Managing Value through Alternative Investments: Evidence from Corporate Defined-Benefit Pension Plans

---

Master Thesis

Prof. A. Andonov

Prof. C. M. Lin

Erasmus University Rotterdam

MSc Financial Economics

Dmitri Staicov

383475

Abstract. Based on a sample of 134 US corporate defined-benefit pension plans during 1995-2014, the paper provides a comprehensive analysis of the determinants of pension plans' allocation, investment performance and specialization decisions in venture capital, buyout and real estate assets. The research provides evidence for the informational advantage and risk management hypotheses among plans' venture capital and real estate investments and some support for risk shifting and barriers-to-entry hypotheses for allocation to buyout funds. Furthermore, the work confirms the existence of spillover effects onto sponsoring firms as a potential driver of plan investments into venture capital and buyout funds. The paper documents an inverse relationship between plan size and alternatives' specialization on the one hand and pension plans' investment performance on the other. Finally, pension funds' alternative portfolio tilts are found to be driven by larger, financially unconstrained firms.

Declaration

I certify that the thesis presented for final examination of the MSc Financial Economics programme at Erasmus University Rotterdam is solely my own work except where I explicitly indicate that it is the work of others (in which case I cite the relevant authors and their related publications respectively).

I certify that this declaration does not, to the best of my knowledge, violate the rights of any third party.

Table of Contents

List of Table and Figures

Acknowledgements

First and foremost, I would like to kindly thank my professor and master thesis supervisor Professor A. Andonov for continuous support, inspiration and guidance over the past two years – both during the master thesis trajectory and through a number of taught courses in the MSc Financial Economics programme which motivated me to explore the current topic as a subject for master thesis. Additionally, I would like to thank Professor C. M. Lin for co-evaluation of this master thesis and active participation in the final thesis presentation.

Furthermore, I am grateful to the Department of Business Economics at Erasmus University Rotterdam and the Ministry of Education of the Netherlands for an overall making of my master studies at Erasmus University possible.

Last but not least, I would like to express a profound gratitude to my parents, grandparents and brother for immense support and continuous encouragement in my academic, professional and personal aspirations in all imaginable ways throughout.

Rotterdam, The Netherlands

17 October 2016

1 Introduction

According to the Board of Governors of the Federal Reserve System, total US corporate defined benefit plan assets have reached a value of over $3.1 trillion by the end of 2015. Given their substantial size, many pension plans are facing increasing values of their obligations due to aging population and a persistently low interest rate environment. Such structural changes encourage pension investors to explore additional asset classes, including alternative investments, in order to achieve higher risk-adjusted returns while remaining diversified from traditional debt and equity markets. Furthermore, an increase in liabilities among defined benefit pension plans appears to be of particular concern for corporate managers because the resulting plan underfunding has to be born directly by the sponsoring firms.

A wide range of empirical studies documents an increasing interest of institutional investors towards alternative asset classes. The work of Andonov (2014) demonstrates institutional investors' dramatically increasing allocation to real assets, private equity and hedge funds: from 5% of funds' total assets in 1999 to over 15% in 2011. Furthermore, the author documents that investor diversification – approximated by the share of alternative investments simultaneously allocated to two or three alternative asset classes – is shown to increase from 45% of total alternative investments in 1999 to over 70% in 2011. Complementary to these findings, Hochberg and Rauh (2013) demonstrate an increasing demand for alternative investments among US public pension funds and university endowments. According to the study, in 2010 the largest 1,000 US public pension fund sponsors allocated an average of 17.4% to alternative investments, including 8.9% for venture capital and 5.5% for real estate. Moreover, US university endowments are shown to hold an average of 26% of their investment portfolios in alternative asset classes with approximately half of the allocation dedicated to real estate, venture capital or buyout funds.

Despite a dramatic increase in the demand and amount of institutional allocation to alternative investments, relatively few empirical papers investigate the ways investors choose specific alternative sub-asset classes and how their choices affect investment performance. As documented by Kaplan and Schoar (2005), average US private equity fund returns (net of fees) are equal to the ones of the S&P 500 over the period of 1980-2001, yet the authors provide the evidence of substantial heterogeneity across the funds. Furthermore, Andonov, Eichholtz and Kok (2014) research pension fund investments in the main alternative asset class, real estate, and find significant heterogeneity across funds' investment costs and net returns determined by two main factors: *pension fund size* – with larger funds achieving economies of scale and lower investment costs, and *investment approach*

– with smaller funds underperforming due to investment delegation and overlooking listed REITs as alternatives to direct real estate investing.

Contributing to the research above, Atanasova and Chemla (2016) investigate the determinants of pension funds' allocation to private equity and real estate investments. According to authors' research of corporate defined benefit plans in the US during 1998-2012, pension plans' allocation to these alternative asset classes is driven by investors' familiarity bias and possible spillover effects for corporate sponsors. Furthermore, based on the authors' findings, sponsoring firms with alternative portfolio tilts are not found to benefit from the relevant informational advantage and asset-specific expertise as their pension plans tend to underperform those without alternative investments' overweighting.

However, given a wide heterogeneity in characteristics and return distributions not only among the main alternative asset classes (private equity and real estate), but also within each alternative asset class per se (e.g. venture capital, buyout and other strategies within private equity), there appears to be a rising need to perform a more granular and comprehensive analysis of major alternative sub-asset classes and their potential impact on pension plans' investment performance. Thus, extending the research of Atanasova and Chemla (2016)[1], this paper performs a more detailed analysis of pension funds' alternative investments and investigates the main determinants of asset allocation and investment performance at the level of major *sub-asset* classes within the private equity and real estate universe. Furthermore, using the same degree of granularity, it explores pension funds' specialization and diversification decisions among venture capital, buyout and other private equity and real estate fund types and researches associated specialization benefits for pension plans based on their characteristics.

The paper can be of high relevance to a wide range of parties. Firstly, it can allow a better understanding of pension funds' alternative investments from a regulatory perspective. Given that pension plans' asset allocation to private equity and real estate represents a relatively new trend, there may be a number of uncertainties with respect to the way institutional investors must be regulated regarding their investments in these asset classes. According to Perez (2015), this can be particularly important given that most countries currently have nearly no regulatory oversight over plans' alternative investments. Secondly, this research could be of benefit for plan participants as direct stakeholders of pension plans' investment strategies. Considering that plan members experience

1 Based on a sample of 134 US defined-benefit corporate pension plans over a period of 1995-2014.

direct consequences of their pension funds' asset allocation, they may be interested in ensuring that the plans employ optimal investment strategies for meeting long-term pension obligations. This can be particularly relevant for the fields of private equity and real estate which proved to be the standout performers over the last 15 years compared to traditional debt, equity or other alternative asset classes (Preesman 2015 and Perez 2015). Thirdly, the implications of this paper could be of interest for pension plans themselves for generating higher risk-adjusted returns in light of modern challenges of aging population and a persistently low interest rate environment. Finally, the research could be relevant for private equity and real estate investment managers who could gain insights into the dynamics of pension plan and sponsor characteristics and their relationship with plans' further demand for specific alternative asset classes. Given the fact that pension funds are by far the largest investors in the alternative asset space with nearly 33% of its total holdings (Perez 2015), their investment demand could have a high impact on the development of highly innovative venture capital and buyout activities and investment-driven growth of real estate projects.

The contribution of the paper is fourfold. Firstly, as mentioned above, it extends the analysis of the relationship between pension funds' and sponsors' characteristics and plans' alternative portfolio allocation initially documented by Atanasova and Chemla (2016). More specifically, the study takes a more granular approach and investigates the determinants of alternative portfolio tilts at the level of major private equity sub-asset classes (venture capital, buyout and others) in combination with real estate investments. Secondly, the paper performs the analysis in the context of the alternative investments' portfolio rather than plans' overall asset allocation, focuses on funds already invested in private equity and real estate, and does it over a more extensive sample period of 1995-2014. Thirdly, the research explores the determinants of plans' venture capital, buyout (as opposed to general private equity) and real estate investment performance. Finally, following the approach of Andonov (2014), the work investigates the main drivers of plans' specialization (diversification) decisions within the private equity and real estate universe. As such, it looks not into the previously documented diversification options among the major alternative asset classes (e.g. private equity or real estate), but rather into plans' decisions to diversify within an alternative asset class (e.g. between venture capital and buyout investments) and their potential effects on plans' investment performance.

The paper's first number of hypotheses relate to the plan and sponsor characteristics as potential determinants of plans' allocation to venture capital, buyout and real estate assets. Firstly, following Atanasova and Chemla (2016) I hypothesize that sponsors' high R&D and land & buildings intensities could serve as proxies for companies' expertise in high-innovation industries associated

with venture capital and buyout investments, and property-focused industries associated with real estate. Such unique knowledge – as a firm's informational advantage – could be proven to drive both pension plans' allocation and investment performance in their venture capital, buyout and real estate (sub-) asset classes. Furthermore, I hypothesize that plan and firm size could serve as a barrier to entry into the alternative investment universe due to the alternative assets' large investment and active management requirements as implied from Campbell and Viceira (2005). In addition, I observe the relationship between plans' venture capital, buyout and real estate allocation and their funding ratio as a barometer between the risk management hypothesis suggested by Rauh (2009) and a risk shifting hypothesis documented by Frank (2002). By regressing the plans' venture capital, buyout and real estate allocation against a number of plan and sponsor characteristics mentioned above, some evidence of risk management and informational advantage hypotheses as determinants of plans' venture capital and real estate allocation and some support for risk shifting and "barriers to entry" hypotheses for buyout funds. (Table 4). Consistent with Atanasova and Chemla (2016), I hypothesize the possibility of a spillover effect of plans' alternative investments on their sponsor's investment performance. By regressing a number of sponsor performance measures – return on equity, return on assets and Tobin's Q, as suggested by Becht et al (2009) and Guiso, Sapienza and Zingales (2013), against plan's characteristics including venture capital, buyout and real estate portfolio tilts, I find some evidence for the existence of spillover effects for pension funds' venture capital and buyout investments.

Going further, the paper investigates the effects of specialization within alternative (sub-)asset classes. Based on the approach of Andonov (2014), I perform logit ordered regressions of the probability of investing in up to five researched alternative (sub-)asset classes – venture capital, buyout, funds-of-funds, real estate and other – against the above-mentioned plan-sponsor characteristics and plans' asset allocation to equities, bonds and alternatives. Consistent with the author's findings for broader alternative asset classes, I find plan size to be a major determinant of plans' specialization decision. More specifically, I document larger plans' higher probability to diversify across private equity and real estate sub-asset classes, and smaller funds – to specialize respectively. This can be in line with the above-mentioned "barriers to entry" hypothesis as well as the liquidity constraints for large alternatives' positions suggested by Campbell and Viceira (2005). By dividing pension plans into tertiles by size and performing an additional regression analysis of fund's investment performance against their size, major asset allocation weights and their decision to specialize within the alternative investment universe, I document an inverse relationship between small fund size/specialization decision and the plans' investment decision. However, such negative

performance appears to be alleviated by small funds' specialization in one alternative sub-asset class, consistent the findings of Andonov (2014).

Last but not least, following Atanasova and Chemla (2016) I perform a number of robustness tests as a check for pension plans' determinants of venture capital, buyout and real estate allocation. I divide the sample into top 50% and bottom 50% of observations based on pension funds two major characteristics: firm size (measured by total assets) and financial constraints (proxied by Altman Z Score). By observing the differences in allocation to venture capital, buyout and real estate among the sub-samples and comparing them to the regression results for whole samples augmented by interaction terms based on firm size or financial constraints, I finally conclude that alternative portfolio tilts are driven by larger and less financially constrained firms.

Following a general overview of the research and its main findings, the rest of the paper is organized as follows. Section 2 provides a preliminary theoretical background on pension funds' general structure and asset allocation strategies and narrows down to the theories underlying their alternative investments. Section 3 continues with research design, including suggested hypotheses, and discusses the methodology, main findings of the paper's empirical results and their possible implications. Section 4 provides an overview of the robustness tests for some of the prior findings of Section 3. Finally, Section 5 concludes and provides final recommendations for future research.

2 Theoretical Background

The purpose of the theoretical background is to provide a foundational knowledge of the pension fund industry, pension funds' key considerations in portfolio allocation and the main determinants of their investments, performance and specialization decisions within the alternative investment universe. The section is intended to build a general overview of key issues related to pension plans' alternative asset allocation as preparation for further analysis and discussion of paper's empirical results, conclusion and recommendations.

2.1 Pension Funds' Overview

Pension funds play a pivotal role in the economies of most countries as they transform savings of millions of people into their retirement income through long-term investments in financial assets. Total global pension assets under management have reached USD 35.4 trillion in 2015 and are expected to grow up to nearly USD 55 trillion by 2050 (Willis Towers Watson 2016). According to the company study, the pension market of the United States is by far the largest in the world representing $21.9 trillion (or 62%) of global assets under management, followed by the UK with $3.2 billion (9%) and Japan with $2.8 trillion (8%) of global assets under management respectively.

Evaluating historical performance of pension funds during the past years, it becomes obvious that financial crisis weighed the most both on funds' total assets under management and their returns. Nonetheless, since then global pension assets witnessed significant growth from a level of 58% of the world GDP in 2008 to a 70% mark by 2010 (Stewart 2010) and a level of 80% by 2015 (Willis Towers Watson 2016). Several developed countries, including the United States, United Kingdom, Switzerland and Australia have even total pension assets exceeding 100% of the GDP. However, only the Netherlands – the world's 6th largest pension market – has been able to bring its total pension assets to 166% of GDP and surpass the 150% level necessary for sustainable, value-creating investments (Lokhandwala 2015). These developments further suggest a need for pension funds to enhance their asset allocation strategies as a main driver of their investment performance (Bams, Schotman and Tyagi, 2016).

One of the major distinctions between pension funds and other conventional asset managers is the presence of the liabilities structure for the former which represents plan participants' future retirement benefits and is often indexed to the local price level. According to Wigglesworth (2016), currently low fertility rates in combination with aging population develop a situation in which the number of retirees is increasing whereas the number of new entrants into the workforce is gradually

reduced. As a result, the number of people receiving retirement benefits may exceed the amount of people in the workforce who predominantly make pension contributions, thus, posing a significant problem for pension plans in meeting their future retirement liabilities. An additional feature of pension funds is their dependence on the market level of interest rates which serve as a discount rate for plan liabilities and, thus, determine the plans' overall solvency level (OECD 2015). As such, the current interest rates of most developed countries at their historical lows pose an additional challenge for pension funds in fulfilling their retirement obligations (Bank of International Settlements 2015).

Considering the above-mentioned increases in pension funds' liabilities, there has been a growing tendency among pension funds of shifting from traditional debt and equity-invested portfolio towards more diversified allocations in order to address their obligations (Preqin Investor Outlook 2016). According to Poelhuis (2011), over the last two decades pension funds have increased their allocation to alternative assets from 5 to 25 percent of their portfolio, while reducing their holdings of equities and cash to by varying degrees. Such strong preference is quite logical and can be explained by a number of benefits of alternative assets, for instance, lower correlation with conventional debt and equity investments and a higher level of absolute returns (Andonov 2014). The topic of pension funds' allocation to alternative assets is discussed in subsequent sections, following the description of the US pension system and the consideration of pension funds' major risks.

2.2 US Pension System

Given the availability of data and the main focus of this paper on the United States pension market, it could beneficial to provide a brief overview of the US pension system for a better understanding of its further analysis throughout the paper.

As mentioned above, the United States is home to the world's largest pension market with nearly USD 21.9 billion of total pension assets under management. According to the OECD Private Pension Outlook (2008), there are three main forms of pension provision in the country: defined benefit (DB), defined contribution (DC) and hybrid schemes combining the elements of both pension types. A defined-benefit (DB) scheme represents a pension structure in which sponsors (employers) agree to provide a monthly post-retirement benefit based on pre-determined formula, which typically accounts for employee's earnings history, age, years of tenure at the firm and other characteristics (Bodie, Shoven and Wise, 1988). Considering that the amount of post-retirement benefits is defined independently of pension assets' future investment returns, the investment responsibilities and pension asset allocation decisions are born by employers. Although only 21% of US private sector

employees are covered by the Defined Benefit pension schemes (OECD Private Pension Outlook 2008), they present a particular interest from an investment allocation perspective as the investment decisions of pooled pension assets have to be made professionally by employers on behalf of their employees. Thus, as described further throughout the paper, defined benefit (DB) pension plans represent the main scheme of focus for this thesis.

On the other hand, US employees can participate in a defined contribution (DC) pension scheme whereby the employee's contribution is fixed and future post-retirement benefits depend of employees' own pension investment decisions (US Department of Labor 2016). As documented by the OECD Private Pension Outlook (2008), US pension system is generally characterized by a gradual shift from a defined benefit to a defined contribution scheme, with the latter reaching a coverage of 55% of all private-sector workers by 2008. By means of an example, a usual defined benefit (DB) scheme could typically offer between 1% and 1.5% of an employee's pre-retirement earnings for each year of tenure, subject to a service cap of 30-35 years and some early retirement subsidies past a specified age or number of years in service. Furthermore, a usual DC plan, such as 401(k), allows workers to contribute up to 25% of their compensation to pension, having the employer match 50% of any contribution amount up to a maximum of 6% of employees' total pay.

Defined benefit plans typically represent public employees' retirement funds sponsored by states and municipalities, as well as retirement plans of some corporations. The types of DC funds include the above-mentioned 401(k) plans based on employees' before-tax contributions from their salaries, as well as employers' profit sharing and stock options plans and individual retirement arrangements (IRAs) which can all be described as contribution-based, employer-sponsored pension plans.

US pension plans can be established both by a single and multiple employers and allow sponsors to select the type of preferred pension plan. In case of a DB plan, employees' participation is automatic and is obligatory for all registered employees. On the other hand, DC plans can be either automatic or voluntary based on the rules established in the plan agreement. Although US employers are not obliged to cover all employees, they are nonetheless subject to a minimum coverage percentage and non-discrimination rules.

Finally, a typical retirement age in the US is 65 years old.

Although not directly related to the research questions described further in the paper, the information above provides a brief insight into the US pension system and is intended to enhance general understanding of its more detailed analysis presented in other parts of the paper.

As a complement to the details regarding the US pension market, there are a number of features typical for most pension funds across the world, including those in the United States. Some of such pressing and most relevant issues for pension fund analysis are further presented below.

2.3 Plan Allocation: Traditional View

Considering the fact that over 60% of pension fund portfolios continue to be invested in traditional debt and equity assets (Willis Towers Watson 2016), the topic of traditional asset allocation appears to be highly relevant in the context of current research. Traditional asset allocation is typically two-dimensional and is viewed as a choice between debt and equity allocation. According to the pension lifecycle theory discussed by Bodie, Treussard and Willen (2007), investors should be gradually decreasing their allocation to risky assets (equities) as they as they near their retirement. The authors suggest that the percentage invested in equities should be declining with age for two major reasons. Firstly, because human capital tends to be less risky than equities and the value of human capital as a share of a person's accumulated wealth decreases with age, a younger individual may have to invest a larger portion of his financial assets (wealth) in riskier assets to obtain the necessary risk exposures. Secondly, due to the flexibility which younger workers have in being able to alter their labor supply provides them with an opportunity to invest more in equities earlier in their lifecycle. Thus, based on an example of US public pension funds over the period of 2000 to 2009, Pennacchi and Rastad (2011) suggest that plans must and do consider their participants' characteristics in making asset allocation decisions.

Exploring a sample of Dutch pension funds and their investments plans in 2007, Bikker et. al. (2009) test the validity of the life-cycle model in the pension system of the Netherlands. The authors combine all three major types of pension funds in the country: *corporate pension plans* which represent nearly 85% of all Dutch pension funds, *industry-wide plans* which are formed by employees in a particular industry, such as education, healthcare and others and represent the majority of remaining 15% of plans, and *professional pension funds* designed for select groups of professionals such as notaries. The work investigates the relationship between plans' equity exposure as a dependent variable and the average age of plans' active and retired members as independent one. Given that some previous works, such as by Malkiel (2007), have found a linear relationship between the two variables, whereas the others, e.g. Benzoni et al (2007), have seen it as non-linear, Bikker et al introduce two models to address both possible outcomes. The authors find support for Dutch funds following the life-cycle model as they document a negative relationship between participants' age and pension plans' equity allocation. Furthermore, consistent with the life-cycle theory, the paper

finds a positive and significant relationship between plans' equity exposures and such characteristics as plan size, funding ratio and participants' pension wealth.

By contrast, the research of US target-date funds by Booth and Chang (2011) provides a different insight for the United States. Pioneered by Barclays Global Investors in 1993 and available for most American DC plans, the target-date products were designed to address the asset allocation problem and gradually rebalance participants' portfolios with their age towards less the risky products (bonds). Contrary to the marketing and participants' assumptions, in reality many of such funds were found not to rebalance from equities or do it insufficiently as the retirement date approached. A major explanation of such dichotomy was the retirees' need to continue investing in equities to address the peril of outliving their savings. Following the "your age in bonds" rule, according to which the percentage allocation to bonds should be equal to participants age in years, an average target-date fund was found to under-rebalance from equities by more than 10 percentage points for most age groups past the age of 50. Such overinvestment in equities provides the funds with a higher risk profile and questions the suitability of such investment products for long-term pension investments. As demonstrated by Booth and Chang, over the period of 2006 to 2009 target-date funds allocated an average of 75% of their portfolios to equities, which triggered average losses of approximately 30% during the financial crisis of 2008. As such, the paper has demonstrated that – unlike the pension funds in the Netherlands – a number of plans in the United States do not completely abide by the pension lifecycle theory, suggesting a natural requirement for a more disciplined investment approach.

The evidence presented above is undoubtedly relevant as pension funds and other institutional investors continue allocating much of their portfolios to debt and equity assets. However, given their high absolute returns and appealingly low correlation with traditional asset classes, plan allocation to alternative investments has been steadily increasing among pension funds in many countries including those in the United States (Willis Towers Watson 2016).

2.4 Pension Allocation to Alternative Investments

2.4.1 Definitions and Overview

Alternative investments experienced a dramatic increase in popularity among institutional investors over the past two decades due to their diversification benefits and higher promised absolute returns (Andonov 2014). According to author's research, institutional investors increased their allocation to alternative assets from 5% in 1999 to over 15% in 2011. A Global Alternatives Survey (2016) by

Willis Towers Watson reveals that in 2015 the world's 100 largest alternative investment managers have been overseeing approximately USD 3.6 trillion of alternative assets on behalf of their clients. As mentioned in the sections above, the study confirms pension funds as the largest institutional investors in alternative assets (34% of the world's total), followed by wealth management and insurance firms, sovereign wealth funds, foundations, endowments and others. Furthermore, geographically North America is assigned with the largest alternative asset allocation (50%), followed further by Europe (37%) and Asia Pacific (8%) regions.

Despite a lack of uniform, commonly accepted definitions for alternative investment sub-asset classes, the Global Alternatives Survey distinguishes between three major alternative asset classes: private equity, hedge funds and real estate.

According to Willis Towers Watson, *private equity* represents 44% of the value of total alternative investments and is the largest alternative asset class. The strategy typically entails long-term investing in private, non-listed companies at an early stage of their life-cycle with a purpose of yielding benefits (returns) by selling the business at a later stage. Venture capital funds are often associated with investments in high-innovation, start-up companies, whereas the buyout strategy tends to focus on reorganizing the business of more established companies for realizing them at higher valuations in the future (Bodie, Kane and Marcus, 2014). These definitions are particularly important in testing the paper's hypotheses on the determinants of pension funds' asset allocation and performance of their venture capital and buyout investments. A substantial overall benefit of private equity companies is a lack of daily price fluctuations due to their private nature, which allows to significantly decrease the volatility of an entire portfolio. Combined with its long-term investment horizon, the asset class provides an opportunity to remain on hold in challenging markets and be able to sell the position as macroeconomic conditions become more favorable (Morgan Stanley Research 2015).

According to the Global Alternatives Survey (2016), the second largest alternative asset class accounting for approximately 35% of all alternative investments is *hedge funds*. The asset class is typically characterized by reduced regulation compared to other long-only investment managers and ability to take short positions in their investments, which allows them to pursue contrarian strategies and avoid the market herding behavior (Bodie et. al. 2014). According to Morgan Stanley Research (2015), hedge fund benchmarks tend to be based on absolute returns and imply an ability to provide superior investment performance independently of market conditions. Due to limitations of data

availability from Preqin and other databases, this asset class is not included in the current paper but is highly encouraged to be considered for future research.

A third and final major alternative asset class suggested by the Global Alternatives Survey (2016) is *real estate*. Comprising 14% of the alternative investment universe according to the survey, the asset class implies investing directly into real estate assets or indirectly into Real Estate Investment Trusts (REITs) – publicly listed companies which use investors' funds to develop, acquire and operate income-producing properties (Morgan Stanley Research 2015). According to Morgan Stanley, the advantage of real estate is that it is subject to lower return volatility and is able to provide a hedge against possible inflation.

There are a number of other alternative asset classes which are however relatively insignificant compared to the three major asset types. Such asset classes include *commodities* which represent a wide range of fungible natural resource products, such as oil, natural gas, wheat, corn, base and precious metals and many others, and comprise less than 4% of total alternative investments (Global Alternatives Survey 2016). The remaining alternative asset classes include specific *infrastructure* projects, *tactical asset allocation* (TAA) and other strategies. Due to their relatively small size in the total alternative investment structure, they are provided mainly for descriptive purposes and remain outside the scope of the paper's further research.

Alongside strategy-specific characteristics and ability to provide superior absolute returns, alternative investments as a general asset class are also associated with particular features which can either underpin their benefits or serve as their specific risks. Compared to traditional assets, alternative investments are subject to the following features and risks described below.

2.4.2 Features, Advantages and Risks

The first and perhaps the most significant alternative assets' risk is a potential lack of liquidity. Based on the Morgan Stanley Research (2015), certain alternative assets, such as private equity funds, involve lock-up periods of one year or longer and positions on particular alternative assets are not always readily available for redemption. This can be further exacerbated by the risk of liquidity black holes in which market liquidity tends to quickly dry up and asset prices are in a downfall (Hull 2010). Considering these risks, alternative investments could be less appealing than conventional assets in a market where liquidity is limited and/or particularly during financial crises when the market can be subject to a liquidity black hole.

A second distinctive feature of alternative investments, particularly for real estate and hedge funds, is the ability to use leverage. As such, this feature makes alternative assets particularly responsive to changes to interest rates which, in their turn, influence the cost of gearing (ABN AMRO 2016). Thus, higher leverage tends to make alternative investments more sensitive to interest rate fluctuations.

In addition to interest rate differentials, alternative investments – similar to traditional asset classes – could be subject to inflation. The general increase in the price level can be considered a major factor in determining real investment income and can be interpreted as a minimum investment hurdle rate. This is understandable as investors focus not always on obtaining an absolute increase in value but, firstly, on increasing their purchasing power and enhancing their general living standards (PIMCO 2012). According to Bodie et. al. (2014), inflation risk is considered to be less significant for equities as companies' earnings and revenue growth tend to be in line with inflation in the long-term. However, bonds with their (typically) fixed periodic income are usually negatively affected by an increase in the price level. Furthermore, alternative investments such as real estate provide strategies for hedging inflation risk (ABN AMRO 2016), which may suggest that higher inflation levels could be favorable to alternative asset allocation.

Last but not least, lack of transparency and limited liquidity can pose a challenge in pricing alternative assets. This may result in model and valuation risk which can be magnified in distressed markets and thus, provide little if any guidance on precise value of the alternative portfolio (Morgan Stanley Research 2015). Additionally, investors could become subject to managers' fraudulent actions or excessive risk-taking aimed at maximizing their compensation.

All the above-mentioned risks and potential limitations have to be undoubtedly taken into account by investors for their optimal decision making. However, equally likely investors, too, can be subject to a wide range of behavioral motives which prompt them to invest both among and within particular alternative asset classes. The following sections investigate investors' potential behavioral biases and motivations and explore the potential effect of pension plan and sponsoring firms' characteristics on the ultimate allocation to alternative asset classes.

2.4.3 Motivation for Investing in Alternative Assets

A number of papers investigate corporate pension funds' underlying motives that can explain their portfolio allocation to alternative assets. Among the most recent and the most comprehensive works in this regard is the paper of Atanasova and Chemla (2016) which tests for a possibility of a wide range of hypothesized plan incentives. Firstly, the authors test for a possibility of sponsors'

informational advantage whereby firms with a higher share of research and developments (R&D) and land and buildings (L&B) in their capital structure are predicted to have higher expertise in the private equity and real estate space accordingly. According to the authors, this could be further capitalized on by making investments in the respective asset classes. By ranking the US corporate defined benefit pension funds based on their sponsors' R&D and L&B intensity and finding that the funds in the bottom quartiles (with the lowest R&D and L&B intensity measures) outperform those in the highest quartile, the research does not find supporting evidence for informational advantage as a possible explanation of plans' alternative investment tilts.

Furthermore, Atanasova and Chemla (2016) examine the *hedging hypothesis* according to which equity investments can be used as a hedge against inflation due to a high correlation between risk assets' returns and firms' expected earnings. To test this hypothesis the authors apply two variables - pension plans' share of active participants and plan age (factor of pension liability duration) – which may have a positive relationship with funds' necessity to hedge. By finding neither variable to have a statistically significant effect on funds' private equity and real estate allocation, the authors also do not find support for plans' hedging motive.

Moreover, the authors hypothesize that pension funds' alternative portfolio tilts could be motivated by their positive effect on the sponsoring firm's investment performance. By using R&D and L&B intensity and a number of plan characteristics as potential drivers of the sponsors' market-to-book ratio (Tobin's Q), return on assets and return on equity, the authors find some confirmation for the *spillover hypothesis.* According to this theory, real estate and private equity tilts are found to add value to the sponsoring firm's performance rather than the pension fund per se. Additionally, the authors find that spillover benefits for sponsors tend to be alleviated by pension plan underfunding as resources from sponsoring firms have to be drawn to enhance the plans' funded status, reducing the sponsors' final returns.

Finally, the paper investigates the possibility of a *familiarity bias* where investors' preference for alternative asset classes is motivated by their ambiguity aversion and tendency to avoid the unknown. Building on the theories of Boyle et. al. (2012) and Cao et. al. (2009), the bias predicts that investors prefer familiar (unambiguous) assets, experience a trade-off between investing in familiar assets and portfolio diversification, and allocate increasingly more funds to familiar assets ("flight to familiarity") as the general correlations among all asset classes increase. Similarly to tests of other hypotheses, the authors regress portfolio weights of private equity (real estate) investments against a number of pension fund and sponsoring firms' characteristics. A distinctive feature of testing this

hypothesis is controlling for correlation between a private equity (real estate) index and the broader equity market used as a proxy for investors' preference for familiar assets. By creating an interaction term between the above mentioned factor and a private equity (real estate) dummy to proxy for a fund's private equity (real estate) investment tilt based familiarity, Atanasova and Chemla (2016) find supporting evidence for the familiarity bias as the main driver of DB corporate pension funds' investments in private equity and real estate assets.

The authors' findings are consistent with Huberman (2001) who – based on a sample of US-based firms in 1997 – demonstrates that the majority of equity holders of a Regional Bell Operating Company (RBOC) is comprised of individuals living in the same coverage area it serves, many of whom tend to be either the customers or the employees of the firm. Thus, the author's research similarly confirms people's tendency to invest in familiar assets and generally ignore the modern portfolio theory.

Research on familiarity bias is complemented by Hochberg and Rauh (2013) who focus particularly on private equity investments by the largest US public pension funds and university endowments. The work reiterates the evidence of investors' tendency to invest in familiar assets, which is particular typical for public pension funds. The authors demonstrate the funds' overinvestment in in-state private equity firms and their 2 to 4 percentage point underperformance relative to both their out-of-state investments and investments in their home state by their out-of-state counterparts. However, by contrast to Atanasova and Chemla (2016), the authors do not base their findings on theories of ambiguity aversion or rationing, but rather assign in-state overweighting to plans' poor managerial expertise, mismanagement or political incentives to invest in their local state. On the other hand, however, Brown et. al. (2011) demonstrate that in equity markets home-state investments generate positive excess returns, particularly among smaller stocks in the primary industry of the state, thus justifying investors' local overweighting. Furthermore, based on a unique dataset of Swedish investors, Massa and Simonov (2006) find that familiarity is not a behavioural bias, but is rather driven by better available information, and that familiarity-based overweighting in stocks allows to generate higher returns than if the investors were appropriately diversified or hedged.

Following the investigation of familiarity hypothesis, the research of Rauh (2009) addresses the common trade-off between pension funds' risk shifting and risk management practices. By looking at a number of characteristics of US defined benefit pension plans over the period of 1990-2003, he finds that the weaker the financial condition of a pension fund – as expressed by the level of plan funding and sponsoring firm's credit rating, the lower the fund's allocation to risky assets. Thus, the

author contrasts the often assumed influence of moral hazard in pension funds' asset allocation and documents that the incentive to avoid the costly financial distress dominates the risk shifting motives in plans' asset allocation. These results are confirmed by Guan and Lui (2016) who further find the evidence that – only in situations when both financial distress of sponsoring firm and severe plan underfunding are present – the risk shifting incentive becomes more dominant as firms attempt to "gamble out" of potential bankruptcy. Interestingly, based on a sample of US corporate defined benefit pension plans during 2003-2011, the authors find that plans on the other side of the spectrum – well overfunded and with a highly remote probability of bankruptcy – would also have higher incentives for risk shifting as the costs associated with plan underperformance would be minimal. In other words, in cases when pension plans are well overfunded, their lagging investment performance would put immediate pressure on sponsor's profitability. Nonetheless, an average company would most likely experience much higher costs of risky investments compared to peers from the two extremes and thus would be inclined to be more conservative in their pension plan management, consistent with the risk management hypothesis.

The contribution of Guan and Lui extends to the examination of regulatory differences among corporate defined-benefit pension plans in the US, UK and the Netherlands. As the pension insurance premium required by the US Pension Benefit Guaranty Corporation is based on a predominantly flat rate, financially distressed US firms with severe plan underfunding are described as receiving higher incentives for risk shifting. By contrast, the risk-adjusted pension insurance premium implemented in the UK and mandatory full pension funding in the Netherlands reveal opportunities for limiting the risk shifting incentives and demonstrate structural challenges for the US pension insurance system that leave room for excessive risk taking in case of firms' foreseeable financial distress.

2.4.4 Plan and Sponsor Characteristics

Extending the above-mentioned findings, pension funds' alternative asset allocation depends not only on investors' and pension trustees' motivation and plan managers' risk incentives, but also on plan characteristics and overall investment approach. As such, a number of studies document the influence of pension plans' size on their asset allocation and investment performance. Together with the findings of Atanasova and Chemla (2016) on the importance of investors' flight to familiarity, the research of Andonov (2014) documents fund size as a main determinant of funds' intermediation level and investment performance. The study finds that larger funds have sufficient economies of scale to invest internally rather than through intermediaries or funds-of-funds, incur lower investment fees and select better-performing investment managers. These results are consistent with the theories

of Goyal and Wahal (2008) and Stoughton et. al. (2011) that underperforming assets are more likely to be sold indirectly, through a number of layers of financial intermediation that can be based on kickback fees to a variety of consultants and placement agents. Additionally, according to Campbell and Viceira (2005), the large size of defined benefit pension plans and their relatively stable cash streams make them a good fit for alternative asset classes which require large amounts of investment and exhibit limited liquidity. It is also consistent with the findings of Andonov (2014) based on which smaller funds overcome the lack of economies of scale by concentrating on one alternative asset class whereas larger funds benefit from diversification by reducing the possible illiquidity limits associated with larger investment positions.

Pension fund size is further investigated by Andonov, Bauer and Cremers (2012) who find evidence that large pension funds' investment fees do not necessarily translate into higher net returns. Instead, the authors find the large funds tend to be subject to diseconomies of scale due to size-related liquidity constraints. Whereas an average pension fund within the CEM database is documented to produce an alpha of 89 basis points over the period of 1990-2011, smaller funds are found to generate the highest total returns. This can be explained by their lower market impact in case of portfolio rebalancing and higher flexibility to deviate from strategic asset allocation while exploiting momentum opportunities across their asset classes. By contrast, even large funds invested in equities are shown to deviate from the benchmark by selecting relatively illiquid stocks and, thus, are able to generate positive active returns only if the funds are relatively small.

Such results are juxtaposed to the findings of Dyck and Pomorski (2011) who find the evidence of large funds' economies of scale. On the other hand, Andonov, Bauer and Cremers (2012) do not find large plans outperforming their smaller counterparts – both before and after estimating their risk-adjusted performance, which is estimated to be due to differences in authors' methodologies. Whereas the former research does not risk-adjust plans' performance for factor returns, fund fixed effects and momentum, the latter controls for all three specifications to obtain a more objective performance evaluation as can be observed from their different results.

In addition to plan size, White and Wu (2006) introduce another important characteristic: sponsors' financial constraints reflecting information about their leverage, dividends, credit rating and other credit risk factors. After constructing a new index of firms' external financial constraints, the research suggests the existence of a financial constraint factor unexplained the Fama-French or momentum factors. Furthermore, by performing cross-sectional regressions of returns on the newly developed Financial Constraints Index and suggested firm characteristics the paper documents that

financially constrained firms earn higher returns, and that the financial constraints effect is dominant over the size effect.

Lastly, the work of Andonov (2014) performed a unique investigation of plans' decision to diversify among the alternative asset classes. In general, the topic of specialization in alternative investments appears to be quite thought-provoking. On the one hand, diversifying among alternative asset classes should reduce the overall portfolio risk and provide the benefits of diversification. On the other hand, all alternative asset classes require active management and (costly) asset-specific expertise, which may eventually result in sub-optimal portfolio allocations. Consistent with Campbell and Viceira (2005), the work of Andonov (2014) documents the presence of diversification benefits for larger funds given their higher negotiating power in attracting and retaining better investment managers with lower investment costs. These results can also be consistent with larger funds having more resources to develop internal alternative investment teams, as well the presence of liquidity constraints for larger alternative investment positions. The author also finds that smaller funds could alleviate their diseconomies of scale by specializing in one alternative asset class. However, because the majority of small plans were found to diversify across the alternative investment universe, their net investment performance was documented to be at least 2 percentage points lower than could otherwise be achieved through alternatives' specialization. These findings are particularly important in the context of this paper and serve as a foundation for taking a more granular approach in investigating pension plans' specialization decisions within the alternative sub-asset classes (venture capital, buyout and other fund types).

2.4.5 Investment Performance

Finally, a number of papers make a more detailed investigation into pension funds' performance within the alternative investment universe. As briefly mentioned above, Andonov, Eichholtz and Kok (2014) evaluate the effects of financial intermediation on pension funds' investments in one of the major alternative asset classes: real estate. On the one hand, the study documents significant heterogeneity in pension plans' investment costs and net performance determined by the funds' size and investment approach. Specifically, consistent with the findings of Andonov (2014), larger funds able to achieve economies of scale are shown to invest mainly internally, incur lower investment costs (which are easier to justify via larger investments) and attain higher net-of-fees returns, whereas smaller funds are found to delegate more to external managers, avoid investing in listed REITs and experience disproportionally higher costs and, thus, lower net returns. On the other hand, the paper focuses on the geographical distribution of pension funds' performance, highlighting the

underperformance of US pension plans relative to their international counterparts in Canada, Europe and Australia/New Zealand. Such findings are explained by a higher tendency of US plans to delegate alternative asset management externally and US tax-exempt private investors' excessive "irrational exuberance" behavior during the pre-crisis real estate bubble which subsequently weighed on their investment performance.

Complementing the study in real estate, Kaplan and Schoar (2005) decompose pension funds' investment performance in private equity. The study finds the average private equity returns net of fees equal to the ones of the S&P 500, however documents significant heterogeneity of performance across the funds. For instance, based on the value of committed capital, venture capital funds tend to outperform the S&P 500 index during 1980-2001, whereas the buyout funds do not. Additionally, the paper confirms the persistence of returns of both VC and LBO funds raised by a partnership, where the highly performing funds are more likely to raise larger follow-up funds. Lastly, the paper of Phalippou (2009) confirms the gross performance results within the field of private equity, but warns of limitations of alternative performance measures such as internal rate of return (IRR) and cash multiples. The study provides further warnings of multiple hidden fees for private equity investors and documents a private equity performance below that of the S&P 500 on a net return basis.

The theoretical background described above provides a strong foundation for understanding the determinants of pension plans' allocation and investment performance within the alternative investment universe. It also allows to better understand the implications of funds' specialization (diversification) decisions among the major alternative asset classes. As mentioned above, the purpose of this paper is to extend the existing body of knowledge and to investigate the main allocation and investment performance drivers on a sub-asset class level among two major alternative asset classes: private equity and real estate. Furthermore, the paper intends to examine the determinants of plans' specialization (diversification) decisions among private equity sub-asset classes and real estate and whether such decisions could enhance plans' portfolio allocation decisions and ultimately increase their returns.

The sections below proceed with the description of research methodology, including hypothesis development, provide an overview of the research sample data and describe the main empirical results and key research takeaways for pension investment community.

3 Hypothesis Development, Research Design and Empirical Results

3.1 Sample Data

Using the insights from the Theoretical Background for a better understanding of development and testing of suggested hypotheses, this section provides an overview of the data sample applied in this research.

The research sample contains corporate defined-benefit pension plan and sponsor data for 134 companies headquartered in the United States over a period of 1995-2014. Pension fund characteristics are retrieved from the Compustat Pension database and are supplemented by plan data available on Bloomberg. Furthermore, sponsor characteristics are obtained by matching the information from Compustat Fundamental (North America) and Compustat Global databases, Bloomberg terminal and sponsor companies' annual reports.

In addition, the information obtained from the Preqin database provides a detailed overview of pension plans' private equity and real estate investments, including the lists of private equity and real estate funds invested in by sample pension plans. I classify all private equity fund types into four major categories – venture capital, buyout, fund of funds and other – as the main strategies of private equity allocation. All funds associated with investments in start-ups and early-stage businesses – such as general venture funds, early stage/seed funds and funds investing in growth and venture debt – are classified as venture capital. The funds focused on companies' medium- to later-stage financing and reorganization – for instance, turnaround and mezzanine funds – are grouped as buyout. Due to their investments through an additional level of intermediation, funds of funds are classified into a separate category. Finally, all private equity strategies that do not exhibit distinctive characteristics of venture capital or buyout strategies and are not part of funds-of-funds – are combined into the fourth group: "other" private equity entities.

By contrast, given the fact that core and core-oriented strategies account for over 80% of all real estate investments, and that real estate strategies are reported only in bundles with limited commitment data for each strategy, I do not decompose real estate into fund types, but report it as a standalone asset class alongside venture capital, buyout, fund of funds and other alternative strategies. Moreover, considering limited data on plans' investment commitments, I estimate the allocation of alternative asset classes based on the number of funds of a pension plan invested in each asset class (e.g. real estate) as percentage of total private equity and real estate funds during each particular year. By way of example, if during a particular year a pension plan invested in two venture

capital funds out of five alternative (private equity and real estate) funds in total, the venture capital weight during the year would be 20%. The weights of all other sub-asset classes would be accounted in a similar manner. Although such an assumption may not be always highly objective, it generally allows to address the limitations of data regarding plans' investment commitments to each alternative asset class.

The performance data for private equity and real investments is also obtained from the Preqin database and is measured by funds' net internal rate of return and investment multiple. For funds invested both in private equity and real estate investments, a weighted average internal rate of return (investment multiple) is applied based on the allocation weights suggested above.

Furthermore, I eliminate public, government and multi-employer pension funds due to a lack of or limited availability of plan- and sponsor-specific information. Likewise, due to limited publicly available data, I do not include funds invested in hedge funds and tactical asset allocation strategies as a third major sub-asset class within the alternative investments, however highly encourage to take them to be taken into consideration for future empirical research.

After matching the information from Compustat, Bloomberg, Preqin and company annual reports I winsorize all sample variables at 1% and 99% levels to avoid any possible impacts of outliers. The final sample consists of 134 pension plans and includes 804 plan-year observations. Finally, although several sample variables – Tobin's Q, Altman Z Score, R&D and L&B intensity – contain missing observations of up to 5% of total sample equivalent and enable the use of unbalanced panel data, including them in this form allows to increase the sample size by over 20% (alternatively from 106 funds and 631 observations) and enhance the predictive power of performed statistical tests described in subsequent sections.

3.2 Descriptive Statistics

Table 1 summarizes the descriptive statistics for all pension plans and their sponsors invested in private equity and real estate. Panel A presents the summary statistics of pension plans whereas Panel B focuses on sponsor characteristics.

A median pension fund manages over $4 billion of assets, generates an average investment return of 8.9% over the period of 1995-2014 and tends to be underfunded with a funding ratio (beginning-of-year assets divided by beginning-of-year liabilities) of 0.88. This is contrasted to the sample of Atanasova and Chemla (2016) which includes plans both with and without investments in alternative

assets that tend to be significantly smaller in size – with $178 million of average assets only, yet appear to have a better funded status - with an average funding ratio of 1.06. Within the current sample, plans invested in real estate tend to be larger than those with allocation to private equity ($13.9 billion and $11.4 billion of assets under management respectively), whereas within the private equity asset class plans investing in buyout strategy tend to be the largest and the best performing (with over $16 billion of total assets and 4.6% actual return on average), followed by venture capital ($14.9 billion of assets and 3.8% return) and other private equity ($14.2 billion and 3.3% return) sub-asset classes respectively.

Panel B, on the other hand, provides an overview of sponsoring firms' characteristics. Tobin's Q is also presented as a firms' market-to-book ratio, leverage is defined through the share of firms' long-term debt in its total assets, profitability is expressed as firms' EBITDA/Total Assets ratio and Z Score stands for Altman's Z Score with a cutoff value for bankruptcy-remote firms of 2.99 (Arnold and Earl 2006). Furthermore, R&D/PPE and L&B/PPE ratios represent firms' R&D expenditures and land & buildings investments as percentage of their total capital (property, plant & equipment). A median sponsor firm is over $28 billion of assets in size, has a leverage of 17.53% and profitability level of 12.21%, is fairly bankruptcy-remote and has the R&D/PPE and L&B/PPE ratios of 0.12 and 0.55 respectively.

Similarly to the pension plans, sponsors invested in real estate tend to be larger than those invested in private equity funds ($65.5 billion versus $53 billion of assets respectively). Sponsor firms with allocation to buyout funds are the largest among private equity sub-asset classes, with average assets of $95.9 billion, but also are the least profitable (at profitability level of 11.8%) and creditworthy (with a Z score of 3.23). On other side of the spectrum, fund of funds sponsors tend to be the smallest (average assets of $51.4 billion), having the lowest leverage (18.1%) and the highest profitability levels (14.86%). Finally, private equity sponsors have a higher R&D intensity than their real estate counterparts (0.19 versus 0.16 respectively), whereas the latter have a higher share of land and buildings in the total PPE structure (0.67 compared to 0.63), prompting to investigate the informational advantage hypothesis as documented by Atanasova and Chemla (2016).

Additionally, Table 2 provides a correlation matrix between the dependent and independent variables within the sample. *w(RE), w(VC), w(Buyout), w(FoF)* and *w(Other)* which represent the weights of real estate, venture capital, buyout, fund of funds and other private equity investments in a total alternative portfolio of private equity and real estate assets tend to have a negative or a moderately

positive correlation with the other variables. Overall, the majority of correlations among the variables is predominantly negative and rarely exceeds the value of 30%.

Figure 1 (Panels A and B) further demonstrates historical dynamics of allocation weights within an overall real estate and private equity portfolio during 1995-2014. Real estate and buyout funds tend to have the highest historical allocation of 21.8% and 24.2% respectively, whereas venture capital and buyout weights have been able to reach a 60% mark in 2001 and 2005 accordingly. As presented by Panels A and C, during the most recent years of 2012-2014 real estate, venture capital and other private equity strategies experienced an increase of asset allocation within the alternative investment portfolio whereas the buyout and fund of funds strategies – a relative decrease in portfolio weights respectively.

Finally, Panel D reveals private equity and real estate investors' consistent preference for specialization, with an average of 45.8% of all funds in 1995-2014 having investments in one sub-asset class only. The number of simultaneous investments in two and three private equity and real estate sub-asset classes (25% and 20% of all funds respectively) also remains substantial. However, although the current sample considers only the plans already invested in alternative asset classes and, thus, excludes those with no private equity and real estate allocation (NPI=0), the number of funds invested in all five sub-asset classes simultaneously (NPI=5) is also close to zero at the beginning and end of the sample period (1995-1998 and 2012-2014 respectively).

Based on the approach of Atanasova and Chemla (2016), Table 3 demonstrates the relationship between the plan-sponsor characteristics and pension plans' allocation to private equity and real estate investments. However, it is important to emphasize the difference between the sample of this paper and that of the cited research. Whereas Atanasova and Chemla (2016) investigate all available pension plans - both with and without investments in alternative assets, this paper intends to complement their original study by looking specifically at the plans already invested in private equity and real estate and, thus, to investigate namely a sub-sample of pension plans which are already active in the alternative investment universe. Furthermore, while the authors emphasize the allocation to private equity and real estate as percentage of the plans' total assets, this paper takes a more granular approach and looks into real estate and private equity fund types (particularly venture capital and buyout) in the context of the alternative investment portfolio.

I arrange the plan and sponsor characteristics by funding ratio, credit quality (Altman Z Score), leverage and R&D and L&B intensity among funds invested in venture capital, buyout and real estate

assets. As mentioned in the previous section, because buyout funds focus mainly on larger, more established companies and often take a 100% stake in a singular investment whereas venture capital funds take minority stakes in a wide range of start-ups with high growth potential, the two private equity fund types exhibit distinct characteristics and thus are categorized into separate private equity sub-asset classes. On the other hand, as suggested above, fund of funds and other private equity fund types represent a variety of different fund combinations, are more difficult to trace and ultimately derive a statistical relationship with respect to plan and sponsor characteristics and, thus, are currently excluded from the analysis. Finally, real estate funds with their expertise in property investments and a distinct set of characteristics are also included as a separate alternative asset class. The rationale of combining funds by their distinct set of characteristics also explains the selection of venture capital, buyout and real estate as the main alternative sub-asset classes described in further analysis.

Table 3a demonstrates a weakly significant positive relationship between plans' funded status and their investments in venture capital assets, which is consistent with the risk management motive documented by Rauh (2009). Conversely, on a sponsor level companies with a lower credit quality (represented by Altman Z Score) appear to allocate more to venture capital and buyout funds, which may provide some support for the risk shifting hypothesis suggested by Frank (2002). However, such controversial results can be consistent with the findings of Guan and Lui (2016) who find the evidence of risk shifting predominance among plans on two sides of the spectrum: those with both poor funded status and low credit quality who try to "gamble" out of bankruptcy, and those with overly high funding ratio and credit quality for whom poor plan performance could have a negligible effect on sponsor's profitability. An average firm, as Guan and Lui (2016) argue, would be quite sensitive to poor plan performance and would likely prioritize risk management over risk shifting as suggested by Panel A of Table 3a. By contrast to the findings of Atanasova and Chemla (2016) who document the dominance of the risk management motive over the risk shifting one among all pension investors, Table 3a suggests the opposite outcome namely among the funds already invested in private equity and real estate. More specifically, the table provides evidence of the dominance of risk shifting over risk management incentives – particularly for buyout funds - based on a higher statistical significance of the difference between the sponsors of higher and lower credit quality (Z Score). In other words, a significant number of firms are suggested to be on the extreme sides of the spectrum – with either poor funded status and poor creditworthiness on the one hand, or both excellent plan funding and sponsor credit quality on the other – all with respect to the number of "average" firms. Panel C does not reveal statistically significant differences in venture capital, buyout

and real estate investments among sponsors with higher and lower leverage, which could shed additional light on the dominance of their risk management motives.

Furthermore, Panels D and E confirm the existence of relationship between sponsor characteristics – as measured by R&D and L&B intensity – and their plans' alternative investments. Pension plans with sponsors in the top R&D/PPE quartile allocate over 7 percentage points more to buyout strategies than those in the bottom quartile, which is consistent with the informational advantage hypothesis. By contrast to the findings of Atanasova and Chemla (2016) for all pension plans with and without alternative investments, the current study focusing only on plans invested in alternative assets does not provide a statistically significant relationship between sponsors' L&B intensity and their plans' real estate investments.

Following a similar approach, Tables 3b and 3c investigate the relationship between plan-sponsor characteristics and pension plans' alternative investment performance, as measured by plans' investment multiple and internal rate of return. According to Table 3b, plans with sponsors in the top L&B/PPE quartile tend to generate a lower real estate investment multiple (1.18) than those with sponsors in the bottom quartile (1.29), thus providing no support for the informational advantage hypothesis. Furthermore, the analysis does not reveal any statistically significant relationship between sponsors' R&D intensity and pension plans' performance in their venture capital and buyout investments. Likewise, it suggests no confirmation of sponsors' informational advantage motives for investing in specific private equity sub-asset classes.

Based on the above-mentioned sample analysis, the next section extends the analysis by exploring the main determinants of plans' asset allocation and investment performance in the alternative investment universe, potential spillover effects of alternative portfolio tilts on corporate sponsors' performance, and plans' specialization and diversification decisions within private equity and real estate (sub-)asset classes. The section below performs a comprehensive analysis providing a comprehensive overview of each theory – from motivation and initial hypothesis development to obtained empirical results and their wider implications for the academic and investment communities.

3.3 Hypothesis Development, Empirical Results and Discussion

The following section combines two major components of a master thesis structure: hypothesis development, on the one hand, and empirical results and discussion on the other. As mentioned above, combining the two sections by topic – from an initially proposed hypothesis to the final results

and analysis of their implications – is suggested to facilitate a more holistic and integral understanding of each tested theory.

3.3.1 Determinants of Plan Investments in Venture Capital, Buyout and Real Estate

This section complements the analysis of Atanasova and Chemla (2016) and investigates the determinants of pension funds' allocation within real estate and private equity sub-asset classes with a distinctive focus on plans already invested in alternative assets. The results presented in Table 4 aim to address several hypotheses regarding the relationship between pension plans' and sponsors' characteristics and plans' allocation to venture capital, buyout and real estate investments.

Firstly, I test the informational advantage hypothesis which suggests a link between sponsors' R&D and L&B intensity and their pension plans' propensity to invest in private equity and real estate sub-asset classes. Following Atanasova and Chemla (2016), I hypothesize that sponsors' involvement in high-innovation industries may translate into its insiders' higher expertise in these fields. Thus, such companies' insiders could likely extend their expertise onto their pension plan management and may favour alternative investments associated with highly innovative activities, for instance, venture capital and buyout funds, for their final pension plan allocation. Similarly, companies with a higher concentration of land and buildings in their capital structure could likely have insiders with higher real estate expertise who may favor real estate-related investments as part of their pension plan management more than their average non-real estate focused peers. As such, companies' expertise in innovative activities and real estate could be approximated by their R&D expenditures and ownership of land & buildings as a share of their total capital respectively. Adhering to this rationale, I attempt to test the following hypotheses related to the impact of sponsors' possible informational advantage on the alternative investments of their pension plans:

Hypothesis 1a: firms with higher R&D intensity (R&D/PPE ratio) have a higher allocation to venture capital and buyout assets in their pension plans' total private equity and real estate portfolio.

Hypothesis 1b: firms with higher L&B intensity (L&B/PPE ratio) have a higher allocation to real estate in their pension plans' total private equity and real estate investments.

To test the hypothesis and analyze the overall determinants of pension plans' alternative asset allocation to private equity and real estate (sub-)asset classes, I perform a panel data regression analysis by controlling for the following plan and sponsor characteristics.

Plan Size and *Sponsor Size* are used as general proxies for barriers to entry into the alternative investment universe. According to Campbell and Viceira (2005), defined-benefit pension plans represent large institutional investors with fairly stable cash inflows and outflows, which makes them a good fit for investing in asset classes characterized by large size and (possibly) limited liquidity. Thus, if barriers to entry are in important determinant of plans' investments in alternative assets, larger sponsors and plans could have higher allocations to private equity and real estate and/or their sub-asset classes, including venture capital and buyout funds.

Funding ratio is included as a proxy of pension plans' risk-taking behavior. As documented by Bader (1991), pension plans' risk appetite declines when their funding ratio deteriorates as sponsors attempt to minimize the volatility of their retirement contributions. Furthermore, based on the example of US-based pension funds, Rauh (2009) suggests that well-funded plans are more likely to invest in riskier equities supporting the risk management hypothesis. Conversely, Guan and Lui (2016) suggest that plans with lower funding ratios and less creditworthy sponsors are more likely to increase their exposures to risky assets to "gamble out" of their potential bankruptcy, advocating the validity of the risk shifting hypothesis. As such, the *funding ratio* is used as a barometer of pension plans' risk management and risk shifting motives.

Furthermore, I include sponsors' *Profitability* defined as a ratio of plans' earnings before interest, taxes, depreciation and amortization (EBITDA) to total firm's assets. As documented by Frank (2002), sponsors are often prone to offset their corporate business risk by decreasing their pension investment risks, providing support for the above-mentioned risk shifting theory. As such, I hypothesize that lower profitability could imply lower allocation to plans' venture capital, buyout and real estate assets and test its impact in the context of plans' overall private equity and real estate allocation.

Following the work of Atanasova and Chemla (2016), I further include sponsors' *Altman Z Score* and *Leverage* (Long-Term Debt/Total Assets ratio) as measures of their overall credit risk, and *Tobin's Q* (Market-to-Book ratio) – as a proxy for companies' available investment opportunities. Finally, for regressions predicting the allocation to venture capital and buyout funds I use sponsors' R&D/PPE ratio as a possible indication of sponsors' expertise in high-innovation activities and their higher pension investment preference for respective private equity sub-asset classes. Accordingly, I include the L&B/PPE ratio into regressions with real estate allocation as a proxy for sponsors' expertise and plan investment preference for real estate assets. Once again, I emphasize the difference between the allocation weights as percentage of total plan assets suggested by Rauh (2009) and Atanasova and

Chemla (2016) and the current allocation weights expressed as a share of total private equity and real estate portfolio.

The results in Panel A, Table 4 provide some evidence in support of informational advantage hypothesis when accounting for both fund and vintage fixed effects. The coefficient of the R&D/PPE variable suggests that on average a 1% increase in sponsors' R&D intensity increases their plans' allocation to venture capital – as a percentage of overall private equity and real estate portfolio – by almost 0.09%. However, given the magnitude of the coefficient and its weak statistical significance, the impact of sponsors' informational advantage on venture capital allocation is likely to be limited.

A similar analysis reveals no statistically significant relationship between R&D intensity and investment allocation for buyout funds. On the other hand, I find some evidence of sponsors' informational advantage in their plans' real estate allocation when clustering sample observations by fund (pension plan). The L&B/PPE coefficient suggests that a 1% increase in sponsor's L&B intensity is likely to increase real estate allocation within the total alternative portfolio by 0.25%.

However, sponsors' R&D and L&B intensity does not entirely explain their plans' allocation to alternative investments, providing room for additional investor motives. Hypotheses based on risk shifting suggest that risk-taking incentives are stronger for plans with lower funded status, as already described above. By contrast, the risk management motives predict well-funded pension plans to have a higher allocation to risky assets, for instance, to equities as demonstrated by Rauh (2009) and alternative investments as advocated by Atanasova and Chemla (2016) and further considered in this paper.

Thus, I further test plans' motivation for investments in private equity and real estate (sub-) asset classes based on potential risk management and risk shifting motives:

Hypothesis 2a: Pension plans' higher funded status is associated with higher allocation to venture capital, buyout and real estate assets within a total private equity and real estate portfolio.

Hypothesis 2b: Pension plans' higher profitability is associated with higher allocation to venture capital, buyout and real estate assets within a total private equity and real estate portfolio.

Hypothesis 2c: Pension plans' higher credit quality is associated with higher allocation to venture capital, buyout and real estate assets within a total private equity and real estate portfolio.

Furthermore, I attempt to test whether alternative investments' characteristics of large-sized investments and limited liquidity expressed through the above-mentioned 'barriers to entry' hypothesis could serve as a significant determinant of plans' alternative asset allocation. As such, I test the following related hypotheses:

Hypothesis 3a: Larger plan size is associated with higher allocation to venture capital, buyout and real estate assets in a total private equity and real estate portfolio.

Hypothesis 3b: Larger sponsor size is associated with higher allocation to venture capital, buyout and real estate assets in a total private equity and real estate portfolio.

Panels A and B of Table 4 suggests that pension plans' investments in venture capital and real estate are dominated by the risk management motive suggested by Rauh (2009). I find some evidence of a positive relationship between the plans' allocation to venture capital and their funding ratio on the one hand (when clustering observations by pension plan) and their profitability on the other (when clustering either by pension plan or vintage). Similarly, I derive a positive relationship of real estate allocation weights with plans' funded status and their negative, statistically significant relationship with sponsor leverage. Conversely, pension investments in buyout assets tend to be driven primarily by risk shifting incentives documented by Frank (2002) as both plans' funding ratio and sponsor profitability are found to have an inverse and statistically significant relationship with buyout allocation weights. This may be explained by the fact that, within private equity, buyout funds can be considered a less risky investment than venture capital, having a market beta of 0.90 compared to 1.64 respectively (Woodward, 2012). Thus, pension investors could be guided by the risk management motive when investing in an asset class which – in their perception – is riskier than the general market (i.e. venture capital), whereas they can be driven by risk hedging incentives when investing in an asset class which is relatively safe (buyout funds). Furthermore, Panel B reveals a positive relationship between plan investments in buyout funds and plan size, consistent with the 'barriers to entry' hypothesis.

In addition to risk management and risk shifting theories, Atanasova and Chemla (2016) investigate the risk hedging hypothesis. According to the latter motive, pension plans may invest in assets correlated with their sponsors' industry returns as a means of hedging against expected inflation and/or wage growth. For instance, innovative companies may expect their wage growth to have a positive correlation with the venture capital and buyout (private equity) industries and, thus, allocate more to these alternative asset classes. Furthermore, as suggested by the authors, the incentive for

risk hedging would be more likely to increase with the plans' share of active participants and plans' liability duration. However, due to limited availability of data for plans' share of active participants and plan age as a proxy for pension liability structure, I bear in mind a possible presence of the risk hedging motive and suggest testing the given hypothesis (assuming a more complete data set) for further research.

The overall results of Table 4 provide the evidence of a strong relationship between plan-sponsor characteristics and the allocation of pension investments in venture capital, buyout and real estate assets. More specifically, better funded plans with profitable, R&D-intensive sponsors tend to invest more in venture capital, whereas well-funded plans with more L&B-intensive sponsors invest more in real estate, consistent with risk management and informational advantage hypotheses. Alternatively, less funded plans with less profitable sponsors tend to invest more in buyout funds which is in line with the risk shifting motive and can be explained by a perception of buyout assets to have below-average market risk compared to venture capital. Finally, buyout investments tend to be dominated by larger funds, which is in line with the barriers-to-entry hypothesis.

3.3.2 Informational Advantage Hypothesis

In addition to exhibiting alternative investment tilts, a further explanation of the informational advantage hypothesis could be the use of sponsor's superior expertise in a particular asset class for the benefit of its pension plan investment portfolio. To examine this hypothesis I investigate a possible relationship between pension plans' and sponsor characteristics and their investment performance in alternative assets. In particular I investigate whether the sponsors' R&D and/or L&B intensity (proxies for expertise in highly innovative industries and real estate) tends to be transmitted into plans' superior investment performance in venture capital/buyout and real estate assets respectively. Thus, I test the following hypothesis related to the theory of sponsors' informational advantage in determining pension plans' alternative asset allocation:

Hypothesis 4a: Higher sponsor's R&D intensity provides a higher investment performance of pension plans' venture capital and buyout portfolio tilts.

Hypothesis 4b: Higher sponsor's L&B intensity results in a higher investment performance of pension plans' real estate allocation.

Pension plans' investment performance is measured by two main metrics: net internal rate of return (i.e. net of management fees) and cash-on-cash investment multiple obtained from the Preqin

database. However, when analyzing funds' investment performance it is important to bear in mind the limitations of each performance measure as documented by Phalippou (2009). According to the author, internal rate of return (IRR) can produce an upward investment bias due to its reinvestment assumption stating that future payoffs can be reinvested at the same rate of return as the past ones – a potentially strong assumption in today's low-yield environment. Furthermore, internal rate of return can overly increase investment performance because the difference between the IRR and the effective investment return goes up with the absolute value of the IRR. On the other hand, the cash-on-cash investment multiple does not take into account the cost of capital and the duration of the investment period (time value of money). Thus, it is essential to pay close attention to the limitations of above-mentioned return measures when interpreting plans' investment performance.

Table 5 provides mixed evidence of a relationship between the plans' R&D intensity and their venture capital and buyout investment performance. It suggests some positive, statistically significant relationship between the two metrics as measured by the internal rate of return, but some negative and significant link as suggested by the investment multiple. Similarly, plans' real estate investments provide some evidence of a positive albeit weakly significant relationship between sponsors' L&B intensity and their plans' real estate investment performance. However, when contrasted by the results of Table 3b where plans' real estate investments of sponsors in the top L&B/PPE quartile underperform those of sponsors in the bottom L&B/PPE quartile, the results also appear to be mixed. As such, Tables 3 and 5 provide no vivid support for the informational advantage hypothesis. This is consistent with the findings of Atanasova and Chemla (2016) who examine a broader sample of plans both with and without alternative investment portfolios and conclude that private equity and real estate tilts have, in fact, an inverse relationship with plans' investment performance.

Finally, this paper identifies a number of other plan and sponsor characteristics affecting plans' alternative investment performance. By contrast to Campbell and Viceira (2005) who suggest defined-benefit plans to be well-suited for larger investments, plan size is found to have a negative impact on both the net IRRs and investment multiples across the venture capital, buyout and real estate assets. This can be explained by the fact that a larger plan size could imply larger absolute investments in alternative asset classes, such as those of private equity and real estate, which could be impacted by limited liquidity (Andonov 2014). As such, higher transaction costs associated with lower liquidity could further have an adverse impact on alternative assets' net investment performance. On the other hand, plans' funded status is found to have a positive and statistically significant effect on venture capital and buyout investment performance, whereas sponsor size

appears to have a positive relationship with venture capital and real estate investment results. Finally, higher Altman Z Score suggests to have some positive effect on plans' buyout investment performance, whereas leverage – to have an inverse relationship with funds' real estate returns. Consistent with Andonov (2014), this can be explained by the fact that larger funds may have a better ability to attract better investment managers with lower investment fees which, in the long run, may have a positive impact on their investment performance. Additionally, it is possible to hypothesize that plans with larger, better funded sponsors of higher credit quality and lower leverage are able to devote more resources towards alternative investments' due diligence. Instead of diverting funds to making additional debt interest payments or improving plan's funded status, plans with sponsors of such characteristics could use the resources to enhance their asset specific expertise which is essential for successful investment performance among the actively managed alternative asset classes.

3.3.3 Spillover Hypothesis and Familiarity Bias

Considering that the previous section did not reveal support for the informational advantage hypothesis, I examine whether plans' alternative portfolio tilts provide spillover benefits for their corporate sponsors as documented by Atanasova and Chemla (2016). The spillover hypothesis assumes that pension plans may be investing in innovative projects which are not necessarily value-adding to plans' investment returns, but are beneficial for their sponsoring firms' performance and/or allow their sponsors to obtain favorable investment opportunities in private equity or real estate. Thus, to test whether spillover effects could be a potential determinant of pension plans' investments in private equity and real estate and their sub-asset classes, I will try to confirm or reject the following hypothesis:

Hypothesis 5: pension plans' venture capital (buyout, real estate) portfolio tilts have a positive spillover effect on their sponsoring firms' performance.

To examine the given hypothesis, I use the measures of sponsors' investment performance suggested by Becht et al (2009), Atanasova and Chemla (2016) and Guiso, Sapienza and Zingales (2013): market-to-book ratio (Tobin's Q), return on assets and return on equity as dependent variables. Following the authors, I control for plans' characteristics such as R&D and L&B intensity and funded status as potential determinants of plans' private equity and real estate investments. In order to account for alternative portfolio tilts I follow the approach of Atanasova and Chemla (2016) and apply interaction terms between R&D/PPE ratios and venture capital or buyout dummies, as well as the interaction between the L&B/PPE ratio and real estate dummy. In order to test the possible

impact of underfunding on alternative investment tilts (biases), I apply an interaction term between the venture capital (buyout, real estate) bias and the underfunding dummy. Furthermore, to allow the use of the latter term, I also introduce an interim interaction term between a venture capital (buyout, real estate) dummy and a dummy for underfunding.

Based on the results of Table 6, I find some evidence for the existence of the spillover hypothesis for plans' venture capital and buyout investments. Venture capital portfolio tilts tend to have a positive and statistically significant effect on sponsors' return on equity, whereas the buyout tilt appears to have a positive impact on all three measures of sponsors' investment performance: Tobin's Q, return on equity and return on assets. On the other hand, contrary to the findings of Atanasova and Chemla (2016) within a wider plan sample, investment tilts in real estate do not demonstrate a significant spillover effect on corporate sponsors' performance.

Furthermore, I find plans' underfunding to have a negative impact on sponsors' Tobin's Q and/or return on assets across all three alternative investment categories (venture capital, buyout and real estate). Similar to Atanasova and Chemla (2016), I document that most of the spillover benefits tend to be alleviated by plans' underfunding, as the interaction terms between venture capital, buyout and real estate biases and the underfunding dummy weigh negatively on sponsors' ROE and ROA measures. Such findings appear to be logical and can be explained by the fact that sponsors of underfunded plans would have to provide additional contributions in order to enhance their pension plans' funded status.

Overall, I find supportive evidence for the existence of spillover effects for pension plans' venture capital and buyout investments on their sponsoring firms' performance and confirm the above-mentioned hypothesis for private equity sub-asset classes. Finally, I provide statistically significant evidence that such spillover effects tend to be reduced by pension plans' underfunding across all three researched (sub-) asset classes: venture capital, buyout and real estate.

In addition to possible spillover effects, pension trustees may be investing in private equity and real estate due to their close familiarity with these assets. For instance, a highly innovative sponsor firm with management having expertise in research and development may also value high-innovation activities such as those associated with venture capital and buyout investments. For instance, Gompers and Lerner (2001) document that investments in venture capital are particularly clustered in R&D-oriented industries. Furthermore, Lichtenberg and Siegel (1990) find supportive evidence that firms tend to increase their R&D expenditures relative to their peer group after investing in buyouts,

both on an absolute and a relative basis. Following a similar rationale, Atanasova and Chemla (2016) suggest that sponsoring firms with large land and building holdings may have insiders who value real estate and may exert additional influence on pension plans' decisions to invest in real estate assets.

In order to test the theory of familiarity, Atanasova and Chemla (2016) introduce a new measure alongside the above-mentioned plan and sponsor characteristics to predict alternative investments' portfolio weights. The variable represents historical correlation between the alternative asset benchmark and the broader US stock market (approximated by the S&P 500 index) because market correlations are suggested to be driven mainly by equity rather than debt markets. As such, the authors hypothesize that a higher correlation between a private equity benchmark and the broader equity market could imply a higher degree of investors' broader familiarity with the asset. Thus, by creating an interaction term between the correlation variable and an R&D or L/B dummy (e.g. "Corr(S&P 500, PE Index)*R&D/L&B dummy") they introduce a tentative proxy for plans' familiarity bias with an alternative asset class. Additionally, Atanasova and Chemla (2016) investigate the familiarity bias by examining the determinants of alternative assets' allocation before and after sponsors' investing in R&D or real estate, and in both cases find the evidence for familiarity motives in plans' private equity and real estate allocation. However, due to a lack of publicly available data for venture capital and buyout benchmarks, their wide use of absolute benchmarks or those based on broader market index plus a fixed margin as documented in the work of Andonov (2014) – which poses additional challenges for testing correlations with the broader market, and limited availability of data for the timing of firms' investments in R&D, I consider the limitations of investigating the familiarity bias for plans' venture capital, buyout and real estate investments and suggest it as a subject for future research.

To summarize the above-mentioned motives for investments in alternative assets, I find some evidence of risk management and informational advantage hypotheses for investments in venture capital and real estate and some support for risk shifting and barriers-to-entry hypotheses for buyout funds. Furthermore, I document the existence of spillover hypothesis for venture capital ad buyout investments, and – considering limited availability of relevant data – I suggest examination of the investment motive based on familiarity bias as a priority for future research.

Following the investigation of determinants and investment performance of plans' allocation to venture capital, buyout and real estate assets, I further examine the main drivers of their decisions to specialize or diversify within their alternative investment sub-asset classes.

3.3.4 Specialization and Diversification in Alternative Investment Portfolios

Following the research of Andonov (2014) I further investigate pension plans' decisions to specialize or diversify within their alternative asset classes. Whereas the cited work focuses on allocations among three major asset classes – private equity, real estate and hedge funds – I extend the existing body of knowledge by taking a more granular look into four major private equity sub-asset classes: venture capital, buyout, fund of funds and other funds, in combination with real estate investments. Due to a limited availability of historical data hedge funds are suggested to be considered as an additional asset class for future empirical studies.

The number of portfolio investments (NPI) in real estate and private equity sub-asset classes can thus vary between the value of one, when a plan specializes only in one alternative (sub-)asset class, and can reach a maximum value of five, when a plan invests in all real estate and private equity sub-asset classes simultaneously. Following the approach of Andonov (2014), I regress the number of portfolio investments against a range of estimated determinants based on an ordered logit model. The estimated relationship between the number of portfolio investments and previously defined dependent variables can be best summarized by the following form:

$$NPI_{i,t} = \lambda_1 Z_{i,t} + \lambda_2\, YD_t + \epsilon_{i,t}$$

$$NPI_{i,t} = \begin{cases} 1 \text{ if } NPI_{i,t} \leq \mu_1 \\ 2 \text{ if } \mu_1 \leq NPIi,t \leq \mu_2 \\ 3 \text{ if } \mu_2 \leq NPIi,t \leq \mu_3 \\ 4 \text{ if } \mu_3 \leq NPIi,t \leq \mu_4 \\ 5 \text{ if } \mu_4 \leq NPIi,t \leq \mu_5 \end{cases}$$

in which $Z_{i,t}$ represents the main determinants of portfolio investments: *Plan Size*, *Funding Ratio*, *Sponsor Size*, *Leverage*, *Profitability*, *Market-to-Book ratio (Tobin's Q)*, and *Altman Z score* as defined in section 3.3.1 on the determinants of plans' alternative investments. Additionally, I include the variables *Equity*, *Debt* and *AltInv* to control for pension plans' allocation to equities, fixed income and alternative assets respectively (obtained from Bloomberg) which can have an effect on plans decision to diversify within their alternative investment portfolios. Furthermore, the regression includes vintage (year) dummies, YD_t, whereas variables' standard errors are clustered by plan to allow for intraplan correlation.

As such, in this section I attempt to confirm or reject the following hypothesis associated with plans' diversification across alternative investments:

Hypothesis 6: Plan size and other suggested characteristics have a positive effect on plans' probability to diversify across multiple private equity and real estate sub-asset classes.

The results of Table 7 summarize marginal effects of median estimates for each possible outcome of NPI. I document a statistically significant effect of plan size on the decisions to diversity their alternative investments. Larger funds are found to be 6.13% more likely to invest in all five private equity and real estate sub-asset classes and 22% more likely to invest in four fund types simultaneously, while being 27% less likely to specialize in one particular asset class. On the one hand, this can be explained by larger fixed costs associated with researching and monitoring the opaque private equity and real estate markets which is more unfavorable for smaller plans. On the other hand, it could be also caused by limited liquidity for larger investment positions in alternative markets, as documented by Andonov (2014), which requires them to further diversify.

Furthermore, I include debt, equity and alternative investment allocation weights to test whether plans are likely to substitute one asset class for another. As demonstrated by Table 7, investors with a higher allocation to equities (riskier asset class compared to debt) are also more likely to diversify across four or five private equity and real estate sub-asset classes and are less likely to specialize. This suggests that if plan investors decide to invest in riskier assets (equities and alternative investments), they do not substitute risks among the given asset classes, but rather tend to diversify across a wide range of (risky) public and private markets simultaneously. Finally, I document that a higher allocation to alternative assets increases the plans' probability of diversification across venture capital, buyout and all other alternative sub-asset classes. Such results appear to be expected because larger allocation to alternative portfolios results in higher availability of funds and, thus, higher likelihood for distribution across several alternative fund types.

As documented by the work of Andonov (2014), an additional determinant of the number of portfolio investments could be geographical diversification. Given the scope of this study focused on the United States and limited availability of data for plans' base and investments across the US states, I acknowledge the high relevance of this theory and suggest considering this measure of diversification as an additional subject for future research.

Following the finding of significant determinants of plans' diversification decisions for their private equity and real estate sub-asset classes, I proceed with investigating the effects of diversification

(specialization) on plans' investment performance. More specifically, I examine whether diversification within plans' alternative sub-asset classes results in different performance among pension funds of different sizes.

As mentioned above, higher fixed costs associated with learning about and analyzing alternative investments could be unfavorable for smaller pension funds (Andonov, 2014). On the other hand, larger plans may encounter a lack of liquidity associated with taking large investment positions in alternative asset markets which may weigh down on their investment performance. Reiterating the importance of plan size in funds' diversification decisions, I divide all sample plans into tertiles based on their total assets under management. I further regress plans' investment performance – as measured by their internal rate or return and investment multiple – against a number of suggested determinants of performance.

Thus, I try to prove or reject the following final hypothesis:

Hypothesis 7: plans' size, specialization within private equity and real estate sub-asset classes and other characteristics have a negative effect on the investment performance of plans' alternative asset portfolio.

Based on the approach of Andonov (2014), I include *Small* and *Large* dummies into the regression analysis to control for plan size, as well as a *Specialize* dummy to account for funds' decision to invest in a single private equity or real estate sub-asset class. I further introduce the variables of *Debt*, *Equity* and *AltInv* as plan's portfolio allocation to fixed income, equities and alternative investments considering that up to 90% of final investment performance can be attributed to strategic asset allocation (Ibbotson and Kaplan, 2000 and Brinson, Hood and Beebower, 1986). Finally, in presenting the panel data analysis I do not perform clustering by either fund or vintage as in Table 7 due to the findings of the Hausman test.

The results of Table 8, Panel A suggest an inverse, statistically significant relationship between specialization and plans' alternative investment performance, as well a negative impact of smaller plan size on performance as evidenced by the negative sign of the *Small* dummy. However, statistical significance and a positive sign of the interaction term *Small*Specialize* suggests that the mentioned negative effects are typically alleviated when smaller plans specialize in on alternative sub-asset class. Thus, consistent with Andonov (2014), I find a confirmation of the previous thesis that alternative investments are fixed costs-intensive and likely to be drawing resources and weighing down from smaller funds' total investment performance. As such, I provide supporting evidence for

the above-mentioned hypothesis when plans' investment performance is measured by their internal rate of return.

On the other hand, a similar analysis of plans' performance based on the investment multiple does not reveal statistically significant link between plan size or specialization decision on plans' alternative portfolio performance.

3.3.5 Robustness Tests

Following the development of major hypotheses and discussion of main empirical results, I perform two robustness tests to confirm the determinants of plans' allocation to venture capital, buyout and real estate funds as suggested by Atanasova and Chemla (2016). Namely, I look at two major determinants of companies' decisions regarding their R&D and land & building investments: firm size and financial constraints, as documented by Brown, Fazzari and Petersen (2009).

Following Atanasova and Chemla (2016), I divide the sample into two equal sub-samples: those with sponsor assets above and below the overall sample median. Within each sub-sample I regress plans' allocation weights to venture capital (buyout, real estate) assets as percentage of total private equity and real estate portfolio against the plan-sponsor characteristics suggested in section 3.3.1. In the interaction column containing both sub-samples I control for sponsor size and add an interaction term SponSize*R&D/PPE (SponSize*L&B/PPE) suggesting alternative investment tilts driven by the magnitude of sponsors' assets. Similarly, in the second part of the robustness test I sort the sample into two halves based on sponsors' financial constraints. By contrast to Atanasova and Chemla (2016) who apply a complex White and Wu (2006) financial constraints index, I use Altman's Z Score as a measure of companies' long-term credit quality and an alternative proxy for their possible financial constraints. Similarly, following (Arnold and Earl 2006), I divide the sample based on the minimum critical Z Score value of 2.99 for financially unconstrained firms and introduce an interaction term reflecting R&D (L&B) portfolio tilts based on financial constraints.

The results of Table 8 confirm the prior findings of Table 3 suggesting no statistical significance between sponsor size and plans' allocation to either venture capital, buyout or real estate funds. However, the positive sign and statistical significance of the interaction terms suggests that portfolio tilts for venture capital and real estate investments tend to be driven by larger firms. Similarly, analysis of firms' financial constraints reiterates no statistical significance between alternative portfolio weights and sponsor's credit quality. Nonetheless, a positive sign of the interaction term Z

Score*R&D/PPE (Z Score*L&B/PPE) suggests that alternative portfolio tilts for buyout funds tend to be driven by sponsors of a higher credit quality (financially unconstrained firms).

During the research sample period two major events that could have a possible effect on the tested relationships: global financial crisis weighing on all major asset classes in 2008 and implementation of the Pension Protection Act (2006) coming into force two years thereafter (Atanasova and Chemla, 2008). Whereas the authors replicate their analysis limiting their sample period to years 1998-2007, in the context of this study it could significantly reduce the number of available plan-year observations and affect the researcher's ability to draw meaningful and statistically significant conclusions. Thus, I fully recognize the necessity to revise the analysis during a pre-crisis and/or post-crisis period and, similarly to cases of other research sample limitations, suggest it as an additional subject for future research.

4 Conclusion and Recommendations for Future Research

This paper demonstrates a strong connection between pension plan and sponsoring firm's characteristics and plans' allocation and investment performance in alternative asset classes. The study provides a comprehensive overview of the determinants of pension plans' asset allocation and investment performance within the private equity and real estate universe, highlighting plan and sponsor size, funded status and R&D and L&B intensity as some of the most influential plan and sponsor characteristics. The paper provides some evidence of risk management and informational advantage hypotheses as determinants of plans' venture capital and real estate investments and some support for risk shifting and barriers-to-entry hypotheses for buyout funds. Furthermore, similar to the findings of Atanasova and Chemla (2016) for a broader private equity asset class, the study documents the existence of spillover effects of venture capital and buyout investments on their sponsoring firms' performance, as measured by sponsors' return on assets, return on equity and market-to-book ratio, and suggests that spillover effects tend to be alleviated by plans' underfunding.

In addition, the research finds supportive evidence for the positive influence of plans' size on their decision to diversify across private equity and real estate sub-asset classes. Moreover, it suggests an inverse relationship between plan size and specialization in private equity and real estate fund types on the one hand and plans' investment performance on the other. The diseconomies of scale faced by smaller plans are shown to be addressed by allowing them to specialize in one alternative (sub-)asset

class, which is consistent with the findings Andonov (2014). Finally, the paper confirms that alternative investment tilts are driven by larger and less financially constrained firms.

To summarize, the results of this research suggest a close relationship between pension plan-sponsor characteristics and plans' allocation, diversification and investment performance within their private equity and real estate investments. A wide range of topics are yet to be researched, including investors' familiarity bias with regard to investments in venture capital, buyout and other alternative sub-asset classes, effects of geographical diversification on plans decisions to specialize (diversify) in their alternative investment portfolio and a test of the obtained results over the pre-and post- financial crisis period. Furthermore, as suggested by Atanasova and Chemla (2016), the effects of corporate governance on pension trustees' asset allocation decisions and their link to the sponsoring firms' performance would be a valuable addition to the existing body of knowledge. All the suggested topics would allow to gain a more comprehensive and well-rounded understanding of pension management within the alternative investment universe and would assist pension managers in increasing their awareness and enhancing investment performance within their plans' private equity and real estate allocation.

References

ABN AMRO, 2016. Investment Conditions (Appendix). Research Insights 2016.

Almazan, A., de Motta, A., Titman, S., and Uysal, V., 2010, Financial Structure, Acquisition Opportunities, and Firm Locations, Journal of Finance, 65 (2), pp. 529-563.

Andonov, A., 2014. Delegated Investment Management in Alternative Assets. Working Paper Series, Erasmus University Rotterdam.

Andonov, A., Bauer, R., Cremers, M., 2012. Can Large Pension Funds Beat the Market? Asset Allocation, Market Timing, Security Selection and the Limits of Liquidity. Working Paper Series: Erasmus University Rotterdam/Maastricht University/University of Notre Dame

Andonov, A., Eichholtz, P., Kok, N., 2014. Intermediated Investment Management in Private Markets: Evidence from Pension Fund Investments in Real Estate." Working Paper Series: Erasmus University Rotterdam/University of Maastricht.

Arnold, T., Earl, J., 2006. Applying Altman's Z Score in the Classroom. *Journal of Financial Education.* Vol. 32, pp. 97-102.

Atanasova, C., Chemla, G., 2016. Familiarity Breeds Alternative Investment: Evidence from Corporate Defined-Benefit Pension Plans, Working Paper Series: Imperial College Business School.

Bader, L. N., 1991. The Financial Executive's Guide to Pension Plans. New York: Salomon Brothers, Inc.

Bams, D., Schotman, P., Tyagi, M., 2016. Asset Allocation Dynamics of Pension Funds. NETSPAR Academic Series (Network for Studies on Pension, Aging and Retirement), March 2016.

Bank for International Settlements, 2015. Ultra-Low or Negative Interest Rates: What They Mean for Financial Stability and Growth. Eurofi High-Level Seminar, Riga, 22 April 2015.

Becht, M., Frank, J., Mayer, C., and S. Rossi, 2009. Returns to Shareholder Activism: Evidence from a Clinical Study of the Hermes UK Focus Fund, Review of Financial Studies, 22 (8), 3093-3129.

Benzoni, L., Collin-Dufresne, P., Goldstein, R.S., 2007. Portfolio Choice over the Life-cycle when the Stock and Labour Markets are Cointegrated. *Journal of Finance*, No. 62, pp. 2123–2167.

Bikker, J., Broeders, D., Hollanders, D., Ponds, E., 2009. Pension Funds' Asset Allocation and Participant Age: A Test Of The Life-Cycle Model. *DNB Working Paper*, No. 223, October 2009.

Black, F., 1989. Should you use stocks to hedge your pension liability? *Financial Analysts Journal*, Nr. 45, pp. 10-12.

Bodie, Z., Kane, A., Marcus, A., 2014. Investments (Tenth edition). The McGraw-Hill/Irwin series in finance, insurance and real estate, New York: McGraw-Hill Education.

Bodie Z., Shoven, J., Wise, D., Defined Benefit versus Defined Contritbution Pension Plans: What Are the Real Trade-Offs? *Pensions in the US Economy*, University of Chicago Press, pp. 139-162

Bodie, Z., Treussard, J., Willen, P., 2007. The Theory of Life-Cycle Saving and Investing. *Federal Reserve Bank of Boston*, Public Policy Discussion Papers, No. 07-3.

Boyle, P., Garlappi, L., Uppal, R. and Wang, T., 2012. Keynes Meets Markowitz: The Tradeoff Between Familiarity and Diversification, *Management Science*, Nr. 58, pp. 253-72.

Brinson, G., Hood, R., and Beebower, G., 1986. Determinants of Portfolio Performance. *Financial Analysts Journal*, Vol. 42, No. 4, July/August 1986: 39-48.

Brown, J., Fazzari, S., and B. Petersen, 2009. Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom, *Journal of Finance*, 64 (1), 151-85.

Brown, J., Pollet, J., Weisbenner, S., 2011. The investment behavior of state pension plans. *Working Paper*, University of Illinois

Booth, L., Chang, B., 2011. The Global Financial Crisis and the Performance of Target-Date Funds in the United States. *Rotman International Journal of Pension Management*, Vol. 4, Issue 2, Fall 2011.

Campbell, J., and Viceira, L., 2005. Strategic Asset Allocation for Pension Plans. *Oxford Handbook of Pensions and Retirement Income*, edited by Gordon Clark, Alicia Munnell and Michael Orszag. Oxford University Press.

Cao, H., Han, B., Hirshleifer, D. and Zhang, H., 2009. Fear of the Unknown: Familiarity and Economic Decisions, *Review of Finance*, Nr. 15(1), pp. 173-206.

Chaney, T., Sraer, D., and Thesmar, D., 2012. The Collateral Channel: How Real Estate Shocks Affect Corporate Investments, *American Economic Review*, Nr. 102, pp. 2381-2409.

Dyck, A., Pomorski, L., 2011. Is Bigger Better? Size and Performance in Pension Plan Management, *Working Paper:* Rotman School of Management, University of Toronto

Frank, M., 2002. The Impact of Taxes on Corporate Defined Benefit Plan Asset Allocation, *Journal of Accounting Research*, 4. 1163-84.

Global Alternatives Survey, 2016. Willis Towers Watson, Research Insights, 11 July 2016.

Guiso, L. P. Sapienza, and L. Zingales, 2013. The Value of Corporate Culture. *Working Paper:* Einaudi Institute of Economic Research & CEPR, Northwestern University, University of Chicago, National Bureau of Economic Research (NBER)

Gompers, P., Lerner, J., 2001. The Venture Capital Revolution, *Journal of Economic Literature*, Nr. 15, pp. 145-68.

Goyal, A., Wahal, S., 2008. The Selection and Termination of Investment Management Firms by Plan Sponsors. *The Journal of Finance*, 63(4), pp. 1805-1847.

Grinblatt, M., and M. Keloharju, 2001. How Distance, Language, and Culture Influence Stockholdings and Trades, *Journal of Finance*, 56, pp. 1053-73.

Guan, Y., Lui, D., 2016, "The Effect of Regulations on Pension Risk Shifting: Evidence from the US and Europe," *Forthcoming Journal of Business Finance and Accounting.*

Huberman, G., 2001. Familiarity Breeds Investment, Review of Financial Studies, Nr. 14 (3), pp. 659-680.

Hochberg, Y. and J. Rauh, 2013. Local overweighting and underperformance: Evidence from Limited Partner Private Equity Investments. *Review of Financial Studies*, Nr. 26(2), pp. 403–451.

Hull, J. C., 2010. Risk Management and Financial Institutions (Second Edition). Boston: Pearson Education.

Ibbotson, R., Kaplan, P., 2000. Does Asset Allocation Policy Explain 40, 90 or 100 Percent of Performance? *Financial Analysts Journal*, Vol. 56, No.1, Jan/Feb 2000.

Kaplan, S., Schoar, A., 2005. "Private equity performance: Returns, persistence, and capital flows." *The Journal of Finance* 60 (4), 1791–1823.

Lerner, J., Sorensen, M., and Stromberg, P., 2011, Private Equity and Long-Run Investment: The Case of Innovation, *Journal of Finance*, Nr. 66, pp. 445-77.

Lichtenberg, Frank R., and Donald Siegel, 1990. The effects of leveraged buyouts on productivity and related aspects of firm behavior, *Journal of Financial Economics*, 27, 165–194.

Lokhandwala, T., 2015. Global Pension Assets Top $36 trillion, rising 6% in 2014 – Towers Watson. *Investment and Pensions Europe Magazine*, February 2015.

Malkiel, B., 2007. A Random Walk Down Wall Street: The Time-Tested Strategy For Successful Investing. W.W. Norton & Company, New York.

Massa, M., Simonov, A., 2006. Hedging, Familiarity and Portfolio Choice." *Review of Financial Studies*, Nr. 19, pp. 633-85.

Morgan Stanley Research, 2015. Alternative Assets Innovation Strategies for Asset Allocation. Research Insights Report, 2015.

Organization for Economic Cooperation and Development, 2015. Low Interest Rates Threaten Solvency of Pension Funds and Insurers. OECD Newsroom, June 2015.

Organization for Economic Cooperation and Development, 2008. OECD Private Pensions Outlook. OECD Newsroom 2009.

Pennachi, G., Rastad, M., 2011. Portfolio Allocation to Public Pension Funds. *Journal of Pension Economics and Finance*, Vol. 10, Issue 02, pp. 415-434.

Perez, S., 2015. An Investor Primer on Alternative Asset Management. Marketrealist.com, January 2015.

Phalippou, L., 2009. Beware of venturing into private equity. *The Journal of Economic Perspectives*, No. 23 (1), 147–166.

PIMCO, 2012. Inflation and Its Impact on Investments. Research Insights on Investment Basics, March 2012.

Preesman, L., 2015. Asset Allocation: The Dutch Top Five. *Investments and Pensions Europe Magazine*, September 2015.

Poelhuis, J., 2011. Towers Watson: Managed Pension Fund Alternative Assets On the Rise in ’10. Retrieved from Search.proquest.com on January 2016.

Preqin Investment Outlook: Alternative Investments, 2016. Preqin Research Center, January 2016.

Rauh, J., 2009, Risk Shifting versus Risk Management: Investment Policy in Corporate Pension Plans, Review of Financial Studies, 22(7), pp. 2687-2733

Stefanescu, I., Vidangos, I., 2014. Introducing Actuarial Liabilities and Funding Status of Defined-Benefit Pensions in the U.S. Financial Accounts. FEDS Notes, October 31, 2014.

Stewart, N., 2010. Global Pension Assets Reached 70% of GDP. *Investments and Pensions Europe*, February 2010.

Stoughton, N. M., Wu, Y., Zechner, J., 2011. Intermediated investment management, The Journal of Finance, 66 (3), pp. 947-980.

U.S. Board of Governors of the Federal Reserve System, First Quarter 2016. Financial Accounts of the United States: Flow of Funds, Balance Sheets and Integrated Macroeconomic Accounts, *Federal Reserve Statistical Release*, Washington DC.

U.S. Department of Labour, 2016. Types of Retirement Plans. Retirement Plans, Benefits and Savings, October 2016.

Whited, T., Wu, G., 2006. Financial Constraints Risk. *Review of Financial Studies*, 19(2), pp. 531-559

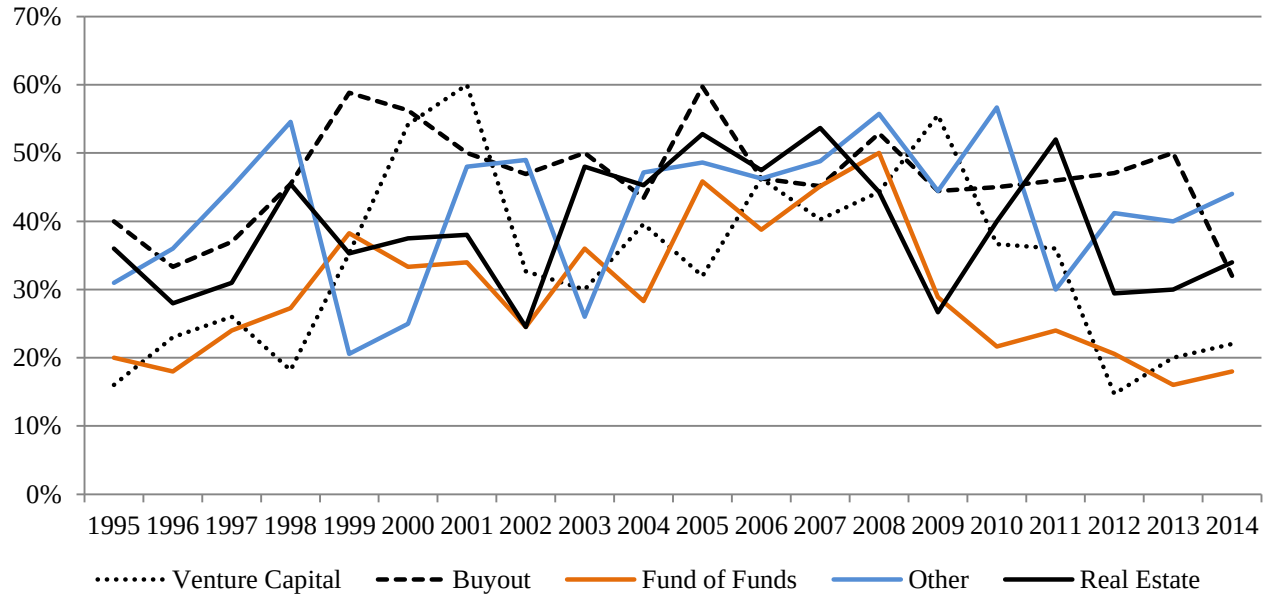
Wigglesworth, R., 2016. Pensions and Aging Populations: The Problem Explained. *Financial Times*, August 2016.

Willis Towers Watson, 2016. Global Pension Assets Study. *Willis Towers Watson Insights*, February 2016.

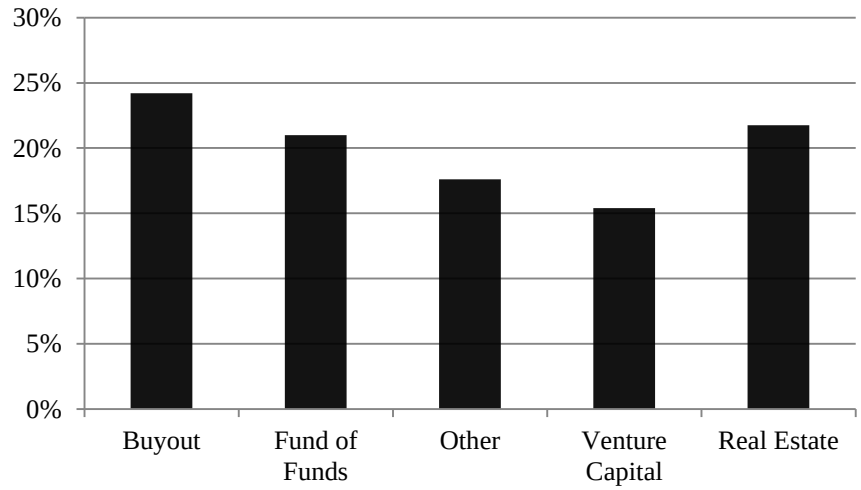
Woodward, S., 2012. Measuring Risk for Venture Capital and Buyout Portfolios. *Journal of Performance Measurement*, Vol. 17, No. 1 (Fall 2012): pp. 8-23

Figure 1: Corporate Defined-Benefit Pension Plans' Investments in Alternative Assets

Panel A: Percentage of funds invested in venture capital, buyout, fund of funds, real estate and other alternative asset classes[2]

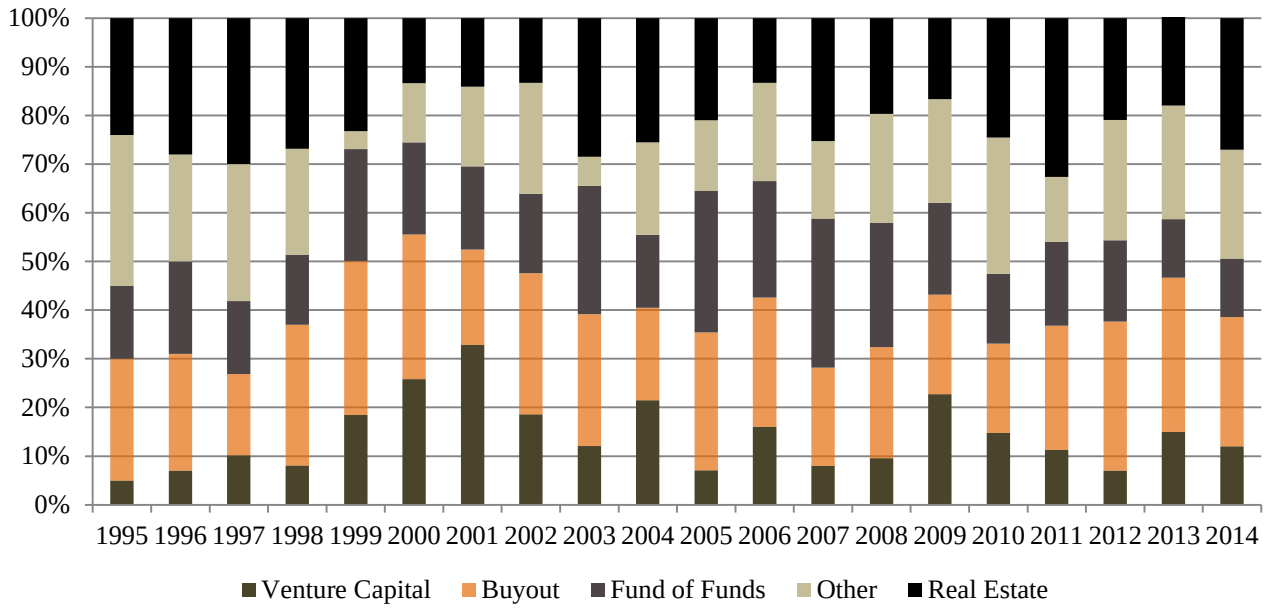


Panel B: Average allocation within private equity and real estate portfolio during 1995-2014[3]



[2] Within a total portfolio consisting of private equity and real estate assets
[3] Assuming the weights of total private equity and real estate investments summing up to 100%

Panel C: Historical allocation within private equity and real estate investments



Panel D: Number of portfolio investments (NPI) in private equity and real estate assets

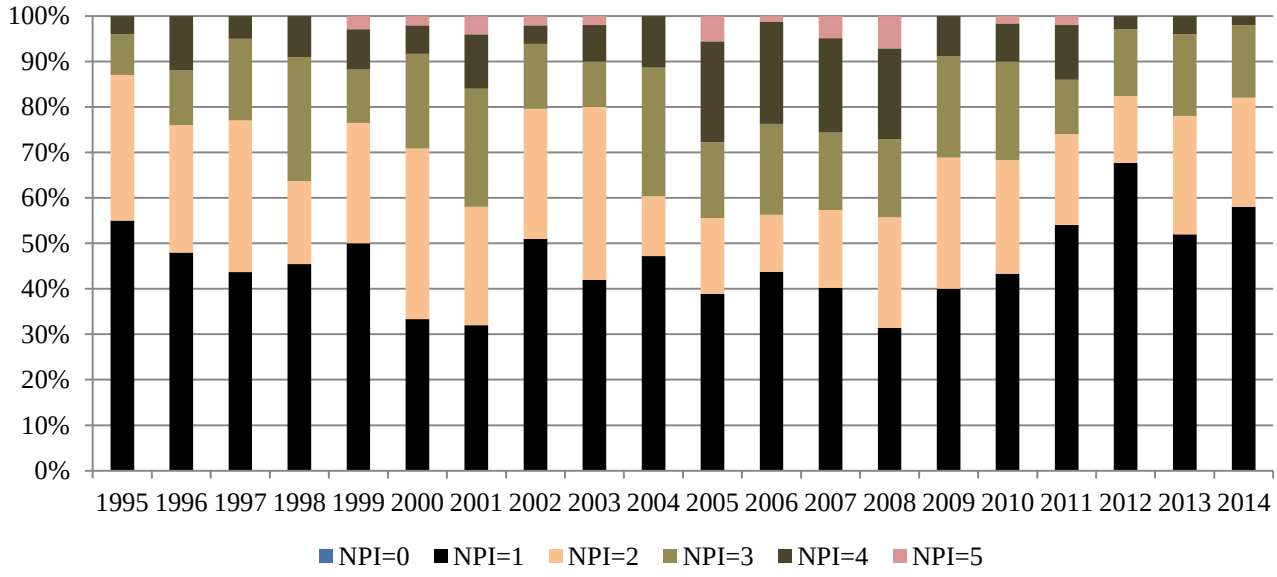


Table 1: Summary Statistics for Corporate Defined Benefit Plans and Their Sponsoring Firms

The research sample contains cross-sectional pension plan data for 134 firms headquartered in the United States obtained by matching the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. The units of observation are presented on a fund-strategy-vintage basis. Panel A provides the descriptive statistics for sample pension plans. I define the *Plan Actual Return* as a ratio of plan's investment income over beginning-of-year plan assets, plan's *Funding Status* – as a ratio of beginning-of-year plan assets to the beginning-of-year liabilities, and *Contribution (%AuM)* – as employer's pension contribution expressed through percentage of plan's assets. Panel B provides descriptive statistics for plans' sponsoring firms. Tobin's Q is defined as a ratio of market value of equity and book value of debt to total book value of firm's assets; leverage is the ratio of firm's long-term debt over total assets; Z score is the Altman Z-score reflecting the firm's creditworthiness. All plan and sponsor characteristics are matched to the respective year of firm's performance.

Panel A: Summary Statistics for Corporate Defined Benefit Pension Plans (Bloomberg, Preqin, Compustat Pension)										
Mean (St. Dev.)	All Funds	10%	50%	90%	PE Funds	RE Funds	VC	Buyout	FoF	Other
Plan Size (AuM $m)	9,769 (13,548)	997	4,138	27,262	11,396 (15,026)	13,894 (18,242)	14,896 (17,275)	16,019 (18,488)	8,680 (13,705)	14,282 (17,456)
Plan Actual Return	4.48% (12.59%)	-14.90%	8.93%	15.24%	4.10% (12.94%)	4.93% (12.70%)	3.81% (13.34%)	4.61% (12.37%)	3.43% (14.29%)	3.27% (13.35%)
Funding Ratio	0.90 (0.19)	0.69	0.88	1.15	0.91 (0.19)	0.92 (0.19)	0.94 (0.20)	0.93 (0.20)	0.91 (0.18)	0.90 (0.17)
Contribution (%AuM)	4.79% (4.59%)	0.37%	3.39%	11.72%	4.62% (4.37%)	4.14% (4.24%)	4.06% (3.81%)	3.89% (3.69%)	5.47% (5.08%)	4.17% (3.87%)
Panel B: Summary Statistics for Corporate Defined Benefit Sponsors (Bloomberg, Preqin, Compustat Fundamentals)										
Mean (St. Dev.)	All Funds	10%	50%	90%	PE Funds	RE Funds	VC	Buyout	FoF	Other
Sponsor Size (AuM, $m)	63,830 (116,640)	6,176	28,242	151,740	53,036 (74,572)	65,508 (112,130)	83,299 (142,401)	95,862 (174,059)	51,411 (63,553)	62,295 (125,235)
Tobin's Q	1.78 (0.83)	1.06	1.48	2.90	1.82 (0.87)	1.71 (0.63)	1.76 (0.79)	1.69 (0.77)	2.07 (1.07)	1.78 (0.74)
Leverage	19.29% (10.01%)	7.01%	17.53%	34.43%	18.5% (9.80%)	19.37% (9.73%)	19.24% (9.38%)	18.95% (9.49%)	18.10% (10.10%)	19.38% (9.21%)
Profitability	12.58% (6.85%)	2.78%	12.21%	22.07%	12.91% (6.84%)	12.12% (5.97%)	12.31% (6.60%)	11.76% (6.24%)	14.86% (7.49%)	12.67% (6.25%)
Z Score	3.51 (1.85)	1.31	3.19	6.14	3.52 (1.94)	3.27 (1.55)	3.38 (1.87)	3.23 (1.68)	4.06 (2.21)	3.46 (1.79)
R&D/PPE	0.16 (0.14)	0.01	0.12	0.46	0.19 (0.18)	0.16 (0.17)	0.21 (0.24)	0.21 (0.23)	0.19 (0.17)	0.21 (0.20)
L&B/PPE	0.63 (0.35)	0.25	0.55	1.10	0.63 (0.35)	0.67 (0.36)	0.61 (0.32)	0.66 (0.35)	0.59 (0.30)	0.70 (0.38)
Firms	134	134	134	134	112	79	74	69	76	80
Observations	804	804	804	804	664	342	322	397	275	349

Table 2. Correlation Matrices between Predicted and Control Variables

	w (VC)	w (Buyout)	w (FoF)	w (Other)	w (RE)	Multiple	IRR	Tobin's Q	ROA	ROE
w (VC)	1.0000									
w (Buyout)	-0.1013***	1.0000								
w (FoF)	-0.2350***	-0.3706***	1.0000							
w (Other)	-0.1863***	-0.1665***	-0.2733***	1.0000						
w (RE)	-0.2744***	-0.2930***	-0.3081***	-0.2492***	1.0000					
Multiple	-0.0125	0.1259***	-0.0159	-0.0111	-0.0774**	1.0000				
IRR	-0.0122	0.2532***	-0.1677***	-0.0503	-0.0005	0.4987***	1.0000			
Tobin's Q	-0.0130	-0.0766**	0.1476***	0.0080	-0.0846**	0.0309	-0.0454	1.0000		
ROA	-0.0574	-0.0627*	0.1065***	-0.0082	-0.0046	-0.0466	-0.0639*	0.5741***	1.0000	
ROE	-0.0692*	-0.0452	0.0444	-0.049	0.0869*	-0.0985*	-0.1159*	0.2645***	0.5035***	1.0000

***, **, * represents 1%, 5% and 10% significance levels respectively

	Plan Size	Funding Ratio	Sponsor Size	Tobin's Q	Leverage	Profitability	Z Score	R&D/PPE	L&B/PPE	FI_Percent	Eq_Percent	Alt_Percent
Plan Size	1.0000											
Funding Ratio	0.0403	1.0000										
Sponsor Size	0.2814***	0.0038	1.0000									
Tobin's Q	-0.0498	0.0004	-0.1767***	1.0000								
Leverage	0.0145	-0.0417	-0.0605*	-0.1847***	1.0000							
Profitability	-0.0352	-0.0244	-0.2816***	0.6947***	-0.0762**	1.0000						
Z Score	-0.1800***	-0.0185	-0.1911***	0.7493***	-0.3875***	0.7296***	1.0000					
R&D/PPE	0.0721**	-0.0201	-0.0663*	0.0832**	-0.0718**	-0.0866**	0.0372	1.0000				
L&B/PPE	-0.0859**	-0.0315	-0.0306	-0.0897**	-0.0321	-0.0759**	0.0995***	0.1173***	1.0000			
FI_Percent	0.2120*	-0.0136	0.0236	-0.1209***	-0.0623***	-0.0854*	-0.0764**	0.2405***	0.1047***	1.0000		
Eq_Percent	-0.1287*	0.0182	0.0043	0.1472***	-0.1168***	0.0951***	0.1244***	-0.2564***	-0.0997***	-0.5690***	1.0000	
Alt_Percent	-0.0587*	-0.0073	-0.0325	-0.0566	0.2076*	-0.0072	-0.0555	0.1272*	0.0062	-0.1842***	-0.6419***	1.0000

***, **, * represents 1%, 5% and 10% significance levels respectively

Table 3a. Alternative Portfolio Tilts and Pension Plan-Sponsor Characteristics

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases during the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. Investment performance is expressed through a cash-on-cash investment multiple. *Funding Ratio* is defined as a ratio of beginning-of-year plan assets to the beginning-of-year liabilities. *Leverage* is the ratio of sponsoring firm's long-term debt to its total assets. Sponsor's *Credit Quality* is expressed via Altman's Z Score. All Venture Capital, Buyout, Fund of Funds, Real Estate and Other funds' portfolio weights are defined as a share of plans' total private equity and real estate assets. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Variable	Mean	St. Dev.	Mean	St. Dev.	p value
	-(1)-	-(2)-	-(3)-	-(4)-	-(5)-
Panel A: Funding Ratio	Well-Funded Plans		Underfunded Plans		
Venture Capital	18.11%	(0.2634)	14.55%	(0.2570)	0.0916*
Buyout	26.54%	(0.3074)	23.39%	(0.3017)	0.2041
Real Estate	20.05%	(0.3061)	22.34%	(0.3489)	0.4092
Panel B: Credit Quality	Z Score 75th percentile		Z Score 25th percentile		
Venture Capital	13.07%	(0.2392)	17.28%	(0.2723)	0.0219**
Buyout	21.61%	(0.2844)	26.19%	(0.3161)	0.0338**
Real Estate	19.85%	(0.3207)	23.26%	(0.3518)	0.1560
Panel C: Leverage	Leverage 75th percentile		Leverage 25th percentile		
Venture Capital	16.15%	(0.2594)	14.72%	(0.2586)	0.4339
Buyout	22.61%	(0.2818)	25.75%	(0.3229)	0.1416
Real Estate	23.01%	(0.3546)	20.52%	(0.3220)	0.2990
Panel D: R&D/PPE	R&D/PPE 75th percentile		R&D/PPE 25th percentile		
Venture Capital	15.19%	(0.2473)	15.64%	(0.2689)	0.8075
Buyout	28.13%	(0.3166)	20.76%	(0.2871)	0.0006***
Real Estate	15.42%	(0.2669)	27.25%	(0.3822)	0.0000***
Panel E: L&B/PPE	L&B/PPE 75th percentile		L&B/PPE 25th percentile		
Venture Capital	13.99%	(0.2469)	17.11%	(0.2716)	0.0883*
Buyout	25.65%	(0.3056)	22.48%	(0.3001)	0.1391
Real Estate	20.63%	(0.3255)	23.08%	(0.3534)	0.3075

Table 3b. Alternative Investment Performance and Pension Plan-Sponsor Characteristics (measured by Investment Multiple)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases during the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. Investment performance is expressed through a cash-on-cash investment multiple. *Funding Ratio* is defined as a ratio of beginning-of-year plan assets to the beginning-of-year liabilities. *Leverage* is the ratio of sponsoring firm's long-term debt to its total assets. Sponsor's *Credit Quality* is expressed via Altman's Z Score. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Variable	Mean	St. Dev.	Mean	St. Dev.	p value
	-(1)-	-(2)-	-(3)-	-(4)-	-(5)-
Panel A: Funding Ratio	Well-Funded Plans		Underfunded Plans		
Venture Capital	1.43	(0.7380)	1.32	(0.3450)	0.1798
Buyout	1.40	(0.6811)	1.32	(0.4176)	0.2415
Real Estate	1.32	(0.4258)	1.20	(0.3688)	0.0177**
Panel B: Credit Quality	Z Score 75th percentile		Z Score 25th percentile		
Venture Capital	1.32	(0.3224)	1.39	(0.6221)	0.2568
Buyout	1.31	(0.3172)	1.39	(0.6711)	0.1894
Real Estate	1.22	(0.3579)	1.26	(0.4132)	0.4100
Panel C: Leverage	Leverage 75th percentile		Leverage 25th percentile		
Venture Capital	1.38	(0.5992)	1.33	(0.3645)	0.3995
Buyout	1.37	(0.6242)	1.32	(0.3699)	0.4181
Real Estate	1.24	(0.3570)	1.22	(0.4186)	0.8331
Panel D: R&D/PPE	R&D/PPE 75th percentile		R&D/PPE 25th percentile		
Venture Capital	1.33	(0.3775)	1.37	(0.5913)	0.4301
Buyout	1.32	(0.3637)	1.39	(0.6323)	0.1893
Real Estate	1.22	(0.4065)	1.25	(0.3928)	0.4991
Panel E: L&B/PPE	L&B/PPE 75th percentile		L&B/PPE 25th percentile		
Venture Capital	1.34	(0.5948)	1.35	(0.3736)	0.9564
Buyout	1.33	(0.5658)	1.38	(0.4686)	0.5332
Real Estate	1.18	(0.3349)	1.29	(0.4261)	0.0111**

Table 3c. Alternative Investment Performance and Pension Plan-Sponsor Characteristics (measured by Internal Rate of Return)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases during the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. Investment performance is expressed through internal rate of return (%). *Funding Ratio* is defined as a ratio of beginning-of-year plan assets to the beginning-of-year liabilities. *Leverage* is the ratio of sponsoring firm's long-term debt to its total assets. Sponsor's *Credit Quality* is expressed via Altman's Z Score. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Variable	Mean	St. Dev.	Mean	St. Dev.	p value
	-(1)-	-(2)-	-(3)-	-(4)-	-(5)-
Panel A: Funding Ratio	Well-Funded Plans		Underfunded Plans		
Venture Capital	8.64%	(0.0690)	9.67%	(0.0665)	0.2655
Buyout	8.22%	(0.0728)	9.68%	(0.0743)	0.1023
Real Estate	6.61%	(0.1007)	6.96%	(0.1041)	0.7750
Panel B: Credit Quality	Z Score 75th percentile		Z Score 25th percentile		
Venture Capital	8.34%	(0.0629)	10.39%	(0.0704)	0.0124**
Buyout	8.45%	(0.0621)	10.51%	(0.0817)	0.0166**
Real Estate	6.69%	(0.1021)	7.89%	(0.1038)	0.3114
Panel C: Leverage	Leverage 75th percentile		Leverage 25th percentile		
Venture Capital	9.64%	(0.0717)	9.09%	(0.0627)	0.5034
Buyout	9.65%	(0.0816)	8.81%	(0.0656)	0.3095
Real Estate	7.97%	(0.1107)	5.77%	(0.0939)	0.0498**
Panel D: R&D/PPE	R&D/PPE 75th percentile		R&D/PPE 25th percentile		
Venture Capital	9.43%	(0.0637)	9.29%	(0.0709)	0.8652
Buyout	9.24%	(0.0635)	9.26%	(0.0836)	0.9808
Real Estate	6.30%	(0.1014)	7.59%	(0.1062)	0.2775
Panel E: L&B/PPE	L&B/PPE 75th percentile		L&B/PPE 25th percentile		
Venture Capital	9.62%	(0.0697)	9.10%	(0.0649)	0.5336
Buyout	9.63%	(0.0686)	9.15%	(0.0789)	0.5783
Real Estate	6.65%	(0.1050)	7.19%	(0.0988)	0.6320

Table 4a: Determinants of Pension Plans' Allocation to Alternative Investments

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. In columns (1), (2), (3) and (4) the dependent variable is pension portfolio weight of Venture Capital/Buyout/Real Estate investments within total assets allocated to private equity and real estate. The definitions of dependent variables are similar to the ones in Table 1. All regressions include year dummy variables, and cluster-robust standard errors are provided in parentheses. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Panel A: Venture Capital				
	Predicted Variable: %Total PE and RE Assets			
	-(1)-	-(2)-	-(3)-	-(4)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	0.2050**	0.5131	0.5308	0.0659**
	(0.1781)	*(0.4094)*	*(0.4714)*	*(0.0462)*
Plan Size, ln(AuM)	0.0054	-0.0428	0.0198	0.0089
	(0.0185)	*(0.0352)*	*(0.0472)*	*(0.015)*
Funding Ratio, %	0.0012	0.0998*	-0.039	0.0030
	(0.0046)	*(0.0669)*	*(0.1074)*	*(0.0039)*
Sponsor size, ln(AuM)	-0.0105	-0.0115	-0.0274	-0.0003
	(0.0238)	*(0.0462)*	*(0.0412)*	*(0.0171)*
M/B ratio	-0.0062	-0.0303	-0.0342**	0.0070
	(0.0141)	*(0.0138)*	*(0.0170)*	*(0.0212)*
Z Score	-0.0024	0.0055	0.0039	-0.0051
	(0.0074)	*(0.007)*	*(0.0083)*	*(0.0106)*
Leverage, %	0.0863	0.1862	0.1308	0.0649
	(0.1081)	*(0.1511)*	*(0.1463)*	*(0.0831)*
Profitability, %	0.0753	0.3524*	0.5312**	-0.0577
	(0.1977)	*(0.2257)*	*(0.2616)*	*(0.1951)*
R&D/PPE, %	-0.0139	-0.0665	-0.0852	0.0875*
	(0.0995)	*(0.1294)*	*(0.1283)*	*(0.0554)*
Fund FE	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes
Adj. R^2	0.0152	0.0161	0.0332	0.0144
Funds	134	134	134	134
Obs	804	804	804	804

Table 4b: Determinants of Pension Plans' Allocation to Alternative Investments

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. In columns (1), (2), (3) and (4) the dependent variable is pension portfolio weight of Venture Capital/Buyout/Real Estate investments within total assets allocated to private equity and real estate. The definitions of dependent variables are similar to the ones in Table 1. All regressions include year dummy variables, and cluster-robust standard errors are provided in parentheses. ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Panel B: Buyout				
	Predicted Variable: %Total PE and RE Assets			
	-(1)-	-(2)-	-(3)-	-(4)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	-0.4297*** *(0.1315)*	-0.1544 *(0.4271)*	-0.0499 *(0.0831)*	-0.4372*** *(0.1572)*
Plan Size, ln(AuM)	0.0611*** *(0.0184)*	0.0286* *(0.0423)*	0.0917* *(0.0533)*	0.0678*** *(2.327)*
Funding Ratio, %	-0.0131*** *(0.0022)*	-0.0887* *(0.0683)*	-0.2468* *(0.1290)*	-0.0127* *(0.0026)*
Sponsor size, ln(AuM)	0.0216 *(0.0195)*	0.0634 *(0.0517)*	0.0793 *(0.0506)*	0.0163 *(0.0198)*
M/B ratio	0.0235 *(0.0232)*	0.0368 *(2.0850)*	0.0154 *(0.0314)*	-0.0324 *(0.0680)*
Z Score	-0.0097 *(0.0125)*	-0.0105 *(1.1890)*	0.0052 *(0.0168)*	0.0018 *(0.0131)*
Leverage, %	-0.1470 *(0.1552)*	-0.1344 *(0.1604)*	-0.2126 *(0.1886)*	-0.1074 *(0.1566)*
Profitability, %	-0.4101 *(0.4778)*	-0.5878* *(0.3313)*	-0.6332** *(0.3008)*	-0.2856 *(0.2671)*
R&D/PPE, %	0.0240 *(0.1315)*	-0.0681 *(0.1027)*	-0.0499 *(0.0831)*	-0.0471 *(0.0568)*
Fund FE	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes
Adj. R^2	0.1489	0.1163	0.1215	0.1487
Funds	134	134	134	134
Obs	804	804	804	804

Table 4c: Determinants of Pension Plans' Allocation to Alternative Investments

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. In columns (1), (2), (3) and (4) the dependent variable is pension portfolio weight of Venture Capital/Buyout/Real Estate investments within total assets allocated to private equity and real estate. The definitions of dependent variables are similar to the ones in Table 1. All regressions include year dummy variables, and cluster-robust standard errors are provided in parentheses. Finally, the signs ***, ** and * designate respective 1%, 5% and 10% levels of statistical significance.

Panel C: Real Estate				
	Predicted Variable: %Total PE and RE Assets			
	-(1)-	-(2)-	-(3)-	-(4)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	0.3769**	0.1637**	0.4384**	0.6919**
	(0.2878)	*(0.6234)*	*(0.6557)*	*(0.2718)*
Plan Size, ln(AuM)	-0.0058	0.0260	-0.0066	-0.0061
	(0.0235)	*(0.0337)*	*(0.0461)*	*(0.0186)*
Funding Ratio, %	0.0230***	0.0769**	0.0827**	0.0283***
	(0.0065)	*(0.0864)*	*(0.1936)*	*(0.0036)*
Sponsor size, ln(AuM)	-0.0095	0.0045	-0.0015	-0.0340
	(0.0306)	*(0.0574)*	*(0.0625)*	*(0.0262)*
M/B ratio	0.0043	0.0305	0.0224	-0.0453
	(0.0194)	*(0.0245)*	*(0.0254)*	*(0.0796)*
Z Score	-0.0135	-0.0151	-0.0137	-0.0192
	(0.0133)	*(0.0152)*	*(0.0157)*	*(0.0136)*
Leverage, %	-0.0915	-0.0639*	-0.0355*	-0.1097
	(0.2260)	*(0.3007)*	*(0.3249)*	*(0.1739)*
Profitability, %	0.1616	0.2228	0.2689	0.2407
	(0.2405)	*(0.2695)*	*(0.2789)*	*(0.2836)*
L&B/PPE, %	0.0695	0.2499*	0.1427	-0.0343
	(0.0716)	*(0.1373)*	*(0.1216)*	*(0.0506)*
Fund FE	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes
Adj. R^2	0.0357	0.0359	0.0534	0.0367
Funds	134	134	134	134
Obs	804	804	804	804

Table 5a: Testing the Informational Advantage Hypothesis: Determinants of Pension Plan Investment Performance (Venture Capital)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. Panels A presents characteristics of pension plans and sponsors invested in venture capital, testing the former as potential determinants of plan performance measured through investment multiple and internal rate of return. Panels B and C similarly present characteristics of pension plans and sponsors invested in buyout and real estate funds respectively as possible predictors of their plan performance. Signs ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Panel A: Venture Capital								
	Predicted Variable: Internal Rate of Return (IRR)				Predicted Variable: Investment Multiple			
	-(1)-	-(2)-	-(3)-	-(4)-	-(5)-	-(6)-	-(7)-	-(8)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	-0.0214	-0.2724	0.3771*	-0.0213	1.0447	1.5566	5.7638***	1.0932***
	(0.0526)	*(0.3368)*	*(0.1997)*	*(0.0662)*	*(1.0210)*	*(2.1695)*	*(1.0196)*	*(0.3418)*
Plan Size, ln(AuM)	0.0009	-0.0353**	-0.0071	0.0009	-0.2059***	-0.3471***	-0.0634	-0.0510
	(0.0054)	*(0.0173)*	*(0.0185)*	*(0.0041)*	*(0.0504)*	*(0.1115)*	*(0.0726)*	*(0.0419)*
Funding Ratio, %	-0.0053	0.0018	0.0946*	-0.0053	0.3044*	0.3244**	0.2580	0.0023
	(0.0212)	*(0.0311)*	*(0.0543)*	*(0.0227)*	*(0.1613)*	*(0.1590)*	*(0.3017)*	*(0.0016)*
Sponsor size, ln(AuM)	0.0105*	0.0604**	0.0167	0.0106***	0.1732*	0.2432	-0.0161	0.0446
	(0.0054)	*(0.0297)*	*(0.0189)*	*(0.0037)*	*(0.0897)*	*(0.1831)*	*(0.0773)*	*(0.0281)*
M/B ratio	-0.0116	-0.0008	-0.0019	-0.0116	0.0313	0.0118	-0.0233	0.0255
	(0.0083)	*(0.0092)*	*(0.0072)*	*(0.0088)*	*(0.0378)*	*(0.0380)*	*(0.0371)*	*(0.0512)*
Z Score	0.0074	0.0038	0.0044	0.0074	0.0103	0.0240	0.0261	0.0029
	(0.0048)	*(0.0063)*	*(0.0061)*	*(0.0051)*	*(0.0378)*	*(0.0358)*	*(0.0390)*	*(0.0237)*
Leverage, %	0.0517	0.126	-0.0124	0.0517	0.3898	0.2388	-0.5617	0.0020
	(0.0780)	*(0.1511)*	*(0.0812)*	*(0.0809)*	*(0.8632)*	*(0.9124)*	*(0.3715)*	*(0.0054)*
Profitability, %	-0.1070	-0.0278	-0.0339	-0.1070	-0.6803	-0.6019	-0.2223	-0.0039
	(0.1097)	*(0.1775)*	*(0.1751)*	*(0.1289)*	*(0.9337)*	*(1.0928)*	*(0.8026)*	*(0.0070)*
R&D/PPE, %	0.0089	0.0692**	-0.014	0.0089	-0.1015	0.1103	-0.1982*	-0.0001
	(0.0118)	*(0.0292)*	*(0.0294)*	*(0.0116)*	*(0.0967)*	*(0.1360)*	*(0.1054)*	*(0.0006)*
Fund FE	-	Yes	-	Yes	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes	-	-	Yes	Yes
Adj. R^2	0.0474	0.0452	0.3509	0.0474	0.0102	0.0160	0.4044	0.0151
Funds	74	74	74	74	74	74	74	74
Obs	322	322	322	322	322	322	322	322

Table 5b: Testing the Informational Advantage Hypothesis: Determinants of Pension Plan Investment Performance (Buyout funds)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. Panels A presents characteristics of pension plans and sponsors invested in venture capital, testing the former as potential determinants of plan performance measured through investment multiple and internal rate of return. Panels B and C similarly present characteristics of pension plans and sponsors invested in buyout and real estate funds respectively as possible predictors of their plan performance. Signs ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Panel B: Buyout

	Predicted Variable: Internal Rate of Return (IRR)				Predicted Variable: Investment Multiple			
	-(1)-	-(2)-	-(3)-	-(4)-	-(5)-	-(6)-	-(7)-	-(8)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	0.0336	0.3374	0.4930***	0.0336	1.7339***	4.2893**	5.9071***	1.7274***
	(0.0532)	*(0.2837)*	*(0.1551)*	*(0.0520)*	*(0.4068)*	*(1.7883)*	*(1.0972)*	*(0.3559)*
Plan Size, ln(AuM)	0.0021	-0.0601**	0.0073	0.0021	-0.0589	-0.3651***	0.0309	-0.0319
	(0.0050)	*(0.0250)*	*(0.0167)*	*(0.0056)*	*(0.0387)*	*(0.1317)*	*(0.0798)*	*(0.0383)*
Funding Ratio, %	0.0053	0.0337	0.0369	0.0053	0.2175	0.4267**	0.1848	0.1649
	(0.0237)	*(0.0270)*	*(0.0490)*	*(0.0325)*	*(0.1368)*	*(0.1638)*	*(0.3685)*	*(0.1692)*
Sponsor size, ln(AuM)	0.0014	0.0218	-0.0010	0.0014	0.0034	0.0002	-0.1196	-0.0170
	(0.0055)	*(0.0231)*	*(0.0167)*	*(0.0044)*	*(0.0472)*	*(0.1704)*	*(0.1049)*	*(0.0261)*
M/B ratio	-0.0019	-0.0084	-0.0043	-0.0019	0.0299	-0.0121	-0.0259	0.0256
	(0.0076)	*(0.0075)*	*(0.0075)*	*(0.0081)*	*(0.0365)*	*(0.0360)*	*(0.0413)*	*0.0485*
Z Score	0.0051	0.0083**	0.0068*	0.0051	0.0103	0.0198	0.0252	0.0001
	(0.0035)	*(0.0034)*	(0.0035)	*(0.0034)*	*(0.0189)*	*(0.0150)*	*(0.0211)*	*(0.0232)*
Leverage, %	0.1309*	0.2381	0.0093	0.1309*	0.1750	0.7304	-0.4282	0.1027
	(0.0716)	*(0.1499)*	*(0.0787)*	*(0.0769)*	*(0.4564)*	*(0.7456)*	*(0.3424)*	*(0.3054)*
Profitability, %	-0.0894	-0.1423	-0.1133	-0.0894	1.1568*	0.7643	0.3734	0.4354
	(0.0999)	*(0.2085)*	*(0.1696)*	*(0.1222)*	*(0.6447)*	*(1.0500)*	*(1.0585)*	*(0.6063)*
R&D/PPE, %	0.0085	0.0768***	0.0002	0.0085	-0.1495**	0.0396	-0.1383	-0.0575
	(0.0105)	*(0.0254)*	*(0.0304)*	*(0.0105)*	*(0.0719)*	*(0.1390)*	*(0.1314)*	*(0.0537)*
Fund FE	-	Yes	-	Yes	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes	-	-	Yes	Yes
Adj. R^2	0.0298	0.0884	0.4144	0.0296	0.0198	0.0149	0.4562	0.0238
Funds	69	69	69	69	69	69	69	69
Obs	397	397	397	397	397	397	397	397

Table 5c: Testing the Informational Advantage Hypothesis: Determinants of Pension Plan Investment Performance (Real Estate)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. Panels A presents characteristics of pension plans and sponsors invested in venture capital, testing the former as potential determinants of plan performance measured through investment multiple and internal rate of return. Panels B and C similarly present characteristics of pension plans and sponsors invested in buyout and real estate funds respectively as possible predictors of their plan performance. Signs ***, ** and * denote 1%, 5% and 10% levels of statistical significance respectively.

Panel C: Real Estate								
	Predicted Variable: Internal Rate of Return (IRR)				Predicted Variable: Investment Multiple			
	-(1)-	-(2)-	-(3)-	-(4)-	-(5)-	-(6)-	-(7)-	-(8)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	0.0239	0.2806	0.0030	0.0195	1.6540***	4.3445***	2.5955**	1.5355***
	(0.0586)	*(0.1990)*	*(0.2074)*	*(0.0531)*	*(0.2410)*	*(1.0096)*	*(1.2236)*	*(0.2925)*
Plan Size, ln(AuM)	-0.0005	-0.0501***	-0.0121	0.0010	-0.0043	-0.3146***	-0.0428	0.0036
	(0.0051)	*(0.0172)*	*(0.0181)*	*(0.0047)*	*(0.0244)*	*(0.0834)*	*(0.0861)*	*(0.0220)*
Funding Ratio, %	-0.0033***	0.0375	0.0008	-0.0034***	0.0238***	0.4597***	-0.0085	0.0234***
	(0.0005)	*(0.0280)*	*(0.0338)*	*(0.0006)*	*(0.0045)*	*(0.1173)*	*(0.1830)*	*(0.0050)*
Sponsor size, ln(AuM)	0.0081	0.0186	0.0134	0.0070*	-0.0112	-0.0311	-0.0596	-0.0087
	(0.0060)	*(0.0185)*	*(0.0185)*	*(0.0039)*	*(0.0324)*	*(0.1201)*	*(0.1307)*	*(0.0251)*
M/B ratio	-0.0054	-0.0167	-0.0049	-0.0036	0.0235	-0.1004*	-0.1058**	0.0352
	(0.0081)	*(0.0132)*	*(0.0116)*	*(0.0088)*	*(0.0472)*	*(0.0586)*	*(0.0507)*	*(0.0422)*
Z Score	-0.0052	-0.0013	0.0020	-0.0051	-0.0348	0.0143	0.0426	-0.0348
	(0.0045)	*(0.0074)*	*(0.0079)*	*(0.0041)*	*(0.0252)*	*(0.0379)*	*(0.0433)*	*(0.0244)*
Leverage, %	0.0238	-0.0283	-0.1146	0.0330	-0.3621	-0.6141	-1.0123**	-0.2434
	(0.0595)	*(0.1476)*	*(0.1039)*	*(0.0607)*	*(0.2667)*	*(0.4402)*	*(0.4247)*	*(0.2209)*
Profitability, %	0.0182	0.0684	0.0272	0.0060	-0.0959	-0.4847	-0.0831	-0.1551
	(0.0836)	*(0.1544)*	*(0.1172)*	*(0.0790)*	*(0.4036)*	*(0.0060)*	*(0.6094)*	*(0.3715)*
L&B/PPE, %	0.0154	0.0808	0.0719*	0.0161*	-0.0598	-0.0783	-0.0121	-0.0548
	(0.0098)	*(0.0501)*	*(0.0397)*	*(0.0092)*	*(0.0628)*	*(0.1865)*	*(0.1964)*	*(0.0536)*
Fund FE	-	Yes	-	Yes	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes	-	-	Yes	Yes
Adj. R^2	0.0569	0.0488	0.1879	0.0576	0.0407	0.0714	0.1237	0.0432
Funds	83	83	83	83	83	83	83	83
Obs	341	341	341	341	341	341	341	341

Table 6a: Testing the Spillover Hypothesis – Influence of Plan Investment Bias on Sponsor Performance (Venture Capital)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. Sponsoring firm's performance is expressed via three dependent variables: natural logarithm of firm's *Tobin's Q*, sponsor's Return on Assets (*ROA*) and the Return on Equity (*ROE*). *Tobin's Q* represents a ratio of the market value of firm's equity to the book value of its total assets. *Underfunding* is a dummy taking a value of one if the pension plan is underfunded. *VC/Buyout/RE* are the dummy variables equal to one if the fund invests in venture capital, buyout or real estate assets respectively. The interaction term between the VC/Buyout dummy and R&D/PPE ratio or between the RE dummy and L&B/PPE ratio is defined as *Bias*. Cluster-robust standard errors are presented in parentheses. The signs ***, ** and * designate the 1%, 5% and 10% levels of statistical significance respectively.

Panel A: Venture Capital	Ln(Tobin's Q)				ROA				ROE			
	-(1)-	-(2)-	-(3)-	-(4)-	-(1)-	-(2)-	-(3)-	-(4)-	-(1)-	-(2)-	-(3)-	-(4)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	0.4961***	0.5518***	0.0832**	0.0467***	0.0537***	0.0506***	0.0427***	0.0605***	0.2414***	0.2219***	0.2901***	0.2328***
	(0.0401)	*(0.0237)*	*(0.0365)*	*(0.0566)*	*(0.0071)*	*(0.0040)*	*(0.0078)*	*(0.0090)*	*(0.0465)*	*(0.0555)*	*(0.0920)*	*(0.0482)*
R&D/PPE	-0.1417	-0.2544**	-0.1633	0.1910	-0.0007	0.0093	-0.031	-0.0104	-0.0074	-0.0143	-0.2313	-0.0750
	(0.0951)	*(0.1092)*	*(0.1111)*	*(0.1996)*	*(0.0211)*	*(0.0185)*	*(0.0221)*	*(0.0294)*	*(0.1348)*	*(0.1921)*	*(0.2393)*	*(0.1302)*
Underfunding	-0.1078***	-0.1062***	0.0087	-0.0786	-0.0182**	-0.0198**	-0.0175**	-0.0077	-0.0487	-0.0355	-0.0489	-0.0763
	(0.0323)	*(0.0326)*	*(0.0481)*	*(0.0649)*	*(0.0079)*	*(0.0085)*	*(0.0085)*	*(0.0073)*	*(0.0492)*	*(0.0436)*	*(0.0419)*	*(0.0548)*
VC dummy	-0.0381	-0.0433	-0.0298	0.0267	0.0025	-0.0042	-0.0011	0.0049	-0.0714	-0.0760	-0.0820	-0.0200
	(0.0368)	*(0.0372)*	*(0.0358)*	*(0.0722)*	*(0.0061)*	*(0.0061)*	*(0.0065)*	*(0.0120)*	*(0.0442)*	*(0.0557)*	*(0.0541)*	*(0.0531)*
R&D/PPE*VC [Bias]	0.0054	0.0049	-0.0129	-0.1541	0.0099	0.0101	0.0159	-0.0118	0.1680*	0.2080**	0.3048**	0.0199
	(0.0749)	*(0.0771)*	*(0.0834)*	*(0.2001)*	*(0.0149)*	*(0.0167)*	*(0.0137)*	*(0.0349)*	*(0.0881)*	*(0.1014)*	*(0.1179)*	*(0.1237)*
VC*Underfunding	0.0213	0.0359	0.0244	-0.0817	-0.0040	-0.0005	0.0048	-0.0148	-0.0016	0.0346	-0.0375	-0.1060
	(0.0495)	*(0.0508)*	*(0.0569)*	*(0.0819)*	*(0.0105)*	*(0.0101)*	*(0.0111)*	*(0.0149)*	*(0.0511)*	*(0.0457)*	*(0.0452)*	*(0.0687)*
Bias*Underfunding	0.1022	0.0999	0.1028	0.2228	-0.0138	-0.0207	-0.0222	0.0178	-0.1254*	-0.1716**	-0.1643**	0.0410
	(0.1805)	*(0.1787)*	*(0.1838)*	*(0.1617)*	*(0.0215)*	*(0.0225)*	*(0.0215)*	*(0.0210)*	*(0.0703)*	*(0.0783)*	*(0.0803)*	*(0.0723)*
Fund FE	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes	-	-	Yes	Yes	-	-	Yes	Yes
Adj. R^2	0.0613	0.0634	0.0393	0.0576	0.0193	0.0199	0.0396	0.0105	0.0107	0.0169	0.0417	0.0183
Funds				*134*				*134*				*134*
Obs				*804*				*804*				*804*

Table 6b: Testing the Spillover Hypothesis – Influence of Plan Investment Bias on Sponsor Performance (Buyout)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All pension plan and sponsor variables are winsorized on 1% and 99% levels. Sponsoring firm's performance is expressed via three dependent variables: natural logarithm of firm's *Tobin's Q*, sponsor's Return on Assets (*ROA*) and the Return on Equity (*ROE*). *Tobin's Q* represents a ratio of the market value of firm's equity to the book value of its total assets. *Underfunding* is a dummy taking a value of one if the pension plan is underfunded. *VC/Buyout/RE* are the dummy variables equal to one if the fund invests in venture capital, buyout or real estate assets respectively. The interaction term between the VC/Buyout dummy and R&D/PPE ratio or between the RE dummy and L&B/PPE ratio is defined as *Bias*. Cluster-robust standard errors are presented in parentheses. The signs ***, ** and * designate the 1%, 5% and 10% levels of statistical significance respectively.

Panel B: Buyout	Ln(Tobin's Q)				ROA				ROE			
	-(1)-	-(2)-	-(3)-	-(4)-	-(1)-	-(2)-	-(3)-	-(4)-	-(1)-	-(2)-	-(3)-	-(4)-
Constant	0.5190***	0.5775***	0.1466***	0.5196***	0.0617***	0.0603***	0.0572*	0.0685***	0.2634***	0.2590***	0.3495*	0.2518***
	(0.0412)	*(0.0318)*	*(0.0395)*	*(0.0627)*	*(0.0075)*	*(0.0054)*	*(0.0088)*	*(0.0081)*	*(0.0377)*	*(0.0394)*	*(0.0622)*	*(0.0344)*
R&D/PPE	-0.2399***	-0.3721***	-0.2914**	0.1144	-0.0104	-0.0065	-0.0423**	-0.0198	-0.1202*	-0.0919	-0.2708	-0.1356
	(0.0937)	*(0.1346)*	*(0.1294)*	*(0.1663)*	*(0.0207)*	*(0.0179)*	*(0.0223)*	*(0.0294)*	*(0.1230)*	*(0.1651)*	*(0.2046)*	*(0.1197)*
Underfunding	-0.0796**	-0.0829**	0.0341	-0.0435	-0.0008	-0.0003	-0.0001	-0.0051	-0.0196	-0.0189	-0.0242	-0.0279
	(0.0343)	*(0.0358)*	*(0.0487)*	*(0.0547)*	*(0.0071)*	*(0.0075)*	*(0.0088)*	*(0.0070)*	*(0.0524)*	*(0.0531)*	*(0.0572)*	*(0.0481)*
BY dummy	-0.0859*	-0.0913*	-0.1085***	-0.1022	-0.0182**	-0.0179*	-0.0185*	-0.0155	-0.1235***	-0.1414***	-0.1590***	-0.0622
	(0.0461)	*(0.0480)*	*(0.0412)*	*(0.0779)*	*(0.0091)*	*(0.0097)*	*(0.0091)*	*(0.0113)*	*(0.0444)*	*(0.0478)*	*(0.0522)*	*(0.0532)*
R&D/PPE*BY [Bias]	0.1985*	0.2263*	0.2267**	0.041	0.0368**	0.0421***	0.0395***	0.0156	0.2718***	0.3213***	0.3574***	-0.1459
	(0.1198)	*(0.1277)*	*(0.1026)*	*(0.2158)*	*(0.0173)*	*(0.0158)*	*(0.0144)*	*(0.0405)*	*(0.1035)*	*(0.1050)*	*(0.1044)*	*(0.1158)*
BY*Underfunding	0.0774	0.0764	0.0648	0.0337	0.0374***	0.0404***	0.0386***	0.0179*	0.0611	0.0685	0.0691	0.0063
	(0.0504)	*(0.0519)*	*(0.0506)*	*(0.0558)*	*(0.0125)*	*(0.0132)*	*(0.0120)*	*(0.0121)*	*(0.0691)*	*(0.0773)*	*(0.0760)*	*(0.0745)*
Bias*Underfunding	0.0367	0.0502	0.0531	0.0549	-0.0366**	-0.0387*	-0.0376*	-0.0113	-0.1716*	-0.1896**	-0.1784**	-0.0417
	(0.1525)	*(0.1564)*	*(0.1621)*	*(0.1614)*	*(0.0179)*	*(0.0199)*	*(0.0192)*	*(0.0270)*	*(0.0861)*	*(0.0888)*	*(0.0865)*	*(0.0617)*
Fund FE	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes	-	-	Yes	Yes	-	-	Yes	Yes
Adj. R^2	0.0724	0.0745	0.0864	0.0790	0.0378	0.0487	0.0438	0.0382	0.0175	0.0229	0.0444	0.0139
Funds				*134*				*134*				*134*
Obs				*804*				*804*				*804*

Table 6c: Testing the Spillover Hypothesis – Influence of Alternative Investment Bias on Sponsor Performance (Buyout)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All fund and sponsor variables are winsorized on 1% and 99% levels. Sponsoring firm's performance is expressed via three dependent variables: natural logarithm of firm's *Tobin's Q*, sponsor's Return on Assets (*ROA*) and Return on Equity (*ROE*). *Tobin's Q* represents a ratio of the market value of firm's equity to the book value of its total assets. *Underfunding* is a dummy taking a value of one if the pension plan is underfunded. *VC/Buyout/RE* are the dummy variables equal to one if the fund invests in venture capital, buyout or real estate assets respectively. The interaction term between the VC/Buyout dummy and R&D/PPE ratio or between the RE dummy and L&B/PPE ratio is defined as *Bias*. Cluster-robust standard errors are presented in parentheses. The signs ***, ** and * designate the 1%, 5% and 10% levels of statistical significance respectively.

Panel C: Real Estate	Ln(Tobin's Q)				ROA				ROE			
	-(1)-	-(2)-	-(3)-	-(4)-	-(1)-	-(2)-	-(3)-	-(4)-	-(1)-	-(2)-	-(3)-	-(4)-
Constant	0.4638***	0.4457***	0.0319***	0.5478***	0.0645***	0.0730*	0.0656*	0.0665***	0.1667***	0.0558	0.1872	0.1676***
	(0.0974)	*(0.1609)*	*(0.0641)*	*(0.0915)*	*(0.0201)*	*(0.0371)*	*(0.0170)*	*(0.0128)*	*(0.0453)*	*(0.0901)*	*0.0396*	*(0.0444)*
L&B/PPE	-0.0227	0.0379	-0.1036	-0.0251	-0.0220	-0.0340	-0.0909	-0.0093	0.0333	0.1934	0.0084	0.0280
	(0.1193)	*(0.2450)*	*(0.1755)*	*(0.0873)*	*(0.0318)*	*(0.0576)*	*(0.0551)*	*(0.0163)*	*(0.0443)*	*(0.1315)*	*(0.1193)*	*(0.0379)*
Underfunding	-0.1649***	-0.1685***	-0.0507	-0.1601***	-0.0174**	-0.0173**	-0.0193**	-0.0144	-0.0323	-0.0396	-0.0498	-0.0385
	(0.0474)	*(0.0470)*	*(0.0539)*	*(0.0587)*	*(0.0074)*	*(0.0082)*	*(0.0088)*	*(0.0113)*	*(0.0261)*	*(0.0279)*	*(0.0332)*	*(0.0422)*
RE dummy	0.0096	0.0218	0.0022	-0.0099	0.0079	0.0135	0.0081	-0.0077	0.0621	0.0475	0.0605	0.0461
	(0.0528)	*(0.0540)*	*(0.0491)*	*(0.0906)*	*(0.0119)*	*(0.0129)*	*(0.0118)*	*(0.0105)*	*(0.0701)*	*(0.0771)*	*(0.0669)*	*(0.0650)*
L&B/PPE*RE [Bias]	0.0628	0.0678	0.0787	-0.0557	0.0051	0.0001	0.0025	0.0078	-0.0012	0.0136	0.0185	0.0116
	(0.0530)	*(0.0553)*	*(0.0579)*	*(0.0889)*	*(0.0146)*	*(0.0144)*	*(0.0124)*	*(0.0143)*	*(0.0975)*	*(0.1064)*	*(0.1074)*	*(0.1049)*
RE*Underfunding	-0.0540	-0.0600	-0.0519	-0.1040	0.0122	0.0149	0.0168	0.0008	0.1307	0.1377	0.1522	0.0552
	(0.0744)	*(0.0787)*	*(0.0760)*	*(0.1258)*	*(0.0152)*	*(0.0168)*	*(0.0149)*	*(0.0188)*	*(0.1085)*	*(0.1148)*	*(0.1139)*	*(0.1271)*
Bias*Underfunding	-0.0221	-0.0120	-0.0179	-0.0484	-0.0313*	-0.0342*	-0.0376**	-0.0289*	-0.2116*	-0.2167*	-0.2497**	-0.1357
	(0.0848)	*(0.0936)*	*(0.0908)*	*(0.1535)*	*(0.0160)*	*(0.0178)*	*(0.0161)*	*(0.0163)*	*(0.1126)*	*(0.1226)*	*(0.1219)*	*(0.1338)*
Fund FE	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Vintage FE	-	-	Yes	Yes	-	-	Yes	Yes	-	-	Yes	Yes
Adj. R^2	0.0242	0.0158	0.0311	0.0235	0.0321	0.0329	0.0410	0.0391	0.0124	0.0137	0.0408	0.0195
Funds				*134*				*134*				*134*
Obs				*804*				*804*				*804*

Table 7: Logistic Regressions - Number of Portfolio Investments (NPI)

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All regressions are performed only for funds with an investment in at least one alternative asset class and are specified using an ordered logit model. The dependent variable *NPI* is the number of alternative asset classes invested in simultaneously by a pension plan on a given year and has a maximum value of five when a plan invests in venture capital, buyout, fund of funds, other private equity funds and real estate funds at the same time. The included dependent variables *Debt %*, *Equity %* and *AltInv %* are the pension plans' allocation weights to fixed income, equity and alternative investments respectively. Other fund and sponsor characteristics are defined as in Table 1. Coefficients' standard errors are presented in parentheses. Signs ***, ** and * denote 1%, 5% and 10% significance levels respectively.

	NPI = 1	NPI = 2	NPI = 3	NPI = 4	NPI = 5
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Plan Size, ln(AuM)	-0.2700***	-0.098*	0.0864*	0.2200***	0.0613**
	(0.0910)	*(0.0610)*	*(0.0466)*	*(0.0809)*	*(0.0302)*
Funding Ratio	0.0945	0.0342	-0.0302	-0.0770	-0.0215
	(0.3250)	*(0.1175)*	*(0.1475)*	*(0.2621)*	*(0.0739)*
Sponsor Size, ln(AuM)	0.0936	0.0338	-0.0299	-0.0763	-0.0213
	(0.0998)	*(0.0416)*	*(0.0430)*	*(0.0826)*	*(0.0247)*
Leverage	-0.0991	-0.0358	0.0317	0.0808	0.0225
	(1.0237)	*(0.3710)*	*(0.4714)*	*(0.8341)*	*(0.2332)*
Profitability	0.6743	0.2441	-0.2158	-0.5494	-0.1532
	(1.1257)	*(0.4214)*	*(0.5019)*	*(0.9197)*	*(0.2618)*
M/B Ratio	-0.1570	-0.0568	0.0502	0.1279	0.0357
	(0.1177)	*(0.0501)*	*(0.0508)*	*(0.0958)*	*(0.0294)*
Z Score	0.0833	0.0302	-0.0267	-0.0679	-0.0189
	(0.0603)	*(0.0271)*	*(0.0350)*	*(0.0502)*	*(0.0152)*
Debt %	-0.0157	-0.5675	0.5018	0.0128	0.0036
	(0.0171)	*(0.6487)*	*(1.3682)*	*(0.0135)*	*(0.0039)*
Equity %	-0.0322**	-0.0116	1.0297	0.0262**	0.0073*
	(0.0158)	*(0.0078)*	*(1.5277)*	*(0.0126)*	*(0.0041)*
AltInv %	-0.0329**	-0.0119	1.0537	0.0268**	0.0075*
	(0.0161)	*(0.0081)*	*(1.4747)*	*(0.0130)*	*(0.0043)*
Vintage Dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Funds	134	134	134	134	134
Obs	804	804	804	804	804

Table 8: Specialization in alternative investments and plan performance

The research sample contains pension plan-sponsor level data for 134 companies headquartered in the United States which is obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All pension fund and sponsor variables are winsorized on 1% and 99% levels. The predicted variables are used to measure pension plans' investment performance and are presented by investment multiples and internal rates of return. *Small* and *Large* dummies are included to control for pension plans' size whereby all funds in the sample are divided into tertiles based on total assets under management. I apply a *Specialize* dummy to represent situations when pension funds invest only in one alternative asset class among venture capital, buyout, fund of funds and other private equity funds and real estate investments. *Large*Specialize* and *Small*Specialize* are the interaction terms provided to control for the difference in specialization effect among large and small pension funds. *Debt%*, *Equity%* and *AltInv %* are the pension plans' allocation weights to fixed income, equity and alternative investments respectively. Signs ***, ** and * denote 1%, 5% and 10% significance levels respectively.

Dependent Variable: PE and RE internal rate of return	-(1)-	-(2)-	-(3)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	7.937		7.685
	(5.060)		*(4.894)*
Specialize	-4.649***	-5.779***	-5.856***
	(0.690)	*(0.614)*	*(0.884)*
Large	0.852		-0.195
	(0.705)		*(0.781)*
Small		-2.455***	-2.564***
		(0.665)	*(0.772)*
Large*Specialize	-1.096		0.105
	(1.207)		*(1.341)*
Small*Specialize		2.761***	2.839**
		(1.037)	*(1.181)*
Debt %	-0.015	0.004	0.005
	(0.057)	*(0.054)*	*(0.055)*
Equity %	0.021	0.031	0.031
	(0.054)	*(0.053)*	*(0.053)*
Alt Inv %	0.080	-0.090	0.089
	(0.054)	*(0.056)*	*(0.055)*
R-squared	0.121	0.129	0.130
Funds	134	134	134
Obs	804	804	804

Dependent Variable: PE and RE investment multiple	-(1)-	-(2)-	-(3)-
	Coefficient (St Error)	Coefficient (St Error)	Coefficient (St Error)
Constant	1.008***	0.971***	1.010***
	(0.290)	*-0.283*	*(0.287)*
Specialize	0.049	0.048	0.037
	(0.055)	*(0.050)*	*(0.079)*
Large	-0.110		-0.109
	(0.073)		*(0.077)*
Small		0.035	0.012
		(0.051)	*(0.053)*
Large*Specialize	0.004		0.016
	(0.080)		*(0.099)*
Small*Specialize		0.015	0.024
		-0.078	*(0.095)*
Debt %	-0.001	-0.002	-0.001
	(0.004)	*-0.004*	*(0.004)*
Equity %	0.007**	0.007**	0.007**
	(0.003)	*(0.003)*	*(0.003)*
Alt Inv %	0.004	0.001	0.001
	(0.032)	*-0.003*	*(0.003)*
R-squared	0.015	0.016	0.014
Funds	134	134	134
Obs	804	804	804

Table 9a. Robustness Test for Venture Capital Investment Tilts: Sponsor Size and Financial Constraints (measured by Z Score)

The research sample contains pension fund-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All plan and sponsor variables are defined as in Table 1 and winsorized on 1% and 99% levels. In Panel A the predicted variable is the percentage of total private equity and real estate assets allocated to venture capital. Similarly, in Panels B and C the predicted variable is the percentage of all private equity and real estate assets allocated to buyout funds and real estate accordingly. Coefficients' robust standard errors are specified in parentheses. Signs ***, ** and * denote 1%, 5% and 10% significance levels respectively.

Panel A: Venture Capital	Predicted Variable: %Total PE and RE Assets			Predicted Variable: %Total PE and RE Assets		
	Small Funds (Bottom 50%)	Large Funds (Top 50%)	Interaction	Constrained (Z < 2.99)	Unconstrained (Z > 2.99)	Interaction
Constant	1.3291**	0.0863	0.6961	0.1071	0.5793	0.2008*
	(0.5247)	*(0.1968)*	*(0.4215)*	*(0.2554)*	*(0.3604)*	*(0.1823)*
Plan Size, ln(AuM)	-0.1375*	-0.0001	-0.0416	0.0278	-0.0240	0.0052
	(0.0821)	*(0.0170)*	*(0.0349)*	*(0.0289)*	*(0.0247)*	*(0.0184)*
Funding Ratio	0.0405	-0.0051***	0.0948	-0.0069**	0.1651*	-0.0012
	(0.0968)	*(0.0016)*	*(0.0667)*	*(0.0030)*	*(0.0932)*	*(0.0047)*
Sponsor Size, ln(AuM)			-0.0311	-0.0130	-0.0242	-0.0101
			(0.0465)	*(0.0336)*	*(0.0339)*	*(0.0239)*
M/B Ratio	-0.0714	0.0094	-0.0245*	-0.0701	-0.0124	-0.0071
	(0.0938)	*(0.0322)*	*(0.0143)*	*(0.0491)*	*(0.0158)*	*0.0152*
Z Score	0.0810	-0.0149	0.0042			-0.0015
	(0.0518)	*(0.0184)*	*(0.0067)*			*(0.0077)*
Leverage	-0.7184**	0.1919	0.2073	0.2146	-0.7082***	0.0865
	(0.3563)	*(0.1276)*	*(0.1430)*	*(0.1611)*	*(0.2359)*	*(0.1086)*
Profitability	-1.0405**	0.4510	0.3210	0.8451	-0.4636**	0.0818
	(0.5142)	*(0.3196)*	*(0.2291)*	*(0.6055)*	*(0.2366)*	*(0.2090)*
R&D/PPE	0.2159	0.1336**	-0.1225	-0.1395	0.4299**	-0.0067
	(0.1839)	*(0.0663)*	*(0.8000)*	*(0.0946)*	*(0.1891)*	*(0.1190)*
Spon Size*R&D/PPE			0.0017**			
			(0.0008)			
Z Score*R&D/PPE						-0.024
						(0.1378)
Adj. R^2	0.2412	0.2351	0.2560	0.068	0.1017	0.2560
Funds	94	65	134	76	79	134
Obs	402	402	804	367	399	766

Table 9b. Robustness Test for Buyout Investment Tilts: Sponsor Size and Financial Constraints (measured by Z Score)

The research sample contains pension fund-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All plan and sponsor variables are defined as in Table 1 and winsorized on 1% and 99% levels. In Panel A the predicted variable is the percentage of total private equity and real estate assets allocated to venture capital. Similarly, in Panels B and C the predicted variable is the percentage of all private equity and real estate assets allocated to buyout funds and real estate accordingly. Coefficients' robust standard errors are specified in parentheses. Signs ***, ** and * denote 1%, 5% and 10% significance levels respectively.

Panel B: Buyout	Predicted Variable: %Total PE and RE Assets			Predicted Variable: %Total PE and RE Assets		
	Small Funds (Bottom 50%)	Large Funds (Top 50%)	Interaction	Constrained (Z < 2.99)	Unconstrained (Z > 2.99)	Interaction
Constant	-0.0544	-0.3508*	-0.4395***	-0.2523	-0.7093*	-0.3873***
	(0.6524)	*(0.1916)*	*(0.1456)*	*(0.1806)*	*(0.4372)*	*(0.1307)*
Plan Size, ln(AuM)	0.1003	0.0827***	0.0610***	0.0516**	0.0466*	0.0617***
	(0.0916)	*(0.0189)*	*(0.0184)*	*(0.0238)*	*(0.0288)*	*(0.0188)*
Funding Ratio	-0.3641**	-0.0132***	-0.0131***	-0.0115***	-0.0832	-0.0125***
	(0.1613)	*(0.0020)*	*(0.0022)*	*(0.0024)*	*(0.1559)*	*(0.0022)*
Sponsor Size, ln(AuM)			0.0226	0.0208	0.0570	0.0185
			(0.0197)	*(0.0266)*	*(0.0469)*	*(0.0197)*
M/B Ratio	0.1385	0.0187	0.0231	-0.0135	0.0345	0.0266
	(0.1961)	*(0.0317)*	*(0.0232)*	*-0.0603*	*(0.0283)*	*(0.0230)*
Z Score	-0.0736**	-0.0012	-0.0097			-0.0178
	(0.0388)	*(0.0218)*	*(0.0126)*			*(0.0122)*
Leverage	0.4419	-0.2838	-0.1481	-0.2261	0.2176	-0.1545
	(1.1594)	*(0.2278)*	*(0.1544)*	*(0.2032)*	*(0.3362)*	*(0.1569)*
Profitability	-0.1435	-0.7240	-0.4052	-0.7874*	-0.3379	-0.4319
	(1.5550)	*(0.5304)*	*(0.2717)*	*(0.4062)*	*(0.4285)*	*(0.2755)*
R&D/PPE	-0.2753	-0.0343	0.0297	-0.0345	-0.0761	-0.0262
	(0.2268)	*(0.0866)*	*(0.0559)*	*(0.0504)*	*(0.1657)*	*(0.0417)*
Spon Size*R&D/PPE			-0.0002			
			(0.0007)			
Z Score*R&D/PPE						0.1684*
						(0.1114)
Adj. R^2	0.1167	0.1071	0.1487	0.1032	0.1385	0.1547
Funds	94	65	134	76	79	134
Obs	402	402	804	367	399	766

Table 9c. Robustness Test for Real Estate Investment Tilts: Sponsor Size and Financial Constraints (measured by Z Score)

The research sample contains pension fund-sponsor level data for 134 companies headquartered in the United States obtained by combining the Bloomberg, Preqin, Compustat Pension and Compustat Fundamental databases over the period of 1995-2014. All plan and sponsor variables are defined as in Table 1 and winsorized on 1% and 99% levels. In Panel A the predicted variable is the percentage of total private equity and real estate assets allocated to venture capital. Similarly, in Panels B and C the predicted variable is the percentage of all private equity and real estate assets allocated to buyout funds and real estate accordingly. Coefficients' robust standard errors are specified in parentheses. Signs ***, ** and * denote 1%, 5% and 10% significance levels respectively.

Panel C: Real Estate	Predicted Variable: %Total PE and RE Assets			Predicted Variable: %Total PE and RE Assets		
	Small Funds (Bottom 50%)	Large Funds (Top 50%)	Interaction	Constrained (Z < 2.99)	Unconstrained (Z > 2.99)	Interaction
Constant	0.8885***	0.1033	0.5479**	0.4350*	0.8948**	0.4217*
	(0.3431)	*(0.2800)*	*(0.2464)*	*(0.3062)*	*(0.4644)*	*(0.2721)*
Plan Size, ln(AuM)	-0.0269	0.0024	0.0048	-0.0235	0.0439	-0.0077
	(0.0339)	*(0.0240)*	*(0.0248)*	*(0.0362)*	*(0.0475)*	*(0.0222)*
Funding Ratio	-0.3549*	0.0245***	0.233***	0.0273***	-0.0490	0.0234***
	(0.1847)	*(0.0064)*	*(0.0064)*	*(0.0036)*	*(0.1692)*	*(0.0067)*
Sponsor Size, ln(AuM)			-0.0314	-0.0056	-0.0987	-0.0105
			(0.0311)	*(0.0429)*	*(0.0629)*	*(0.0310)*
M/B Ratio	-0.1109	0.0099	0.0044	0.0301	-0.0130	0.008
	(0.1108)	*(0.0286)*	*(0.0186)*	*(0.0734)*	*(0.0159)*	*(0.0216)*
Z Score	-0.0221	-0.0125	-0.0127			-0.0179
	(0.0560)	*(0.0192)*	*(0.0134)*			*(0.0147)*
Leverage	-0.2823	-0.0023	-0.1654	-0.2389	-0.0291	-0.0844
	(0.6878)	*(0.2828)*	*(0.2141)*	*(0.2319)*	*(0.3575)*	*(0.2281)*
Profitability	1.6495	-0.0130	0.1323	0.2226	-0.0086	0.0964
	(1.1035)	*(0.2986)*	*(0.2302)*	*(0.4540)*	*(0.2645)*	*(0.2345)*
L&B/PPE	-0.0967	0.1615*	-0.0748	0.0808	-0.1885*	0.0293
	(0.1155)	*(0.0915)*	*(0.0613)*	*(0.0823)*	*(0.1120)*	*(0.0662)*
Spon Size*L&B/PPE			0.0010**			
			(0.0005)			
Z Score*R&D/PPE						0.0587
						(0.0757)
Adj. R^2	0.1955	0.1514	0.1842	0.0882	0.2119	0.1346
Funds	94	65	134	76	79	134
Obs	402	402	804	367	399	766