that class. In untabulated results we find again that the ratio of external costs to internal costs is at least 3, finding ratios of 3- 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. The bottom line is that there are substantial cost savings associated with internal management.

If, as we hypothesize, larger plans use internal and passive management in part to avoid running head-on into areas of decreasing returns, this has ambiguous predictions for returns to these approaches within an asset class, but should improve net abnormal returns for larger plans at the plan level. To the extent that plans are optimally allocating resources, they should shift resources across the four styles available to them (internal active, internal passive, external active, external passive) until the risk-adjusted returns are equalized. Plans that do so may avoid diseconomies and produce net return gains at the plan level. We find evidence consistent with both of these contentions.

[25] Another concern that our cost data does not allow us to address is that internal and external active managers are asked to do something quite different that requires different expertise.

In untabulated regressions we relate asset class net abnormal returns to the proportion of holdings that are not invested in external active management (controlling for size and plan characteristics), and find positive but insignificant results on this variable. In Table V we show regressions at the plan level, where we add an additional control variable of the fraction of holdings not invested in external active management to the main specifications from Table III. This variable produces positive returns in (1) and (2). We find in (3) that this positive result comes mainly from internal management and that it is driven by the impact on costs (4-6) with no significant impact on gross returns (7-9). The economic impact of the management style is noticeable, reducing the estimated impact of size on performance by 32 to 44% compared to Table III (e.g. Table III column 6 versus Table V column 1 and 3).

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 at the fund level is to expand the number of investment categories in the portfolio and to increase weights on categories that are less likely to face decreasing returns to scale or where there are more than offsetting positive economies of scale. Again, whereas mutual funds given additional resources are usually constrained to invest in a narrowly defined asset class and style, pension plans can do something different. This asset reallocation may also have diversification benefits[26], but we are ignoring these and focusing only on whether it provides positive economies of scale in net abnormal returns.

[26] 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.

An *ex ante* indicator of where skill and negotiating power of pension plan managers should matter is the variance or perhaps better yet the interquartile range of performance (which is less driven by outliers). With a bigger range of performance, there is a greater potential gain associated with strong management of that asset class. To the extent that size of a plan 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 4 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 VI. The positive and significant coefficient in column (1) shows that they do. The estimate implies an 8% greater allocation 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 column (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.[27] 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 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? Table II provides indications of such a relationship. The 1st and 2nd quintile have the lowest gross and net abnormal returns of -13 and -87 points respectively, while the 5th quintile shows the highest gross returns and 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 VII we analyze separately the investment categories of private equity, real estate, REITs and hedge funds that make up the bulk of the alternative asset category.[28] [29] We

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

[28] Private equity accounts for 44%, real estate for 32%, hedge funds for 9%, and REITs for 5% of alternative assets. A few large plans provide additional information for other sub-categories of real assets, e.g., infrastructure. Size tends to be positive and economically large in regressions on these sub-categories, but is rarely statistically significant, perhaps because the number of plan-year observations drops to about 200-300.

[29] It is important to note that in our net return and cost regressions here we are using only the costs associated with a given asset class, rather than plan-level costs linked to audit, consulting, etc., to provide a purer test of performance in that asset class. We did include these plan-level costs in the regressions in Table III.

begin with private equity net abnormal returns in Panel A of Table VII.[30] 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. Its value, 1.28, implies that a move from the 1st to the 5th size quintile produces a 6% increase in net abnormal returns. This premium is higher than half of the overall average gross return in that asset class. In columns (3) we include plan size outside of private equity to see if this return is driven by overall plan size or the allocation in that sector, and find that the sector allocation dominates with a slight increase in coefficient. In column (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 both cases, the overall impact of size remains economically large and significant.

In Table VII Panel B we report the coefficient on size for identical regressions for 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. In contrast, for REITs and hedge funds we find mostly insignificant results.[31] For reference purposes we also include 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 overweighting of investment categories reported in section V.1, consistent with pension plans focusing on categories where scale benefits are largest. The greatest overweighting is in private equity and real estate, with a smaller overweighting in REITs and no overweighting in hedge funds.

[30] CEM suspects that prior to 2008 some plans in the database, when asked to report gross returns and costs separately, had difficulty of accurately separating these variables. This introduces noise to our analysis when we separately look at gross returns and costs in section IV.4, but does not affect the analysis in this section as we are looking at net abnormal returns (net returns less the benchmark).

[31] Additional analysis in the Appendix shows no evidence of economies of scale in REITs and hedge funds in subsamples of our data (when non-US or when smallest/ largest plans are excluded, etc.).

In Figure 5 we plot the implied relationship between investment and net abnormal returns for private equity and real estate based on coefficients in Table VII. We also explore whether this relationship could be non-linear by including squared terms, and then squared and cubic terms. We find increasing returns to be robust to these alternative specifications, with no notable change in private equity, and weaker scale economies for smaller holdings but a greater slope for higher holdings of real estate.

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 the returns in addition to size. Three such variables, highlighted by Lerner, Schoar, and Wang (2007), are experience, access, and timing. Perhaps larger pension plans have simply 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 columns (8) and (9) we include plan fixed effects so that the size effect comes solely off the within-plan variation. The 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 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.

What this analysis does not do is to 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 fund 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 VIII 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.[32] 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.[33] In columns (1) and (5) we establish a baseline and show that our prior finding of positive returns to scale in private 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 columns

[32] 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 VIII, we would find positive, although a little lower (e.g., 1.621 instead of 1.818 in (5)) with somewhat lower t-stats (e.g., 1.62 versus 1.83 in (5)).

[33] 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). Clearly, this is only an approximation and does not account for investments that were closed down prior to 2008. 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.

(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?

The differences in economies of scale closely follow the interquartile range in net abnormal returns. Scale economies are greatest in private equity, which has the greatest interquartile range in net abnormal returns of 17%, and are also high in real estate (7.1%), with no economies of scale in investment categories with lower interquartile range (fixed income, equities). This is consistent with larger plans having skill and/or superior negotiating power in less competitive/ efficient asset classes. The only outlier here is hedge funds that have high interquartile range, but no scale economies.[34]

We now look for further evidence of negotiating power and skill by examining gross returns and costs separately. These analyses are not influenced by plan-specific benchmarks and by using year fixed effects we are effectively imposing a common benchmark on gross returns.

The cost data provides indirect evidence of the importance of factors such as skill, negotiating power, and co-investments where pension plans are given the option of investing alongside the private equity holdings. Metrick and Yasuda (2010) and Phalippou (2009) have shown that private equity contracts are complex and opaque, and larger plans may be better equipped to understand the complexity and negotiate better terms. Co-investments are usually provided with no fees, lowering average costs for the plans' private equity funds. In column (1) of Panel A, Table IX we introduce our base specification and in column (2) our preferred specification producing a coefficient on costs of -30.3 that is highly significant. In column (3) we

[34] 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.

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 (192 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 133 basis point difference in moving from 1st quintile allocation to private equity to the 5th quintile allocation.[35]

Looking at gross returns provides an indication 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 that may help funds in regulatory arbitrage or, say, in winning contracts. Consistent with this hypothesis, 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 control for the percentage of the allocation that is internally managed. The coefficient of 1.13 in (6) implies that moving from the 1st to the 5th size quintile would improve gross returns by 5.46 percentage points.

We also find this same pattern of cost and gross returns both driving positive net abnormal returns for real estate, with somewhat smaller magnitudes. Real estate funds, like private equity funds, often offer co-investment opportunities to plans 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 benefit in net abnormal returns.

Further indications that co-investment opportunities and skill play a role in the superior returns to large pension plans is provided in Table X. Here we restrict our attention to the returns on the external active holdings of those plans that also have internal active

[35] 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 with 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.

management. We test whether there are positive spillovers between larger plans' ability to use internal management and performance of externally managed assets by investigating whether returns on internal and external holdings of the same asset class co-move.

We find a positive and significant coefficient on internal active return in (1). When we look at sub categories of investments and at other asset classes we find a positive coefficient on this variable for all investment categories in alternatives, with the greatest coefficient in private equity, a high coefficient but not quite significant in real estate, and coefficients close to zero with no significance in public equities and fixed income.

This variable has two possible interpretations (that our data do not allow us to disentangle). Internal management teams in private equity might provide skill and experience that improves external manager selection and monitoring and potentially leads to greater returns. Better internal teams are likely to earn higher returns, and also indirectly improve the performance of select external managers. Similarly, if co-investments are important and management of plans exercises their co-investment option on the most valuable opportunities, these will lead to superior returns in both internal and external private equity holdings.

VI Are There Limits to Economies of Scale?

The results in Section III suggest economies of scale that do not exhaust themselves even for the largest plans in our sample. Nonetheless, we do find two factors that attenuate this relationship: smaller plan size and poorer plan governance.

VI.1 Lack of Scale Economies in Smaller Plans

In Section III (e.g., regression (9) in Table III) we reported no evidence of significant scale economies when we restricted our attention to smaller plans, and some evidence of superior returns for the smallest quintile plans. Two facts lead us to interpret this result as arising because diseconomies of scale at the fund level are not sufficiently offset by positive economies of scale at the plan level in this size range. First, in 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, the investment category most likely to face decreasing returns. 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% versus 6%). Their performance in alternatives is not as bad, with summary statistics showing a return of -13 basis points rather than -87 basis points, and the coefficient on Q1 dummy being positive in Table VII column (4), although not significant. 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.

VI.2 Weaker Scale Economies in Plans with Weaker Governance

So far we have included a dummy variable for plan type (corporate, non-US plan) to provide a cleaner identification of the relationship between size and performance. In this section we take the analysis further and examine whether plan type limits the ability of some plans to capture economies of scale. We do this by looking at the interaction of plan type and scale and also analyzing the direct impact of plan type on performance. We argue that our plan type proxies provide a measure of governance differences across plans.

We interpret the US public plans dummy as a (crude) proxy for poorly governed plans, as these plans are most often suggested to have the greatest resource constraints in their internal management and the weakest oversight.[36] By a similar logic we interpret the corporate dummy as a (crude) proxy for stronger governance, as 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. US public plans are a subset of the omitted category when we use the corporate dummy (other types include non-US public plans, and 'other' plans in the US and abroad). To the extent that corporate plans (US public plans) have superior (inferior) governance, we predict this will lead to a positive (negative) and significant coefficient on the dummy variable. Superior governance should also lead to a positive (negative) coefficient on the interaction between corporate (US public) status and size, because stronger governance will allow plans to take greater advantage of their scale.

Table XI provides our results, with column (1) reproducing our base regression from Table III. In (2) and (3) we interact plan type with size. The negative and significant coefficient on the US public dummy in (2) indicates that performance of US public plans is, on average, lower by 29 basis points.[37] The interaction with size is negative (although not significant), suggesting weaker scale economies for such plans. Both results are consistent with weaker governed plans having poorer performance and a weaker ability to capture scale economies. This story is even stronger statistically when we focus on better-governed plans. The positive and significant coefficient on the corporate plan dummy in (3) indicates that corporate plans have superior performance, while the positive and significant coefficient on the interaction with size shows that bigger corporate plans do even better. These results are also economically

[36] These concerns have been voiced most recently following the scandals in the New Jersey pension plans, see, e.g., "A Gold-Plated Burden," The Economist, Oct 14, 2010.

[37] Interestingly, public plans outside of the US do not seem to do as badly. This can be seen Table III columns 4 and 5, where the corporate plan dummy is insignificant. In the context of Table XI, when we add a non-US public dummy to regression 2, its estimate is insignificant, while the US public dummy is still negative (-0.27) and significant (t-stat=-3.06). A possible explanation, in line with anecdotal evidence we gathered from industry practitioners, is that non-US public plans are better able to provide the requisite resources and governance structures than US plans and that the gap in pay between public and corporate plans is also somewhat smaller. Unfortunately such factors are not included in the data set and examining them more fully is beyond the scope of the present paper.

meaningful, with corporate status improving returns by 16 basis points (and more for larger plans). In columns (4) and (5) we repeat the analysis, this time controlling for possible differences in the use of external active management across plan types, and find similar statistical and economic results.

If the results for corporate plans are driven by fewer constraints on resources and the ability to attract and motivate the right managers, we expect that such plans would have higher returns and costs than public plans. This is what we see in columns (7) and (9), where the corporate dummy indicates 61 basis points improvement in gross returns, and with a positive (but insignificant) coefficient on the interaction with size, only partially offset by a 4 basis points cost increase. US public plans have particularly bad returns, with column (8) implying a performance drop of 1.48%, a loss that is only partially offset by lower costs in (6).

Finally, we provide an additional result that strengthens the above arguments about plan governance. One feature of poorly governed plans is that they may be unable due to resource constraints to attract and retain top management talent that would allow them to form their own view of the investment environment. Such plans are more likely to have to resort to the help of outsiders, such as consultants, and this may lead to herd-like behaviour that produces no superior performance. We test for whether plan type is correlated with governance in Table XII, where we relate expenses on consulting to plan size and our proxies for governance. We find that US public plans pay more to consultants, both in terms of the over the level of consulting costs (columns 1 and 2) and as the fraction of their overall investment administration expenditures (5 and 6). We also find that for consulting spending of corporate plans is a smaller fraction of their overall administrative expenses (7 and 8). These results are not driven by public plans' higher portfolio complexity, as proxied by the portfolio weight on alternative assets.

VII Conclusions

We use a novel dataset to examine the relationship between size and performance in asset management in defined benefit pension plans. Diseconomies of scale in asset management in mutual funds do not translate to multi-asset class pension plans. We document substantial *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 45 - 50 basis points/ year. To explain this finding, we document 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, increasing their allocation to alternatives, particularly private equity and real estate.

At the intensive margin, larger plans act as if they are aware of decreasing returns at the fund level, and increase the number of mandates and more aggressively steer away from external active management. This produces cost savings large enough to be detectable in overall net abnormal returns, accounting for approximately 32 to 44 percent of the scale benefits. The effect on the extensive margin is even more dramatic. As plans grow, they change their asset allocation and invest much more in alternative assets and in private equity and real estate in particular. Plans realize significant economies of scale both in costs and in gross returns in these areas. The overall impact of size on net abnormal returns is substantial, with the movement from 1st to 5th size quintile improving 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.

Bigger is better when it comes to pension plans. However, bigger is not *always* better. We find some evidence of constant or even decreasing returns to scale in smaller plans (first and second quintile plans). This is related to second quintile plans getting large enough that they feel they are able to invest in alternatives, but apparently being ill equipped as seen in significant negative returns, while first quintile plans largely avoid the asset class. We also find some evidence that governance interacts with the ability to take advantage of scale. Proxies for poor (better) governance are associated with lower (higher) returns and weaker (stronger) economies of scale.

These results, based on largely exogenous firm size, support the neoclassical theory of the firm and its focus on technological factors. The results are more challenging for theories of the firm such as Stein (2002), who posits that frictions in transmitting soft information will become overwhelming in larger organizations and will check the growth in firm size. Our finding that the benefits of scale accrue mainly to well governed plans helps reconcile our results with Stein's concerns, 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 that the move to defined contribution plans produces opportunity costs for these plans' members, as they lack access to the large plans that would be able to use their degrees of freedom to capture positive economies of scale.

APPENDIX

In Table AI we present regression analysis that helps reinforce the point we made in section IV.2. In all asset classes, larger plans steer away from external active management and manage more of their fixed income holdings passively or internally and more of their alternative holdings internally (since alternatives cannot be managed passively).

The database we use in our paper contains both US and international pension plans. Some audiences may be interested in analysis that is limited to US plans. We do that in Panel A of Table AII, where we reproduce key specifications from Tables III and VII. As can be seen from the table, our results are as strong for the US plans as they are for the overall sample. We see strong economies of scale at the plan level and in private equity and real estate, and no evidence of any size economies in REITs and in hedge funds.

In Panel B of Table AII we summarize key estimation results obtained earlier (for the overall sample featured in the paper and for US plans), as well as additional robustness checks for sub-samples of plans from different regions, public and non-public plans, and for subsamples excluding plans with extreme size. The overall results are quite similar to those presented earlier. Bigger is better at the overall plan level and, in particular, for holdings of private equity and real estate. Moreover, size does not seem important for REITs and hedge fund performance. Excluding the largest or the smallest plans indicates that the effect is not driven by plans at the extremes of the size distribution. Importantly, the absence of scale effects in the smallest two quintiles does not change the main message of the paper. We find as strong, and sometimes stronger, results when we restrict our attention to the largest 60% of plans in our sample. Finally, the effect is strong in both halves of the sample period. All in all, these additional results support the evidence we present and discuss in body of the paper.

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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 the graph on the left representing size from the 5th to the 95th percentile and that on the right the subset of data between the 5th percentile and $10B. 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.

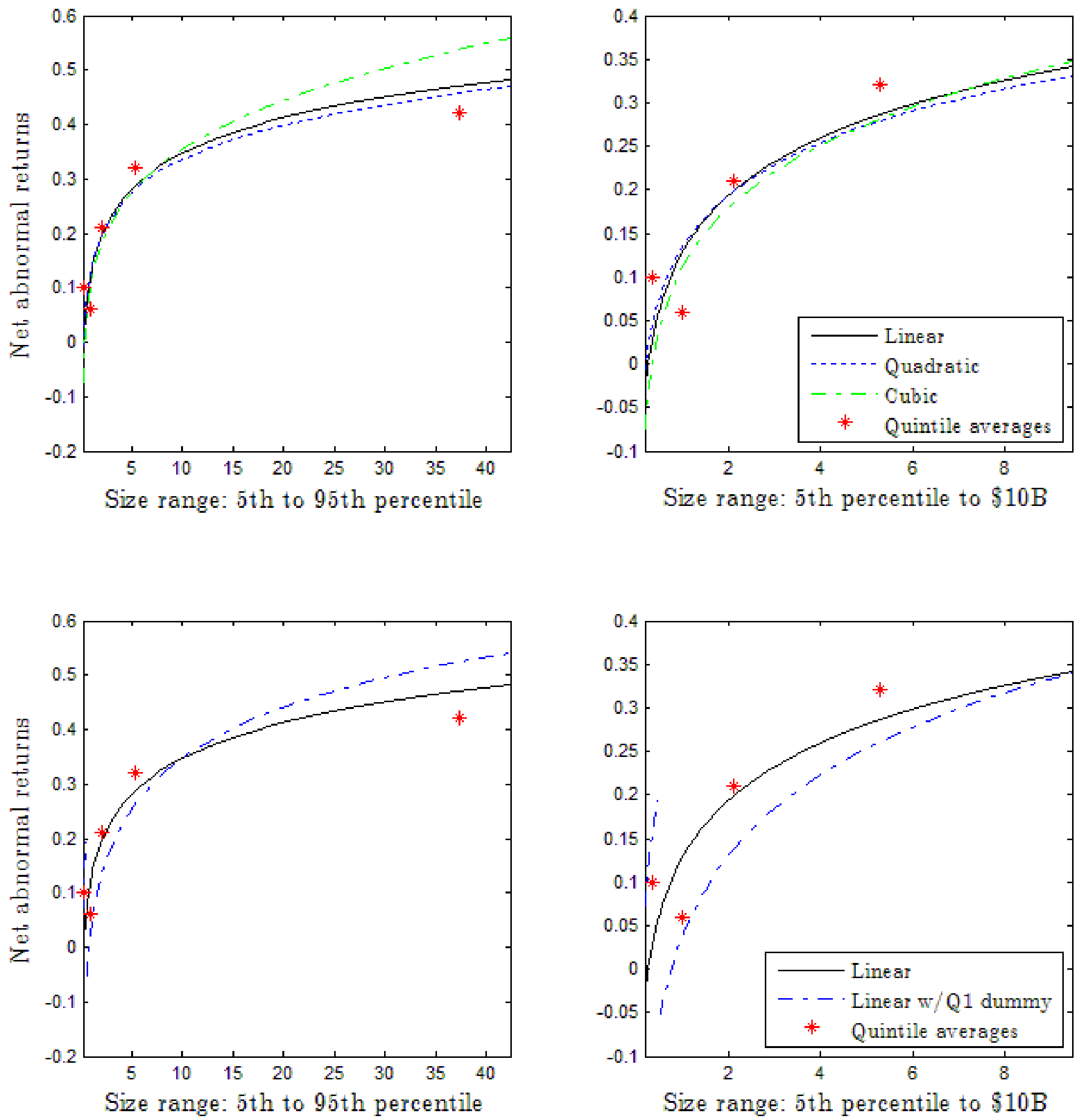


Figure 2. Average external mandate size over time. This graph presents the average external mandate size, in millions of dollars, for largest (dash-dotted line), medium (dotted line), and smallest (solid line) third of pension plans. In each case, mandate size is computed as the ratio of external holdings of a given asset class and the number of external mandates plans report. While we have holdings data for the entire sample period for most asset classes (except for hedge funds, where holdings start in 2000), the data on the number of mandates are only available at the end of our sample for most asset classes.

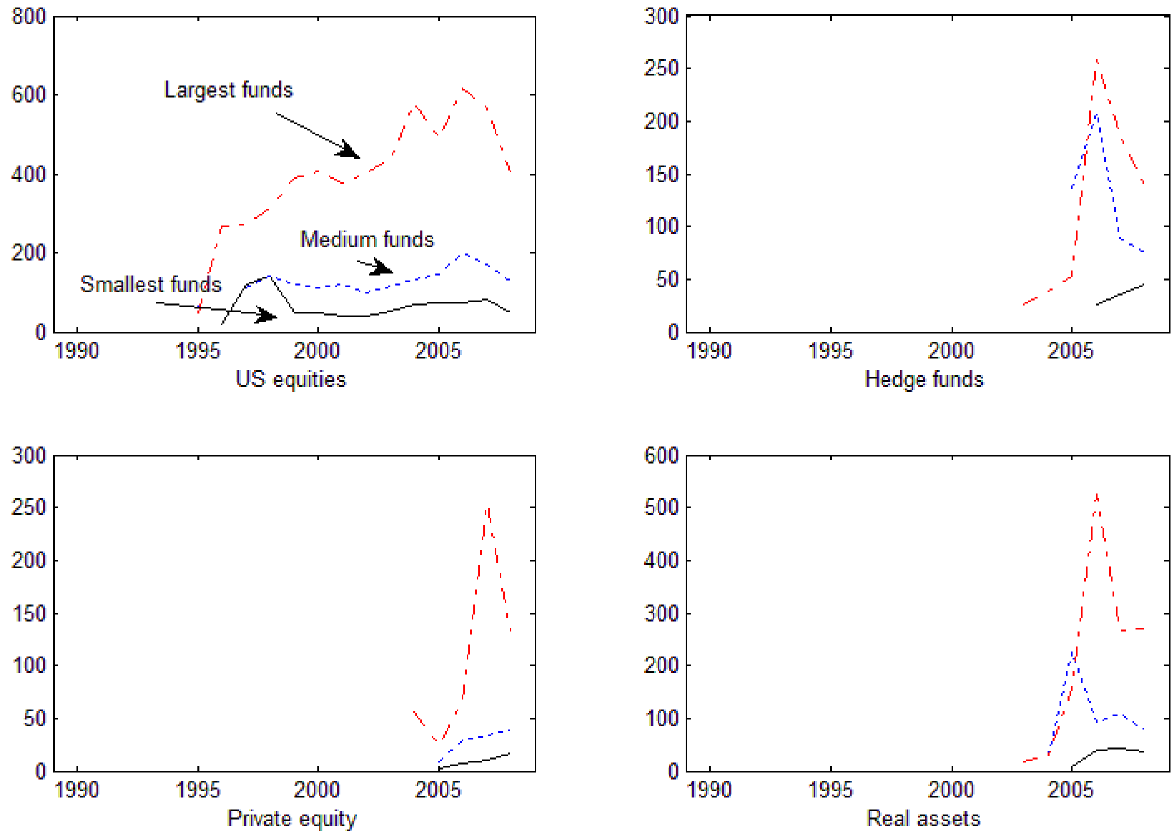


Figure 3. Do larger plans manage their holdings differently? The top (middle, bottom) panel presents the fraction of plans with the employ any approach other than active external management of holdings (any passive holdings, any internal active holdings) in public equities, fixed income, private equity, and real estate. Each point corresponds to the average fraction of funds 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.

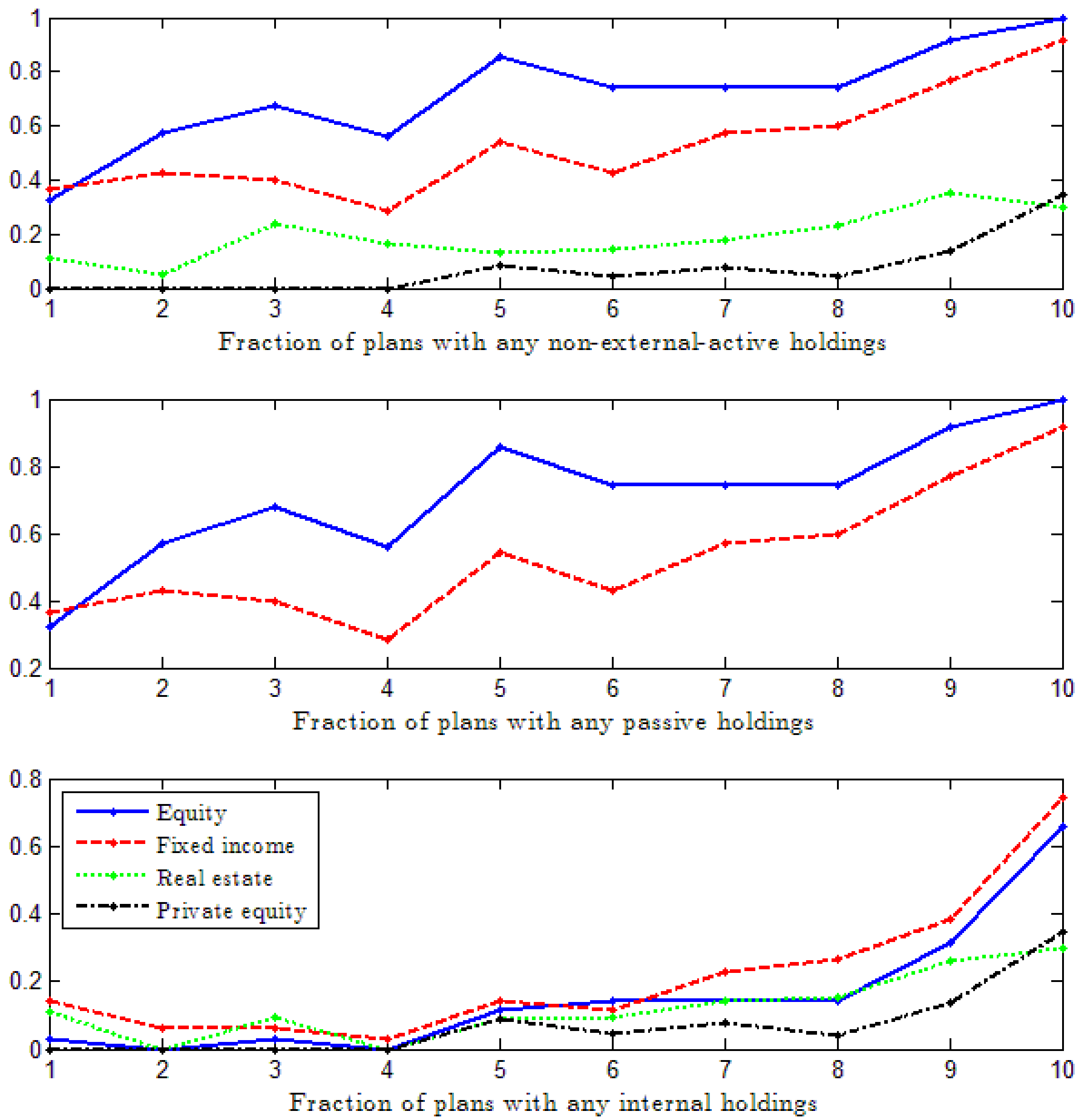


Figure 4. Do larger plans allocate more to alternatives? This figure presents portfolio weights of fixed income, public equities, and alternative assets for plans sorted into deciles based on their size. The graph depicts values estimated using the Fama-MacBeth method: Each sample year, size deciles 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.

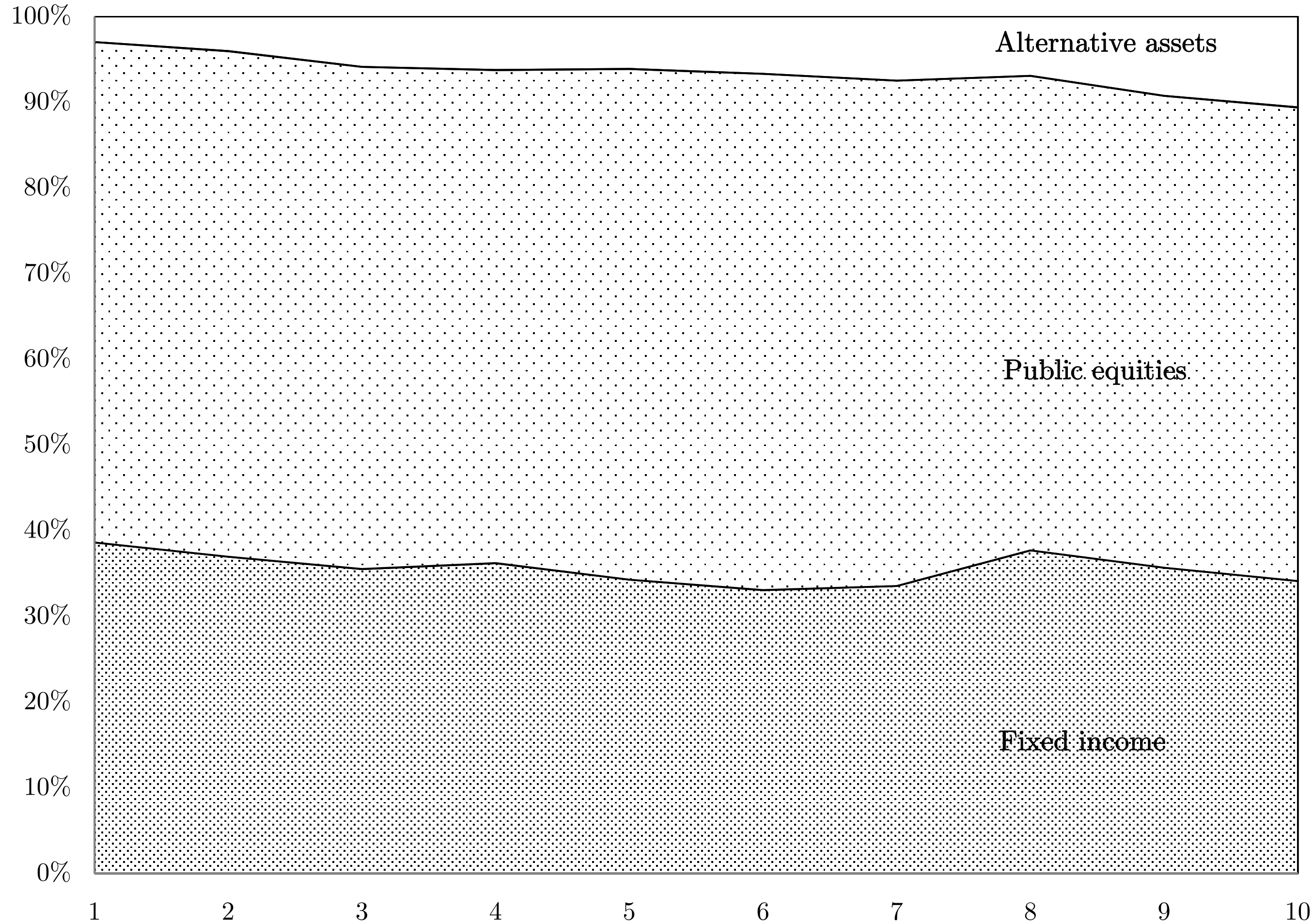
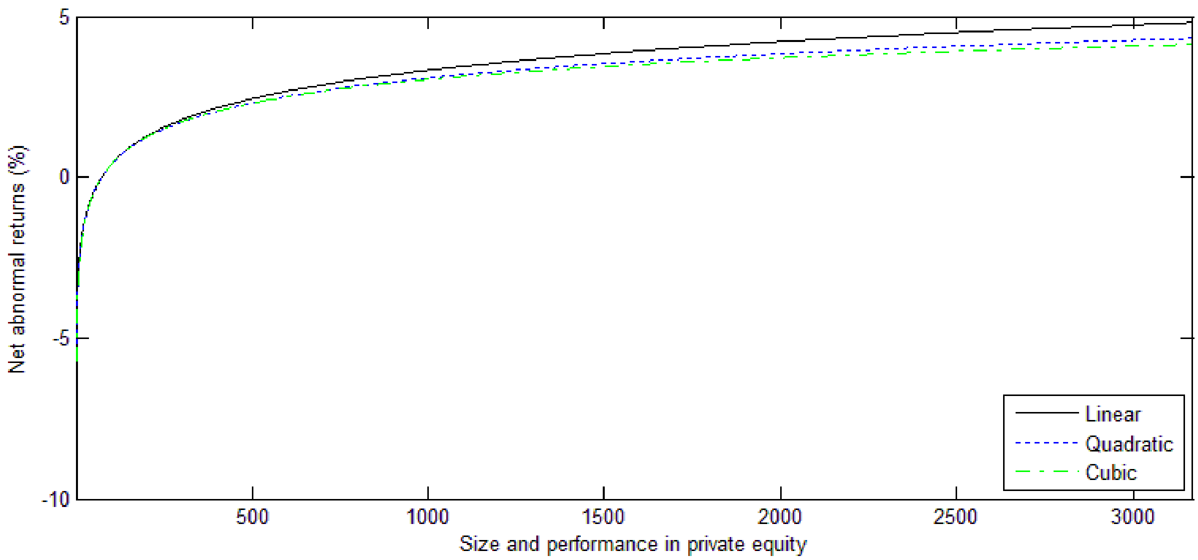


Figure 5. Do larger plans achieve higher performance on their private equity and real estate holdings? This figure presents the relationship between lag holdings and net abnormal returns in private equity and real estate. Within each plot, the solid (dotted, dash-dotted) line illustrates the fitted values of the linear (quadratic, cubic) regression of net returns on lagged log holdings of a given asset class. The solid line corresponds to regression (1) in Table VII. The values on the x-axis are in millions of dollars and range from the 5th to the 95th percentile of holdings of a given asset class. The values on the y-axis are net abnormal returns, in percent, implied by a given value of size and the regression coefficients. The intercept is chosen so that a plan with the median holdings size has zero net return.



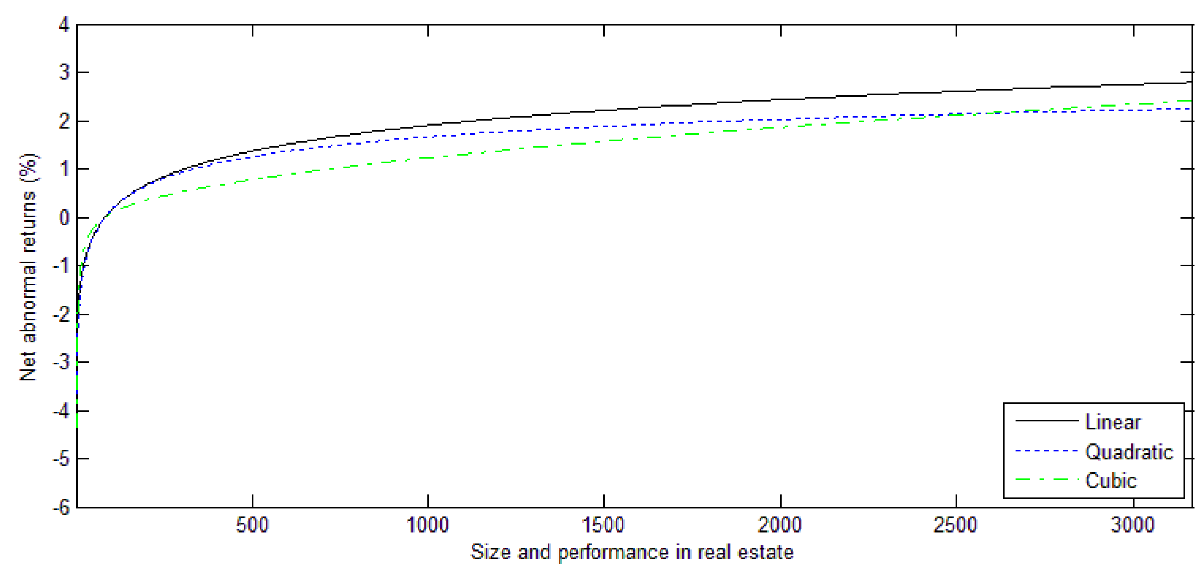


Table I. Summary statistics. This table presents summary statistics from the CEM Benchmarking, Inc. database of defined benefit pension plans. Panel A provides key summary characteristics at the plan level. Panel B presents performance data by asset class, with different asset classes ranked by interquartile 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 excess 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	37391	37049	36397
% US funds	24%	52%	64%	75%	72%	47%	20%
% corporate funds	64%	57%	65%	52%	31%	-34%	-26%
% liabilities due to current retirees	46	47	47	47	48	2	2
Overall plan performance							
Gross fund returns (%)	9.3	8.8	9.3	9.3	9.4	0.2	0.6
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
Net returns (%)	8.84	8.39	8.88	9.01	9.19	0.35	0.8
Net abnormal returns (%)	0.1	0.06	0.21	0.32	0.42	0.33	0.36
Standard deviation of net returns	13.32	12.66	13	12.32	12.2	-1.12	-0.46
Sharpe ratio (using net returns)	0.36	0.34	0.37	0.41	0.43	0.07	0.08
Information ratio	0.07	0.05	0.18	0.31	0.45	0.38	0.39
Costs and performance by asset class							
Gross return on equity (%)	9	8.8	9.1	9.5	9.2	0.2	0.4
Overall equity costs (bps)	37	36	31	27	16	-20	-20
Internally managed equity costs (bps)	12	13	9	8	7	-5	-7
Net abnormal equity returns (%)	0.41	0.35	0.32	0.48	0.35	-0.06	0
Gross return on fixed income (%)	8.7	8	8.3	8	8	-0.7	0
Overall fixed income costs (bps)	20	19	18	14	9	-11	-10
Internally managed fixed income costs (bps)	7	7	7	5	3	-4	-3
Gross return on alternative assets (%)	8.3	7.4	8.9	9.7	10.6	2.3	3
Overall alternatives costs (bps)	93	130	119	120	115	23	-15
Internally managed alternatives costs (bps)	31	27	29	27	23	-9	-4
Net abnormal alternative assets returns (%)	-0.13	-0.87	0.11	0.08	1.3	1.43	2.17
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 plan-specific benchmark for a given asset class. The main independent variable is log of plan size at the end of year *t*-1. 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. 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)
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**	0.182**	0.095***	0.086***		-0.001	0.135***
	(2.45)	(2.26)	(2.76)	(2.25)	(2.13)	(3.74)	(3.63)		(-0.01)	(4.46)
Corporate plan dummy			0.245**	0.025	0.127	0.147*	0.140*	0.142*	-0.028	0.156**
			(2.33)	(0.20)	(0.44)	(1.84)	(1.86)	(1.77)	(-0.22)	(1.98)
Non-US plan dummy						0.091	0.107	0.052	0.154	0.059
						(1.06)	(1.32)	(0.61)	(1.02)	(0.68)
Net plan 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								-0.498***		
								(-4.31)		
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	0.257	0.182	0.189	0.183	0.230	0.183
Year FE	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Plan FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Economic effects:										
Effect of Q1 to Q5 change	0.41	0.38	0.46	0.45	0.85	0.45	0.40		-0.005	0.63
Effect of Q2 to Q5 change	0.32	0.29	0.36	0.35	0.66	0.34	0.31		-0.004	0.49

Table IV. Do larger plans use more mandates? 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. "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 of end of year t-1 holdings	0.345***	0.271***	0.168***	0.334***	0.425***	0.491***	0.282***	0.361***
	(20.83)	(11.57)	(3.64)	(13.71)	(7.69)	(8.13)	(5.73)	(5.03)
Corporate plan dummy	0.036	0.092		0.262***	-0.139	-0.207	-0.163	0.075
	(0.78)	(1.54)		(3.92)	(-0.79)	(-0.82)	(-0.95)	(0.66)
Non-US plan dummy	-0.102*	-0.653***		0.057	-0.293*	-0.213	-0.837***	0.040
	(-1.96)	(-8.35)		(0.30)	(-1.72)	(-0.90)	(-4.35)	(0.22)
Observations	5575	1965	1965	1590	164	222	316	131
R-squared	0.517	0.569	0.890	0.489	0.404	0.400	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)	1565.98	964.87	327.08	743.66	108.42	71.05	213.59	79.45
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table V. What is the impact of less size-sensitive approaches on 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)	(7)	(8)	(9)
Dependent variable	Net abnormal returns			Costs			Gross returns		
% holdings that are not external active	0.325**	0.309**		-26.67***	-26.63***		0.045	0.024	
	(2.15)	(2.06)		(-11.78)	(-11.81)		(0.11)	(0.06)	
% holdings that are internally managed			0.420***			-16.67***			-0.232
			(2.78)			(-6.94)			(-0.53)
% holdings that are passively managed			0.146			-28.38***			0.359
			(0.83)			(-9.07)			(0.80)
Log of end of year t-1 plan size	0.065**	0.104***	0.052*	-2.53***	-2.62***	-2.86***	0.095	0.148*	0.114
	(2.26)	(3.11)	(1.74)	(-5.79)	(-4.94)	(-6.28)	(1.34)	(1.93)	(1.53)
Plan size in Q1		0.246*			-0.56			0.329	
(smallest size quintile)		(1.83)			(-0.32)			(1.15)	
Corporate plan dummy	0.154*	0.162**	0.161**	3.88***	3.86***	3.59***	0.590***	0.602***	0.588***
	(1.93)	(2.06)	(2.03)	(2.80)	(2.78)	(2.59)	(3.51)	(3.59)	(3.50)
Non-US plan dummy	0.040	0.012	0.013	-9.22***	-9.16***	-10.85***	0.732***	0.694***	0.792***
	(0.46)	(0.13)	(0.14)	(-6.20)	(-6.11)	(-6.88)	(3.75)	(3.47)	(3.91)
Observations	3829	3829	3829	3829	3829	3829	3829	3829	3829
R-squared	0.005	0.006	0.006	0.353	0.353	0.348	0.007	0.007	0.007

Table VI. 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	0.013***	0.011***	0.0004	-0.001	0.006***	0.003*	0.006***	0.008***	0.001***	0.001
	(8.68)	(2.92)	(0.64)	(-1.03)	(7.40)	(1.71)	(5.88)	(3.09)	(3.83)	(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		-0.0005		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		0.0005
		(-1.03)		(-1.66)		(-5.63)		(1.40)		(0.30)
Observations	5008	4202	2683	2440	5008	4202	5008	4202	5008	4202
R-squared	0.195	0.251	0.045	0.055	0.110	0.205	0.086	0.111	0.075	0.083

Table VII. 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 plan size	1.247***	1.283***	1.364***	1.333***	1.234***	1.139	1.090***	1.779**	1.842**
	(5.21)	(5.12)	(3.75)	(4.96)	(4.80)	(1.59)	(4.89)	(2.42)	(2.48)
Log (plan size-holdings)			-0.158						
			(-0.33)						
Corporate plan dummy		2.530**	2.444**	2.508**	2.414**	2.335	2.264**		
		(2.39)	(2.32)	(2.37)	(2.25)	(0.98)	(2.31)		
Non-US plan dummy		-0.333	-0.312	-0.413	-1.276	-4.931**	-0.364		
		(-0.30)	(-0.28)	(-0.37)	(-1.11)	(-2.11)	(-0.36)		
Fund in Q1				1.458					
				(0.66)					
% holdings internally managed					3.311*				
					(1.71)				
Average mandate size						0.009**			
						(2.39)			
Net return in year t-1							0.110***		-0.023
							(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	0.171	0.135	0.177	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	6.02	6.19	6.59	6.44	5.96	5.50	5.26	8.59	8.89
Effect of Q2 to Q5 change	4.66	4.79	5.10	4.98	4.61	4.26	4.07	6.65	6.88

Table VII, 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	1.247***	1.283***	1.364***	1.333***	1.234***	1.139	1.090***	1.779**	1.842**
	(5.21)	(5.12)	(3.75)	(4.96)	(4.80)	(1.59)	(4.89)	(2.42)	(2.48)
Real estate	0.682***	0.769***	0.839***	0.847***	0.709***	1.013**	0.570***	0.411	0.342
	(5.70)	(6.04)	(3.51)	(6.09)	(5.53)	(2.48)	(5.39)	(0.93)	(0.79)
REITs	0.538	0.451	0.976*	0.535	0.689*	-0.032	0.362	0.038	0.202
	(1.35)	(1.13)	(1.75)	(1.30)	(1.71)	(-0.03)	(0.96)	(0.03)	(0.16)
Hedge funds	0.102	0.074	-0.391	0.116	N/A	-0.211	0.002	-1.285	-1.241
	(0.32)	(0.24)	(-1.04)	(0.42)	N/A	(-0.19)	(0.01)	(-1.15)	(-1.10)
Public equities	-0.021	0.016	0.181	0.041	-0.018	-0.119**	0.010	-0.238	-0.290
	(-0.69)	(0.49)	(1.49)	(1.05)	(-0.46)	(-2.10)	(0.32)	(-0.97)	(-1.16)
US equity	0.139***	0.025	0.398***	0.063	0.026	-0.156**	0.012	0.171	0.139
	(3.06)	(0.49)	(2.76)	(1.14)	(0.45)	(-2.06)	(0.25)	(0.70)	(0.57)
Fixed income	0.059***	0.051**	-0.006	0.057**	0.027	0.045	0.045**	0.288	0.284
	(2.91)	(2.22)	(-0.07)	(1.99)	(0.96)	(0.78)	(2.02)	(1.40)	(1.41)

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

Table VIII. 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 holding	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 IX. 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			Returns	
Log of end of year t-1 size	-23.434***	-30.331***	-27.472***	1.272***	1.128***	1.131***
	(-3.96)	(-4.97)	(-4.71)	(4.61)	(4.04)	(4.01)
Corporate plan dummy		-108.327***	-101.571***		0.949	0.954
		(-4.91)	(-4.71)		(0.91)	(0.90)
Non-US plan dummy		-71.729***	-16.931		-2.644**	-2.603**
		(-2.79)	(-0.55)		(-2.30)	(-2.14)
% holdings internally managed			-192.424***			-0.144
			(-6.28)			(-0.06)
Observations	1,897	1,897	1,897	1,897	1,897	1,897
R-squared	0.131	0.173	0.204	0.362	0.365	0.365
Economic effects:						
Effect of Q1 to Q5 change	-113.14	-146.44	-132.64	6.14	5.45	5.46
Effect of Q2 to Q5 change	-87.56	-113.33	-102.65	4.75	4.21	4.23

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

	(1)	(2) Costs	(3)	(4)	(5) Returns	(6)
Private equity	-23.434***	-30.331***	-27.472***	1.272***	1.128***	1.131***
	(-3.96)	(-4.97)	(-4.71)	(4.61)	(4.04)	(4.01)
Real assets	-4.842***	-6.342***	-4.245***	0.314***	0.367***	0.345***
	(-5.48)	(-8.01)	(-5.33)	(2.86)	(3.24)	(2.87)
Real estate	-5.027***	-7.084***	-5.756***	0.538***	0.568***	0.546***
	(-5.11)	(-7.88)	(-6.48)	(4.05)	(4.18)	(3.93)
REITs	-8.717***	-8.331***	-4.632***	0.663*	0.546	0.582
	(-5.12)	(-4.61)	(-2.71)	(1.68)	(1.41)	(1.41)
Hedge funds	-13.565***	-13.286***	N/A	0.040	0.022	N/A
	(-3.14)	(-3.24)	N/A	(0.14)	(0.08)	N/A

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

Table X. 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 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.

	(1) Alternatives	(2) Private equity	(3) Real estate	(4) Public equities	(5) Fixed income
Log of end of year t-1 holdings	0.328	1.392*	-0.256	0.553***	-0.126
	(1.11)	(2.03)	(-0.53)	(2.74)	(-0.74)
Internal active net abnormal return	0.094*	0.335***	0.190	0.018	0.007
	(1.86)	(4.13)	(1.51)	(0.29)	(0.14)
Corporate plan dummy	0.775	2.564	4.339**	-0.089	0.937**
	(0.68)	(0.90)	(2.64)	(-0.16)	(2.28)
Non-US plan dummy	-1.199	1.403	-2.887	0.325	-1.492***
	(-1.05)	(0.46)	(-1.23)	(0.49)	(-3.10)
Observations	491	158	129	646	517
R-squared	0.139	0.358	0.409	0.193	0.275

Table XI. Does governance influence economies of scale? This table reproduces the main regressions from Tables III and VI, with interaction terms between plan size and proxies for plan governance (an indicator for US public plans and an indicator for corporate plans). 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)	(9)
Dependent variable	Net abnormal returns					Costs		Gross returns	
Log of end of year t-1 plan size	0.095***	0.104***	0.058**	0.081***	0.019	-1.094**	-2.183***	0.116	0.030
	(3.74)	(3.62)	(2.13)	(2.66)	(0.62)	(-2.57)	(-3.79)	(1.61)	(0.39)
Corporate plan dummy	0.147*		0.156**		0.165**		3.793***		0.606***
	(1.84)		(1.98)		(2.09)		(2.73)		(3.59)
Non-US plan dummy	0.091		0.116		0.062		-9.387***		0.763***
	(1.06)		(1.36)		(0.71)		(-6.34)		(3.87)
Corporate dummy * de-meaned size			0.101**		0.114**		-0.876		0.164
			(2.19)		(2.45)		(-1.28)		(1.46)
US public dummy		-0.293***		-0.269***		-0.276		-1.480***	
		(-3.01)		(-2.74)		(-0.19)		(-7.37)	
US public dummy * de-meaned size		-0.014		-0.024		-1.431**		-0.068	
		(-0.29)		(-0.49)		(-2.00)		(-0.61)	
% holdings that are not external active				0.292**	0.366**	-31.766***	-26.977***	0.150	0.103
				(1.97)	(2.43)	(-14.00)	(-11.72)	(0.38)	(0.25)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.182	0.183	0.183	0.184	0.184	0.334	0.387	0.868	0.868

Table XII. Do poorly governed plans rely more on consultants? This table presents the regressions of consulting costs (1-4) and the ratio of consulting costs to overall investment administration costs (5-8) on plan size and proxies for plan governance: US public plan dummy and corporate plan dummy. 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	Consulting costs (bps)				Consulting over total admin costs			
Log year t fund size	-0.450***	-0.483***	-0.445***	-0.472***	-0.018***	-0.018***	-0.019***	-0.018***
	(-11.97)	(-11.84)	(-12.34)	(-12.07)	(-7.62)	(-7.15)	(-7.72)	(-7.12)
US public plan dummy	0.125*	0.143**			0.076***	0.076***		
	(1.81)	(2.10)			(7.95)	(7.91)		
Corporate plan dummy			0.115	0.109			-0.031***	-0.031***
			(1.41)	(1.34)			(-3.79)	(-3.79)
Non-US plan dummy			-0.138	-0.118			-0.055***	-0.055***
			(-1.60)	(-1.35)			(-6.58)	(-6.67)
% alternatives plan portfolio		2.256***		2.128***		-0.006		-0.053
		(3.55)		(3.26)		(-0.11)		(-0.81)
Observations	4,737	4,737	4,737	4,737	4,737	4,737	4,737	4,737
R-squared	0.155	0.162	0.157	0.162	0.111	0.111	0.104	0.105

Table AI. Do larger plans focus on less size-sensitive investment approaches? 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***	0.092***	0.090***	0.095***		0.078***	0.098***		0.034***	0.055***	
	(11.83)	(13.41)	(14.08)	(13.89)		(7.80)	(10.49)		(3.20)	(5.90)	
Log holdings of asset class					0.052***			0.103***			0.007
					(2.76)			(2.95)			(0.68)
log (plan size - holdings)					0.042**			-0.004			0.046***
					(2.20)			(-0.11)			(3.20)
Corporate plan dummy		-0.021		-0.002	-0.002		-0.043	-0.032		-0.001	0.002
		(-0.96)		(-0.08)	(-0.10)		(-1.51)	(-1.10)		(-0.06)	(0.09)
Non-US plan dummy		0.141***		0.056**	0.056**		0.252***	0.232***		0.297***	0.291***
		(6.40)		(2.52)	(2.46)		(8.77)	(8.15)		(9.31)	(8.91)
Observations	5008	5008	4989	4989	4978	4990	4990	4981	3976	3976	3971
R-squared	0.204	0.257	0.240	0.248	0.244	0.109	0.207	0.217	0.034	0.211	0.213

Table AII. 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)
Non-US plan dummy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Plan 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
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Fund FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

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

Asset class	(1) Overall plan	(2)	(3) Private equity	(4)	(5) Real estate	(6)	(7) REITs	(8)	(9) Hedge funds	(10)
Benchmark -- all plans	0.09***	0.13***	1.28***	1.33***	0.77***	0.85***	0.45	0.53	0.07	0.12
(as in the paper)	(3.74)	(4.46)	(5.12)	(4.96)	(6.04)	(6.09)	(1.13)	(1.30)	(0.24)	(0.42)
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	-0.00	-0.40
	(2.26)	(2.48)	(3.80)	(3.73)	(4.42)	(4.34)	(1.81)	(1.69)	(-0.00)	(-1.29)
European & Australian/	0.18**	0.20*	1.71**	1.71**	0.51	0.38	0.16	0.21	0.44	0.44
New Zealand plans only	(2.20)	(1.92)	(2.38)	(2.38)	(0.63)	(0.47)	(0.21)	(0.26)	(0.90)	(0.90)
Public only	0.06**	0.11***	1.79***	1.82***	0.73***	0.84***	0.06	0.04	-0.21	-0.21
	(2.12)	(2.98)	(5.96)	(5.92)	(3.50)	(3.69)	(0.12)	(0.08)	(-0.47)	(-0.47)
Non-Public only	0.07**	0.13***	1.75***	1.79***	0.77***	0.87***	0.46	0.55	0.23	0.07
	(2.43)	(3.80)	(6.37)	(6.08)	(4.23)	(4.35)	(1.03)	(1.19)	(0.57)	(0.19)
Excluding Q1	0.14***	0.14***	1.32***	1.32***	0.79***	0.79***	0.57	0.57	0.12	0.12
(plans in smallest size quintile)	(4.58)	(4.58)	(4.83)	(4.83)	(5.67)	(5.67)	(1.42)	(1.42)	(0.44)	(0.44)
Excluding Q2	0.08***	0.12***	1.39***	1.44***	0.75***	0.83***	0.21	0.29	0.28	0.35
(plans in the second size quintile)	(2.92)	(3.28)	(6.11)	(6.08)	(5.38)	(5.32)	(0.53)	(0.70)	(0.72)	(0.87)
Excluding Q1&Q2	0.14***	0.14***	1.52***	1.52***	0.85***	0.85***	0.35	0.35	0.13	0.13
(plans in two smallest size quintile)	(3.48)	(3.48)	(6.16)	(6.16)	(5.21)	(5.21)	(0.82)	(0.82)	(0.36)	(0.36)
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)	(1.02)	(1.76)	(1.82)	(1.82)	(2.24)	(2.20)	(0.31)	(0.42)	(-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)	(5.59)	(4.35)	(2.47)	(3.02)	(4.09)	(4.36)	(0.04)	(2.10)		
Year>1998	0.05	0.10**	1.20***	1.14***	0.82***	0.89***	0.62	0.60	0.07	0.12
(second half of the sample)	(1.49)	(2.57)	(3.94)	(3.57)	(4.83)	(4.75)	(1.53)	(1.43)	(0.24)	(0.42)