

# Familiarity Breeds Alternative Investment: Evidence from Corporate Defined Benefit Pension Plans\*

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## Abstract

Defined benefit pension plans sponsored by firms with high R&D expenditures and high land and buildings (L&B) holdings exhibit high private equity and real estate investment, respectively. Plans with R&D intensive sponsors overweight venture capital and buyouts whereas L&B intensive sponsors overweight opportunistic real estate strategies. Pension funds with such alternative investment tilts underperform other plans by up to 200 basis points. We do not find evidence consistent with an informational advantage, hedging or risk shifting incentives for such over-allocation. Our results, however, support the existence of a familiarity bias in asset allocation to alternative assets that reduces total corporate pension plan resources by about \$1.4 billion a year.

*JEL Classification:* G30; G31; G32

*Key Words:* DB pension plans, familiarity, R&D intensity, L&B holdings, private equity and real estate investment.

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# 1 Introduction

Corporate defined benefit (DB) pension plans are central to corporate strategy as they represent both important deferred labor compensation and large corporate liabilities.<sup>1</sup> Increasing life-longevity, an ageing population and prolonged periods of low interest rates have resulted in significant increases in these pension liabilities. Underfunded pension plan obligations have become a major concern for corporate financial officers and as a result more pension plans have shifted their allocation to alternative asset classes in an attempt to generate higher returns, reduce pension deficits and avoid large increases in contributions. This perhaps explains why much of the existing literature on corporate DB plans has examined the relation between sponsor liability structure and pension plan asset allocation, focusing predominantly on the choice between debt and equity mix.

In this paper, we show that the asset allocation of corporate DB pension plans is also related to features of the asset side of the sponsor's balance sheet (in particular to the investment characteristics of the firm). We argue that several economic mechanisms may generate a largely overlooked link between corporate asset characteristics and pension asset allocation decisions. For example, an optimal risk management strategy may incorporate the management of both pension and corporate assets. Therefore, the pension asset allocation decisions may be influenced by the need to hedge risks related to corporate assets as well as corporate liabilities. In addition, sponsor insiders may provide pension plan administrators and trustees with asset-specific information or expertise.<sup>2</sup> Further, the investment preferences of corporate insiders may trickle down to the pension fund management.<sup>3</sup>

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<sup>1</sup>According to Form 5500 filings with the US Department of Labor, at the end of 2015, the total DB pension assets amounted to over \$2.86 trillion with \$2.36 trillion held by single-employer plans.

<sup>2</sup>Relatedly, stock analysts may not only learn about the sponsoring firm's investment characteristics but also scrutinize the risk associated with the asset allocation of its DB plan. For example, Goldman and Peress (2017) point out that corporate R&D intensity and financial analysis are mutually reinforcing.

<sup>3</sup>Cocco and Volpin (2007) find that over 25% of DB pension plan trustees are corporate insiders

If pension asset allocation is related to sponsor’s asset characteristics, it is most likely that this relation affects the plans’ investment in alternative assets. Some trustees may not have good understanding of alternative investment strategies as they do not follow the widely accepted patterns observed in the traditional breakdown between fixed income and equity. In addition, these asset classes are more illiquid, and measuring their performance is more complicated than for traditional asset classes.<sup>4</sup> The following examples provide a simple way to illustrate how pension fund investment in alternative assets is related to the asset characteristics of the sponsor: During our sample period, Delta Airlines, for which fuel is an essential input for its operations, had between 3% to 5% of its pension assets invested in oil & gas; Eastman Chemicals, which relies heavily on the use of natural resources in its activities, had a DB pension plan holding 6% to 24% of its assets in mining and natural resources; Pfizer, whose business depends largely on the value of its research and development (R&D), had between 7% and 14% of its pension assets in private equity (PE) and venture capital (VC); Macy’s Department Stores, whose assets are predominantly land and buildings (L&B), had a pension plan that held 8% to 12% of its assets in real estate (RE). These funds’ allocation to alternative assets is considerably higher than the allocation of the average pension plan.

In our formal regression analysis, we test for a general pattern between corporate investment characteristics and defined benefit plan asset allocation to alternative assets. Specifically, we examine: (i) the effect of sponsor’s R&D intensity on plan’s investment in private equity; (ii) the effect of sponsor’s L&B intensity on plan’s investment in real estate.<sup>5</sup> It is a well-known fact that venture capital investments

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for their sample of UK pension plans.

<sup>4</sup>As documented by previous studies, alternative assets exhibit a large inter-quartile spread in performance, even within relatively narrowly defined strategy types, and therefore the quality of investment selection is likely to have large consequences for investment performance. Also the relative opacity of these assets raises the possibility for non-financial incentives to affect investment decisions.

<sup>5</sup>We measure R&D intensity and L&B intensity using the ratio of R&D to Property, Plant and Equipment (PPE) and L&B to PPE, respectively. As Table V shows, our main results hold if we

tend to be concentrated in R&D intensive industries (Gompers and Lerner, 2001). Previous studies have also documented a strong link between corporate innovation and private equity investments. Lichtenberg and Siegel (1990) show that, following a buyout, there is an increase in the target’s R&D spending both on an absolute basis and relative to its peers whereas Lerner, Sorensen and Stromberg, (2011) find that the target engages in more influential and focused research and development activities after the deal. Similarly, Amess, Stiebale and Wright (2015) find that buy-outs have a positive effect on innovation output measured as the quality adjusted patent stock. While the connection between corporate L&B holdings and real estate investments is self-explanatory, previous studies have pointed out that pension plans focus on physical and private equity real estate strategies such as opportunistic real estate investments in raw land and speculative property development projects. Andonov, Eichholtz, and Kok (2015) show that defined benefit plans do not invest large amounts in REITs.<sup>6</sup>

We find strong evidence that sponsoring firm’s R&D intensity and L&B intensity have a statistically and economically significant effect on a DB pension plan’s investment in private equity and real estate, respectively: Specifically, one standard deviation increase in the ratio of sponsor R&D expenditures to capital increases the plan’s private equity investment by 0.74%, while on average DB plans allocate 2.34% to private equity and the median plan allocates 0%. Similarly, one standard deviation increase in the ratio of L&B holdings to capital increases pension plan investment in real estate by 1.27%, while the average plan allocates 1.89% to real estate and the median allocates 0%. Such alternative investment tilts result in private equity and real estate being significantly overweighted relative to the average and median pension asset mix.

Further, we examine the structure of these private equity and real estate portfolio tilts and provide evidence that among pension plans that invest in private equity,

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use the total book value of assets or net sales as a denominator.

<sup>6</sup>In the P&I data that we use, real estate represents physical and private equity real estate investments.

the ones with R&D intensive sponsors overweight significantly their investment in venture capital and buyouts relative to other private equity investments such as funds of funds, infrastructure, mezzanine and distressed debt. Similarly, for pension plans that invest in real estate, the plans with L&B intensive sponsors overweight their investment in opportunistic real estate and underweight their exposure to core real estate relative to other strategies such as funds of funds, restructuring, spin offs, and special situation.<sup>7</sup>

The effect of corporate asset characteristics on pension plan alternative asset allocation (which we refer to as alternative investment tilts) remains robust to a number of alternative specifications and when we address concerns of endogeneity and changes in pension regulations. To control for possible bias due to R&D and L&B reporting practices, we check the robustness of our results to alternative measures of innovative activities and exposure to corporate real estate assets. Furthermore, the investment opportunities of the sponsoring firms and their defined benefit pension plans are likely to be correlated. We address this simultaneity issue using the longitudinal approach of Chaney, Sraer, and Thesmar (2012). We estimate the sensitivity of pension plan investment in private equity (real estate) to industry R&D returns (local MSA real estate prices) for sponsors before and after they invest in R&D projects (L&B holdings). Our results show that, before sponsors engage in R&D activities (acquire L&B), their pension plans' allocation to private equity (real estate) is statistically indistinguishable from those pension plans sponsored by firms that have never invested in R&D (L&B holdings). However, after the sponsor engages in R&D (acquires L&B), there is a positive relationship between industry R&D returns (local MSA real estate prices) and the plan's over-allocation to private equity (real estate). This result is consistent with the idea that following sponsor's R&D investment (respectively L&B), pension plan managers acquire information and/or become familiar with the distribution of private equity (real estate) returns and the

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<sup>7</sup>Opportunistic real estate investments have higher expected returns and higher risk (then the more conservative strategies), making them particularly well-suited to the needs of long term investors such as pension plans looking for exposure to real estate markets.

pension plan's investment in this asset class increases. In the appendix to this paper, we also carry out robustness checks using the changes in state-level corporate taxes as an instrument for R&D and L&B investments.<sup>8</sup> Finally, our results remain the same when we address the effects of the 2008 financial crisis and the introduction of 2006 Pension Protection Act (PPA) that became effective in 2008.

We search for an explanation for these alternative investment tilts in the portfolios of corporate DB pension plans. First, such portfolio tilts may arise because of specific information or expertise at the corporate level that spills over to the pension plan strategy and management. Using several performance measures, we compare pension plans with alternative investment tilts to plans without such tilts. We find that plans with alternative investment tilts exhibit both (significantly) lower risk-adjusted total returns as well as a negative active component for the over-allocated asset class when returns are decomposed into active and passive components (Grinblatt and Titman, 1993, and Lo, 2008). We also find that for R&D intensive sponsors, the private equity investments of pension plans that overweight VC and BOs on average underperform the private equity investments of plans that do not overweight VC and BOs by 200 basis points. Similarly, the returns on real estate investments of pension plans with alternative investment tilts that overweight opportunistic real estate are on average 123 basis points lower than the returns on real estate investments of plans that do not over-allocate to opportunistic real estate. These results are not consistent with pension plans benefiting from value-relevant information or better forecasting abilities about asset classes related to the corporate sponsor's asset characteristics.

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<sup>8</sup>Previous research has documented the sensitivity of corporate investment in R&D and L&B to changes in state-level taxes. Wilson (2009) and Mukherjee, Singh, and Zaldokas (2016) show that tax increases reduce innovation and R&D activities whereas Auerbach and Hassett, (1992), and Auerbach, (2005) document an important relationship between corporate taxes and capital accumulation (and in particular land and buildings). The investments of tax exempt DB pension plans, on the other hand, do not respond to state-level corporate tax changes. Since differential changes in state-level taxes are correlated with corporate R&D and L&B investment but uncorrelated with DB plans investment in private equity and real estate, they represent valid instruments.

Secondly, our findings do not support a hedging motive for investing in private equity. We show that pension plans of R&D intensive sponsors do not overweight VC and BOs funds operating in the same industry as the sponsor in order to hedge risks arising from product market competition. The finding that pension plans overweight venture capital (VC) and buyouts (BOs) relative to other (more conservative) private equity strategies is also not consistent with a diversification story but instead supports the idea that plans invest in private equity strategies that they are familiar with because of the sponsor's operating activities. In the same way, the results support a link between sponsoring firm L&B holdings and pension plan real estate investments through riskier (rather than geographically diverse) investment strategies, where conservative core investments are being underweighted, while risky opportunistic real estate strategies are being overweighted.

Finally, we perform a direct test for familiarity bias where the alternative investment tilts emerge as a result of pension managers preference for familiar assets. We conjecture that pension plans sponsored by innovative firms may have corporate-insider administrators and/or trustees who value new, innovative activities such as those carried out in venture capital funded projects. Similarly, DB plans sponsored by firms with large real estate holdings may have insiders acting as administrators and/or trustees who have stronger preference for real estate investments. Our test for familiarity bias follows Boyle et al (2012) who examine asset allocation when investors have different degrees of uncertainty about the return distributions of different assets. When investors prefer familiar assets (i.e. assets with low degree of ambiguity), optimal portfolios are characterized by a trade-off between the tendency to focus on the familiar asset and the benefit from diversification. Their model predicts that investors will increase their allocation to the familiar asset when the correlation with other assets increases. The reason for this so-called flight to familiarity is that as correlation increases, the diversification benefit of holding unfamiliar assets decreases, so there is an increase in the investment in the familiar asset. To test whether the alternative investment tilts in DB pension plan portfolios are the

result of familiarity bias, we examine if pension plans sponsored by R&D intensive (resp. L&B intensive) firms increase their investment in private equity (resp. real estate) when the correlation between private equity (resp. real estate) returns and the returns on U.S. public equity increases. Given pension plan asset allocation and the return volatility of different asset classes, we focus on U.S. equity since correlations are driven by this asset class rather than by international equity or fixed income assets. The result remains the same when we use the correlation between private equity (resp. real estate) returns and the return on a portfolio constructed from all asset classes excluding private equity (resp. real estate), where the portfolio weights are the pension plans asset allocations and the returns are the index returns for each asset class. Our results support the hypothesis that the link between pension plan asset allocation in alternative investments and the sponsor’s asset characteristics is associated with familiarity bias.<sup>9</sup>

Our paper is positioned at the intersection of several strands of literature. Previous research has documented the tendency of many investors to tilt their equity portfolios toward stocks of firms that are geographically, culturally or professionally close to them. The tendency for individual investors to hold familiar stocks has been established in the US (Huberman, 2001), Sweden (Massa and Simonov, 2006), Norway (Døskeland and Hvide, 2010) and Finland (Grinblatt and Keloharju, 2001).<sup>10</sup> Døskeland and Hvide (2010) find that individuals who trade professionally close stocks more than others generate negative abnormal returns (inconsistent with an information advantage), while Massa and Simonov (2006) find evidence of positive returns from investing in familiar assets.

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<sup>9</sup>The alternative investment tilts are also consistent with the theory of familiarity based on fear of the unknown developed by Cao, Hirshleifer, and Zhang (2009) where investors have pessimistic beliefs about deviations from the status quo. Our results are consistent with pension managers having pessimistic beliefs about alternative assets when the corporate sponsor’s operating activities are not related to these alternative investments.

<sup>10</sup>Huberman (2001) shows that the shareholders of a Regional Bell Operating Company (RBOC) tend to live in the same area it serves, and customers of a local RBOC tend to hold those shares rather than shares of other RBOCs.



Familiarity bias has also been documented for institutional investors. Coval and Moskowitz, (1999) show that the portfolios of U.S. mutual fund managers are characterized by a local bias. They provide evidence of a positive return on local information as institutional investors are able to generate excess returns on their local holdings. We add to this literature by showing that pension plans hold alternative investments that are tilted toward their sponsoring firm asset characteristics. Unlike earlier findings, on other classes of institutional investors such as mutual funds, we find that pension funds that exhibit familiarity bias generate negative excess returns on these investments.

Our paper is most closely related to Hochberg and Rauh (2013), who report a substantial home-state bias in venture capital and real estate investments by public pension funds. It complements their paper by focusing on corporate, rather than public pension plans and by examining a familiarity bias generated by the corporate asset characteristics rather than by the geographical location of the sponsor. We do not find evidence for significant local (in-state) overweighting in the private equity and real estate investment of corporate pension plans. In fact, the private equity and real estate investments of the plans in our sample are clustered in a few states. In contrast to Hochberg and Rauh (2013) who focus on the geographical location of public pension plans' investments in the same asset class (private equity or real estate), we focus on corporate pension plans' allocation decisions among different asset classes. To the best of our knowledge, we are the first to document such a familiarity bias in the asset allocation of an important type of institutional investors, i.e. corporate DB pension plans.

Our paper also contributes to the large literature on pension asset allocation. Previous studies have provided several explanations for the large equity holdings of corporate DB pension plans, which traditional tax-based theories have failed to do (e.g. Tepper, 1981, and Bodie, 1991). For example, pension plans of indebted firms with a high proportion of insider-trustees invest a higher proportion of their assets in risky equities to minimize expected contributions (Cocco and Volpin, 2007); equity

investing provides a hedge against increases in real wages as future earnings growth and risky asset returns are correlated (Black, 1989, Lucas & Zeldes, 2006); consistent with risk management incentives, better funded plans invest more in risky equities (Rauh, 2009). We do not find support for an earnings growth hedging motive as the share of active participants and plan age do not have a significant effect on plans' investment in risky assets such as private equity and real estate. Our finding that funds decrease their allocation to these assets, as their funding levels deteriorate, extends Rauh's (2009) risk-management result to alternative investments.<sup>11</sup>

The remainder of this paper is organized as follows. Section 2 provides background to the study. Section 3 describes the data and presents descriptive statistics. Section 4 examines the determinants of pension investment in private equity and real estate and the effect of sponsor's R&D and L&B intensity. Subsection 4.1 presents our main results whereas subsection 4.2 provides several robustness tests that focus on edogeneity and measurement error. Section 5 examines possible explanations for the relation between sponsor's asset characteristics and plan's investment in alternative assets. We analyze pension plan investment performance and provide a direct test for familiarity bias. Finally, section 6 concludes.

## 2 Background

### 2.1 Pension Plan Governance

In this section, we briefly describe the general rules for decision making by corporate DB pension plans. DB pensions promise a certain benefit to employees when they retire, and the company sponsoring the plan becomes responsible for ensuring that

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<sup>11</sup>Our findings also complement existing studies that document a link between pension plan design and pension liability risk and corporate policies. See, e.g., Petersen, (1994) for sponsor's choice of plan design and contribution policy; Rauh, (2006) and Webb, (2007) for the effect of pension funding on corporate investment policy and Shivdasani and Stefanescu, (2010) for the effect of pension liabilities on corporate capital structure.

sufficient assets are set aside in a trust to pay those benefits as they fall due. In addition, the sponsor is responsible for any shortfall between the pension assets and liabilities.<sup>12</sup> The primary law governing the establishment, maintenance, and termination of pension plans in the United States is the Employee Retirement Income Security Act (ERISA).<sup>13</sup> In the US, the pension trust is fully an asset of the corporation and its directors make decisions regarding the administration of the pension plan. ERISA requires single company pension plans to have one or more named fiduciaries who have the authority to control and manage the pension plan, including its investments. The sponsoring employer and the trustee(s) (usually appointed by the employer) are always named fiduciaries but it is possible for the trustee(s) to be devoid of any major fiduciary responsibility (directed trustee), following instead another named fiduciary such as an investment committee. In addition, the compensation of pension trustees differs substantially from the compensation received by corporate directors. Often trustees serve on pension boards without compensation.<sup>14</sup>

The pension legislation in the US also reflects the fact that employers act as administrators, trustees or other fiduciaries of plans. For example, ERISA imposes limits on acquisitions of employer securities by DB pension plans. Defined benefit plans may invest in employer securities only if no more than 25% of the outstanding stock of the same class is owned by the plan and at least 50% of the outstanding stock of the same class is owned by persons independent of the employer. In addition, employer securities cannot exceed 10% of the assets of a defined benefit plan.<sup>15</sup> The

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<sup>12</sup>Pension plans have a set of legal documents that set up the trust and the rules of the plan. These documents, however, are usually not publicly available.

<sup>13</sup>ERISA includes various provisions of labor law, as well as provisions of tax law that parallel certain provisions in the Internal Revenue Code.

<sup>14</sup>Schedule C of the IRS 5500 form reports information about service provider compensation. For corporate DB plans, when a trustee receives compensation, it is a financial institution (Fidelity Investments, BNY Mellon, Northern Trust Asset Management etc.) acting as a directed trustee. This is in contrast to the case of union plans, where it is common for individuals to receive compensation as trustees.

<sup>15</sup>No such restrictions exist for defined contribution plans.

pension legislator has attempted to address two concerns in enacting these limits. The first is a concern over self-dealing, since employers often serve as plan administrators, trustees, or in some other fiduciary capacity to the plan. The second is a concern over diversification of the trust fund that is to pay benefits owed to plan participants. In that respect, the P&I database provides information about the key personnel overseeing the investment management of the pension plan. Most corporate defined benefit plans report their CIO, CFO, Treasurer or another director/office of the sponsoring employer as the key personnel for their plan(s).

Even for countries such as the UK, where the pension trust is independent from the corporate assets and the trustees have significant independence on how to manage the plan, there is evidence that such independence is de facto compromised. Cocco and Volpin (2007), for example, use hand-collected pension trustees data for DB plans sponsored by UK firms and find evidence consistent with agency costs where insider trustees act in the interests of the sponsor shareholders and not necessarily in the interest of the pension beneficiaries.<sup>16</sup>

While the availability of detailed data on corporate pension trustees limits direct evidence, previous studies have provided indirect evidence that corporate sponsors have significant effect on pension plan funding and asset allocation. Webb (2007) shows that higher dividend payouts to shareholders are accompanied by lower pension plan contributions. Bergstresser, Desai, and Rauh (2006) find evidence that corporate managers manipulate the assumptions they use for valuing pension liabilities. When preparing to acquire other companies, managers increase the assumed rate of return on equity so as to increase earnings (see also Fabozzi and Ryan, 2003 and Dimson, Marsh, and Staunton, 2003). Chuk (2013) points out that the use of expected rather than actual returns reflects the financial reporting benefit of risk-taking (via a higher expected return, which reduces pension expense), but not the costs of risk-taking (i.e., higher volatility in actual returns). She shows that spon-

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<sup>16</sup>Cocco and Volpin argue that the US case is a limiting case of the UK experience where the proportion of pension plan trustees who are also executive directors of the sponsor is one.

soring firms seeking to gain from the financial reporting benefits of higher expected rate of returns (ERRs), however, have to take the real actions of increasing risky asset allocations in order to realize those benefits. This is the result of the FASB requirement to disclose asset allocations which tightens the alignment between ERRs and actual asset allocation. Similarly, although pension assets and liabilities are now marked-to-market on corporate balance sheets, pension expense on the income statement still does not reflect the entire change in these assets and liabilities over the course of the year, but is instead smoothed. Anantharaman and Chuk (2017) show that this asymmetry in the accounting regime creates incentives for plan sponsors to engage in more risk-taking in the pension plan than they otherwise would in the absence of such a smoothing mechanism.<sup>17</sup>

## 2.2 Corporate Assets and Plans Alternative Investments

Private equity and private real estate investments are characterized by substantial information asymmetry and illiquidity so we expect sponsor characteristics to be particularly important for these asset classes. For example, the value of an informational advantage or the effect of preferences for high risk investments may be particularly strong for these types of assets. These asset classes exhibit a large inter-quartile spread in performance, even within relatively narrowly defined strategy types, and therefore the quality of investment selection is likely to have large consequences for investment performance. Also the relative opacity of these assets raises the possibility for non-financial incentives to affect investment decisions.

Theories based on risk shifting incentives suggest that firms may choose to invest in pension assets whose performance is positively correlated with their operating

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<sup>17</sup>The recent passage of IAS 19 Employee Benefits marked a fundamental shift in pension accounting, by removing from pension expense the use of a managerial estimate that is directly tied to the riskiness of plan assets (i.e., the expected rate of return on plan assets), and replacing it with a managerial estimate that is unrelated to plan asset riskiness (i.e., the discount rate). The enactment of this passage, however, occurred after the end of our sample period.

performance, and that incentives for such risk shifting are stronger the more underfunded the pension plan liabilities. Such risk shifting incentives exist for corporate defined benefit pension plans because the Pension Benefit Guaranty Corporation insurances pension liabilities, i.e. provides sponsors with a valuable put option when the pension plan is terminated due to financial distress of the sponsoring firm. Alternatively, an optimal risk strategy may incorporate the management of both pension and corporate assets. Such strategy may create hedging incentives to invest pension funds in assets whose returns are correlated with the sponsor's industry returns in order to (i) hedge wage growth risks and/or (ii) hedge product market competition risks.<sup>18</sup>

Investing in employer's related assets and/or business may encourage employee ownership in pension plans as a means of entrenchment. Jensen and Meckling (1976) list strong relations between management and employees as a non-pecuniary benefit enjoyed by managers, which has led to management employee allies in many proxy contests (e.g., Stulz, 1988; Pagano and Volpin, 2005). Besides management-employee bonding, employees that are interested in job retention are more likely to side with incumbent management in proxy contests. Thus, employee ownership in pensions can serve as an effective takeover defence (Rauh, 2006; Coco and Volpin, 2013).

According to Campbell and Viceira (2005), barriers-to-entry related to plan and sponsor size could also account for the link between corporate assets and pension plan allocation to alternative investments. Large corporate sponsors tend to have large R&D expenditures and L&B holdings. They usually sponsor large DB pension plans that have access to VC, BOs and private real estate investments.<sup>19</sup> In that case, large DB pension plans sponsored by large firms will have better diver-

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<sup>18</sup>In the latter case, pension plans of R&D intensive sponsors will have an incentive to overweight VC and BOs funds operating in the same industry as the sponsor in order to hedge risks arising from product market competition.

<sup>19</sup>For example, Boeing's pension plan (top 1% for DB assets) invested up to 6% in private equity over our sample period. At the same time Boeing (top quartile for corporate assets) had between 12% and 74% R&D to capital ratio and between 137 and 477 patents a year.

sified alternative investments - both in terms of strategy and geography. Finally, a link between corporate assets and plans alternative investments may arise because corporate insiders have asset-specific information or expertise associated with the sponsor's operating activities and/or investment preferences for such assets.

### 3 Data and Stylized Facts

Our data are collected from four primary sources. First, we obtain data on pension asset allocation from the annual Pensions and Investments (P&I) surveys for the period from 1999 to 2014. P&I breakdowns include amount invested in equities, fixed income, private equity, real estate, other investments such as hedge funds and natural resources.<sup>20</sup> After removing all plans with non-corporate or multi-employer sponsors and those where the sponsor is a private firm or a firm incorporated outside the United States, our sample contains 461 defined benefit corporate pension plans.

Table 1 reports summary statistics on asset allocation for corporate DB pension plans. Panel A presents statistics for plans with private equity or real estate investments versus plans without such alternative investments. Panel B presents pension plan portfolios for two periods: 1999 to 2007 and 2008 to 2014. Allocation in each asset class is measured as a percentage of total DB pension assets. The average pension portfolio composition is 61.53% in equity investments, 31.00% in bonds, 1.80% in cash, 2.34% in private equity, and 1.89% in real estate. Pension plans with private equity investments on average allocate 5.40% of their DB funds to that asset class. Their investment in domestic equity and fixed income is lower (by 11.93% and 2.5% respectively), but they invest more in international equity and real estate than plans

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<sup>20</sup>Pensions & Investments (P&I) is a biweekly magazine aimed at pension professionals and investment management executives. The second issue of every calendar year publishes a detailed report, the so-called P&I 1000, on asset allocation by the largest 1,000 pension plans ranked by total assets under management. Information is gathered through a survey that is matched with further information collected from follow-up e-mails, phone calls, and data from Money Market Directories Inc.

that do not invest in private equity. Similarly, plans with real estate investments on average allocate 4.75% to that asset class. They have lower domestic equity and fixed income investment (by 7.32% and 2.78% respectively), but higher international equity and private equity investment than plans without real estate investments.

Panel B allows us to examine pension asset allocation before and after the 2008 financial crisis and the implementation of the 2006 Pension Protection Act (enacted in 2008). While the drop in domestic equity investment from 52.64% to 36.04% offers a stark example of a flight to safety, it was partly offset by increase in international equity investment from 12.53% to 14.72%, in private equity from 1.87% to 3.75%, and in real estate from 1.74% to 2.33%. Also, there was a substantial decrease in the number of pension plans in the second sub-period which is the result of many corporate sponsors decision to terminate or freeze their defined benefit plans, in response to the changes in the economic conditions, regulatory environment and demographic trends. The 2008 financial crisis led to both a decline in the value of pension assets, due mostly to the collapse of equity markets, and to an increase in the value of pension liabilities due to low interest rates. The 2006 Pension Protection Act tightened the funding requirements for corporate pension plans.<sup>21</sup>

Next, the sample sponsors from the P&I dataset are manually matched with Compustat using firm name and company information.<sup>22</sup> We use two sources for data on pension plan characteristics. Pension plans with 100 or more participants are re-

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<sup>21</sup>To address the attrition bias in the later years of our sample, we estimate our regression specification for the period from 1999 to 2007. Our results remain the same.

<sup>22</sup>Since the sponsor names are manually entered into the P&I forms, the matching of names with a standard identifier raises several issues. In particular, the same company can be reported under different names, e.g. IBM and International Business Machines, acronyms may or may not be included, and company names are often misspelled. First, we have removed all common acronyms such as "Inc" or "Co", and we have considered those pairs for which the reported name in the P&I dataset and the entry in Compustat matched perfectly. Second, we have hand-matched pension plans and corporate sponsors using string matching. When there were multiple matches, we identified pairs manually with additional information from the company website, the P&I dataset and/or Compustat.



quired to file a Form 5500 jointly developed by the IRS, Department of Labor (DOL), and the Pension Benefit Guaranty Corporation (PBGC). The data files for each plan are available from the DOL website and contain information on pension plan financials, plan participants and operations. In addition, Compustat provides pension data obtained from the sponsors annual reports. FASB 132R requires sponsoring firms to disclose details on their pension plan characteristics, plan assumptions, and returns. The difference between IRS5500 dataset and Compustat is that the former contains data for each individual plan whereas the latter aggregates all the defined benefit pension plans sponsored by a given corporation.

Table 2 presents summary statistics for the financials of the pension plans and their corporate sponsors. Panel A of Table 2 reports descriptive statistics calculated from the 5500 forms data for the period from 1999 to 2014. Table A1 in the Appendix provides the definition for the variables used in this study. The average plan in our sample has total assets worth \$1,06 billion, is 34 years-old, has an annual investment return of 10.19%, a funded status of 103%, and a ratio of active to total (active and retired) participants of 43.14%. As expected, plans with private equity and real estate investments are significantly larger, older and better funded than plans without these asset classes.

Panel B presents pension plan financials from Compustat. Since the pension data in Compustat is aggregated across all DB pension plans sponsored by a given corporation, the value for the average plan assets is much higher than the IRS5500 value at \$4.48 billion. The average plan generates an 8.64% investment return and its funded status is 91.6%.<sup>23</sup>

Panel C of Table 2 reports summary statistics for the sponsoring firms from Compustat for the period from 1999 to 2014. The average firm has assets worth \$67.7 billion while firms that sponsor DB plans with private equity pension investment (on

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<sup>23</sup>We calculate funded status as beginning of year pension assets over current pension liabilities when we use the IRS5500 forms data and beginning of year pension assets over projected benefit obligations when we use the pension data in Compustat. This explains the difference between the two numbers.

average) have assets worth \$86.3 billion. The average firm has R&D expenditures to capital (PPE) ratio of 10.21%, while land and buildings represent 60.36% of capital. The mean R&D intensity for firms with (without) pension private equity investment was 11.02% (9.53%). The mean L&B intensity for sponsors with (without) pension real estate investment was 63.65% (58.05%).<sup>24</sup>

Finally, we obtain data on private equity and real estate investments from Preqin. The vast majority of institutional investments in private equity and private real estate are made via legally separate funds run by professional managers (referred to as general partners), as the selection of appropriate direct investments requires more resources and specialized human capital that few institutional investors have (Fang, Ivashina, and Lerner, 2015). Private equity and real estate funds are raised for a specified period (typically 10 to 12 years, with possible short extensions) and are governed by partnership agreements between the investors (limited partners) and the fund's principals. We identify all limited partners (LPs) that are defined benefit corporate pension plans and manually match their names with the data in Compustat, IRS500 and P&I data. Investments are made by the LPs at the start of the fund's life, often referred to as the vintage year, and we can track the investment performance for each fund.

Table 3 reports descriptive statistics about the distribution of private equity and real estate funds by strategy and vintage year as well as key performance measures from Preqin. Panel A presents a typical picture of waves in venture capital and

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<sup>24</sup>In Table A2 in the Appendix, we provide information about the variation in alternative asset allocation. We compute the within and between pension plan variation in private equity and real estate investment. The within variation is 2.03% whereas the between is 3.16%. In other words, alternative investments vary significantly more across plans than within plans over time. Table A2 shows the importance of the within firm, within industry and between industry variation in pension plan private equity and real estate investments as well as the percentage of each of these sources of variation that is explained by the observable variables used in our regression specification: plan size, funded status, sponsor size, market to book, leverage, profitability and R&D/PPE or L&B/PPE. Table A2 shows that the within industry variation is more important than the between variation in explaining private equity and real estate investment.

buyout activity. The number of VC and buyout funds went up in 1998 to 2001 and then again in 2005 to 2007. The number of Value Added and Opportunistic real estate funds, on the other hand, grew until 2007 and then had a steady decline until the end of our sample period. The IRRs reported in Panel B have gone down from 16% in 1999 to 8% in 2014, but the time pattern suggests that pension managers have either managed their investments and exits over time to smooth their performance or have simply smoothed their reported IRR. This pattern is common to both private equity and real estate and to funds in each performance quartile, and it is consistent with reported IRRs remaining low since the financial crisis. Prequin follows industry practice in providing performance measures by investment strategy. However, such measures are prone to bias in reporting and general partner decisions and they have been subject to a number of criticisms (See Phalippou and Gottschalg, 2009). Hence, we consider several measures of pension plan performance.

Finally, to construct our performance measures, we require estimates of portfolio benchmark returns and correlations. We obtain time series of benchmark returns on each asset class: the S&P 500 for U.S. equities; the MSCI EAFE for international equities; the Barclays U.S. Aggregate Bond Index for U.S. bonds; the Barclays Global Bond Index for global bonds; the three-month Treasury bill yield for cash; the Cambridge Associates Venture Capital Private Equity Index for private equity; the NCREIF Property Index for real estate investment returns.<sup>25</sup>

## 4 Baseline Results

### 4.1 The Determinants of Investment in Alternative Assets

In this section, we examine the link between sponsor characteristics and pension plan investment in private equity and real estate. We begin our empirical analysis by examining the determinants of pension plan investment in these asset classes. The

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<sup>25</sup>All indices are available monthly apart from the private equity and real estate indices that are available quarterly.

results in Table 4 can be interpreted as tests of several hypotheses about the relationship between the investment behavior of the pension plan, and the plan and sponsor firm characteristics. To test for a link between the corporate sponsor characteristics and the pension plan investment in alternative assets we include R&D intensity in the private equity regressions and L&B intensity in the real estate regressions. Our hypotheses are that stronger corporate involvement in innovation is associated with a greater pension plan investment in private equity and large corporate land and buildings holdings are associated with a greater pension plan investment in private real estate.<sup>26</sup>

Panel A of Table 4 reports the estimation results using data from the IRS5500 forms from 1999 to 2014. The results show that R&D/PPE has a positive and statistically significant effect on private equity investment in all regression specifications. Similarly, the coefficient of L&B/PPE in the real estate regression is positive and statistically significant in all specifications. These results suggest that there is an important link between the sponsor's involvement in innovation and pension private equity investment and the sponsor's L&B holdings and pension plan real estate investment. The effects are also economically large. One standard deviation increase in the ratio of R&D expenditures to capital increases the plan's private equity investment by 0.74% (column (2)). This increase is significant relative to the mean private equity investment of 2.34% and the median of 0%. Similarly, one standard deviation increase in the ratio of L&B holdings to capital increases pension plan investment in real estate by 1.27% (column (4)). This is large relative to the mean real estate investment of 1.89% and the median of 0%. To the best of our knowledge this link has not been documented before.

The results in Table 4 do not support risk shifting theories according to which firms have an incentive to invest in risky assets and/or assets that are positively correlated with their own stock. These incentives are stronger, the more underfunded the pension liabilities are. On the contrary, we find that improvement in the pension

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<sup>26</sup>It should be noted that P&I reports REITs as domestic equity.

plan funded status has either a positive effect on the private equity and real estate investment of the pension plan or the effect is not significant. This result, which is consistent with Rauh’s (2009) finding that better funded U.S. pension plans invest more in equity, provides some evidence of risk management in pension investment in alternative assets.

We do not find evidence consistent with wage growth hedging incentives since pension plans with large share of active participants do invest more in private equity and real estate in order to hedge against increases in real wages. Table 4 shows that the coefficient of the share of active participants is not statistically significant in almost all specifications.

Finally, the rest of the sponsor characteristics, (log of total assets (size), investment opportunities (market to book ratio), internally-generated funds (profitability), and leverage) do not have a significant effect on pension plan private equity and real estate investments.<sup>27</sup>

Panel B replicates the estimation of the regression specifications in panel A using data from Compustat for the same period. The coefficients and their significance level are not materially different. Overall, our results provide strong evidence that pension plans tilt their portfolio towards alternative assets related to the characteristics of their sponsoring firm. In addition, the investment in private equity and real estate is

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<sup>27</sup>Frank (2002) and Rauh (2009) provide evidence that sponsors offset their (non-pension) business risk by reducing the investment risk of the pension plan assets. We do not find support for this in explaining investment in alternative assets. Results remain the same if we include the sponsor’s Z-score or credit ratings as a measure of the sponsor’s credit risk. In our robustness tests, we also include the one year lagged asset class investment return (instead of time dummies) and find that higher returns lead to a higher probability of investing in that asset class. This is consistent with both the risk management (as in Rauh, 2009) and other frictions such as the transactions costs of rebalancing portfolios, behavioral biases, e.g. investor inertia, or an excessive focus by managers on the short-term lagged return. The relationship between pension asset allocation and sponsor’s corporate characteristics is robust when controlling for lagged investment returns, which suggests that the portfolio tilts cannot be explained by the tendency of short-term asset allocation to be affected by lagged performance. The results are available on request.

higher for large plans and well-funded plans, which is inconsistent with risk shifting, hedging motives, but consistent with the risk management and barriers to entry hypotheses.

## 4.2 Measurement and Endogeneity Concerns

Our empirical analysis faces several challenges. Previous studies have argued that R&D expenditures may not be a reliable measure of innovative activity, in particular because reporting is typically biased, e.g. only large industrial companies report R&D expenses as explicit line items in their budgets (Bound et al, 1982, Lev, Sarath, and Sougiannis, 2005). Similarly, the L&B holdings reported in Compustat may be under reported (Chaney, Sraer and Thesmar, 2012). We also face estimation issues because of the potential effects of endogeneity on our results. For example, the returns to R&D investment and local L&B prices may be correlated with the investment opportunities of pension plans and specifically the returns to private equity and real estate. In addition, a sponsoring firm's decision to invest in R&D projects and to own land and buildings may be correlated with pension plan's investment opportunities.

In Table 5, we address the measurement error estimation concerns by examining sponsoring firm's (citation weighted) patents as an alternative measure of its innovation and tangibility as another proxy for a sponsoring firm's preference for owning real assets. Columns (1) and (2) of Table 5 report the estimation results for private equity based on the same specifications as Table 4 but instead of using R&D to capital ratio, we use  $\ln(1+\text{patents})$  as a measure for innovation.<sup>28</sup> Columns (3) and (4) report the estimation results for real estate allocation as the dependent variable (based on the same specifications as Table 4) but instead of using L&B to capital we use the ratio of property, plant and equipment to total assets to measure tangibility. The results in Table 5 show that overall our main findings remain the same.

Next, we address the potential endogeneity issues of our estimation using a lon-

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<sup>28</sup>We thank Noah Stoffman for making the data on citation weighted patents available. The time period is from 1999 to 2010.

gitudinal approach. In Table 6, we follow Chaney, Sraer, and Thesmar (2012) and estimate the sensitivity of private equity investment to industry R&D returns for firms that invest in R&D and the sensitivity of real estate investment to local MSA real estate prices for firms before and after they acquire land and buildings. Panel A of Table 6 uses IRS5500 data and shows that before their sponsoring firm invests in R&D, future plan investors in private equity are statistically indistinguishable from the pension plans sponsored by firms that never invest in R&D. Using the same data, Panel B shows that before acquiring land and buildings, sponsoring firms are statistically indistinguishable from firms that never own land and buildings. The sensitivity of their pension investment in private equity (resp. real estate) to R&D (resp. L&B) returns becomes large, positive, and significant only after sponsors invest in R&D (resp. L&B). The results remain the same when we use the Compustat data for the period 1999-2014. These regression results are reported in Panel C and Panel D.<sup>29</sup>

In Table A3 in the Appendix, we report the results from IV regressions as a robustness check. We use changes in state-level corporate taxes as an instrument for both R&D and L&B intensity. Previous studies have shown that both R&D expenditures and the value of corporate land and buildings holdings are sensitive to change in these taxes. The allocation decisions and the performance of the (tax-sheltered) pension plans, on the other hand, are not. We use the corporate tax data available in Heider and Ljungqvist (2015).<sup>30</sup> Our baseline results remain the same.

During our sample period, two major events had possible effects on the relation-

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<sup>29</sup>R&D returns at two-digit SIC industry level are calculated for the whole population of firms in Compustat passing the usual filters such as firms with missing observations, financial firms, and mergers and acquisitions. We follow Hall, Mairesse, and Mohaen (2010) and estimate industry level R&D returns.

<sup>30</sup>The study is based on a natural experiment in the form of 121 staggered changes in corporate income tax rates across U.S. states to show that tax considerations are a first-order determinant of firms' capital structure choices. To identify these changes, the authors use data obtained from the Tax Foundation, the Book of the States, a search of the Current Corporate Income Tax Developments feature published periodically in the Journal of State Taxation, and state codes accessed through Lexis-Nexis.

ships we examine in this paper: the financial crisis hit most asset classes in 2008, and the 2006 Pension Protection Act (PPA) became effective in 2008. The PPA requires sponsors of underfunded pension plans to pay higher premium to the PBGC. The PPA also extends the requirements of providing additional contributions to underfunded pension funds. This, coupled with the flight to quality following the crisis, led pension plans to engage in de-risking strategies, which resulted in a substantial increase in investments in fixed income and cash at the expense of investments in risky assets. We do observe a decrease in pension plan investment in real estate during crisis years while private equity investments remained stable. We estimate all specifications using a subsample from 1999 to 2007. The main results remain the same and some of our findings, in particular those on the effects of the alternative investment tilts on plan and sponsor performance, are actually stronger.<sup>31</sup>

Several other robustness tests provide further insight. We split the sample by firm size (total assets) and constrained versus unconstrained firms (Whited and Wu Index) to examine the effect of the main determinants of R&D and L&B investments on our results. There is no significant difference across subsamples and all our results continue to hold. In addition, we account for the fact that asset allocation weights are censored below zero and above one and use a two-limit Tobit model to estimate the regression specifications in Table 4. We control for the effects of persistence in asset allocation that may be caused by regular rebalancing towards a strategic asset allocation, and we have included a one-year lag of the dependent variable in our main regressions. The results remain the same and they are available upon request.

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<sup>31</sup>Finally, we split the sample firms into those with R&D expenditures and those without and match them on the covariates from the regression specifications in Table 4. The average treatment effect on pension plan private equity investment is 0.004 (0.0017)\*\*. Similarly, we split sample firms into those with large (above median) and those with small (below median) L&B intensity and again match them on the same covariates. The average treatment effect on the pension plan real estate investment is 0.00297 (0.0014)\*\*. These results support the positive relationship between corporate sponsor R&D (L&B) intensity and the pension plan alternative asset allocation.



## 5 Searching for Explanation

### 5.1 Analysis of Investment Overallocation

A more detailed analysis of pension plan investment in private equity and real estate may prove helpful in explaining the rationale for the portfolio tilts that we have documented in the previous section. Preqin distinguishes between various investment strategies. We group private equity strategies into three types: venture capital (VC), buyouts (BOs), and Others (including funds of funds, hybrid investments, and infrastructure, mezzanine and distressed debt). Similarly, we aggregate real estate strategies into core, core plus, value-added, opportunistic and others including funds of funds, public to private investments, restructuring, and spinoffs. We examine the possible channels through which corporate R&D expenditures may affect pension plan private equity investment. We investigate whether there is a venture capital and/or buyout bias (the innovation channel) relative to other private equity investment strategies (Gompers and Lerner, 2001). We test whether pension plans sponsored by R&D intensive firms tend to overweight (i) VC and BOs in the same industry as the sponsor to hedge product market competition risks; (ii) other investment strategies relative to VC and BOs if they want to diversify away from the innovation-intensive corporate investments; (iii) overweight VC and BOs relative to other assets if they invest in assets that they are familiar with as a result of the firm's operating activities.

We also examine whether there is a link between sponsoring firm L&B holdings and pension plan real estate investments through the risk return profile of the investments. Conservative investments would lead to core investments being overweighted, while a risky strategy would lead to opportunistic real estate being overweighted relative to other investment strategies.

One drawback of the Preqin dataset is that the capital commitments of the LPs (DB corporate pension plans) to the private equity and/or real estate fund

is generally unavailable.<sup>32</sup> In order to construct measures of over-allocation to funds/strategies and their performance from the Preqin data, we follow Hochberg and Rauh (2013) and assume that these investments are all of equal size (i.e., effectively equal-weighting the investments). We compute two benchmarks that help us measure the relative overweighting. First, we use a pooled benchmark: the share of all investments in a particular strategy. We call this benchmark the overall strategy share. However, if LPs investment patterns change over time, it is useful to examine the overweighting on a rolling basis over the several years preceding any given vintage, as opposed to over the entire sample. Given our sample period, we use a 5-year rolling benchmark, i.e. we compare investments relative to the previous five years of investment activity for each strategy we have identified.

Table 7 reports the results from analysis of the overweighting of private equity and real estate investment strategies by sponsor characteristics, where the strategy overweighting each year is calculated versus benchmarks based on (i) the overall share of the investment strategy; (ii) the prior five years share of the investment strategy. Panel A of Table 7 reports the results from t-tests for differences in means for plans with sponsors in the top and bottom quartiles for R&D and L&B intensity. The results show that pension plans with R&D intensive sponsors over-allocate to venture capital and buyouts relative to other private equity strategies. Plans with L&B intensive sponsors overweight opportunistic real estate and underweight core real estate investment relative to other real estate investment strategies. The table shows that there is a significant difference in overweighting related to the link between corporate sponsor characteristics and pension plan investment in alternative assets consistent with our main results. The results remain the same regardless of the benchmark, i.e. whether we use the overall share for each investment strategy or the prior five-year benchmark.

Further, Panel B and C of Table 7 show the results from our formal regression

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<sup>32</sup>The capital commitments data are better quality for public pension plans. For the corporate plans, these data are mostly missing.

analysis. All specifications contain vintage year effects. The results show that sponsor R&D intensity is an important determinant of overweighting in venture capital and in buyouts, and the effect of L&B intensity on overweighting in opportunistic real estate and on underweighting in core real estate investments is statistically significant. The results are also economically large with one standard deviation increase in R&D intensity resulting in 0.39% (Panel B, column 1) overweighting in venture capital and 0.48% (Panel B, column 3) overweighting in Buyouts. Similarly, one standard deviation increase in L&B intensity results in 1.16% (Panel C, column 1) overweighting in Opportunistic and 1.23% (Panel C, column 3) underweighting in Core. Consistent with our baseline results' support for the risk management hypothesis, the coefficient of funded status is large, positive and significant in almost all specifications.<sup>33</sup>

## 5.2 Performance

Another possible explanation for the alternative investment tilts is that sponsors have superior information or specific skills related to the corporate assets that may trickle down from the corporate sponsor to the firm's trustees and affect the defined benefit plan investment decisions.<sup>34</sup> To investigate this hypothesis, we examine the effect of the link between sponsor characteristics and plan investment in alternative assets on the investment performance of pension plan portfolios. If pension plan managers have value relevant information related to the characteristics of the sponsoring firm,

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<sup>33</sup>Similar regressions on other private equity investments and both value added and other real estate investments are available upon request. Results are not significant or not economically large.

<sup>34</sup>Asset allocation across broad asset classes has been shown to be a major determinant of the performance of portfolios managed by institutional investors such as pension funds, and particularly so in the time series. See, among others, Brinson, Hood, and Beebower (1986), Brinson, Singer, and Beebower (1991), Blake, Lehmann, and Timmermann (1999), Ibbotson and Kaplan (2000), and Brown, Garlappi, and Tiu (2010). A typical DB plan's annual investment return is much higher than its annual employer and employee contributions. Thus, portfolio choice is a first-order concern for funding status as well.

we expect their pension plans to generate higher returns than other plans, and particularly so on asset classes in which they benefit from an informational advantage or specific expertise.

We rank all pension plans with private equity investments according to their corporate sponsor R&D intensity and all plans with real estate investments according to their corporate sponsor L&B intensity. From the informational advantage hypothesis, we expect that pension portfolios in the top quartile for R&D intensity and pension portfolios in the top quartile for L&B intensity will outperform the portfolios in the bottom quartiles. A potential performance differential may be observed in the entire pension portfolio or more specifically on the asset class related to sponsor investment characteristics.

Table 8 presents the estimation results from the regression analysis of the effect of sponsoring firm characteristics on its pension plan investment performance using the ERISA data. Our first performance measure is plan excess return calculated as the difference between the actual pension plan return (investment income divided by beginning of year pension assets) and the return on a portfolio of benchmark investments replicating the plan asset allocation (the portfolio weights are the actual pension plan asset allocations and the returns are the index returns for the asset class). Our second performance measure is the active-passive return decomposition where we split plan portfolio returns into these two components.<sup>35</sup> The passive component reflects only the average values of portfolio weights and asset returns. The active component depends on the covariances between portfolio weights and asset returns. The weights of the portfolio allocation chosen by a skillful or informed pension manager will be positively correlated with the asset class returns. The correlation between portfolio weights and returns at date  $t$  is a measure of the predictive power

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<sup>35</sup>The active component of portfolio returns may be computed using solely data on the average portfolio weights and the average portfolio returns. Under some very general assumptions, the active component of any portfolio may be estimated consistently from the sample moments where the estimator is asymptotically normal with variance that may be estimated consistently using GMM.

of the information used by the manager to select her date  $t$  portfolio weights. If these weights have no forecasting power, the only source of expected return is the risk premium, in which case the return is the same as a buy-and-hold portfolio (passive component). This latter performance measure has an added advantage in that it does not rely on the choice of a benchmark.

Panel A of Table 8 reports the investment performance of the pension plans in our sample. Panel A examines the overall effect of investing in private equity and real estate. Plans that have neither private equity nor real estate investments generate an average return that is not significantly different from the average return of those plans with either real estate or private equity. In addition, when we sort pension plans in quartiles by plan size, we find that pension plan performance does not improve with size.

Panel B of Table 8 shows the effect the alternative investment tilts on the performance of DB pension portfolios using the excess plan return (actual return over a benchmark return). Among funds that invest in private equity, those with sponsors in the top quartile of R&D/PPE (resp. L&B/PPE) generate a statistically significant lower abnormal return than funds with sponsors in the bottom quartile.

Panel C of Table 8 shows the effect of the portfolio tilts on pension performance using the active-passive decomposition. The results show that pension managers do not add value relative to plans without tilts by choosing tilted portfolios: On average, the active component of plan portfolios in the top quartiles for both R&D/PPE and L&B/PPE underperforms significantly the active component of funds in the bottom quartiles. Therefore, the worse performance of plans with alternative investment tilts is not likely to be the result of bad luck for investing in alternative assets during our sample period.

Another possible explanation for the lack of superior performance of tilted plans that is consistent with an information advantage is that managers can successfully time investments in alternative asset classes but they underperform when actively managing investments in traditional asset classes. Panels D and E show the results

for active investment in private equity and real estate, respectively. The results in Panel D show a negative effect of the private equity and real estate tilts on the plan’s performance from private equity and real estate investments, respectively: the active component of returns of plans in the top quartile is statistically significantly lower than the active component of plans in the bottom quartile. Overall, our results show that portfolio tilts do not benefit pension plans. In addition, the performance of the investment funds of pension plans with private equity tilts is worse than for plans with real estate tilts.

Next, we turn to analyzing the performance of pension plan investment in private equity and real estate funds using the Preqin dataset. As discussed in the previous section, pension plans with R&D intensive sponsors overweight their investment in venture capital and buyouts relative to other private equity strategies whereas plans sponsored by firms with large L&B holdings overinvest in opportunistic real estate and underinvest in core real estate. Next, we investigate whether the overweighted strategies of the plans with tilted portfolios are the sources of underperformance for their alternative investments.<sup>36</sup>

Panel A of Table 9 reports the means and the  $p$ -values from the  $t$ -tests of differences in net IRR between the private equity investments of pension plans with tilted portfolios (top quartile of R&D investment) and plans without such tilts (bottom quartile). Columns (1) and (2) report the net IRR and the excess IRR for all private equity investments. The excess IRR is calculated as the equally weighted IRR for each fund minus the mean of all other observations in the same strategy and vintage year of the investment fund. Consistent with the results in Table 8, the plans with tilted portfolios underperform the plans without investment tilts, on average, by 200 basis points. Columns (3) and (4) report the same numbers for the portfolio of venture capital funds, while columns (5) and (6) report these performance measures of investments in buyout funds. The underperformance of pension plans with tilted

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<sup>36</sup>Although these are by no means immune from criticisms (see e.g., Phalippou and Gottschalg, 2009), we follow industry practice and data availability and rely on the net IRRs provided by Preqin as a measure of performance.

portfolios can be attributed to the worse performance of the venture capital funds in which they overinvest. There is no significant difference in the buyout investment performance of pension plans with portfolio tilts relative to the ones without investment tilts.

Panel B reports the means and the  $p$ -values from the  $t$ -tests of differences in portfolios net IRR between the real estate investments of pension plans with tilted portfolios (top quartile of L&B holdings) and plans without such tilts (bottom quartile of L&B holdings). Columns (1) and (2) report the net IRR and the excess IRR for all real estate investments. The excess IRR is calculated as the equally weighted IRR for each fund minus the mean of all other observations in the same strategy and vintage year. The plans with tilted portfolios underperform the plans without investment tilts by 123 basis points. Columns (3) and (4) report the same numbers for the portfolio of opportunist real estate funds and columns (5) and (6) report the performance measures of investments in core real estate. The underperformance of pension plans with tilted portfolios can be attributed to the worse performance of the funds with an opportunistic strategy in which pension plans with real estate tilts overinvest. In addition, even though the portfolios with investment tilts underperform on their core investment, they underweight this strategy in their overall portfolio.

Panel C provides a dollar value estimate of the cost of the alternative investment tilts in an attempt to quantify the cost of the bias. Column (1) and (2) relate to a cost estimate of the total investment in private equity and in real estate, respectively, for our sample firms every year. These numbers indicate that the cost of the private equity tilt is higher than the cost of the real estate tilt. In addition, the cost of the two tilts amounted to \$US 1.1 billion in 2000, \$US1.6 billion in 2010, and \$US1.3 billion in 2014. The average value of the losses due to the portfolio tilt in a given year since 2008 amount to \$1.4 billion.

Overall, we do not find evidence supporting the informational advantage hypothesis since plans with alternative investment tilts underperform plans without tilts for

each of our performance measures. We note that our results provide a new channel that explains the underperformance of the private equity investments of corporate pension plans as documented by Lerner, Schoar, and Wongsunwai (2007) and the persistent heterogeneity in private equity performance documented by Kaplan and Schoar (2005). Our results indicate that such underperformance does not harm all funds. Rather, corporate pension plans with portfolio tilts that we have identified are those that exhibit significant, persistent underperformance.

### **5.3 Familiarity Bias**

The results that plans with tilted portfolios underperform other plans, and in particular underperform in their private equity and real estate investments are not consistent with an information advantage., but they are consistent with a familiarity bias that breeds overconfidence. We add to the existing studies that provide evidence of a familiarity bias within an asset class and show that investors typically invest in stocks that are geographically, professionally, or culturally close to them. Table 7 provided evidence that pension plans with R&D intensive sponsors invest more in venture capital and buyouts, while plans with L&B intensive sponsors overinvest in opportunistic real estate (a more speculative real estate investment strategy that requires better understanding of real estate markets than the more conservative real estate investments) and underinvest in core real estate relative to other types of real estate investment.

In this section, we discuss the results from a direct test for the existence of such familiarity bias. Specifically, we test Boyle et al's (2012) theory of familiarity based on ambiguity aversion. In their paper, investors view as familiar an asset class on which they exhibit a low degree of uncertainty on the distribution of asset returns. Their main empirical prediction is that investors hold more funds in the familiar asset class as the correlation with the other asset classes decreases. Table 10 tests whether or not our results are consistent with Boyle et al's (2012) theory of familiarity based on ambiguity aversion. Specifically, it examines whether investment in private equity



(resp. real estate) increases with the correlation between its returns and the returns on the S&P500 Index. In Table 10, we augment our main regression specification with an interaction term of an R&D (resp. L&B) dummy that equals one if the corporate sponsor invests in R&D (resp. L&B) and the correlation between the returns on our private equity (resp. real estate) index and the S&P500.<sup>37</sup> Table 10 provides strong evidence that this correlation is a significant determinant of pension plan investment in private equity and real estate. The coefficient of the interaction variable is significant and positive in all specifications. Hence, this tests supports the existence of a familiarity bias in alternative investments.

In addition, these results are consistent with overconfidence once sponsor assets are related to alternative assets available to defined benefit pension plans. Our results are also consistent with Cao, Hirshleifer, and Zhang's (2009) theory of familiarity based on fear of the unknown. In their paper, investors are pessimistic about assets in which they have not yet invested and they require an unfamiliarity premium to start investing in these new assets. In our paper, investors become familiar with these assets through their professional activities. Our results are consistent not only with investors being pessimistic about assets that they have not become familiar with, but also with an explanation where economic activity can create a sense of familiarity that can in turn generate financial investment conducive to losses.

## 6 Conclusion

This paper shows that corporate asset characteristics have a significant impact on pension plan investment in alternative assets. Pension plans with R&D intensive sponsors invest more than twice as much in private equity than their peers with less innovative sponsors. Similarly, plans with L&B intensive sponsors invest significantly more in real estate than their peers sponsored by firms with low L&B holdings.

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<sup>37</sup>We use quarterly time series of index returns to calculate the annual correlations from 1999 to 2014.

These results shed light on our understanding of the determinants of pension plan investment in alternative assets.

Further, we show that the alternative investment tilts can be attributed to a familiarity bias. In particular, before their sponsoring firm invests in R&D (resp. L&B), future plan investors in private equity are statistically indistinguishable from the pension plans sponsored by firms that never invest in R&D (resp. L&B). The sensitivity of their pension plan investment in private equity (resp. real estate) to R&D (resp. L&B) returns becomes large, positive, and significant only after sponsors invest in R&D (resp. L&B). This is consistent with a familiarity bias in the spirit of Boyle et al (2012) and Cao, Hirshleifer, and Zhang (2009). As pointed out in Boyle et al (2012), this view of a familiarity generates portfolios that are exposed to idiosyncratic risk and to higher rebalancing than Markowitz portfolio theory. Although our data does not enable us to investigate these issues, this will certainly be the subject of future research as this issue is important to pension managers and beneficiaries, sponsors, and regulators.

Overall, our results indicate that the investment characteristics of corporate sponsors are important determinants of pension investment decisions. This raises a number of questions. For example, there may be relationships other dimensions than those we have identified here between sponsor asset side characteristics and investment decisions by pension plans. Further, the importance of pension trustees and of their relationship with their sponsoring firm remains largely unknown due to data limitations. They play a central role in pension governance, asset allocation, and in the magnitude of the familiarity bias that we documented. Their influence over these areas in pension management will certainly be the subject of future research.

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Table 1: Summary statistics: Asset Allocation by Corporate DB Pension Plans

The table presents asset allocation for pension plans. Panel A reports summary statistics for plans: (1) with and without private equity investments ; (2) with and without real estate. Panel B reports statistics for the time period before and after 2008. The sample consists of 461 corporate sponsored DB plans the period from 1999 to 2014. The last column of (1), (2) and (4) reports  $p$ -values from  $t$ -tests for differences in means. Significance at the 1%, 5%, and 10% levels is represented by \*\*\*, \*\*, and \*, respectively.

Panel A: Asset Allocation for Plans with Alternative Investments										
	(1)					(2)				
	Plans without PE		Plans with PE			Plans without RE		Plans with RE		
	mean	std	mean	std	$p$ value	mean	std	mean	std	$p$ value
US equity	53.62%	0.1480	41.69%	0.1324	0.00***	51.50%	0.1567	44.18%	0.1374	0.00***
US fixed	30.97%	0.1371	28.71%	0.1216	0.01***	31.15%	0.1409	28.37%	0.1140	0.00***
International equity	11.08%	0.0850	15.70%	0.0664	0.00***	11.98%	0.0877	14.61%	0.0670	0.00***
International fixed	0.61%	0.0295	1.54%	0.0406	0.00***	0.85%	0.0347	1.24%	0.0355	0.00***
Cash	1.83%	0.0602	1.78%	0.0317	0.59	1.96%	0.0611	1.59%	0.0271	0.00***
Private equity	0.00%	0.0000	5.40%	0.0461	0.00***	1.61%	0.0361	3.36%	0.0439	0.00***
Real estate	1.24%	0.0266	2.74%	0.0325	0.00***	0.00%	0.0000	4.54%	0.0315	0.00***
Others	0.23%	0.0078	0.48%	0.0112	0.00***	0.24%	0.0082	0.48%	0.0109	0.00***
Observations	<b>1,927</b>		<b>1,494</b>			<b>2,012</b>		<b>1,409</b>		

  

Panel B: Asset Allocation by Time Period							
	(3)		(4)				
	1999-2014		1999-2007		2008-2014		
	mean	std	mean	std	mean	std	$p$ value
US equity	48.45%	0.1533	52.64%	0.1296	36.04%	0.1509	0.00***
US fixed	29.99%	0.1311	28.14%	0.1123	35.47%	0.1636	0.00***
International equity	13.08%	0.0808	12.53%	0.0830	14.72%	0.0714	0.00***
International fixed	1.01%	0.0350	0.82%	0.0281	1.60%	0.0499	0.00***
Cash	1.80%	0.0498	1.88%	0.0557	1.57%	0.0255	0.25
Private equity	2.34%	0.0405	1.87%	0.0352	3.75%	0.0505	0.00***
Real estate	1.89%	0.0302	1.74%	0.0301	2.33%	0.0301	0.00***
Others	0.34%	0.0095	0.38%	0.0101	0.21%	0.0076	0.67
Observations	<b>3,421</b>		<b>2,541</b>		<b>880</b>		

Table 2: Summary statistics: Pension Plans and Sponsors Characteristics

The table presents summary statistics for: (1) all plans; (2) plans without PE vs plans with PE; and (3) plans without RE vs plans with RE. The sample consists of 461 US defined benefit pension plans for the period from 1999 to 2014. The last columns of (2) and (3) reports  $p$ -values from  $t$ -tests for differences in means. Significance at the 1%, 5%, and 10% levels is represented by \*\*\*, \*\*, and \*, respectively.

	(1)		(2)				$p$ value	(3)				
	All Plans		Plans without PE		Plans with PE			Plans without RE		Plans with RE		
	mean	std	mean	std	mean	std		mean	std	mean	std	$p$ value
<b>Panel A: Plan Financials from IRS 5500 (1999-2014)</b>												
Plan Size (Million USD)	1,060	(3,730)	709	(2,180)	1,720	(5,490)	0.00***	729	(2,220)	1,840	(5,830)	0.00***
Plan age (years)	33.97	(27.75)	33.28	(23.03)	35.25	(19.97)	0.00***	33.028	(19.51)	36.17	(26.89)	0.00***
Plan return	10.19%	(0.14)	10.43%	(0.15)	9.73%	(0.14)	0.06*	10.33%	(0.14)	9.86%	(0.13)	0.22
Funded Status	1.03	(0.26)	1.02	(0.25)	1.04	(0.28)	0.01***	1.02	(0.26)	1.05	(0.26)	0.00***
Active participants	43.14%	(0.25)	46.24%	(0.21)	43.69%	(0.21)	0.01**	43.71%	(0.26)	41.82%	(0.23)	0.01***
<b>Observations</b>	<b>2,148</b>		<b>1,295</b>		<b>853</b>			<b>1,315</b>		<b>833</b>		
<b>Panel B: Plan Financials from Compustat (1999-2014)</b>												
Plan Size (Million USD)	4,481	(9,688)	2,069	(3,529)	7,573	(13,465)	0.00***	2,447	(4,818)	7,101	(13,143)	0.00***
Plan return	8.66%	(0.50)	4.20%	(0.33)	13.99%	(0.64)	0.00***	4.36%	(0.36)	14.10%	(0.63)	0.00***
Funded Status	0.92	(0.25)	0.91	(0.26)	0.92	(0.24)	0.21	0.90	(0.26)	0.94	(0.24)	0.00***
<b>Panel C: Sponsor Financials from Compustat (1999-2014)</b>												
Size (USD \$mil)	67,700	(232,728)	53,264	(208,277)	86,311	(259,781)	0.00***	15,357	(27,985)	30,095	(62,239)	0.00***
Market-to-Book	3.14	(18.67)	2.46	(10.91)	4.03	(25.44)	0.063*	2.63	(12.64)	5.49	(30.94)	0.02**
Leverage	21.83%	(0.1351)	21.72%	(0.14)	21.97%	(0.13)	0.59	21.12%	(0.1355)	21.88%	(0.13)	0.19
EBITDA/Assets	12.34%	(0.07)	12.32%	(0.07)	12.36%	(0.06)	0.84	14.08%	(0.08)	14.34%	(0.06)	0.38
R&D/PPE	10.21%	(0.25)	9.53%	(0.24)	11.07%	(0.25)	0.05**	9.82%	(0.26)	10.71%	(0.24)	0.26
L&B/PPE	60.36%	(0.35)	60.83%	(0.37)	59.73%	(0.32)	0.46	58.18%	(0.35)	63.65%	(0.32)	0.00***
<b>Observations</b>	<b>3,595</b>		<b>2,020</b>		<b>1,575</b>			<b>2,024</b>		<b>1,571</b>		

Table 3: Summary statistics: Distribution and Performance of PE and RE Funds

The table presents summary statistics for: Panel A: the distribution of PE and RE funds by strategy and vintage year; Panel B: the key performance measures (1) net IRR; (2) excess IRR, i.e. the difference between the fund IRR and the mean of all other observations with the same strategy and vintage; and (3) multiples of invested capital) for vintage years from 1999 to 2013.

Panel A: Distribution of funds by strategies							
Vintage Year	Number of PE funds			Number of RE Funds			
	VC funds	BO funds	Others	Core	Value Added	Opportunistic	Others
1990	12	7	24	1	0	0	0
1991	16	18	24	3	0	8	0
1992	75	45	33	0	0	3	0
1993	100	88	108	0	12	0	0
1994	225	210	130	5	0	60	0
1995	240	414	186	0	78	60	0
1996	518	315	364	0	21	175	21
1997	656	824	512	0	96	232	24
1998	1,206	1,593	765	243	162	270	0
1999	2,050	1,130	1,100	0	130	250	0
2000	2,200	1,940	960	90	160	150	0
2001	1,470	770	1,600	0	220	220	40
2002	450	750	770	80	40	150	30
2003	600	1,010	1,000	70	290	190	0
2004	990	950	1,280	120	280	300	10
2005	1,026	2,340	1,890	18	504	837	63
2006	1,312	2,192	1,984	72	464	512	16
2007	1,043	1,806	2,030	63	455	644	84
2008	660	960	1,422	12	144	312	24
2009	300	315	400	20	20	95	0
2010	192	276	464	12	52	152	28
2011	168	225	336	21	54	180	0
2012	74	136	208	6	18	42	0
2013	22	57	44	2	15	11	1

  

Panel B: Fund Performance									
	(1)			(2)			(3)		
	mean	std	median	mean	std	median	mean	std	median
1999	31.36%	(0.2033)	27.71%	0.72%	(0.2885)	-4.53%	2.12	(3.5572)	1.42
2000	31.88%	(0.2138)	24.32%	0.88%	(0.2653)	-2.88%	1.92	(3.1691)	1.39
2001	16.61%	(0.1569)	11.65%	0.94%	(0.2529)	-2.05%	1.85	(2.9315)	1.40
2002	7.45%	(0.1505)	4.84%	1.00%	(0.2485)	-2.39%	1.81	(2.8338)	1.40
2003	5.04%	(0.1176)	4.63%	0.70%	(0.2406)	-2.63%	1.71	(2.5443)	1.38
2004	10.42%	(0.1185)	10.48%	0.40%	(0.2281)	-2.21%	1.56	(1.8792)	1.36
2005	12.64%	(0.1073)	12.06%	0.27%	(0.2115)	-1.43%	1.43	(1.1623)	1.30
2006	15.97%	(0.1077)	15.17%	0.11%	(0.1797)	-0.28%	1.32	(0.7123)	1.22
2007	15.97%	(0.0910)	15.40%	0.16%	(0.1338)	0.37%	1.24	(0.4629)	1.18
2008	9.95%	(0.0910)	9.76%	0.18%	(0.1305)	0.43%	1.23	(0.4498)	1.18
2009	8.81%	(0.1005)	7.77%	0.40%	(0.1271)	0.67%	1.24	(0.4360)	1.18
2010	8.67%	(0.0850)	8.49%	0.27%	(0.1231)	0.43%	1.23	(0.4088)	1.18
2011	10.06%	(0.0629)	9.23%	0.23%	(0.1203)	0.43%	1.20	(0.3638)	1.16
2012	10.37%	(0.0606)	9.73%	0.14%	(0.1169)	0.47%	1.18	(0.3471)	1.15
2013	11.41%	(0.0561)	10.59%	0.30%	(0.1140)	0.80%	1.16	(0.3123)	1.15

Table 4: Corporate DB Pension Investment in Alternative Assets

The table presents coefficient estimates from regressions that examine the determinants of pension plan alternative investments. The dependent variable is: the percentage of pension assets allocated to private equity for (1) and (2); and the percentage of pension assets allocated to real estate in (3) and (4). The sample consists of 461 US corporate DB pension plans and their sponsors from 1999 to 2014. Firm and year fixed effects are included in all specifications. Robust standard errors are included in brackets. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

Panel A: Determinants of Alternative Investments using IRS5500 Data								
	Private Equity				Real Estate			
	(1)		(2)		(3)		(4)	
Plan size	0.0004	(0.0004)	-0.000294	(0.0005)	0.00405***	(0.0004)	0.00635***	(0.0005)
Plan age	-0.0001	(0.0001)	0.00000680	(0.0001)	0.000761	(0.0049)	-0.0000439	(0.0001)
Funded status	-0.0012	(0.0029)	-0.00340	(0.0032)	0.00677**	(0.0026)	0.00694*	(0.0030)
Share of active participants	0.00525	(0.0041)	0.0111*	(0.0053)	0.000264	(0.0036)	-0.00125	(0.0049)
Sponsor size			0.00115	(0.0025)			0.000359	(0.0023)
Market to Book ratio			0.0000956	(0.0001)			0.0000638	(0.0001)
Leverage			0.00427	(0.0092)			-0.000958	(0.0084)
Profitability			-0.00250	(0.0072)			0.0000776	(0.0066)
R&D/PPE	0.0149***	(0.0020)	0.0300**	(0.0116)				
L&B/PPE					0.01690***	(0.00424)	0.0154**	(0.0071)
Adjusted R-squared	12.42%		12.77%		12.43%		12.73%	
Observations	3,557		2,547		3,450		2,513	
Panel B: Determinants of Alternative Investments using Compustat Data								
Plan size	0.00694***	(0.00116)	0.000880	(0.00191)	-0.000211	(0.000946)	0.00142	(0.00167)
Funded status	0.0199***	(0.00214)	0.0181***	(0.00258)	0.00837***	(0.00173)	0.0123***	(0.00224)
Sponsor size			0.00717***	(0.00188)			0.000296	(0.00163)
Market to Book ratio			0.00775	(0.00628)			0.0003	(0.000207)
Leverage			-0.0191*	(0.00747)			0.00367	(0.00536)
Profitability			0.000626	(0.00595)			0.00156	(0.00507)
R&D/PPE	0.0106***	(0.00370)	0.0347*	(0.0150)				
L&B/PPE					0.0295***	(0.0027)	0.00989**	(0.00361)
Adjusted R-squared	3.10%		12.80%		6.30%		11.60%	
Obs	3,557		2,547		3,450		2,513	

Table 5: Pension Investments and Alternative Measures of Corporate Characteristics

The table presents coefficient estimates from regressions that examine the determinants of pension plan alternative investments using alternative measures of innovation and tangibility. The dependent variable is: the percentage of pension assets allocated to private equity in (1) and (2); and the percentage of pension assets allocated to real estate in (3) and (4). The sample consists of 461 US corporate DB pension plans and their sponsors from 1999 to 2014. Year fixed effects are included in all specifications. Robust standard errors are included in brackets. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

	Private Equity				Real Estate			
	1999-2010 Patent & IRS5500 Data				1999-2014 Compustat & IRS550 Data			
	(1)		(2)		(3)		(4)	
	coeff	std error	coeff	std error	coeff	std error	coeff	std error
Plan size	0.00125	(0.00514)	0.00138**	(0.000520)	0.00448***	(0.000495)	0.00446***	(0.000495)
Plan age	0.000265	(0.00146)	0.00319**	(0.00123)	-0.0000576	(0.00141)	0.00412***	(0.00117)
Funded status	0.0349***	(0.00338)	0.00215	(0.00378)	0.00594**	(0.00226)	0.00713*	(0.00359)
Share active participants	0.0113*	(0.00560)	0.00653	(0.00476)	-0.00277	(0.00539)	-0.00721	(0.00453)
Sponsor size	0.00472*	(0.00278)	0.00330**	(0.00104)	0.000422	(0.00173)	0.00144	(0.000920)
Market to book	0.000734	(0.000778)	0.000757	(0.00102)	0.0031	(0.0021)	0.00513	(0.00334)
Leverage	0.00784	(0.0101)	0.0119	(0.00836)	0.00548	(0.00540)	0.00251	(0.00556)
Profitability	0.00162	(0.00789)	0.0128	(0.0103)	0.00172	(0.00511)	-0.00547	(0.00734)
Patents	0.0176***	(0.00128)	0.00506***	(0.000700)				
Tangibility					0.0510***	(0.00749)	0.0477***	(0.00479)
Adjusted R-squared	14.20%		22.50%		14.60%		16.50%	
Firm fixed effects	Yes		IND dummies		Yes		IND dummies	
Obs	1,398		1,344		1,962		1,395	

Table 6: Corporate Assets and Pension Investment: Longitudinal Approach

Panel A and C: The dependent variable is the percentage of pension assets allocated to private equity. We split the sample as: (1) firms that never invest in R&D projects; (2) firms that will invest in R&D before they invest; (3) firms with R&D expenditures after they have invested in R&D projects. Test "R&D before=R&D after" presents  $p$ -value from a  $t$ -test of equality of the Industry R&D returns coefficients between the R&D investors before and after the investment. Panel B and D: The dependent variable is the percentage of pension assets allocated to real estate. (1) firms that never invest in L&B; (2) firms that will acquire in L&B before they invest; (3) firms with L&B holdings after they acquire them. Test "L&B before=L&B after" presents  $p$ -value from a  $t$ -test of equality of the Industry R&D returns coefficients between the R&D investors before and after the investment. Test "L&B before=L&B after" presents the  $p$ -value from a  $t$ -test of equality of the MSA real estate prices coefficients between the purchasers before and after the purchase. Firm and year fixed effects are included in all specifications. Robust standard errors are included in brackets. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

Panel A: Private Equity Investment (Compustat Data 1999-2014)							
	Non R&D firms		R&D Firms				$p$ -value
			Before R&D Investing		After R&D Investing		
	(1)		(2)		(3)		
	coeff	std error	coeff	std error	coeff	std error	
Plan size	0.0143***	(0.00128)	0.00638	(0.00754)	0.00752***	(0.00135)	
Funded status	0.00268	(0.00556)	0.185*	(0.0818)	0.00022	(0.00620)	
Sponsor size	0.0049***	(0.00113)	-0.0143	(0.00904)	0.00325*	(0.00138)	
Market to book ratio	-0.00034	(0.000213)	0.00595	(0.00477)	0.00331	(0.000433)	
Leverage	0.0394***	(0.00848)	-0.0432	(0.0795)	-0.0189*	(0.00869)	
Profitability	0.0336	(0.0181)	-0.382	(0.291)	0.00656	(0.0105)	
Industry R&D returns	0.0211	(0.0223)	0.0133	(0.152)	0.0614**	(0.0212)	0.002***
Adjusted R-squared	0.220		0.149		0.168		
Obs	875		547		1,061		
Panel B: Real Estate Investment (Compustat Data 1999-2014)							
	Non L&B firms		L&B Firms				$p$ -value
			Before L&B Purchase		After L&B Purchase		
	(1)		(2)		(3)		
	coeff	std error	coeff	std error	coeff	std error	
Plan size	0.00963***	(0.00143)	0.00171	(0.00649)	0.00442***	(0.000884)	
Funded status	-0.00280	(0.00651)	-0.00360	(0.0262)	-0.000981	(0.00421)	
Sponsor size	0.00147	(0.00129)	0.0100	(0.00649)	0.00130	(0.000955)	
Market to book ratio	0.000182	(0.000260)	-0.00158	(0.00200)	0.0000316	(0.0000330)	
Leverage	-0.0107	(0.0103)	0.135**	(0.0463)	0.00466	(0.00596)	
Profitability	-0.0492*	(0.0245)	0.0406	(0.0420)	-0.000697	(0.00780)	
MSA real estate returns	0.0402	(0.0251)	0.159	(0.103)	0.0391**	(0.0150)	0.0289**
Adjusted R-squared	0.107		0.179		0.169		
Obs	692		270		1,513		

Table 6 (CONT'D): Corporate Assets and Pension Investment

Panel C: Private Equity Investment (ERISA data 1999-2014)							
	Non R&D firms		R&D Firms				<i>p</i> -value Before=After
			Before R&D Investing		After R&D Investing		
	(1)		(2)		(3)		
	coeff	std error	coeff	std error	coeff	std error	
Plan size	0.0028	(0.0013)**	0.0059	(0.0013)***	0.0032	(0.0009)***	
Plan age	0.0073	(0.0021)***	-0.004	(0.0119)	-0.0001	(0.0024)	
Funded status	0.0009	(0.0036)	-0.009	(0.0091)	0.0067	(0.0047)	
Share active participants	0.001	(0.0110)	0.0158	(0.0417)	0.0066	(0.0086)	
Sponsor size	0.0071	(0.0019)***	0.0046	(0.0017)***	0.0059	(0.0012)***	
Market to book ratio	0.0158	(0.0137)	0.0585	(0.0519)	-0.0236	(0.0123)	
Leverage	0.0121	(0.0237)	0.0140	(0.0116)	-0.0172	(0.0106)	
Profitability	0.1152	(0.1009)	0.0164	(0.0315)	-0.0743	(0.0288)***	
Ind R&D returns	0.0163	(0.0122)	0.0017	(0.0267)	0.0275	(0.0102)***	0.0317**
Adjusted R-squared	19.11%		16.88%		16.92%		
Obs	625		410		748		
Panel D: Real Estate Investment (ERISA data 1999-2014)							
	Non L&B firms		L&B Firms				t-test Before=After
			Before L&B Purchase		After L&B Purchase		
	(1)		(2)		(3)		
	coeff	std error	coeff	std error	coeff	std error	
Plan size	0.0033	(0.0012)**	0.0061	(0.0021)**	0.0004	(0.0008)	
Plan age	0.0071	(0.0021)***	0.0039	(0.0026)	0.0002	(0.0017)	
Funded status	-0.0059	(0.0045)	0.0076	(0.0036)*	-0.0019	(0.0028)	
Share active participants	-0.0215	(0.0110)	-0.0359	(0.0142)*	-0.0005	(0.0064)	
Sponsor size	0.0036	(0.0014)*	-0.0020	(0.0025)	0.0012	(0.0011)	
Market to book ratio	-0.0017	(0.0003)***	0.0003	(0.0002)	0.0002	(0.0001)	
Leverage	0.0109	(0.0105)	0.0278	(0.0477)	-0.0016	(0.0169)	
Profitability	0.0028	(0.0014)	-0.0008	(0.0009)	-0.0016	(0.0006)**	
MSA real estate returns	0.0017	(0.0086)	-0.0169	(0.0108)	0.0159	(0.0057)**	0.0122***
Adjusted R-squared	14.26%		12.30%		13.06%		
Obs	345		168		553		

Table 7: Analysis of Overweighting in Private Equity and Real Estate Strategies

Panel A presents the overweighting of PE and RE investments by sponsor type, where overweighting in a strategy in a given year is calculated versus benchmarks based on (i) the overall share invested in the investment strategy; (ii) the prior five years of investments. Panel B and C present our formal regression results. Panel B: the dependent variable is the overweighting of VC in columns (1) and (2); Buyouts in columns (3) and (4). Panel C: the dependent variable is the overweighting of opportunistic RE in column (1) and (2) and Core real estate in columns (3) and (4). All regressions contain vintage year fixed effects. Robust standard errors are brackets. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

Panel A: Strategy Overweighting by Sponsor Investment Characteristics								
R&D/PPE	Overweighting relative to the overall share			Overweighting relative to five year benchmark				
	VC	Buyouts	Others	VC	Buyouts	Others		
Bottom 25%	0.0383 (0.0247)	0.1003 (0.0120)	-0.1511 (0.3362)	0.0324 (0.0296)	0.0986 (0.0129)	-0.1310 (0.3397)		
Top 25%	0.0511 (0.0293)	0.1298 (0.0137)	-0.1413 (0.3296)	0.0523 (0.0253)	0.1117 (0.0178)	-0.1255 (0.3354)		
p value	0.026**	0.00***	0.5721	0.00***	0.00***	0.7128		
L&B/PPE	Core	Value Added	Opportunistic	Others	Core	Value Added	Opportunistic	Others
Bottom 25%	0.1491 (0.3689)	-0.0221 (0.3261)	0.0704 (0.3498)	-0.0018 (0.0947)	0.1644 (0.3690)	-0.0289 (0.3275)	0.0746 (0.3516)	-0.0045 (0.1944)
Top 25%	-0.0683 (0.3095)	-0.0087 (0.3561)	0.1253 (0.3786)	0.0108 (0.1399)	-0.0799 (0.3102)	-0.0142 (0.3575)	0.1309 (0.3812)	0.0089 (0.1409)
p value	0.00***	0.5744	0.0320**	0.1039	0.00***	0.5387	0.0288**	0.1806
Panel B: Private Equity Funds								
	VC				Buyouts			
	(1)		(2)		(3)		(4)	
	coeff	std error	coeff	std error	coeff	std error	coeff	std error
Plan size	0.0263***	(0.00208)	0.00360***	(0.000762)	0.00474*	(0.00226)	0.00814***	(0.00347)
Funded status	0.0152***	(0.00299)	0.0173***	(0.00269)	0.000546	(0.00233)	-0.00224	(0.00348)
Sponsor size	0.00608**	(0.00218)	-0.000767	(0.000878)	0.00504**	(0.00253)	0.00468***	(0.00159)
MTB	-0.000189	(0.000223)	-0.000122	(0.000248)	-0.000500	(0.00249)	-0.00597	(0.00361)
Leverage	-0.0189*	(0.00756)	-0.00463	(0.00572)	-0.00483*	(0.00253)	-0.00584	(0.00351)
Profitability	-0.0241**	(0.00921)	-0.0245**	(0.00908)	-0.0196***	(0.00262)	-0.00399	(0.00346)
R&D/PPE	0.01586**	(0.00788)	0.0158***	(0.00462)	0.0193***	(0.00211)	0.01891***	(0.00112)
Firm fixed effects	Yes		IND dummies		Yes		IND dummies	
Adjusted R-squared	16.90%		12.69%		29.12%		22.54%	
Obs	1,504		1,489		1,623		1,601	
Panel C: Real Estate Funds								
	Opportunistic				Core			
	(1)		(2)		(3)		(4)	
	coeff	std error	coeff	std error	coeff	std error	coeff	std error
Plan size	0.0440***	(0.00465)	0.00740***	(0.00171)	0.0396***	(0.0027)	0.0314***	(0.00858)
Funded status	0.178***	(0.00664)	0.151***	(0.00589)	0.0332***	(0.00231)	0.0668***	(0.00822)
Sponsor size	-0.00803	(0.00486)	0.00211	(0.00196)	0.0306***	(0.00182)	0.00636	(0.00772)
MTB	0.0068	(0.00481)	0.0062	(0.00539)	0.0318	(0.0017)	0.00303	(0.00761)
Leverage	0.0310	(0.0163)	0.0138	(0.0122)	0.0266	(0.0186)	0.000175	(0.00772)
Profitability	-0.0418*	(0.0198)	-0.0500*	(0.0197)	0.0145	(0.0112)	0.00917*	(0.00392)
L&B/PPE	0.0333**	(0.0101)	0.0103**	(0.00390)	-0.0355***	(0.00364)	-0.0124*	(0.00623)
Firm fixed effects	Yes		IND dummies		Yes		IND dummies	
Adjusted R-squared	41.00%		33.10%		23.72%		20.31%	
Obs	1,487		1,472		1,102		918	



Table 8: Pension Plan Performance

The plan data are from IRS5500 for the period from 1999 to 2014. Panel A and Panel B report the total (raw) returns and the excess of the actual pension returns over benchmark portfolios. The benchmark return is the return on a portfolio invested in benchmark indexes with portfolio weights identical to the asset allocation of the pension plan. Panel C reports the active component of pension portfolio returns, the sum of the covariances between asset class returns and pension portfolio weights. Panel D reports the active component of PE returns, the covariances between PE returns and pension portfolio weights and the active component of RE returns, the covariances between RE returns and pension portfolio weights. The  $p$  values are from a  $t$ -test for differences in mean between the top and bottom quartiles. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

<b>Panel A: Pension Plan Returns</b>					
	<b>Raw Returns</b>	<b>Excess Return</b>		<b>Raw Returns</b>	<b>Excess Return</b>
Plans with PE or RE	7.43% (0.1706)	-1.93% (0.1317)	Plan size bottom 25%	7.42% (0.1682)	-2.46% (0.1643)
Without PE and RE	7.79% (0.1632)	-2.02% (0.1254)	Plan size top 25%	7.41% (0.1681)	-2.55% (0.1738)
$p$ value	0.3238	0.1743	$p$ value	0.8769	0.6126
<b>Panel B: Plan Returns for Portfolios with Tilts</b>					
	<b>PE and R&amp;D/PPE</b>			<b>RE and L&amp;B/PPE</b>	
Bottom 25%	7.85% (0.1285)	-1.72% (0.1564)	Bottom 25%	9.60% (0.1739)	-0.44% (0.1229)
Inter-quartile	7.68% (0.1553)	-1.81% (0.1648)	Inter-quartile	7.36% (0.1280)	-1.84% (0.1225)
Top 25%	7.11% (0.1732)	-2.79% (0.1570)	Top 25%	7.55% (0.1678)	-2.25% (0.1247)
$p$ value	0.2509	0.00***	$p$ value	0.1218	0.00**
<b>Panel C: Active Component for Pension Portfolios</b>					
	<b>PE and R&amp;D/PPE</b>			<b>RE and L&amp;B/PPE</b>	
Bottom 25%	0.57% (0.0079)		Bottom 25%	0.45% (0.0012)	
Inter-quartile	0.12% (0.0094)		Inter-quartile	0.29% (0.0093)	
Top 25%	0.12% (0.0041)		Top 25%	0.23% (0.00092)	
$p$ value	0.00***		$p$ value	0.00***	
<b>Panel D: Active Component for PE&amp;RE Investment</b>					
	<b>Active Component for PE Investment PE and R&amp;D/PPE</b>			<b>Active Component for RE Investment RE and L&amp;B/PPE</b>	
Bottom 25%	-0.04% (0.0016)		Bottom 25%	-0.03% (0.0001)	
Inter-quartile	-0.05% (0.0028)		Inter-quartile	-0.001% (0.0002)	
Top 25%	-0.09% (0.0017)		Top 25%	-0.09% (0.0002)	
$p$ value	0.10112*		$p$ value	0.02**	

Table 9: Private Equity and Real Estate Performance: The Cost of Familiarity Bias

The data are from PREQIN for the period from 1999 to 2013. Panel A reports the IRRs from private equity investments by pension plans with a tilt (top quartile of R&D/PPE) relative to plans without a tilt (bottom quartile R&D/PPE). Columns (1), (3) and (5): the reported returns are the average net IRRs. Columns (2), (4) and (6): the reported returns are the IRR minus the mean of all other observations in the same strategy and vintage of the investment fund. Panel B reports the IRRs for real estate investments by pension plans with a tilt (top quartile of L&B/PPE) relative to plans without a tilt (bottom of L&B/PPE). The  $p$  values are from a  $t$ -test for differences in means. Panel C reports the annual cost of the familiarity bias by pension plans in our sample. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

Panel A: Net IRR for Penion Plan Private Equity Investment						
	Total PE investment		VC		Buyouts	
	(1)	(2)	(3)	(4)	(5)	(6)
R&D/PPE top 25%	10.71% (0.111)	-0.006% (0.056)	10.49% (0.235)	1.23% (0.032)	11.28% (0.215)	1.31% (0.073)
R&D/PPE bottom 25%	12.71%(0.161)	0.27% (0.042)	11.76% (0.187)	1.47% (0.053)	11.20% (0.199)	1.19% (0.055)
$p$ -value	0.00***	0.00***	0.01***	0.00***	0.8558	0.4096
Panel B: Net IRR for Pension Plan Real Estate Investment						
	Total RE investment		Opportunistic		Core	
	(1)	(2)	(3)	(4)	(5)	(6)
L&B/PPE top 25%	3.61% (0.034)	-0.14% (0.044)	1.83% (0.169)	0.49% (0.038)	8.02% (0.078)	0.37% (0.047)
L&B/PPE bottom 25%	4.84% (0.011)	0.28% (0.047)	2.12% (0.148)	0.75% (0.037)	9.99% (0.089)	1.43% (0.037)
$p$ -value	0.00***	0.00***	0.00***	0.00***	0.1695	0.00***
Panel C: Cost of the Familiarity Bias						
Year	Total Invested (US\$ mil)		Cost (US\$ mil)			
	PE	RE	PE	RE		
1999	\$26,084.56	\$21,014.65	\$521.69	\$258.48		
2000	\$41,177.54	\$22,855.44	\$823.55	\$281.12		
2001	\$37,441.05	\$32,160.32	\$748.82	\$395.57		
2002	\$32,948.44	\$28,780.93	\$658.97	\$354.01		
2003	\$33,946.45	\$27,850.77	\$678.93	\$342.56		
2004	\$35,539.66	\$31,840.08	\$710.79	\$391.63		
2005	\$37,042.88	\$31,524.95	\$740.86	\$387.76		
2006	\$36,346.77	\$33,224.52	\$726.94	\$408.66		
2007	\$39,731.07	\$30,578.73	\$794.62	\$376.12		
2008	\$50,219.28	\$35,824.63	\$1,004.39	\$440.64		
2009	\$41,973.38	\$21,308.26	\$839.47	\$262.09		
2010	\$59,701.53	\$31,257.50	\$1,194.03	\$384.47		
2011	\$57,690.35	\$32,999.11	\$1,153.81	\$405.89		
2012	\$50,977.52	\$31,545.96	\$1,019.55	\$388.02		
2013	\$40,835.79	\$28,598.25	\$816.72	\$351.76		

Table 10: Direct Test of Private Equity and Real Estate Familiarity Bias

The dependent variable in columns (1) and (2) is the percentage of pension assets allocated to private equity. The dependent variable in columns (3) and (4) is the percentage of pension assets allocated to real estate.  $\text{Corr}(\text{S\&P500, PE Index})/\text{Corr}(\text{S\&P500, RE Index})$  is the annualized correlation between the quarterly returns of the S&P 500 and the PE and RE indices. All regressions contain year fixed effects. Robust standard errors are included in brackets. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

Panel A: ERISA Data for 1999-2014								
	(1)		(2)		(3)		(4)	
Plan size	0.0052	(0.0015)***	0.0043	(0.0015)***	0.0043	(0.0019)***	0.0033	(0.0016)**
Plan age	0.0031	(0.0019)*	0.0057	(0.0038)	-0.0014	(0.0016)	-0.0038	(0.0026)
Funded status	0.0059	(0.0027)**	0.0072	(0.0026)***	-0.0047	(0.0023)	0.0007	(0.0019)
Share active participants	0.0179	(0.0076)**	0.0082	(0.0109)	-0.0126	(0.0071)	0.0091	(0.0085)
Sponsor size	0.0032	(0.0013)***	0.0141	(0.0019)***	0.0018	(0.0013)	0.0015	(0.0029)
Market to book ratio	0.0051	(0.0016)***	0.0017	(0.0018)	0.0010	(0.0014)	0.0008	(0.0012)
Leverage	-0.0211	(0.0283)	-0.0153	(0.0349)	-0.0086	(0.0281)	0.0749	(0.0257)
Profitability	0.0003	(0.0016)	-0.0049	(0.0033)	0.0003	(0.0014)	-0.0038	(0.0023)
R&D/PPE	0.0168	(0.0056)***	0.0124	(0.0048)***				
L&B/PPE					0.0100	(0.0030)***	0.0178	(0.0081)**
Corr(S&P500,PE Index) *Dummy R&D	0.0158	(0.0041)***	0.0077	(0.0020)***				
Corr(S&P500,RE Index) *Dummy L&B					0.0172	(0.0051)***	0.0152	(0.0018)***
Firm fixed effects	Industry effects		Yes		Industry effects		Yes	
R-squared	14.72%		12.31%		24.22%		18.93%	
Obs	2,547		2,532		2,513		2,498	
Panel B: Compustat Data for 1999-2014								
Plan size	0.0121	(0.0023)***	0.0129	(0.0010)***	-0.0022	(0.00206)	0.0082	(0.0008)***
Funded status	0.0199	(0.0045)***	-0.0047	(0.0040)	-0.0099	(0.00406)	-0.0028	(0.0034)
Sponsor size	0.0039	(0.0018)*	-0.0007	(0.0011)	-0.000862	(0.00164)	-0.0013	(0.0009)
Market to book ratio	0.0000	(0.0000)	0.0000	(0.0000)	0.0000328	(0.0000206)	0.0000	(0.0000)
Leverage	0.0032	(0.0061)	0.0042	(0.0065)	0.00353	(0.00541)	0.0040	(0.0056)
Profitability	0.0029	(0.0058)	0.0114	(0.0086)	0.000408	(0.00510)	-0.0049	(0.0073)
R&D/PPE	0.0218	(0.0072)**	0.0245	(0.0055)***				
L&B/PPE					0.0130	(0.00436)**	0.0144	(0.0023)***
Corr(S&P500,PE Index) *Dummy R&D	0.0113	(0.0048)*	0.0130	(0.0029)***				
Corr(S&P500,RE Index) *Dummy L&B					0.0026	(0.00147)*	0.0035	(0.00242)
Firm fixed effects	Industry effects		Yes		Industry effects		Yes	
R-squared	13.30%		24.80%		14.70%		16.60%	
Obs	2,547		2,532		2,513		2,498	

## Appendix A1: Variable definitions

Variable	Definition
Panel A: Pension plan characteristics	
$Size_{i,t}$	Total assets (log of total assets in regressions).
$Funded\ status_{i,t}$	Beginning of year assets / total pension liabilities.
$Age_{i,t}$	Years since plan inception (log of one plus years in regressions)
$Share\ of\ active\ participants_{i,t}$	Active pension participants / Total (active + retired) participants
$Return_{i,t}$	Investment income / beginning of year assets
Panel B: Sponsoring firm characteristics	
$Size_{i,t}$	Total assets (log of total assets in regressions).
$Asset\ tangibility_{i,t}$	Property, plant, and equipment / assets.
$q_{i,t}$ (market-to-book)	(Total assets - book value of equity + market value of equity) / assets.
$Profitability_{i,t}$	Operating income before depreciation / assets.
$Leverage_{i,t}$	Book leverage = (long term debt + short-term debt) / assets.

### Appendix A2: The Variation of Private Equity and Real Estate Investment

The P&I, IRS550 and Compustat sample consists of 461 plans for the period 1999 to 2014. The first two columns report the proportion of total variation in pension plan private equity investment (column 1) and real estate investment (column 2). The last two columns shows the percentage of each source of variation that is explained by the following covariates: plan size, funded status, sponsor size, market to book, leverage, profitability and R&D/PPE or L&B/PPE.

	<b>% of total variation</b>		<b>% of variation explained</b>	
	<b>PE</b>	<b>RE</b>	<b>PE</b>	<b>RE</b>
Between Industries	7.94%	9.34%	8.57%	12.83%
Within Industries	65.19%	63.55%	13.33%	11.14%
Within Pension Plans	26.86%	27.11%	1.72%	3.15%

## Appendix A3: IV Analysis of Alternative Investment

The table presents coefficient estimates from IV regressions using changes in state taxed as instruments to examine the determinants of pension plan alternative investments. The dependent variable is: the percentage of pension assets allocated to private equity for (1) and (2); and the percentage of pension assets allocated to real estate in (3) and (4). The sample consists of 461 US corporate DB pension plans and their sponsors from 1999 to 2014. Year fixed effects are included in all specifications. Robust standard errors are included in brackets. \*\*\*, \*\*, \* represent 1%, 5% and 10% significance levels.

1999-2007 State Tax Changes & IRS5500 Data								
	coeff	std error	coeff	std error	coeff	std error	coeff	std error
Plan size	0.0017	(0.0014)	0.00373**	(0.00162)	0.00613***	(0.00119)	0.00710***	(0.00197)
Plan age	0.000748	(0.0132)	0.0133	(0.00722)	-0.000301	(0.00680)	0.00917*	(0.00392)
Funded status	0.00876	(0.0831)	0.01841***	(0.00168)	-0.0121	(0.0428)	-0.0124	(0.00913)
Share active participants	0.0188	(0.0667)	0.0480	(0.0293)	-0.00653	(0.0343)	0.0135	(0.0159)
Sponsor size	0.00909***	(0.0018)	-0.00512	(0.00493)	0.0155	(0.0323)	0.00457	(0.0111)
Market to book	0.0001	(0.0004)	0.00244	(0.00193)	0.00239	(0.00249)	0.00117	(0.00398)
Leverage	0.0178	(0.0327)	-0.0476	(0.0469)	0.00263	(0.0104)	0.0172	(0.0209)
Profitability	0.00961	(0.00862)	0.0396	(0.0224)	0.00814	(0.0156)	0.00525	(0.0105)
Patents	0.0241***	(0.0044)						
R&D/PPE			0.0273**	(0.0137)				
Tangibility					0.0201***	(0.00390)		
L&B/PPE							0.0851***	(0.0016)
Firm fixed effects	Yes		Yes		Yes		Yes	
Obs	1,398		1,344		1,388		1,347	