A Study of U.S. Public Defined-Benefit Pension Plans Alternative Investment Strategies

By Elaine Wong

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Queen's University

Kingston, Ontario, Canada

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1. Introduction

This essay examines American public pension plans' alternative investments strategies, with special attention paid to return patterns and investment determinants. This is important as alternative investments have been growing as a proportion of pension plans' portfolios. Considering the amount of assets held in American pension plans and the imminent need for pension disbursements as the American population ages, pension plan managers' investment decisions should be carefully scrutinized to ensure that they are prudent. Logistic, ordinary least squares and fixed effects regressions are used to examine a dataset that contains 150 state and local pension plans. A case study on the New York State and Local Retirement System is also conducted to study the differences between hedge funds and private equity more closely. The returns analysis and regression results give moderate evidence that pension plans are driven by the chase for higher returns rather than a desire to moderate risk when they invest in alternative investments. However the returns analysis on the dataset and the case study show that alternative investments (especially hedge funds) do not dominate traditional investments using mean-variance analysis. Pension plan managers should therefore examine whether alternative investments can deliver higher returns without exposing public pension funds to undue risk.

Alternative investments (investments that include private equity, hedge funds, and sometimes commodities) is one of the fastest growing asset classes in pension plans' portfolios. The United States Government Accountability Office (GAO, hereafter) found that large pension plans that invest in hedge funds increased to 51% in 2009 from 11% in 2001. Pension plans had started investing in private equity after 1979 when rules relaxed to allow them to venture away from more traditional investments. As such, pension funds' investment in private equity is more

established than hedge funds. In 2001, 71% of large pension plans invested in private equity. By 2009, 90% of large pension plans invested in them[1].

Alternative investments differ from traditional market assets in a few ways. First, they tend to be fairly illiquid. For private equity, illiquidity is due to limited trading in secondary markets (Anantharaman, 2011). For hedge funds, there are often rules that prevent investors from selling early. Furthermore, hedge funds are designed to hedge against general market losses (Stewart, 2007). To accomplish that, a variety of strategies are used and fund managers may take investment positions that take time to be realised – in those cases, preventing investors from easily selling assets is needed to ensure that the strategies can be realised.

There are a number of possible reasons for why pension funds choose to invest in alternative investments. One reason is to achieve higher rates of returns. Hedge funds advertise their ability to gather "alpha", or returns over the stock market (Stewart, 2007). Achieving high rates of return have become increasingly important as the average age of plan members increase since contributions are declining whereas outflows to retirees are increasing (Munnell, Aubry, & Hurwitz, 2013). Consistently high rates of returns are needed to meet pension plan liabilities. The need for high levels of returns is even more pressing for actuarially underfunded pension plans as they need to achieve higher returns than the estimated return assumed by actuaries (usually 8%) to become funded.

In addition to rates of return, another factor that concerns pension plan managers is the volatility of their investments. Munnell et al. (2013) show that even if the average annual returns

[1] *Defined Benefit Pension Plans: Guidance Needed to Better Inform Plans of the Challenges and Risks of Investing in Hedge Funds and Private Equity Highlights*. (2008). United States Government Accountability Office.

for a pension plan follow expected rates of return, high volatility means that compounded returns can be low. In other words, volatility adjusted returns are low compared to unadjusted returns. In Munnell et al. (2013)'s simulation, pension plans in the 10th percentile by funded status have a funding ratio of less than 40% in 2042. In contrast, the 90th percentile achieve a funding ratio of 100% by 2020. A key pre-occupation of pension plans is therefore to stabilize volatility while achieving high returns and most pension fund managers cite a desire to decrease volatility as one of their reasons for investing in hedge funds[2]. Hedge funds may *theoretically* be less volatile because hedge funds aim for market-neutral outcomes (Lahey, Akhigbe, Newman, & Anenson, 2012; Stewart, 2007). Furthermore, they are supposed to offer diversification benefits (which again lowers volatility). For example, a study examining the returns of the S&P 400 and The HFR1 Fund of Funds (FOF) Composite Index found a correlation of 0.44 and 19% joint variability (Lewis, 2009).

Bali et al. (2013) show that "nine out of eleven hedge fund strategies have higher average return and lower standard deviation" which seems to support the contention that hedge funds can generate higher returns while maintaining low volatility. One potential problem with using pure mean-variance analysis to judge the performance of securities returns is that using the first and third moments to compare superior returns only work when the distribution of returns is normal (Scott & Horvath, 1980). When the returns suffer from non-normality, higher moments such as the skewness and kurtosis of the returns distribution play an important role in defining risk. Generally speaking, investors prefer positive skewness and low kurtosis (Scott & Horvath, 1980). However, the distribution for securities returns is not normally distributed. Returns are

[2] *Defined Benefit Pension Plans: Guidance Needed to Better Inform Plans of the Challenges and Risks of Investing in Hedge Funds and Private Equity Highlights*. (2008). United States Government Accountability Office.

usually negatively-skewed and leptokurtic (have fat-tails). Hedge funds are generally more skewed and leptokurtic than equities due to their trading strategies (Bali et al., 2013). Using first and second stochastic dominance analyses rather than mean-variance, Bali et al. find that hedge fund strategies generally outperforms the S&P and US treasury bills when calculating 4 to 5-year horizons (the results are more mixed for shorter periods).

Bali et al.'s result supports the contention that pension funds are ideal hedge fund investors due to their long investment horizons. Moreover, Fraser-Sampson argues that pension funds' long investment horizon means that illiquidity (an oft-cited downside to alternatives) is not a problem (2008).

The alternative investment decision may differ depending on whether a pension is public or private. Plan sponsors make decisions on pension fund management. The plan sponsors are not the same as the plan beneficiaries in the case of defined-benefit plans (Campbell & Viceira, 2006). This means that plan sponsors may have incentives that are different from plan beneficiaries. For example, politicians may be more concerned with balancing the budget rather than making full contributions despite contractual obligations because they know that pension shortfalls would happen after they are out of office.

One of the major differences between public pension plans and private pension plans is that public pension plans' commitments are backed by taxpayers[3]. As a result, potential risk-shifting is quite different between public and private plans. For public pension plans, downside risk shifts to younger taxpayers. Most economic models assume that older taxpayers are

[3] *Defined Benefit Pension Plans: Guidance Needed to Better Inform Plans of the Challenges and Risks of Investing in Hedge Funds and Private Equity Highlights*. (2008). United States Government Accountability Office.

concerned about the welfare of their younger relatives, so the rational individual may be concerned about risk shifting.

In contrast, if a company goes bankrupt, shareholders are not responsible for their full liabilities. Furthermore, the United States has the Pension Benefit Guaranty Corporation (PBGC, hereafter), which insures corporate defined benefit pension plans (Anantharaman, 2011). The insurance premiums do not fully cover the liabilities – as such, there is a moral hazard problem for corporations to take more extreme risks (Sharpe, 1976; Treynor, 1977). Since shareholders are unlikely to care about the welfare of the PBGC in the same way that older taxpayers may care for the welfare of younger taxpayers, corporate pension plans may have stronger incentives to shift risks.

Another difference is that American public pension plans are governed by different rules than private pension plans. Private pension plans are governed by the Employee Retirement and Income Security Act (ERISA), which sets out numerous rules and tasks pension plan managers to be "prudent investors". One of the differences is the actuarial method by which liabilities are calculated. Public pension plans discount liabilities using assumed rates of return (Novy-Marx & Rauh, 2009). An ongoing issue is that if the assumed investment return is higher than actual market returns, then liabilities seem less than they actually are. Different return assumptions have significant effects on funded ratios. For example, for the California State Teacher's Retirement System (CalSTRS), an investment return assumption of 8% (typical of most public pensions) gives a funded ratio of 71%.[4] However, an assumption of 5% gives a funded ratio of 48%. True funded ratios for public pension plans may therefore be a lot lower than reported figures.

[4] CalSTRS annual report, 2013

Previous studies have examined private defined benefit pension plans investment decisions into alternatives. This paper's contribution is that factors affecting public pension plans' decision to invest in alternative investments are examined. Furthermore, marginal effects and fixed effects analysis are used, which have not been used in previous studies of pension plan investment. First, returns of plans that hold alternative investments are compared with plans that do not hold alternative investments. Second, factors that determine pension plans decision to invest in alternative investments are studied using three different regression techniques. The analysis finds evidence that pension plans' decision to invest in alternative investments is driven by the chase for higher returns rather than to decrease volatility. Finally, the New York State and Local Retirement System's alternative investment strategy is examined as a case study. The returns analysis and the case study show that investing in hedge funds do not seem to meet their promise of increasing returns while decreasing volatility. In contrast, private equity shows some promise.

2. Literature

Antolin (2008) compares the performance of select OECD private pensions from December 2000 to December 2005. A simple graph of returns and volatility show that pensions suffered from low returns and high volatility during the period of study. However, he also notes the problems with comparing returns between countries since countries vary substantially in their reporting conventions. For example, US pensions often report net returns while Latin Americans report gross returns. He also uses Sharpe ratios to measure excess returns over risk. However, he notes that pension plans have a very long-term investment horizon, and performance can only be judged on a long-run basis but most conventional methods for measuring performance are designed for short-term analysis.

Though examining long-run returns empirically is quite difficult, there have been both simulations and empirical studies on the role of alternatives in pension plans. One simulation examines the returns and volatility of life cycle investment funds (Lewis, 2009). For his baseline simulation, Lewis finds that investment funds that have a larger share of equities over bonds have much higher returns in the long-run. He then portions out a fraction of the equities to hold a fund of hedge funds instead. Using bootstrapping and the Monte Carlo method, he finds that returns are significantly higher when the equities include the fund of hedge funds. Volatility is also lower. However, the magnitudes of the differences are not high. For example, replacing equities entirely with funds of hedge funds leads to only 1% excess return. The volatility also drops by 1%. He notes that the differences are slight enough that high management fees may wipe out the difference.

Anantharaman (2011) studies United States' private defined-benefit pension funds' investment into alternative investments. The sample period is from 2003 to 2008. She tests three hypotheses. First, whether institutions invest in alternative investments to shift risk. The theory behind the risk-shifting hypothesis is that corporate pensions are similar to corporate debt and firms are free from their obligations if they become bankrupt. This gives firms perverse incentives to invest in risky investments since they do not have to bear the full cost of the downside risk, and enjoys the full benefit of the upside risk. She finds moderate support for this. Well-funded and severely underfunded pension plans avoid alternatives. However, moderately underfunded plans tend to invest in alternative investments. Furthermore, she finds that firms in less stable positions (i.e. "highly leveraged, lower market-to-book ratios, more volatile earnings") tend to invest in alternatives.

Her second hypothesis is that pension funds choose to invest in alternative investments to take advantage of their long-run investment horizon. She tested this hypothesis by examining

whether plans with younger members are more likely to invest in alternatives. She did not find any evidence to support this. However, it is important to note that she did not have direct data regarding plan members age and used an indirect measure.

Finally, she tested whether there were diversification benefits. She found that pension funds with hedge funds performed better before the 2008 financial crisis, and poorer after the 2008 financial crisis. She concludes that this means that pension managers are seeking high returns with alternative investments rather than diversifying away from risk. An important limitation of Anantharaman's work is that her dataset stopped at 2008, and so her conclusions about lower returns during the financial crisis are limited to one year's worth of data.

Lahey et al. (2012) study the role of real estate and alternative assets in U.S. private defined benefit pension plans. Unlike Anantharaman (2011), they break down their study of alternatives into commodities, hedge funds and private equity. Their sample period is relatively longer, spanning 2002 to 2010. They study the variables that affect pension plans' decision to invest in real estate and alternatives. They also compare the returns of plans that invest in real estate and alternatives with plans that do not invest in those asset types. They find that investing in real estate led to higher returns than alternatives during the period they studied. In turn, investing in alternatives led to higher returns than just investing in equities and bonds. However, the differences in returns are small. One possible reason for the small difference is that the share of investment in real estate and alternatives is relatively small. In their study, the median holding of real estate is 5% and alternatives is 5-6%. A shortcoming of their study is that they used pure indicator variables to measure the effects of alternatives (that is, the presence and absence of alternatives were used as independent variables). This means that it is impossible to measure the effect of holding an additional percentage of alternatives, and it is difficult to infer their economic significance. The small difference in returns between pension funds holding alternatives and

those that do not may be due to the small quantities of alternatives held rather than a small performance differential.

3. Data and Empirical Results

This greater part of this essay examines the alternative investment strategies of the 150 US public pension plans in the Public Plans Database. When studying the returns, special attention is paid to the third and fourth moments in addition to the usual first and second moments to take alternative investments' unique statistical distribution into account. Logistic, ordinary least squares and fixed effects regressions are used to examine how different variables affect pension plans' decision to invest in alternative investments and the amount of alternative investments they hold. Variables that are expected to affect pension plans' investment in alternatives include: pension plan size, actuarial funded ratio, members' average age, and the size of employer contribution relative to employee contribution.

In general, I expect plans that are likelier to invest in alternative investments are also going to allocate more of their investments towards alternatives. The logistic and ordinary least squares regressions are thereby expected to generate coefficients with the same directionality, but not necessarily the same magnitude. The fixed effects regression's results may depart significantly from the logistic and ordinary least squares regression since it controls for intrinsic, non-varying factors within each pension plan. Management conservatism and profusion of local private equity projects (e.g. pension plans in California may have been able to benefit from opportunities in Silicon Valley) are potential intrinsic factors which may affect a pension plan's decisions on alternative investments. Those factors may be correlated with some of the independent variables and consequently bias them in the logistic and ordinary least squares

regressions. The fixed effects regression should remove their influence and showcases the true effect of the independent variables under study.

Pension plan size is expected to have a strong positive effect on alternative investment holdings since larger plans have more resources in absolute terms to research and manage alternative investments. Anantharaman's (2011) results show that well-funded and poorly funded private plans avoid alternative investments – as such, a parabolic relationship is expected between actuarial funding and alternative investments.

Pension plans with younger members should have a longer investment horizon. If pension plans are choosing to invest in alternatives to take advantage of the fact that their long investment horizon makes illiquid investments more feasible, then plans with younger members should be likelier to invest in alternatives than plans with older members.

Employer contributions and employee contributions are added as Lahey et. al (2012) show that they may impact the decision to invest in alternative investments. . One difference from Lahey et. al's study is that rather than using employer and employee contributions as separate variables, this essay combines them so that the employer's relative contribution is examined. This gives more insight into identifying the main contributor into the plan. An employer who contributes more may be in worse financial straits, and thereby more willing to take risks by investing in alternatives. Furthermore, if an employer is the main contributor, they may feel that they are the owners of the fund rather than the trustee – this may encourage less conservative behaviour

3.1. Data

The dataset was downloaded from the Public Plans Database produced by the Center for Retirement Research at Boston College. The database contains information on 150 state and local

pension plans. State plans include teachers' plans, police and firefighters' plans, as well as general plans for state employees. The database is compiled through scans of annual reports and financial summaries. The database has information from 2001 to 2013. Less data is available from 2001 and 2002. The downloaded database has 1950 entries.

There are limitations to the database. First, since the database is compiled through manual scans, human error introduced some errors (discrepancies were observed when comparing annual reports to the database). A second limitation is that each pension plan has their own reporting procedures and asset allocations are classified differently depending on the pension plan. The dataset breaks down assets into "equities", "bonds", "cash", "real estate", "alternatives" and "other". Hedge funds and private equity – the class of assets this paper studies – are generally classified as "alternatives". However, this is not necessarily true. For example, the California Public Employees Retirement System (CalPERS, hereafter) integrates their fund of funds with their equities in their annual reports.[5] The "alternatives" category only contains the pension's private equity investments. A similar issue is that some pension funds may report their holdings as "other" rather than "alternatives", especially in the earlier years of the dataset.

3.2 Descriptive Statistics

Equity is the most popular asset class. It makes up an average (mean) of 52.7% of pension portfolios across time. The median holding across time is 55.9%. In 2001, the median holding was 56.9%. By 2013, the median holding had dropped to 50.6%. The second-most popular asset class is fixed income, making up an average (mean) of 27.8% of pension portfolios across time.

[5] CalPERS. (2011, 2012, 2013). *Comprehensive Annual Financial Report*.

The median holding is 27.1% across time. The median holding in 2011 is 29.1%, which had dropped to 23.0% by 2013.

Table 1: Descriptive Statistics for Public Defined Benefits Pension Plans (2001 – 2013)

All Pension Plans				
Variable	**Mean**	**Median**	**S. D.**	**n**
mktassets_net	1.66×10^7	7605511	2.73×10^7	1908
equities_tot	0.527	0.559	0.145	1950
fixedincome_tot	0.278	0.271	0.105	1950
alternatives	0.0789	0.0521	0.0896	1950
activeage_avg	44.8	45.0	3.11	1057
actfundedratio_gasb	0.826	0.826	0.192	1915
contrib_er_regular	378558.9	191182.5	666228.3	1838
contrib_ee_regular	217777.5	98222.26	389641.7	1901
empoveree	10.82	1.552	101.6763	1820

	Pension Plans with Alternative Investments				**Pension Plans without Alternative Investments**			
Variable	**Mean**	**Median**	**S. D.**	**n**	**Mean**	**Median**	**S. D.**	**n**
mktassets_net	1.87×10^7	8232524	3.06×10^7	1387	1.09×10^7	5558766	1.39×10^7	521
equities_tot	0.535	0.55	0.102	1403	0.505874	0.589	0.218798	547
fixedincome_tot	0.267	0.257	0.0710	1403	0.3056424	0.3025	0.1592825	547
alternatives	0.1097234	.00923	0.0881479	1403	0	0	0	547
activeage_avg	44.81752	45.1	2.985776	827	44.71674	44.85	3.527003	230
actfundedratio_gasb	0.8038995	0.81	0.1747213	1383	0.8818466	0.8775259	0.2209514	532
contrib_er_regular	431397.7	222227.7	748355.5	1336	237936.2	101405.8	328506.1	502
contrib_ee_regular	245943.6	114956	442127.8	1378	143565.3	59327	171279.7	523
empoveree	13.94923	1.610569	118.8295	1329	2.354613	1.400056	3.127712	491

Table 1: This table shows the mean, median, standard deviation and number of observations for *mktassets_net* (market value of the assets in the pension plan, in $000s), *equities_tot* (proportion of total assets invested in equities), *fixedincome_tot* (proportion of total assets invested in fixed income assets), *alternatives* (proportion of total assets invested in alternatives), *activeage_avg* (the average age of active members), *actfundedratio_gasb* (actuarial funded ratio using GASB calculations), *contrib_er_regular* (employer regular contributions, in $000s), *contribe_ee_regular* (employee regular contributions, in $000s), *empoveree* (ratio derived from dividing employer regular contribtions by employee regular contributions). The maximum number of plan-year units is 1950, however, some plans are missing data for some of the variables. For example, *activeage_avg* (the average age of active members) only has 1057 data points. The maximum number of plan-year units for pension plans with alternative investments is 1403. The maximum number of plan-year units for pension plans without alternative investments is 547.

In 2001, 67 out of 150 funds (45%) invested in alternatives. In 2013, 128 out of 150 funds (85%) held alternative investments. Across all funds, the percentage of alternatives grew from 2.9% in 2001 to 6.88% in 2013. However, this mean is skewed by the large number of plans that hold no alternatives at all. Calculating the average using only plans that hold alternatives, the

average holding go from 6.4% in 2001 to 17.1% by 2013. Again, only looking at plans that hold alternatives, the median holding in 2001 is 5% whereas the median holding in 2013 is 15.4%. To summarize, holdings of alternative investments was relatively small at the beginning of our time of study. However, by 2013, alternative investments were a significant component for pension plans that hold them.

Only 57 (56 in 2013) plans have the average age of active members. The plans that report average ages tend to be smaller – the average net market value of assets is 16.8 billion dollars. The average net market value of assets for plans that do not report average ages is 21.6 billion dollars. The mean average age of active plan members is 44.8 years for the whole dataset. The median is 45.02 years old. The mean average age changed slightly from 43.7 in 2001 to 45 in 2013.

Employers generally contribute more than employees. The median ratio of employer contribution to employee contribution is 1.55 – that is, employers generally contribute $1.5 for every $1 an employee contributes. There is a strong right-tail skew to this (skewness is 23.45). . At the 10^{th} percentile, the employer to employee contribution ratio is 0.60. This means that for every dollar an employee contribute, an employer contributes sixty cents. However, at the 90^{th} percentile, the employer to employee contribution is 9.13 – that is, employers contribute nine times the employee contribution.

The mean one-year return for all pension funds is 6.11%. Pension funds with alternatives have higher returns than pension plans without – the averages are 6.092% and 4.974% respectively. The average one-year return is even higher for pension funds with more than 3% invested in alternative investments – their average return is 6.443. Five-year returns are lower – 5.42

Table 2: Descriptive Statistics of One and Five-Year Returns

One-Year Returns					
	Mean Return	**Standard Deviation**	**Skewness**	**Kurtosis**	**n**
All Pension Plans	0.0611	0.118	-0.786	3.07	1904
Pension Plans with Alternative Holdings	0.0639	0.123	-0.867	3.09	1393
Pension Plans with No Alternative Holdings	0.0535	0.101	-0.455	2.73	511

Five-Year Returns					
	Mean Return	**Standard Deviation**	**Skewness**	**Kurtosis**	**n**
All Pension Plans	0.0542	0.0360	0.871	3.29	1806
Pension Plans with Alternative Holdings	0.0534	0.0368	0.945	3.47	1354
Pension Plans with No Alternative Holdings	0.0565	0.0333	0.621	2.52	452

Table 2: This table shows the mean return, standard deviation, skewness and kurtosis for US public pension plans from 2001 – 2013. Mean returns and standard deviations are in decimal format (i.e. not in percentages). The five-year returns are provided in the dataset.

Using standard mean-variance analysis, pension plans with alternative holdings do not outperform pensions without alternative holdings. For one-year returns, pension plans that hold alternatives have higher returns, but they also have higher standard deviation. Pension plans with alternative investments unambiguously performed more poorly when examining the five-year returns since they had lower average returns and higher variance than pension plans that do not hold alternative investments.

The conclusion changes when the third and fourth moments are examined. In both 1-year returns and 5-year returns, both skewness and kurtosis are higher for pension plans that hold alternative investments. This means that pension plans with alternative holdings may generally perform better, but suffer more from downside risks.

3.3 Methodology

My study is motivated by Anantharaman (2011) and Lahey et. al's (2012). Following their methodology, I use logistic regression models to understand the factors behind public pension plan's decision to invest in alternative investments. Due to the differences between governments and corporations, I omitted some variables that they used. For example, market-to-book value of the firm is difficult to transfer over to public balances. Furthermore, Anantharaman used %cash and %equities in her regressions to account for liquidity preferences and risk appetite, respectively. I chose to omit those variables since they gave deceptively high R-squares in initial test regressions. Moreover, including %cash and %equities results in high levels of collinearity.

I ran logistic regressions with robust-cluster errors (Froot, 1989). These errors take heteroskedasticity into account and also allow for limited correlation over time within each pension plan. This is more appropriate than White's (1980) commonly used estimate of variance, which do not take within-cluster (i.e. pension plans in this study) correlations into account and are thereby less appropriate for panel data. One improvement of this study over previous studies is that the logistic results are interpreted using marginal effects rather than simply coefficients from the regressions. Logistic regressions are famously difficult to interpret using coefficients, and marginal effects give a greater understanding of each independent variable's economic impact on pension plans.

The first model is:

Model 1

$$\Pi = \beta_0 + \beta_1(ln\ Pension\ Size) + \beta_2(Funded\ Ratio) + \beta_3(Funded\ Ratio^2) + \beta_4\left(\frac{Employer\ Contribution}{Employee\ Contribution}\right) + \beta_5(Average\ Age) + (Year\ Fixed\ Effects)$$

Π is a dummy variable for alternatives: the variable is set to 1 if there is investment into alternative investments, and 0 if there is no investment into alternatives. *lnPensionSize* is the natural logarithm of the market value of the net pension assets. *Funded Ratio* examines whether underfunding increases the likelihood of investing in alternatives. A quadratic term should be used for funded ratio to reflect the fact that I expect pension funds that are severely underfunded and overfunded to avoid alternatives. *Employer Contribution/Employee Contribution* is supposed to measure how much the employer contributes to the plan relative to the employee.

Average Age is the average age of active members. Note that this is different from the *Horizon* measure that Anantharaman uses - she uses $\frac{Service\ Cost}{Service\ Cost+Interest\ Cost}$, where service cost is the additional liability due to pension members' extra year of service and interest cost is the additional liability due to pension members' being one year closer to their payouts. Since service cost and interest cost are not in the dataset I am using, it was not possible to the replicate Anantharaman's *Horizon* measure. Average Age was used instead – however, since only one-third of the plans report average age of active members, using average age resulted in dropping many observations. If there are non-random variables affecting the likelihood of pension plans to report active age, the results may be biased.

I attempted to generate a *Maturity Measure* similar to Anantharaman's calculated horizon. The *Maturity Measure* is derived from the natural logarithm of $\frac{Retirement\ Benefits\ Being\ Paid\ Out}{Employee\ Contributions}$, which is taken from Ratanabanchuen's thesis (2013). The assumption is that plans with older members would have higher benefits being paid out relative to contributions coming in. One potential problem with the maturity measure is that earnings

generally increase with age. A pension plan where the bulk of their members are in their 50s and early 60s may have very high contributions since employees are at the height of their earning potential. If the number of active members in their 50s and early 60s are much higher than retirees, the maturity measure may have a low value despite the fact that plan members are going to retire imminently. To test the validity of the *Maturity Measure,* I tested the correlation between *Average Age* and the *Maturity Measure*. The correlation is 0.1738 using Pearson's correlation and -0.0038 using Spearman's correlation. Considering the low correlation, I did not use the *Maturity Measure* in the regressions.

The next model is identical to Model 1 except for two differences. First, the dependent variable is the percentage of alternative holdings. Second, the funded ratio is centered (that is, each value is subtracted by the mean funded ratio). Centering was done because it is difficult to interpret quadratic terms otherwise. This was not necessary for the logistic regressions in Model 1 since marginal effects rather than coefficients were used for interpretation, which is standard for discontinuous dependent variables. Model 2 was analysed with pooled ordinary least squares.

Model 2

$$\begin{aligned}\%\ \text{of Alternatives} \\ &= \beta_0 + \beta_1(ln\ Pension\ Size) + \beta_2(Funded\ Ratio) \\ &+ \beta_3(Funded\ Ratio^2) + \beta_4\left(\frac{Employer\ Contribution}{Employee\ Contribution}\right) \\ &+ \beta_5(Average\ Age) + (Year\ Fixed\ Effects)\end{aligned}$$

Finally, I ran fixed-effects regression for Model 3. This is identical to Model 2, but the dummy variables for the years were removed since the panel data already take the time dimension into account. A key difference between this paper and Anantharaman (2011) and Lahey et. al's (2012) is that a fixed effects model is used. This allows for variables that are stable and intrinsic to an individual pension plan to be controlled for. For example, a pension plan may be managed by a conservative management group that is opposed to alternative investments in general. Fixed effects regressions allow for those intrinsic effects to be removed and the focus remain on the independent variables of interest. The Hausman (1978) test is used to verify that a fixed effects model is a better fit than a random effects model for this dataset.

Model 3

$$\% \text{ of Alternatives} = \beta_0 + \beta_1(ln\ Pension\ Size) + \beta_2(Funded\ Ratio) + \beta_3(Funded\ Ratio^2) + \beta_4\left(\frac{Employer\ Contribution}{Employee\ Contribution}\right) + \beta_5(Average\ Age)$$

3.4 Empirical Results

Model 1

Table 7 in the Appendix shows the coefficients and p-values for the pooled logistic regression of Model 1. Recall that for logistic regressions, coefficients are often difficult to interpret and should not be interpreted in the standard manner. Rather, marginal effects should be used. Average marginal effects were calculated and are displayed in the following charts.

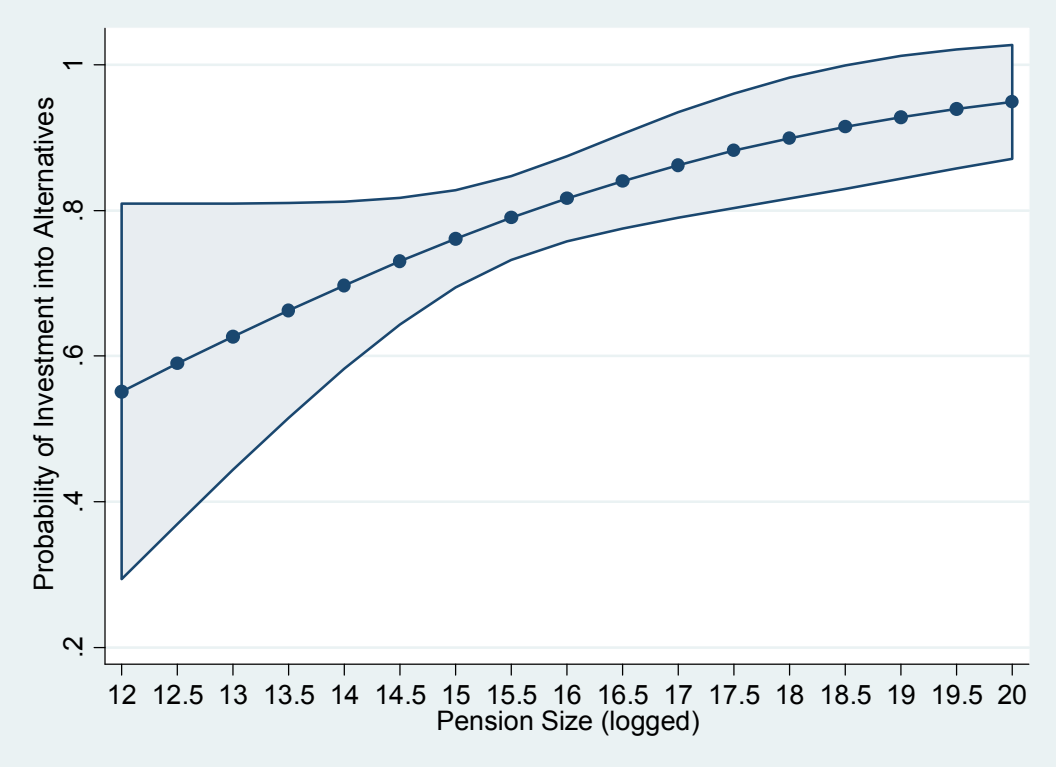

Figure 1: Marginal Effects of Pension Size on the Probability of Investment into Alternatives. Shaded region indicates the 95% Confidence Interval. Pension size is logged by the natural logarithm. n = 988.

As expected, pension size positively affects the probability of pension plans investing in alternatives. The variance is quite stable and narrow for larger pensions (pensions above the 50the percentile in size). However, variance increases quickly as pensions become smaller. The magnitude of the effects is economically relevant. The largest 10% of pensions have almost 90% chance of investing in alternative investments. In contrast, the smallest 10% of pensions have less than 60% chance of investing in alternative investments.

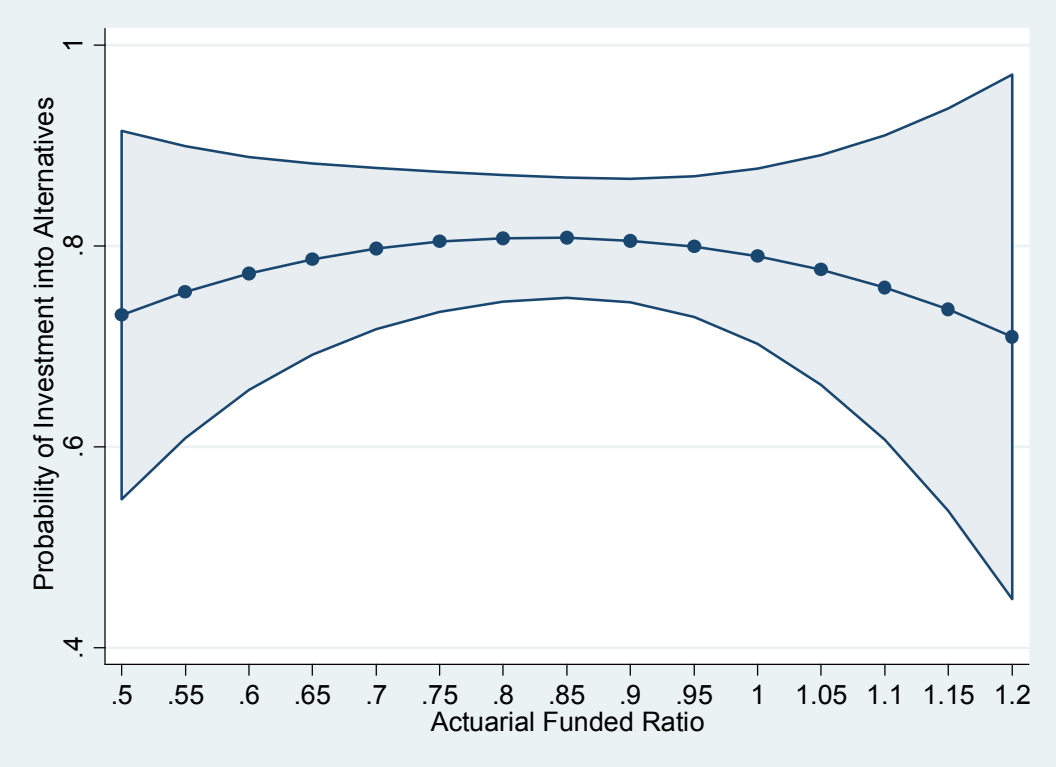

Figure 2: Marginal Effects of Actuarial Funded Ratio on the Probability of Investment into Alternatives. Shaded region indicates the 95% Confidence Interval. Graph shows approximately 90% of the observations. n = 988.

Figure 2 shows the predictive margins for actuarial funded ratio. The pattern is quite clear – the most well-funded and most poorly-funded pension plans are the least likely to invest in alternatives. The shape is an almost perfect inverse parabola. That said, the differences are relatively small. For example, when a pension plan is 50% funded, its likelihood of investing in alternative investments is 0.73. When the pension plan is 85% funded, its likelihood of investing in alternative investments peaks at 0.80. The likelihood of investing in alternative investments then falls, and at an actuarial funded ratio of 1.2, the likelihood of investing into alternative investments is 0.71. The confidence interval for low and high funded ratios is much wider due to the relatively small number of observations at those values.

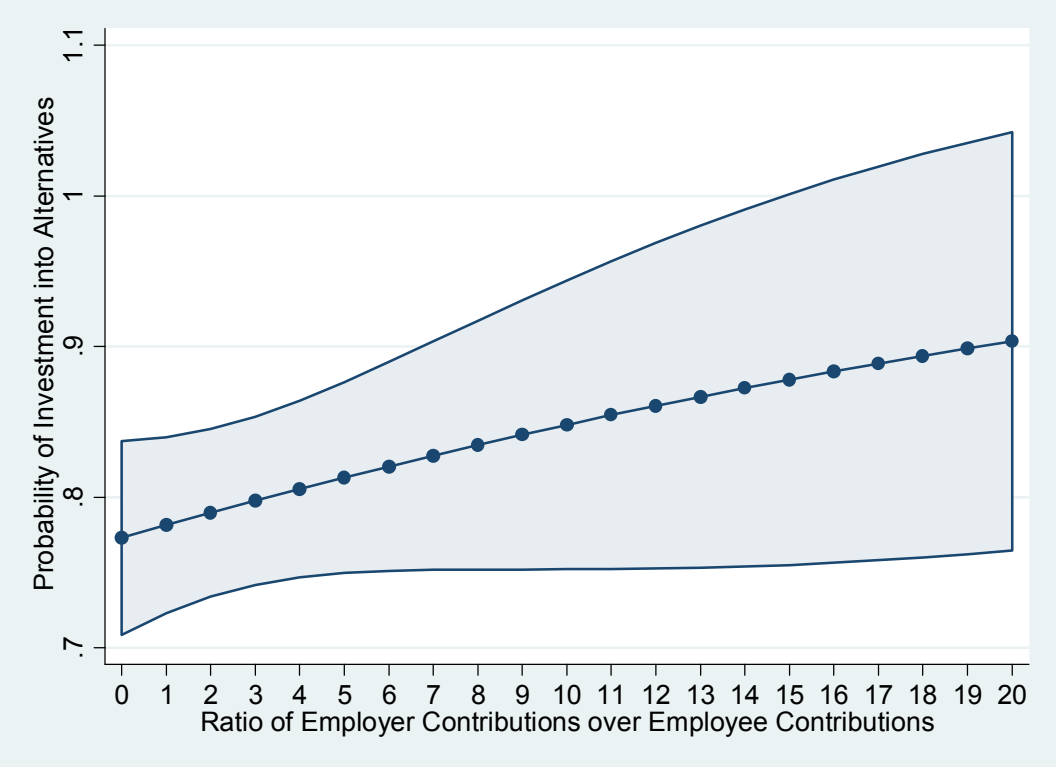

Figure 3: Marginal Effects of Employer Contributions Over Employee Contributions on the Probability of Investment into Alternatives. Shaded region indicates the 95% confidence interval. n = 988. Only 10% of the observations have their ratio of employer contributions over employee contributions over 9.

Higher employer contributions (relative to employee contributions) increases the probability of a pension plan deciding to invest in alternatives. The coefficient in the aggregate is 0.62 with a high standard error. However, the marginal effects give a clearer picture of the effects of higher employer contributions. When the employer to employee contribution is 1 (that is, they contribute equal amounts), the probability of investment into alternatives is 0.78. However, if the employer is contributing 9 times more than employees (recall that this is roughly the top 10% of our sample), then the probability of investing in alternatives is 0.85. Significance levels for all marginal effects are very low (ie. <0.001 level). Marginal effects for the range of employer over employee contributions values can be seen in Figure 3. In other words, employers who are contributing more are also more likely to invest in alternatives.

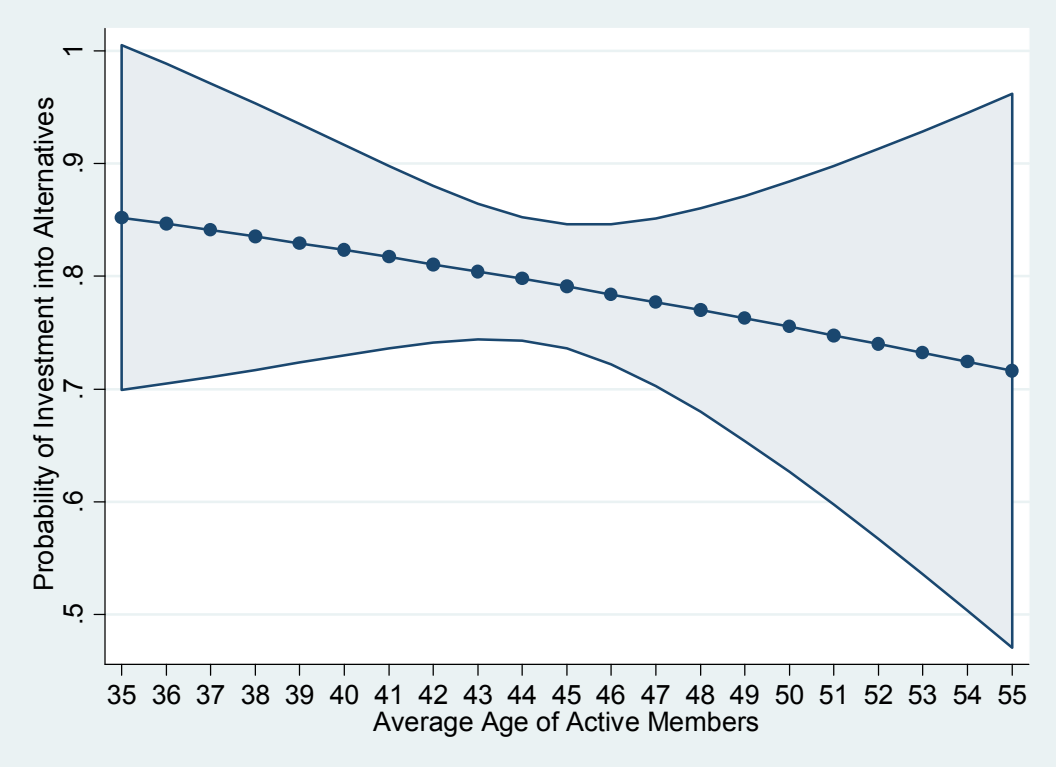

Figure 4: Marginal Effects of Changing Average Age on the Probability of Investment into Alternatives. Shaded region indicates the 95% confidence interval. n = 988.

Average age of active members has a negative effect on the probability of pensions to invest in alternatives. Plans where active members' average age is 35 have 0.85 probability of investing in alternatives whereas plans with active members whose average age is 55 have 0.72 probability of investing in alternatives. The confidence interval is very wide in the mid to late-fifties, a result of the fact that very few plans have active members whose average age is that high.

Model 2

While the Ordinary Least Squares Regressions resulted in coefficients that matched the directions of Model 1, all of the results were statistically insignificant at the 15% level. The complete results are presented in Table 2. The adjusted R-squared is 0.25, which indicates that the independent variables explain about 25% of the variation in percentage of alternative holdings.

Table 3: Predictors of Pension Plan's Decision to Invest in Additional Holdings of Alternative Investments – Ordinary Least Squares

Variable	Coefficient (Standard Error)	T-Value	Significance Level
Pension Size	0.58811 (0.51502)	1.14	0.256
Centered Actuarial Funded Ratio	-1.18235 (3.78603)	-0.31	0.755
Squared Centered Actuarial Funded Ratio	-4.46075 (9.4575)	-0.47	0.638
Employer Contributions Over Employee Contributions	0.01717 (0.01294)	1.33	0.187
Average Age	-0.17072 (0.18724)	-0.91	0.364
Constant	14.29814 (12.76853)	1.12	0.265
Number of Observations	988		
Number of Pension Plans	108		
Adjusted R-Squared	0.2515		

Table 3: The results of the ordinary least squares estimation. Coefficients denote the effect of increasing one unit of the independent variable on the percentage holdings in alternative investments. Coefficients of dummy year variables not shown.

Pension size has a coefficient of 0.59. As the 10^{th} percentile of logged pension holdings is 14.17 and the 90^{th} percentile is 17.49, this means that the largest 10% of pension plans holds approximately 2% more alternative holdings than the smallest 10% of pension plans, ceteris parabis. The coefficient is significant at the 25% level, which should be considered statistically insignificant.

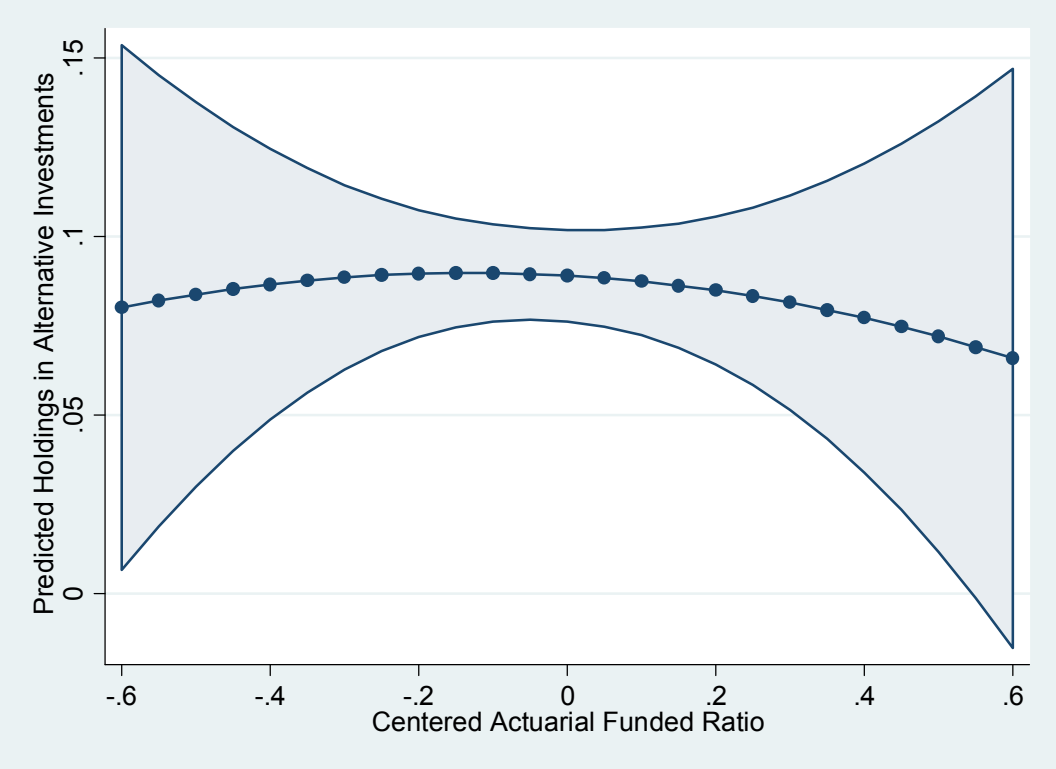

Figure 5: Marginal Effects of Centered Actuarial Funded Ratio on Alternative Holdings from Ordinary Least Squares regression. Alternative holdings is in decimal form rather than percentages. Margins calculated holding all other independent variables at their mean value. Shaded region indicates the 95% confidence interval. n = 988.

As Figure 5 shows, holdings of alternative investments are predicted to be highest for moderately funded pension plans – at both the very well-funded and very poorly funded extremes, holdings of alternative investments decrease. However, the magnitude of the difference is slight. Furthermore, there is considerable variability at either extremes, shown by the wide confidence intervals.

The coefficient before the ratio of employer contributions over employee contributions is 0.017 with a significance level of 18.7%. Like the coefficient for pension size, the low magnitude of this coefficient means that it is economically irrelevant.

The coefficient before average age of active members is -0.17, implying that plans with older members are less likely to invest in alternative investments. The significance level is 0.364, generally considered statistically insignificant.

Model 3

Model 3 uses a fixed effects regression model to control for static intrinsic differences between plans and is a regression method that has not been used in any of the previous literature reviewed. The method is supported by the Hausman (1978) test, which shows that the difference in coefficients are systematic and that a random effects model would not be appropriate (the null hypothesis was rejected at a less than 0.01% level).

Table 4: Predictors of Pension Plan's Decision to Invest in Additional Holdings of Alternative Investments Controlling for Fixed Effects

Variable	Coefficient	T-Value	Significance Level
Pension Size	5.90829 (1.1523)	5.13	<0.001
Actuarial Funded Ratio	-33.11377 (2.23348)	-14.83	<0.001
Squared Actuarial Funded Ratio	38.52992 (7.65892)	5.03	<0.001
Employer Contributions Over Employee Contributions	-0.00201 (0.01416)	-0.14	0.887
Average Age	0.568 (0.15343)	3.70	<0.001
Constant	-111.3864 (18.63241)	-5.98	<0.001
Number of Observations	988		
Number of Pension Plans	108		
Adjusted R-Squared	0.5925		

Table 4: Results of fixed effects regression examining determinants of pension plans holdings in alternative investments.

The results of Model 3 are displayed in Table 3. For the fixed effects regression, pension size has a positive effect on alternatives investments with a coefficient of 6. This means that a pension plan with holdings at the 90th percentile would have an additional 20% of their holdings

in alternative investments than pension plans whose size is at the 10th percentile (again, this uses the 10th percentile value of 14.17 for logged pension size and the 90th percentile value of 17.49). The coefficient is significant at the 0.1% level.

Combining the two coefficients in front of actuarial funded ratio results in a parabola that opens upwards. However, the vertex of the parabola is a little higher than 0.4, which is near the upper bound of the centered actuarial funded values. In other words, the relationship from the regression indicates that actuarial funded ratio has a negative effect, though this effect diminishes as the funded ratios increase. Figure 6 demonstrates the relationship, holding all other independent variables at their mean values.

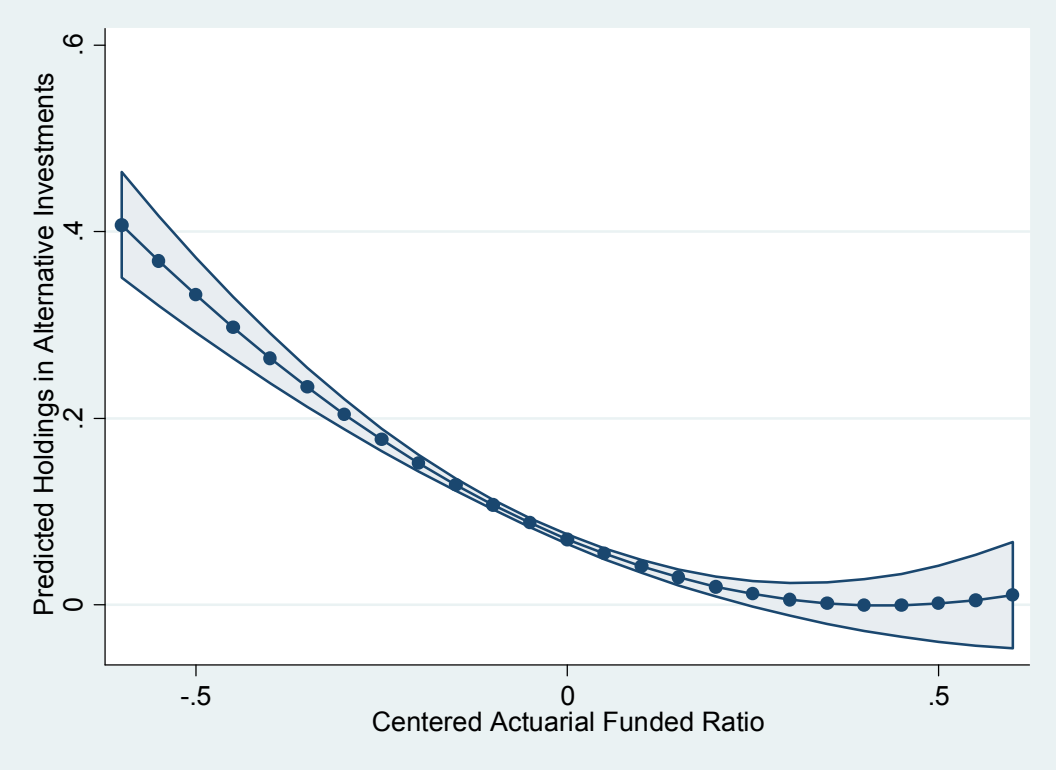

Figure 6: Marginal Effects of Centered Actuarial Funded Ratio on Alternative Holdings from Fixed Effects regression. Margins calculated holding all other independent variables at their mean value. Shaded region indicates the 95% confidence interval. n = 988.

The ratio of employer contributions over employee contributions is slightly negative with a magnitude of 0.002. Considering the small magnitude and the fact that the interquartile range of values for the ratio of employer contributions over employee contributions is quite small, the effects of employers contributing more than employees is negligible. Furthermore, the standard error is quite high, rendering the coefficient insignificant at even the 85% level. This suggests that employer contributions over employee contributions has no effect on the percentage of alternative holdings.

Average age also has a significant (at less than 0.1% level) positive effect on alternatives investment. This is unexpected since I predicted that pension plans with older members would be less likely to invest in alternative investments. The magnitude is 0.568. This means that as the average age of active plan members increase by 1, the pension plans increase their alternative holdings by .57%. This is economically significant since plans with active members who are ten years older would hold approximately 6% more of their holdings in alternative investments.

3.4 Discussion

Of the three models, Model 3 seems to perform the best as it has the highest R-Squared (0.59) and low significance levels for all variables except employer over employee contributions. This suggests that there are a number of fixed effects in play, and that those fixed effects may have masked the effects of the independent variables.

Model 1 is the model that follows Anantharaman's most closely. As noted before, it is not very meaningful to use coefficients by themselves to interpret results from logistic regressions. However, Antharaman did not conduct marginal effects analysis, and so a quick survey of the coefficients may be useful for comparison purposes. Comparing the results to Anatharaman's, a few items stand out. First of all, the coefficient in front of pension plan size is greater in

Anantharaman's study than in this one – 0.602 versus 0.396, respectively. However, the private pension plans studied by Anantharaman are much smaller than the public pension plans studied in this study. For example, the mean (median) logged size of their pension plans is 6.947 (7.020) whereas it is 15.838 (15.844) for public pensions. Since there is a diminishing effect which signifies that differences in pension plan size has a greater effect on the probability of investing in alternative investments for smaller pension plans, I believe that Anthntharaman's study and this study's results are broadly congruent.

Pension size also has a positive effect on the amount of alternative holdings a plan holds according to the ordinary least squares (Model 2) and fixed effects (Model 3) regressions. According to Model 2, pension plans in the top tenth percentile (by size) only hold 2% more alternatives than the bottom tenth percentile. This is very different from Model 3's result, which predicts that that pension plans in the top tenth percentile would hold 20% more alternative investments than pension plans in the bottom tenth percentile. This implies that there is an omitted variable correlated with pension plan size that is "fixed" that has a negative effect on a pension plan's alternative investment holdings. One possible omitted variable is the availability of assets that pension plans can invest in. There are a limited number of hedge funds and private equity projects available at any one time. Pension plans that want to increase their holdings may have difficulty finding enough investment vehicles available to hold the amount they want to invest. This can be relatively "fixed". That is, a pension plan may spend a number of years looking for the right project to invest in – for example, there are a limited number of big venture projects that are available, and it may take years for the plan to find a project that they feel is worth investing in. However, once they find the right project that can absorb the money they want to allocate into it, those funds can stay invested for a relatively long period of time. Difficulty finding investment vehicles may affect larger pension plans more since they have relatively more money

to invest. Whereas a small pension plan can invest in a few small/medium size projects/funds and meet their allocation target (as a percentage of holdings invested in alternative investments), large pension plans will have to invest in many more projects/funds to meet the same allocation target. For example, the NYSLRS had aimed to hold 4% of their holdings in hedge funds since 2008, but had trouble finding enough available hedge fund opportunities to invest in to meet their allocation target from 2009 to 2013.[6] A potential way to control for this in a future study is to include market availability of private equity projects/hedge funds.

The shape of the relationship between actuarial funded ratio and holdings in affirmative assets is different between Model 2 and Model 3. The results of Model 2 implies that better funded and poorly funded plans are more conservative with their investments.

In contrast, the result from Model 3 suggests that, ceteris parabis, poorly funded plans will invest in more alternative holdings. Furthermore, when the centered actuarial funded ratio is 0.25, the predicted holdings in alternative investments drop to zero. This means that supremely well-funded pension plans are not willing to invest in alternative investments. If pension plans are investing to hedge and diversify, the funding ratios should not affect the amount of investment in alternative holdings. However, the negative relationship suggests that pension plans are only willing to invest in alternative investments when their funding ratios are below a certain level. This only makes sense if pension funds see alternative investments as high-risk, high-return investments. Pension funds are obliged to meet their commitments to retirees – funded pension funds are on schedule to meet their commitments, so plan managers should be less concerned by low returns and more focused with protecting the principal. For well-funded

[6] NYSLRS. (2007 - 2013). *Comprehensive Annual Financial Report*.

pension plans to avoid alternative investments, the plan managers must believe that they pose risks to the principal. In contrast, poorly-funded pension plans need higher returns than average (actuaries usually assume 8% returns) to meet their pension obligations. Since poorly funded plans are investing in alternative investments, they must believe that alternative investments can potentially give greater returns than 8%. Together, this implies that pension managers believe that alternative investments are risky investments with potentially high returns. This is consistent with the statistical analysis conducted on the five-year returns which shows that funds that hold alternatives suffer from more downside risk than funds that do not hold alternatives.

One implication from this result is that moral hazard may be at play. It can be plausibly theorized that there may be considerable financial and/or political rewards for pension plan managers and politicians if they bring underfunded pensions to funded status. In contrast, severely underfunded pension plans would already require politically unpalatable taxpayer funded bailouts. Becoming more underfunded or mildly less underfunded may generate limited rewards/punishments. The asymmetric rewards and the fact that fund managers do not have to pay for the losses mean that fund managers may take risks that they would not if they have to bear the full losses. This would explain the strong negative relationship between funding status and alternative investment holdings.

A variable that would be useful to add to the model which may give more insight into the role of funding is public debt. The low funding ratio in pension plans is not only due to poor investment returns from the 2008 – 2009 financial crisis, but mainly due to chronic underfunding by plan sponsors (state and local governments) (Munnell et al., 2013). Furthermore, Mohan and Zhang found that state fiscal constraints led to more risk-taking behaviour (2011). State debt, or state budget flows is likely to give further insight into the incentives that are motivating plan

sponsors. This can serve as a proxy for the "profitability" independent variable in Anantharaman's models.

Using the simple coefficients for analysis, most of Anantharaman's results other than plan size and funding have significant levels above the 10% level. This is one of the major contributions of this study – though the coefficients for the overall regression have high significance levels, using marginal effects analysis allowed me to pinpoint coefficients at various values of average age, funded ratios and employer over employee contributions at less than .01% statistical significance levels.

Plans with younger members are more likely to invest in alternative investments than plans with older plan members. This is expected as alternative investments are often illiquid and both hedging and private equity strategies take time to come to fruition. Plans with the longest investment horizons (ie. youngest members) should theoretically benefit the most from investing in alternative investments.

Comparing Models 1, 2 and 3, there are some contradictions. For example, whereas average age has a negative effect on the decision to invest in alternatives (Model 1) and the percentage of alternative holdings in Model 2, there is a slight positive effect in Model 3. Note that average age of active members within a plan does not generally change a lot. For example, the average age of active members of the California Teachers pension plan changes from 44.3 to 45.6 in 12 years. The low levels of variation in average age inside a plan means that fixed effects regressions may perform poorly at estimating the effects of average age on investment allocations.

Another possible confounding effect is that the American population is aging in general – average age of pension plans may be increasing. At the same time, the popularity of investing in alternative investments with the increase in hedge funds has also increased. Since "popularity"

is not one of the variables in our regressions, its effect is going to be inside the error term. Average age can theoretically be correlated with the "popularity", which may lead to the coefficient before average age to be biased.

Lahey et. al. found that when employers contribute relatively more than employees in private defined benefits pension plans, the plans tend to be less likely to invest in alternative investments. In contrast to Lahey et. al.'s findings, the logistic regression from Model 1 shows that there is actually a small positive effect from employers contributing more. However, the effect is economically negligible, and the standard error is very high. Moreover, Models 2 and 3 show that employer contributions over employee contributions have very small coefficients. The direction for Model 2 also opposes the direction for Model 3. Along with the high standard error, this suggests that the impact of employer versus employee contributions is nil for public pension plans.

One possible reason for the difference between public and private pension plans may be due to the endowment effect oft-cited in behavioural economics (Kahneman, Knetsch, & Thaler, 1990). The endowment effect is a common behaviour where individuals ascribe more value to items that they have owned, even temporarily than to the same items that they have no owned before. A private firms' contributions to an employee's pension plans come from their profits. Those funds could have been used as dividends if they are not used as the employer's portion of pension contributions. Private firms may thus feel ownership over those funds, and consequently value their contributions to employees' pension plans more strongly than they value employee's contributions. In turn, this may cause them to be more conservative with their investments when a greater portion of the pension's assets come from employer contribution. In contrast, the money from public pension plan's employer contributions comes from taxpayers. The nature of public ownership means that the endowment effect may not come into play. As such, managers

may not feel any additional emotional attachment to employer contributions over employee contributions.

One of the major difficulties of trying to draw conclusions between plans' investment decisions into alternatives and their performance is that their alternatives holdings are generally quite small. Furthermore, as noted before, the categorization of alternatives differs between plans. To truly look at alternatives' effect on pension plans, one should examine the returns on the alternatives allocation in pension plans, and compare them to the returns on other assets the pensions are holding. This data does not exist in the aggregate. However, some pension plans' annual reports give detailed information on their alternatives' returns. I chose one of those pensions to examine the effect of alternatives more closely.

4. Case Study: New York State and Local Retirement System (NYSLRS)

4.1 Background

I chose the NYSLRS for further examination because they are a large retirement system (second largest plan in our dataset in 2013), and they have thorough annual reports that clearly delineate their private equity and hedge fund returns and expenses from 2004 to 2013. It should be noted from the onset that since the number of years of data is very low, the statistics presented are meant to give a flavour of one pension fund's experience with alternative investments and are not meant to be broadly applicable.

In 2004, most of the NYSLRS's investments were in equity (62.8%) and fixed income (27.8%). The only alternatives they held were private equity investments, which was 5.6% of assets. By 2013, the pension held much more diverse asset classes. Though alternatives was still

comparatively small, the fund now held 8.6% in private equity, 3.2% in absolute return strategies (their term for hedge funds; ARS, hereafter), and 0.2% in opportunistic funds. Real estate also increased from 0.8% of assets in 2003 to 6.8% of assets in 2014. Equities made up 53% of the portfolio in 2013, with all the decrease happening in domestic equities. Fixed income had also decreased to 20.6%. Furthermore, the pension's policy allocation for alternatives is was 18% (10% for private equity, 4% for absolute return and 4% for opportunistic funds). The trend of increasing investments into alternatives can be clearly observed in the NYSLRS behaviour.

The pension fund's objectives for investing in private equity and absolute return strategy funds are slightly different. They are seeking positive returns in both cases. The private equity is "designed to provide returns that exceed those of public equities…accompanied by increased risk and illiquidity."[7] In contrast, the pension fund's motivation for investing in absolute return strategy investments is to "achieve consistent positive risk-adjusted returns with low correlation to equity and fixed income markets". Below, I will examine whether the fund was able to achieve its stated objectives with its private equity and ARS investments.

4.2 Methods

I examined the 2005 to 2014 comprehensive annual financial reports from the NYSLRS to compile time series data on annual returns of different assets, management and investment expenses for those assets as well as portfolio allocation. Reporting changed through the years – for example, opportunistic funds was part of private equity and absolute return strategy initially. However, they were categorized separately in 2012 and 2013. To maintain continuity for analysis,

[7] NYSLRS. (2007). *Comprehensive Annual Financial Report*.

I integrated the opportunistic funds and absolute return strategy figures together for 2012 and 2013.

The correlations between the returns of equities, fixed income assets, private equity and hedge funds/ARS were calculated to examine whether they were acting effective hedges. Moreover, one-year lagged returns for private equity were compared with equity returns to control for the fact that illiquidity of private equity investments means that private equity prices often lag the markets.

The second objective of investing in alternatives is to achieve higher returns. I created five-year moving-averages to compare the returns between equities, private equity and ARS. The 5-year moving averages were calculated following Bali (2013). Returns are net of fees. Since investments for ARS began in 2007, there are no moving average comparisons for ARS before that.

4.3 Results

Correlation between different assets are displayed in Table 5. Though correlation between ARS and fixed incomes returns is very low, the correlation between the ARS and equity investments is very high (correlation of 0.9304). This is surprising since one of the stated goals of the NYSLRS's investment into hedge funds is to find assets that have low correlation with equities. In contrast, the correlation between private equity and traditional investments is quite low. The lagged private equity returns are negatively correlated with the returns for all other assets.

Examining the 5-year rolling returns, private equity outperforms equities in mean returns and has lower volatility. The magnitudes are significant – the mean of the 5-year moving average return is almost 5% higher for private equity than for equity. Considering the fact that equities' mean 5-year moving average return is 7.37%, the return difference is substantial. Volatility was

also considerably smaller – average 5-year moving standard deviation is 17.38% for private equity, but an incredible 33.68% for equities. Private equity has slightly lower skew and higher kurtosis, which means that it's a poorer performer than equities in the third and fourth moments. However, considering the magnitude of the superior performances in the first and second moments, the slight underperformance in the third and fourth moments seem negligible.

Table 5: Correlations of Returns Between Asset Classes

	Return on Equity	**Return on Fixed Income**	**Return on Private Equity**	**Return on Private Equity (Lagged 1 Year)**	**Return on ARS**
Return on Equity	1.0000	0.4024	0.6014	-0.7853	0.9304
Return on Fixed Income		1.0000	0.5372	-0.2220	0.3130
Return on Private Equity			1.0000	-0.0730	0.8008
Return on Private Equity (Lagged 1 Year)				1.0000	-0.5599
Return on ARS					1.0000

Table 5: Correlation between returns of different asset classes using 2004 to 2013 data. Note that lagged private equity only has 9 data points. Returns are net of expenses.

ARS, on the other hand, has ambivalent results – it has lower volatility, but also consistently lower returns than equity and private equity. It has higher skew than private equity, but lower skew than equities. The results for kurtosis are the opposite – it has lower kurtosis than private equity, but higher kurtosis than equities. Table 6 contains the complete results.

Table 6: Summary Statistics of 5-Year Moving-Averages of Returns of Different Asset Classes

	Equities				Private Equity				ARS			
Years	**Mean**	**Volatility**	**Skew**	**Kurtosis**	**Mean**	**Volatility**	**Skew**	**Kurtosis**	**Mean**	**Volatility**	**Skew**	**Kurtosis**
2004-2008	15.40	17.40	0.68	2.50	24.49	3.06	0.62	2.34				
2005-2009	-1.20	23.16	-1.09	2.65	15.83	21.40	-1.45	3.19				
2006-2010	7.74	33.95	-0.12	2.24	13.24	20.85	-1.17	2.76				
2007-2011	7.53	33.88	-0.10	2.25	11.17	19.32	-1.26	2.91	2.72	13.00	-1.00	2.65
2008-2012	5.64	33.78	0.09	2.28	8.29	18.21	-1.04	2.70	0.31	12.50	-0.54	2.34
2009-2013	9.13	33.39	-0.25	2.42	5.67	16.05	-1.28	3.00	1.52	12.97	-0.74	2.30
Mean (all periods)	7.37	29.26	-0.13	2.39	13.12	16.48	-0.93	2.82				
Mean (post- 2006)	7.43	33.68	-0.09	2.32	8.38	17.86	-1.19	2.87	1.52	12.83	-0.76	2.43

Table 6: Summary statistics of 5-year moving-averages and corresponding volatility (standard deviation), skew and kurtosis of returns for equities, private equity and ARS (hedge funds) of NYSLRS. Returns are in percentage. Mean indicates average annual return over 5-year period. Mean (all periods) indicates mean of all 5-year moving averages. Since ARS wasn't adopted until 2006, returns data is not available prior to 2007.

4.4 Discussion

The correlation analysis shows that ARS investments are failing to act as effective hedges. Interestingly, private equity's fairly low correlation with equity means that private equity is acting as a hedge even though that is not necessarily why pension funds invest in them.

Private equity also fulfilled its investment purpose on the returns front. It delivered returns superior to both equities and hedge funds. Though its third and fourth moments performed more poorly than equities and hedge funds, the differences are small. In contrast, its superiority in the first and second moments are substantial.

It should be noted that the plan restructured its absolute return program in 2009 and eliminated "funds of funds". Furthermore, the plan started investing in hedge funds right before the 2008 – 2009 financial crisis. This means that the plan was fairly inexperienced in hedge fund investing right before the financial crisis. During the financial crisis, many hedge funds – regardless of quality – suffered from liquidity traps (partially due to pension funds such as the NYSLRS cashing out large quantities of shares), which led to many hedge fund bankruptcies. Due to the youth of hedge fund investment, all three moving averages calculated include the crises years. This may be an explanation for hedge funds' poor performance on the returns front. Despite the caveats above, there is no doubt that the hedge funds failed to be uncorrelated with the equity holdings of NYSLRS.

Another point to keep in mind is that the NYSLRS is a very large pension plan. One of the reasons pensions are deemed good candidates for hedge fund investing is because they are supposed to have the resources and expertise to pick the winners. However, that is not the case

in this instance, which implies that picking “winners” and “losers” is very difficult even with vast resources available.

5. Conclusion

U.S. public pension plans that hold alternative investments are rewarded by higher one-year returns, but also higher volatility. The results are less positive for five-year returns where pension plans that hold alternative investments had lower returns and higher volatility at the same time. This suggests that alternative investments’ contribution to a portfolio is ambiguous.

One of the major factors determining whether a pension plan decides to invest in alternatives is its size and its funded ratio. Larger plans are more likely to invest in alternative investments, and invest relatively more of their assets in them. Less well-funded plans tend to make more investments into alternatives. This suggests that plans are investing to seek higher returns. Considering their ambiguous performance though, this may expose pension plans to more volatility and downside risk without increasing their chances of higher returns. This may be dangerous considering the number of imminent retirees from the Boomer Generation in the United States.

One of the difficulties generalizing about alternative investments is that they vary considerably. Hedge funds have very different characteristics from private equity. To examine the differences more closely, the NYSLRS case study was conducted. Though the small number of observations mean that the results from the case study cannot be generalised, it poses interesting results that deserve further study. In the NYSLRS case, private equities were better at hedging equities’ downside risk than hedge funds were. In conjunction with their better returns and lower expenses, they may be superior investments than hedge funds. The dominance is not strict as private equities also had higher volatility, lower skew and higher kurtosis.

The case study serves as an example of the work that can be done to examine different assets' performance in pension plans. To truly determine the effects of alternatives on pension funds will require compiling the returns of hedge funds and private equities to compare them with the performance of other assets that pension funds can hold. That should be the focus of future work.

Pension plans hold a large portion of developed nations' wealth. Their financial health will directly affect the livelihoods of pensioner as well as public budgets. Optimizing their returns is of crucial importance. If alternatives can live up to their promises, they may help American pension plans recover financially. However, if alternatives increase volatility or act as a drag on growth, they can exacerbate the situation. It is therefore important to understand the consequences of investing in alternatives as pension plans continue to increase their investments in them.

6. References

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7. Appendix

Table 7: Logistic Model of Pension Plans Decision to Invest in Alternative Investments

	Coefficients (Standard Error)	**Z-Value**	**Significance Level**
Pension Size	0.3958764 (0.1834488)	2.16	0.031
Actuarial Funded Ratio	8.351718 (7.077894)	1.18	0.238
Squared Actuarial Funded Ratio	-5.026925 (4.294167)	-1.17	0.242
Employer Contributions Over Employee Contributions	0.059575 (0.0495331)	1.20	0.229
Average Age	-0.0512174 (0.0746424)	-0.69	0.493
Constant	-4.06189 (4.766776)	-0.85	0.394
Number of Observations	988		
Pseudo R-Squared	0.1823		

Table 7: The table shows the coefficients for Model 1. For logistic regressions, the marginal effects are usually more meaningful. Note that the pseudo R-square is not identical to R-squares from OLS regressions. The pseudo R-square can be used to compare between different models with the same dataset, but cannot be used to compare between models using different datasets.