The Return Expectations of Institutional Investors[*]

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Abstract

Institutional investors rely on past performance in setting future return expectations. Drawing on newly required disclosures for U.S. public pension funds, a group that manages approximately $4 trillion of assets, we find that variation in past returns adds substantial explanatory power for real portfolio expected returns, above and beyond asset allocation weights. We test for evidence of a rational skill hypothesis, in which pension funds with better investing skills correctly assume superior future performance, but our findings are more consistent with extrapolation that is not justified by persistence. Pension fund past performance affects real return assumptions across all risky asset classes, including in public equity where fund performance is known not to be persistent. Even in private equity, the extrapolation of past performance is driven by old instead of recent investments, and pension plans that have made fewer past private equity investments make more aggressive assumptions. Additionally, state and local governments that are more fiscally stressed by higher unfunded pension liabilities assume higher portfolio returns, and are more likely to do so through higher inflation assumptions than higher real returns.

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I. Introduction

What do institutional investors believe about the expected returns of the asset classes in which they invest, and how do they set these expectations? Greenwood and Shleifer (2014) study stock market return expectations, and conclude that survey expectations of investors are highly correlated with past overall stock market returns and with the level of the stock market.[1] A growing body of evidence also reflects the importance of individual investor past experiences in determining their asset allocation and forward-looking expectations (Vissing-Jorgensen (2003); Malmendier and Nagel (2011)). While considerable attention has been devoted to estimating investor beliefs about expected returns on asset classes as parameters of portfolio choice models (Black and Litterman (1992); Pastor (2000); Avramov and Zhou (2010); Ang, Ayala and Goetzmann (2014)), there has been little direct, large-sample evidence about the beliefs of institutional investors across a range of asset classes, and even less on the *cross-sectional* drivers of such beliefs.

In this paper, we exploit data on allocations and return expectations by asset class, collected from recently-required disclosures of all U.S. public pension funds, a group that manages approximately $4 trillion of institutional assets. U.S. Governmental Accounting Standards Board Statement 67 ("GASB 67"), effective for all fiscal years beginning with 2014, included a requirement that pension plans report long-term expected rates of return by asset class as part of a justification of the plan's overall long-term rate of return assumption. This disclosure separately reveals institutional investor expectations about returns in individual asset classes such as public equity, fixed income, private equity, hedge funds, and other asset classes. It is the only setting of which we are aware in which a large sample of institutional investors expresses their expected returns by asset class, alongside their targeted asset allocation.

[1] As such, these expectations are opposite to what would be predicted by model-based expected returns such as those based on the aggregate dividend price ratio, which have been found to have relatively poor performance in data (Welch and Goyal (2007)). Other papers that examine the relationship between surveyed beliefs and model-based expected returns include Amromin and Sharpe (2014) and Bacchetta, Mertens and Wincoop (2009).

The stated purpose of the GASB 67 disclosure is to clarify the calculation of the discount rate that the pension system uses in calculating the present value of its pension liabilities.[2] An expected rate of return on the pension fund's entire investment portfolio serves as the primary input into the discount rate for the pension liability under GASB rules.[3] Despite the conceptual mismatch of using an expected on assets as a discount rate for a contractually pre-specified, market-invariant stream of liability cash flows, pension plans following GASB guidelines nonetheless rely on an expected return assumption in calculating the present value of their liability, and also in general for the calculation of their actuarially required contributions (Novy-Marx and Rauh (2011)).[4] For example, under GASB 67, the California Public Employees Retirement System (CalPERS) used a 7.65% pension discount rate (or "Pension DR") to discount its liability cash flows in 2016,[5] and Pennsylvania State Employees' Retirement System used a 7.25% Pension DR to discount its liabilities in 2016.

The GASB 67 rule requires the "building-block method" of asset-by-asset disclosure to provide a justification of this Pension DR. In principal, the "dot product" of the vector of a given system's asset-class-based expected returns with the system's chosen weights on each asset class should equal or at least approximate the Pension DR chosen by the pension system. Collecting these disclosures for 231 state and local government pension plans in the U.S. over the period 2014 to 2016, we find that this "dot product" portfolio expected return — which we henceforth call the Portfolio ER — generally does not match the Pension DR, sometimes exceeding it and sometimes falling short of it.[6] While some of these differences

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[2] Specifically, GASB Statement No. 67 requires that "The following information should be disclosed about the discount rate: … (c) The long-term expected rate of return on pension plan investments and a description of how it was determined, including significant methods and assumptions used for that purpose… (f) The assumed asset allocation of the pension plan's portfolio, the long-term expected real rate of return for each major asset class, and whether the expected rates of return are presented as arithmetic or geometric means, if not otherwise disclosed."

[3] GASB 67 specifically instructs systems to use an expected return as a discount rate to measure the present value of promised pension benefits, except in instances where municipal governments project an exhaustion of their pension assets at some future date. In that instance, systems reporting under GASB 67 must use a high-quality municipal bond rate for the benefit cash flows that are not covered by the assets on hand and the expected investment returns on those current assets.

[4] This regime gives U.S. pension funds uniquely strong incentives to invest in risky assets if they wish to improve their stated funding status (Andonov, Bauer, and Cremers (2017)).

[5] In contrast, CalPERS used a 7.5% rate for its funding calculations.

[6] The mean absolute deviation (MAD) of the difference between the Portfolio ER and Pension DR is 0.84%.

are due to reporting of geometric versus arithmetic means, most of the differences appear to be due to actual differences between Portfolio ER and Pension DR. The disclosure therefore reveals significantly more variation in the Portfolio ER than is reflected in the more limited variation in the Pension DR.

When examining the determinants of the Portfolio ER, our null hypothesis is that the expected return reflects only the riskiness of the portfolio, i.e. the asset classes chosen by the pension plan. However, we find that variation in the overall Portfolio ER is explained surprisingly poorly by asset class weights. Asset allocation is an important determinant of expected returns, but the average returns experienced in the past ten years and the extent of unfunded liabilities add substantial explanatory power. Specifically, each additional percentage point of past return raises the Portfolio ER by 36 basis points, even after controlling for the percentage allocated to each class of risky assets. An unfunded liability equal to an additional year of total government revenue raises the Portfolio ER by 14 basis points, consistent with the hypothesis that fiscally stressed governments face pressure to maintain higher expected rates of return.

The Portfolio ER can be further decomposed into an inflation assumption and a real rate of return assumption.[7] We find that the positive effect of past returns on the Portfolio ER is driven mostly through its positive effect on *real* return assumptions. Specifically, past returns have a strong positive effect on the real rate of return underlying Portfolio ER on the order of 32 basis points per percentage point of additional past return. In contrast, we find that the effect of unfunded pension liabilities on the Portfolio ER operates considerably more strongly through its effect on inflation rate assumptions than on assumptions about real asset returns themselves. That is, when unfunded liabilities are large, state pension plans are more likely to make aggressive assumptions about inflation in order to justify high nominal return assumptions than to use higher real asset return assumptions for that purpose. This positive relation between the unfunded liabilities and nominal expected returns indicates that pension plans respond also to strategic incentives to

[7] Although some pension plans report asset-class-based expected returns on a nominal basis and others on a real basis, all plans disclose the underlying inflation assumption. We harmonize all disclosures to a nominal basis, and then examine the inflation rate assumption and real rate of return assumptions separately.

reduce the amount of recognized unfunded liabilities when determining their portfolio expected return (Brown and Wilcox (2009); Novy-Marx and Rauh (2011); Andonov, Bauer, and Cremers (2017)).

Extrapolating past returns to future expectations could be justified if there is a significant level of long-term persistence in pension fund performance. Specifically, if pension funds extrapolate from past returns in asset classes where past performance does in fact predict future performance, due to better skill or access to higher-quality external managers on a relevant time horizon, then past returns would indeed be informative about the distribution of future returns. However, if pension funds extrapolate from past returns in asset classes where there is little or no performance persistence, we would conclude that such extrapolation on the basis of past performance is not justified by the evidence.

To examine whether there is a sound financial basis for the observed extrapolation, we therefore analyze the expected real return by asset class. We document that the expected returns in all risky asset classes (public equity, real assets, private equity, and hedge funds) are strongly and positively related to the past experienced return. Notably, the result that past returns play a significant role in forming expectations about public equity returns is difficult to reconcile with prior evidence on performance persistence in this asset class. Goyal and Wahal (2008) show that pension funds cannot time the hiring and firing of asset managers in public equity, while Busse, Goyal and Wahal (2010) show that these asset managers display heterogeneity in performance, but they have only modest persistence.

There is, however, stronger evidence in the literature of persistence in alternative assets, like private equity, where we also observe extrapolation. Cavagnaro, Sensoy, Wang and Weisbach (2016) document differential skill among institutional investors (public pension funds are one category of these investors) that results in persistent differences in their performance.[8] More skilled pension funds are better able to select and maintain long-term relations with the general partners in private equity by reinvesting in follow-on funds (Lerner, Schoar and Wongsunwai (2007)) and there is evidence of persistence in performance of

[8] At the pension fund (LP) level, other evidence that is consistent with an assumption of LP performance persistence in private equity investing includes Hochberg and Rauh (2013), who show the performance impact of LP local bias in PE investing, and Andonov, Hochberg and Rauh (2017), who show the performance impact of different LP governance structures which are very persistent over time.

consecutive funds managed by the same general partner (Kaplan and Schoar (2005); Hochberg, Ljungqvist and Vissing-Jørgensen (2013); Korteweg and Sorensen (2015)), although diminishing over time (Braun, Jenkinson and Stoff (2017)).

Using plan-level data from Preqin, we therefore analyze in more detail how pension funds develop their expectations in private equity, the asset class with strongest potential for persistence that could potentially support the rational extrapolation of past performance. We divide investments into three categories: those that are more than 13 years old and almost certainly fully realized and liquidated; those that are 9–13 years old and likely mostly realized; and those that are 3–8 years old and therefore only partially liquidated. While on the one hand, measuring the performance of older private equity funds depends least on managerial discretion in disclosing the value of unrealized investments, funds in the middle category should also have had sufficient time for the funds returns to be reflected in reported rates of return, and therefore should be at least as informative if not more since they represent more recent financial decisions. We also might expect the reported performance of recent private equity funds to be informative even if they depend on accounting for illiquid assets, as long as such measures of recent fund performance are unbiased.[9]

We observe, however, that within private equity, pension plans extrapolate exclusively the returns of the oldest group of private equity funds, namely those more than 13 years old. The performance of the 9–13 year old funds and the funds that are 3–8 years have no predictive power for explaining expected returns in private equity. Furthermore, pension plans that have made *fewer* investments in private equity funds are more optimistic above their expected returns, even though prior research documents a positive relation between prior experience and performance in private equity (Lerner, Schoar and Wongsunwai (2007); Sensoy, Wang and Weisbach (2014)).

Overall, we find that the tendency of past returns to predict expected future returns is not entirely driven by the phenomenon of rational persistence in the performance of private investments to which a

[9] The quality of the interim performance measures should have improved over time as, since 2009, GPs are required by FASB Statement of Accounting Standards 157 to report the fair value of their assets every quarter.

given pension fund has access. Specifically, there is a robust relationship between past overall pension fund returns and the assumption about future performance in *public* equity, where fund performance is not persistent. Even in private equity, the extrapolation of past performance is driven by old instead of recent investments and cannot be reconciled with a rational extrapolation of skill in selecting and retaining better managers. Therefore, our paper provides suggestive evidence that pension plans excessively extrapolate past performance when formulating return expectations.

Our paper contributes to the literature on experience and investor expectations. Prior literature studies the relation between experience and risk-taking by exploiting the time-series variation in experienced market-wide returns using differences in age (year of birth) of individual investors (Vissing-Jorgensen (2003); Malmendier and Nagel (2011)), mutual fund managers (Greenwood and Nagel (2009)), and corporate executives (Malmendier, Tate and Yan (2011)). Kaustia and Knüpfer (2008) and Choi, Laibson, Madrian and Metrick (2009) analyze the returns experienced by individual investors, instead of overall market history, and document that within a given time period, individual investors adjust their savings and investments based on the performance they have experienced. Gennaioli, Ma and Shleifer (2016) demonstrate similar extrapolative structures for corporate executives. We analyze differences in the returns that institutional investors have experienced. Our main contributions are to document extrapolation of past performance when institutional investors form return expectations, even after controlling for asset allocation and risk-taking; and to show that such extrapolation is not due exclusively to persistent investment skill or access in alternative assets.

This paper proceeds as follows. Section II examines the data on Portfolio ER, and compares the Portfolio ER with the Pension DR that pension systems use for budgeting, measurement, and planning purposes. Section III studies the determinants of the Portfolio ER, and in particular investigates the role of past returns and unfunded liabilities in formulating these nominal expected returns, real expected returns, and inflation assumptions. Section IV investigates whether these linkages are primarily due to historical and expected returns in illiquid alternative asset classes. Section V concludes.

II. Data on Asset-Class-Based Portfolio Expected Return

As shown in Figure 1, GASB Statement No. 67 (GASB 2012) presents examples of the required disclosure. In this example provided by GASB, the sum of the weight of each asset class times the expected return on each asset class plus assumed inflation equals the system's Pension DR of 7.75%. That is, the Portfolio ER (which is the dot product of asset class weights and asset class return expectations) indeed equals the Pension DR (which is the overall long-term rate of return it uses in its budgeting and pension liability measurement calculations). Under GASB 67, asset-class expected returns can be designed either arithmetic (A) or geometric (G).

In the example in Figure 1, the pension plan has chosen to disclose an arithmetic expected return, and this arithmetic Portfolio ER matches the Pension DR. Since the Pension DR is a compound annualized return, the use of an arithmetic expected return to justify the Pension DR can be rationalized if the definition of the arithmetic expected return is the annualized arithmetic average over states of the world of the compound T-year return:

$$\left[\mathrm{E}_t \prod_{s=1}^{t} (1 + r_{t+s})\right]^{\frac{1}{T}} - 1 \tag{1}$$

The geometric expected return would then be:

$$\mathrm{E}_t \left\{ \left[\prod_{s=1}^{t} (1 + r_{t+s})\right]^{\frac{1}{T}} \right\} - 1 \tag{2}$$

If returns are lognormally distributed with mean μ and variance σ^2, then the difference between these two expressions would converge as T gets large to approximately ($\sigma^2/2$) under the standard statistical properties of the normal distribution.

Although contrary to the principles of financial economics (see Novy-Marx and Rauh (2011)), the Pension DR according to GASB is the rate at which the liability cash flows will be fully funded if assets grow at that rate. Depending on whether pension plans are conceptualizing the Pension DR as representing the required annualized arithmetic expectation of the compound T-year return (similar to equation (1)) or the required arithmetic expectation of the annualized return (similar to equation (2)), differences between the Portfolio ER and Pension DR could emerge if systems are thinking of one of these rates as geometric and the other as arithmetic.

We proceed to collect these disclosures for 231 state and local government pension systems in the U.S. over the period 2014 to 2016, and we examine the widely varying assumptions that institutional investors disclose about asset class returns. Pension plans present this information in their Comprehensive Annual Financial Reports (CAFRs) or in separate GASB 67 statements. As shown in Table 1, contrary to the example provided by GASB and reproduced in Figure 1, the Portfolio ER generally does not match the Pension DR, sometimes exceeding it and sometimes falling short of it. Out of 679 observations, 420 reported the Portfolio ER and asset-class-based expected returns on an arithmetic basis and 259 reported on a geometric basis. Of these, for only 30 (or 7%) of the arithmetic observations and only 29 (or 11%) of the geometric observations, does the Portfolio ER match the Pension DR to within the possible rounding error of 10 basis points. For the remaining 93% of pension plans reporting the Portfolio ER components on an arithmetic basis and the remaining 89% of pension plans reporting the Portfolio ER components on a geometric basis, there was a mismatch between the Portfolio ER and the Pension DR.

Among pension plans reporting on an arithmetic basis, the predominant pattern is one in which the Portfolio ER is greater than the Pension DR. This is the case for 76% of the pension plans reporting the Portfolio ER on an arithmetic basis (318 out of 420). A positive difference between the Portfolio ER and the Pension DR can be rationalized if officials are thinking of the Pension DR as geometric. Specifically, under the standard linearized approximation (geometric mean = arithmetic mean – $\sigma^2/2$), the implied volatility of the portfolio would be 0.152.[10] For the remaining 17% of the arithmetic return observations for which the Portfolio ER is less than the Pension DR, the only logical conclusion is that these are pension plans whose Portfolio ERs do not in fact justify the use of the chosen Pension DR.

[10] The difference between the Portfolio ER and Pension DR for systems reporting the Portfolio ER on an arithmetic basis is 0.01154. If we assume the Pension DR is geometric, then under the standard linearized approximation $\sigma^2/2 = 0.01154$ and $\sigma = 0.152$

Among pension plans reporting on a geometric basis, the observations where the Portfolio ER deviates from the Pension DR are somewhat more evenly split between those where the Portfolio ER exceeds the Pension DR and those where the Portfolio ER falls short of the Pension DR. The latter case (Portfolio ER < Pension DR) can be rationalized if officials are thinking of the Pension DR as an arithmetic mean, in which case the implied volatility of the portfolio would be 0.111.[11] Situations where the geometric Portfolio ER is greater than the Pension DR (the final line of the table) could be explained if pension plans are being conservative in their choice of Pension DR relative to Portfolio ER.

Figure 2 shows the relationship between the Pension DR and Portfolio ER graphically, with Panel A showing the 420 systems that report the Portfolio ER on an arithmetic basis and Panel B showing the 259 systems that report the Portfolio ER on a geometric basis. The beta of the Portfolio ER with respect to the Pension DR is 0.372 and 0.950 respectively, and the R-squared statistics are 0.023 and 0.190. Thus, the Portfolio ER and Pension DR are positively related, but there is also considerable variation in the Portfolio ER that is not explained by a system's choice of Pension DR. For example, there are 48 pension plans in our sample that report exactly the same Pension DR of 7.50% in 2014, but their arithmetic Portfolio ER differ significantly and range from 7.19% to 11.32%.

In sum, even though GASB 67 and its accompanying implementation guide clearly indicate the purpose of the asset-class-based disclosure is to justify the Pension DR, Table 1 shows significant deviations between the two. The "dot product" of the asset class expected returns with their policy portfolio weights yields a Portfolio ER that varies considerably more than the Pension DR assumption implemented by the pension systems for liability measurement. While we can attribute some of these differences possibly to differences in reporting of geometric and arithmetic means, most of the differences appear to be due to actual differences between asset return expectations and the Pension DR that pension plans have chosen to use for measurement and budgetary purposes. Overall, there is considerably more variation in the Portfolio

[11] The difference between the Pension DR and Portfolio ER for systems reporting the Portfolio ER on a geometric basis is 0.00614. If we assume the Pension DR is arithmetic, then under the standard linearized approximation $\sigma^2/2 = 0.00614$, then $\sigma = 0.111$.

ER than in the Pension DR, providing an opportunity to analyze the drivers of heterogeneity in the formation of return assumptions.

Table 2 shows summary statistics for separately for the sample of pension plans choosing an arithmetic Portfolio ER versus a geometric Portfolio ER.[12] In addition to their asset-class expected returns, pension plans also disclose assumed inflation, so that we can observe how much of the return expectations stem from the inflation assumption and how much are the result of differences in real assumed returns.[13] The first several lines of Panel A of Table 2 shows the Portfolio ER (calculated as the dot product), the assumed inflation rate, and the implied real return.

In order to achieve a homogeneous set of asset classes, we aggregate all disclosures into seven categories: fixed income, cash, (public) equity, real assets, hedge funds, private equity, and other risky assets. Real assets include real estate, infrastructure and natural resources. Hedge funds include hedge funds with different styles as well as tactical asset allocation mandates. Private equity includes buyout and venture capital investments. Other risky assets are a small share of portfolios but include most commonly commodities, futures, and covered calls.

The arithmetic and geometric subsamples have roughly similar portfolio composition. Fixed income represents on average 24.5% of the portfolio for systems reporting the ER on an arithmetic basis and 24.3% of the portfolio for systems reporting the ER on a geometric basis. Public equity averages 47.1% and 47.0% respectively. Among the alternative asset classes, the arithmetic systems are slightly more likely to invest in real assets and private equity, while the geometric are slightly more likely in hedge funds and other risky assets.

The Portfolio ERs are 8.30% on average in the Arithmetic sample and 7.61% in the Geometric sample. Geometric returns are therefore on average 0.69 percentage points lower than arithmetic, which

[12] The ultimate Pension DR chosen by systems for measurement and budgetary purposes is quite similar in each of these samples, averaging 7.48% with a relatively tight standard deviation of only 0.55 percentage points, as most systems are choosing Pension DR rates in the range of 7–8%.

[13] Specifically, some systems disclose the asset-class expected returns on a nominal basis and others on a real basis, and systems must indicate under GASB 67 which they are disclosing.

under the standard approximation would imply volatility of 0.118.[14] In comparison, the average of the time-series standard deviation of funds in our sample is similar at 0.121. The fact that the expected return differences are most pronounced in the risky asset classes and essentially non-existent in fixed income and cash supports the hypothesis that the differences are a result of the arithmetic-geometric difference and not different underlying assumption about return moments.

Table 2 also shows summary statistics for the variable *Past return*, which is the average of the 10-year arithmetic mean return, and *Past standard deviation*, which is the standard deviation of the annual returns in the previous 10-year period. These returns are calculated using the disclosure of total net investment income divided by beginning-of-year assets.[15] Pension funds disclose this information in the Financial Section of their Comprehensive Annual Financial Reports (CAFRs). The mean of the variable *Past return* is 6.81%.[16] The Portfolio ER is generally higher than the past 10 years of realized returns, averaging 7.61% for geometric disclosures and 8.30% for arithmetic disclosures. For arithmetic systems, 371 of the 420 systems (or 88%) have a Portfolio ER that exceeds the Past Return. For geometric systems, this is the case for 201 of the 259 systems (or 78%).[17]

Overall, pension plans appear to be optimistic in their beliefs about returns relative to the returns of the past 10 years. The asset allocations of systems reporting on an arithmetic versus geometric basis are broadly similar, whereas the total portfolio return assumptions of these two subsamples reflects the impact of volatility on these two different averaging methods.

Past state inflation measures the average inflation rate in the state of the pension plan in the previous 10-year period. This variable is based on the inflation data reported by the Bureau of Labor

[14] That is, if $\sigma^2/2 = 0.0069$, then $\sigma=0.118$.

[15] We note that in addition to real differences in within asset class performance, these return measurements could be affected by differences in timing of contributions and pension benefit payments during the year, as well as how systems chose to mark the value of their unrealized stakes in private equity funds and other funds involving illiquid assets.

[16] The average past return and standard deviation of past returns are also similar in the two samples. Specifically, the past return has a mean of 6.84% in the arithmetic and 6.78% in the geometric sample. The past standard deviation has a mean of 0.122 in the arithmetic and 0.121 in the geometric sample.

[17] Furthermore, when we calculate the past return as a geometric past return, for 238 (or 92%) of the 259 systems it is the case that the assumed geometric return exceeds the past geometric return.

Statistics (BLS) on a combined statistical area level. We collect the Consumer Price Index for All Urban Consumers (CPI-U) for the largest combined statistical areas. If the state has multiple areas present in the BLS regional data we calculate the state inflation as a weighted average using the population in 2016 of these areas.

Table 2 also shows summary statistics for several additional variables we use in the analysis. To test the extent to which pension plans extrapolate future returns in private equity (PE) based on their past experience investing in private equity, we require data on pension plan PE investments and performance at the plan level. We obtain this information from the 2017 Preqin database. The variables *Past PE IRR recent funds*, *Past PE IRR medium funds*, and *Past PE IRR old funds* capture the average net IRR of investments in private equity funds 3–8 years ago, 9–13 years ago, and more than 13 years ago, respectively. Since private equity funds typically have lives of 10–12 years, the investments in the old category are all fully realized (liquidated) and the investments in the medium category are almost all fully realized. That is, their IRRs are based exclusively or primarily on realized cash flows and not estimates of residual value.[18] In contrast, estimates of residual value will affect the reported net IRRs for investments in the recent category.[19] The table also shows the number of investments in private equity, which averages 125 with a median of 65.

Finally, Table 2 shows measures of unfunded pension liabilities as a multiple of state revenue from taxes and fees, and of Gross State Product (GSP). The unfunded liability measure is the Unfunded Market Value of Liability (UMVL), which re-values each state and local government's accrued liabilities using the point on the Treasury yield curve that matches the plan-specific duration (see Rauh (2017))[20]. The average value of UMVL is 1.48 years of state and local own-generated revenue and almost 0.20 of the annual GSP.

[18] Similarly, Cavagnaro, Sensoy, Wang and Weisbach (2016) do not use all PE funds with vintage 2006 or later, which are those that are less than 9 years old, arguing that for these funds the IRRs are not realized returns. Their IRRs are based mainly on estimated values rather than distributed cash-flows.

[19] The estimated unrealized values of recent funds should be closer to the true values because, since 2009, FASB Statement of Accounting Standards 157 (topic 820 on Fair Value Measurement) requires GPs to estimate the fair value of their assets at the end of every quarter (Harris, Jenkinson and Kaplan (2014)).

[20] These measures therefore do not depend on the chosen Pension DR but rather on market bond yields.

III. Explaining the Portfolio Expected Return

In this section, we analyze the determinants of the Portfolio ER in our sample. Our main null hypothesis is that the only determinants of the Portfolio ER are i.) whether the Portfolio ER is stated on an arithmetic or geometric basis, and ii.) the asset classes chosen by the fund. We test here this null hypothesis against the alternative hypothesis that past returns and the unfunded liabilities of state and local governments play a role in shaping the Portfolio ER.

The advantage of our setting to examine this hypothesis is that we observe the target asset allocation and expected returns by asset class. Analyzing only the relation between asset allocation and past performance is insufficient because the dependence of *asset allocation* on past returns could be explained if institutional investors act similarly to individuals in not rebalancing their portfolios. For example, Rauh (2009) provides suggestive evidence that after the technology crash in 2000, corporate pension funds allowed the share allocated to equities drift downward. Such a finding would be consistent either with status quo bias in asset allocation (Samuelson and Zeckhauser (1988)) or by another form of passive or inertial investing (see also Choi, Laibson, Madrian, and Metrick (2002)) or costs to portfolio rebalancing. But in our current setting we observe the actual return expectations that investors report and relate them to past returns. This allows us to test for whether pension fund past performance also affects real return assumptions by asset class, not just the asset allocation.

Past returns could play a role for several reasons. They could reflect genuine variation in the skill of pension funds, which we refer to as the *rational skill hypothesis*. Cavagnaro, Sensoy, Wang and Weisbach (2016) demonstrate that there are persistent differences in the returns that public pension funds achieve as limited partners in alternative asset (and particularly private equity) fund investing.

However, to the extent that past returns play a role in forming expectations not only about private equity returns but also public equity returns, the rational skill hypothesis would not be able to fully explain the findings. Evidence shows that domestic public equity institutional products themselves show little to no evidence of persistence in factor models (Busse, Goyal, and Wahal (2010)). More importantly, from the perspective of the pension fund LP, Goyal and Wahal (2008) provide evidence on the selection and termination of public equity investment management firms by plan sponsors. They find that pension plan sponsor behavior implies that they believe that public equity investment managers can deliver persistently positive returns, when in fact their decisions to hire high-performing managers do not translate into positive excess returns thereafter.

To the extent that past returns affect pension fund expectations about asset classes in which past returns for pension funds provide no information about future returns, the results cannot be solely explained by the rational skill hypothesis. In this instance, the use of past returns would be most consistent with evidence of *excessive extrapolation* by institutional investors, which has been documented in the case of individual investors by Benartzi (2001) and Greenwood and Shleifer (2014), but not for institutional investors.

We begin this investigation by examining the relationship between the Portfolio ER on the left hand side, an indicator variable for geometric reporting, asset allocation controls, and additional controls for year fixed effects and pension fund size. As our sample is a roughly balanced panel 2014-2016, we double cluster the standard errors by pension plan and year. Denoting *Geometric* as the indicator variable for geometric reporting and ω as a 5-vector of allocations to public equity, real assets, private equity, hedge funds and other risky assets, we estimate the equation

$$Portfolo\ ER_{it} = \alpha_t + \beta * Geometric_{it} + \boldsymbol{\gamma}'\boldsymbol{\omega}_{it} + \varepsilon_{it} \tag{3}$$

where the omitted asset categories are fixed income and cash which we combine in this analysis.

Column (1) of Table 3 shows this regression. Pension plans reporting on a geometric basis report asset-class-based expected returns that yield a Portfolio ER which is lower by 72 basis points compared to those reporting on an arithmetic basis. In addition, relative to a 100% portfolio of fixed income and cash, each percentage point of allocation to Equity raises the Portfolio ER by 5.1 basis points and each percentage point of allocation to Real Assets raises the Portfolio ER by 5.4 percentage points. Each percentage point of allocation to Private Equity, Hedge Funds, and Other Risky Assets raise the Portfolio ER by 3.1, 4.6, and 6.7 basis points respectively. The asset allocation variables explain 28.9% of the variation in the Portfolio ER and the positive coefficients indicate that pension plans that invest more in risky assets expect higher returns.

In column (2), we augment the above equation by adding a term for *Past return*, defined as the 10-year arithmetic average of prior annual returns. The past return is strongly statistically significant and its inclusion allows us to explain an additional 4.8% of the total variation in the Portfolio ER, as the adjusted R-squared rises from 28.9% to 33.7%. The relation is also economically significant: a one percentage point increase in the average arithmetic return in the previous 10-year period is associated with 32 basis points higher Portfolio ER. In column (3), we additionally control for the 10-year standard deviation of prior annual returns, in order to capture the possibility that pension plans set expected returns more in response to the risk they took than to the returns they achieved, but we find no evidence of this.

Figure 3 complements the analysis in Table 3 and presents graphically the relation between past return and Portfolio ER. In Panel A, we plot the raw (unadjusted) data of the Portfolio ER against the past return. The scatter plots report separately the values for pension plans reporting on an arithmetic and geometric basis. In Panel B, we calculate the residuals of Portfolio ER based on column (3) of Table 3, so we adjust the Portfolio ER for differences in asset allocation and past volatility. These figures show that there is a significant positive relation between the expected returns and past performance even after controlling for differences in asset allocation and the past standard deviation as proxies for risk-taking.

Columns (4) and (5) of Table 3 augment the regression equation further by including variables for the unfunded pension liability of the sponsoring state or local government, scaled by revenue or GSP respectively. Here we find that an unfunded liability equal to an additional year of total government revenue raises the Portfolio ER by 14 basis points, consistent with the hypothesis that fiscally stressed governments face pressure to maintain higher expected rates of return. A one standard deviation increase in this fiscal pressure variable is around 2/3rds of a year of revenues, and so it would be consistent with a Portfolio ER assumption that is higher by 9 basis points. Scaling the unfunded liability by GSP yields similar conclusions. Each additional 10 percentage points of *Unfunded liability / GSP* raises the Portfolio ER assumption by 11 basis points, and a one standard deviation of *Unfunded liability / GSP* (or an increase of 0.083) similarly increase the Portfolio ER by 9 basis points.

We conclude from this analysis that past returns and fiscal pressure are both important determinants of the portfolio return assumptions of pension systems, even above and beyond their chosen asset allocation and other control variables. The portfolio expected return of every pension plan can be decomposed into two main components: expected inflation rate and expected real rate of return. Next, we analyze separately these two components of Portfolio ER.

Table 4 examines how much of the effects of past returns and unfunded liabilities on the Portfolio ER are due simply to pension plans adding higher inflation rates to their projected real asset return assumptions. The first two columns establish that the geometric effect and the coefficient on past returns are economically and statistically insignificant. The third column adds a control for the average inflation rate in the state of the pension system in the previous 10-year period. The inclusion of this variable would capture possible reasons for different pension systems to have different inflation assumptions. The *Past state inflation* variable introduces cross-sectional variation in the experienced inflation. For instance, the lowest average 10-year inflation rate in 2015 was in Michigan and equals 1.38, while the highest was in Hawaii and equals 2.79.

There are several reasons why the past local inflation might in theory affect the inflation beliefs of pension funds. First, the literature shows that inflation experiences affect inflation expectations at the individual level (Malmendier and Nagel (2016)). As such, if public pension fund officials are more likely to have lived most of their lives in the local area of the pension fund, they might apply their experiences to the setting of inflation expectations, even if fund investments are diversified. Second, there is evidence that public pension funds tend to overweight local investments in their alternative asset portfolios (Hochberg and Rauh (2013)) as well as in their public equity portfolios (Brown, Pollet and Weisbenner (2015)). That said, there is no evidence that public pension fund performance depends on the cross-sectional differences in inflation rates across U.S. states, let alone evidence that inflation is persistent within regions of the U.S.

over decades. It is therefore questionable whether historical information on local inflation would improve return forecasts. In line with this view, we find no evidence that institutional investors make differential inflation assumptions on the basis of past regional inflation.

Next, adding unfunded liabilities to the regression in columns (4) and (5), we see that the coefficients on these variables are strongly statistically significant and of an economic magnitude as large as 65–70% of the unfunded liability effects found in Table 3. A one standard deviation increase in this fiscal pressure variable is around 0.08 of annual GSP, and so would be consistent with an inflation rate assumption that is higher by 6 basis points. This suggests that pension funds in states and municipalities with large unfunded liabilities relative to their resources tend to justify higher return assumptions using higher inflation. We also document that the impact of past returns on return expectations does not operate through inflation assumptions.

Table 5 focuses on the second component of Portfolio ER by considering only the expected real rate of return (subtracting out the inflation component from the Portfolio ER). Here we find contrasting effects to those seen in the inflation analysis of Table 4. Specifically, past returns operate almost completely through increasing the pension fund's *real* expected return assumptions. Indeed, the coefficients on past returns in this analysis are around 90% of their values in the nominal Portfolio ER analysis of Table 3. Pension funds with high past returns tend to extrapolate these to high real assumed returns on their assets they invest in.

In what asset classes do high past returns seem to drive future expected returns? The answer can shed light on the reasons that pension systems are extrapolating their past returns into the future. Specifically, if the extrapolation is primarily or exclusively in the alternative asset classes such as private equity where there is evidence of performance persistence at both the GP and LP level, it could be argued that systems are simply operating according to the rational skill hypothesis. If the extrapolation also occurs in asset classes where there is no evidence of performance persistence, such as public equities, then the rational skill hypothesis cannot fully explain the findings.

In Table 6, we analyze the expected real rate of return by asset class. We focus on the five major asset classes: equity, real assets, private equity, hedge funds, and fixed income. The number of observations differs across the asset classes, because not all pension plans invest in every asset class in every year. The geometric indicator variable is negatively related to the expected real returns in the risky asset classes. The magnitudes of its coefficients also reflect the volatility of the different risky assets: the geometric indicator ranges from -188 basis points in private equity to -30 basis points in real assets, and is insignificant for fixed income.

Next, in columns (2), (4), (6), and (8), we document that past performance is positively related to the expected real returns in all risky asset classes. The extrapolation of past performance seems to be strongest in private equity where a one percentage point increase in the average arithmetic return in the previous 10-year period is associated with 68 basis points higher expected real return. However, the extrapolation is also significant in public equity, which is considered to be an asset class with higher liquidity and market efficiency, and in which the literature shows minimal or no evidence of return persistent at either the portfolio manager or pension plan level. Based on column (2), a one percentage point increase in the average arithmetic return in the previous 10-year period is associated with 30 basis points higher expected real return in public equity.

Table 6 also shows strong evidence of extrapolation of past performance in both hedge funds and real assets. While Andonov, Eichholtz and Kok (2015) demonstrate persistence in pension fund performance in real estate, we are not aware of evidence showing persistence in pension fund performance in the other components of real assets (natural resources and infrastructure). While there is mixed evidence of persistence by hedge funds at the level of the hedge fund, particularly over short horizons, we are also not aware of any evidence that public pension funds that have performed well in hedge funds over a multiyear period in the past continue to do so in the future.[21] Given the tendency of some hedge fund strategies to generate returns by assuming tail risk, such persistence would also be difficult to document simply based on the observable history of returns, if such a history does not include a sufficient number of tail events.

In sum, we find clear evidence of extrapolation of past returns both in the asset class in which prior evidence *for* persistent pension fund skill or access is the strongest (private equity), and in the asset class in which evidence *against* pension fund skill is the weakest (public equity), as well as in all other risky asset classes. In the next section, we look more closely at the extrapolation that occurs in private equity in order to understand whether the way in which private equity returns are extrapolated is consistent with the rational skill hypothesis or not.

IV. The Role of Illiquid Assets

In this section, we analyze the relation between the expected real return in private equity and the pension plan's (LP's) past performance in private equity. We focus on private equity (PE), which includes buyout and venture capital funds, because this asset class has the strongest potential for persistence and rational extrapolation of past performance. Cavagnaro, Sensoy, Wang and Weisbach (2016) analyze the commitments of institutional investors (including public pension funds) to private equity funds and document persistent differences in skills and performance among institutional investors. Extrapolating private equity performance can be explained if pension plans display skill or have differential access to general partners (GPs) of a given quality. For instance, public pension funds are more likely than other institutional investors to reinvest in the follow-on fund of the same GP (Lerner, Schoar and Wongsunwai

[21] Jagannathan, Malakhov and Novikov (2010) and Kosowski, Naik and Teo (2007) document persistence among the top performing hedge funds at the hedge-fund (not LP) level on an annual frequency, but Fung, Hsieh, Naik and Ramadorai (2008) and Joenväärä, Kosowski and Tolonen (2016) observe that the persistence is reduced when accounting for capital inflows and other real-world investment constraints. These constraints can negatively influence large institutional investors, like the pension funds in our sample, when they engage in return-chasing. For instance, Dichev and Yu (2011) find that investors chase returns in hedge funds, but the poor timing and magnitude of their flows deliver dollar-weighted returns that are significantly lower than the potential buy-and-hold returns.

(2007)). These reinvestment decisions are important because there is evidence of persistence in performance on a GP level when considering consecutive funds (Kaplan and Schoar (2005); Hochberg, Ljungqvist and Vissing-Jørgensen (2013); Korteweg and Sorensen (2015)), although Braun, Jenkinson and Stoff (2017) find that GP-level persistence has diminished over time as the private equity industry has matured. Persistence on a GP level could justify extrapolating recent past performance if pension plans invest with the same GP, because the new follow-on private equity funds are typically raised 3–5 years after the previous fund. This would require, however, that the performance measures available for such a young fund are sufficiently informative so that a reinvestment decision could be made on the basis of such information.

In Table 7, we use Preqin data on pension plan performance in private equity to test the rational skill hypothesis. For every pension plan, we calculate the average net IRR of its investments in private equity funds. We calculate the average performance separately for recent, medium and old investments. *Past PE IRR recent funds*, *Past PE IRR medium funds,* and *Past PE IRR old funds* capture the average net IRR of investments in private equity funds 3–8 years ago, 9–13 years ago, and more than 13 years ago, respectively.

Old funds are fully realized and liquidated and their performance does not depend on valuation of unrealized assets. However, they present information from distant past that may not be relevant for estimating the likely performance of investment decisions a pension plan will make today. Private equity funds in the middle group have sufficient time to incorporate cash distributions in the reported returns, and relative to old funds, their performance may be more informative about current financial decisions. The performance of recent funds would be most meaningful for predicting the likely performance of future funds, but only if such performance can be accurately measured. The reported returns of recent funds depend primarily on the valuation of illiquid assets instead of cash-flow distributions, because they still hold deals that need to be exited and the cash-flows need to be distributed.[22]

[22] For example, the median duration of the buyout investments made by private equity funds is almost four years (Lopez-de-Silanes, Phalippou and Gottschalg (2015); Braun, Jenkinson and Stoff (2017)).

We use 2017 Preqin data on net IRR as our measure of PE performance. Since 2009, FASB Statement of Accounting Standards 157 (topic 820 on Fair Value Measurement) requires GPs to estimate the fair value of their assets at the end of every quarter (Harris, Jenkinson and Kaplan (2014)), rather than reporting at cost. Thus, the majority of funds classified as recent investments will be subject to this regulatory requirement.[23] Overall, we expect that recent and medium PE investments will be most informative about future performance. Even if pension plans managers suspect the reported returns of recent funds, there would be little reason to use the performance of old funds, realized more than 13 years ago, to develop expectations about the future.

In Table 7, we start in the first column by controlling for the average past net IRR of all private equity investments, and in the columns to the right we split the performance into the three categories. The results in column (1) indicate that past experienced return in private equity seems positively related to the expected real return in private equity. Pension plans with higher past performance expect higher returns in the future. In the next columns, we decompose the performance of all private equity investments into three groups based on the age of the funds. We document that pension plans do not extrapolate the performance of their recent private equity investments. The relation between the performance of recent and medium funds is not significantly related to expected returns in private equity. The positive relation in column (1) is driven by the positive relation between the return expectations and the performance of old private equity funds. Extrapolating the performance of private equity funds that are more than 13 years old is difficult to justify as they have been liquidated and their cash flows have been fully distributed to the pension plans.

Furthermore, the negative relation between the number of investments in private equity and the expected real return indicates that less experienced pension plans expect higher returns. This results cannot be rationalized as prior research has documented that experience and access to top-performing GPs are positively related to performance (Lerner, Schoar and Wongsunwai (2007); Sensoy, Wang and Weisbach (2014)).

[23] The only exception would be possibly when we consider the oldest of the recent funds (those that are 5 years old) from the perspective of LP observations in the year 2014.

Overall, we find that pension plans extrapolate performance of old instead of recent investments in private equity and that less experience pension plans are more optimistic. These results indicate that the rational skills hypothesis cannot fully explain our findings.

V. Conclusion

Forward-looking expectations of individual investors about the stock market are driven by the (recent) performance of the stock market (Vissing-Jorgensen (2003); Malmendier and Nagel (2011); Greenwood and Shleifer (2014)). While the relationship between beliefs and past experience has been clearly demonstrated for retail investors, our study is the first that we are aware of to make this determination for institutional investors. We find that cross-sectional variation in institutional investor return expectations are affected by their own past investment histories. Public pension plans, the largest institutional investors based on asset under management, extrapolate past performance when forming return expectations. The variation in pension plan past performance adds substantial explanatory power for real portfolio expected returns even after controlling for asset allocation and risk-taking.

Extrapolating past returns could reflect persistent differences in the skill of pension funds. We test this rational skill hypothesis by examining the relation between past performance and expected real return by asset class and find that it cannot completely explain the findings. First, we document that pension plans extrapolate past returns in both private and public markets. The extrapolation of past performance in public equity does not seem to be justified when we consider the evidence that skill or persistence in pension fund performance in this asset class is weak or non-existent (Goyal and Wahal (2008); Busse, Goyal, and Wahal (2010)). Second, in private equity, we find that the extrapolation of past returns is driven by the oldest investments, even though these are less informative about the future period. The total extent of experience in the private equity asset class is even negatively correlated with the return assumption. Overall, these results are not in line with the rational extrapolation of skills and indicate that the extrapolation of past returns by pension plans is not due exclusively to persistent investment skill or access in alternative assets.

Finally, we have also documented that state and local governments that face higher unfunded pension liabilities relative to their revenues and GSP assume higher portfolio returns, and are more likely to do so through higher inflation assumptions than higher real returns. This behavior of pension plans located in fiscally stressed states is consistent with plans' responding to strategic incentives to reduce the recognized magnitude of unfunded liabilities, although they do not attempt to do so through assumptions of higher real returns on invested assets.

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Figure 1: **Example from Statement No. 67 of the Governmental Accounting Standards Board**

Investments

Investment policy. The pension plan's policy in regard to the allocation of invested assets is established and may be amended by the CERS Board by a majority vote of its members. It is the policy of the CERS Board to pursue an investment strategy that reduces risk through the prudent diversification of the portfolio across a broad selection of distinct asset classes. The pension plan's investment policy discourages the use of cash equivalents, except for liquidity purposes, and aims to refrain from dramatically shifting asset class allocations over short time spans. The following was the Board's adopted asset allocation policy as of June 30, 20X9:

Asset Class	Target Allocation
Domestic equity	46%
International equity	21
Fixed income	26
Real estate	6
Cash	1
Total	100%

...

Actuarial assumptions. The total pension liability was determined by an actuarial valuation as of June 30, 20X9, using the following actuarial assumptions, applied to all periods included in the measurement:

Inflation	3.5 percent
Salary increases	4.5 percent, average, including inflation
Investment rate of return	7.75 percent, net of pension plan investment expense, including inflation

Mortality rates were based on the RP-2000 Healthy Annuitant Mortality Table for Males or Females, as appropriate, with adjustments for mortality improvements based on Scale AA.

The actuarial assumptions used in the June 30, 20X9 valuation were based on the results of an actuarial experience study for the period July 1, 20X5–April 30, 20X7.

The long-term expected rate of return on pension plan investments was determined using a building-block method in which best-estimate ranges of expected future real rates of return (expected returns, net of pension plan investment expense and inflation) are developed for each major asset class. These ranges are combined to produce the long-term expected rate of return by weighting the expected future real rates of return by the target asset allocation percentage and by adding expected inflation. Best estimates of arithmetic real rates of return for each major asset class included in the pension plan's target asset allocation as of June 30, 20X9 (see the discussion of the pension plan's investment policy) are summarized in the following table:

Asset Class	Long-Term Expected Real Rate of Return
Domestic equity	5.4%
International equity	5.5
Fixed income	1.3
Real estate	4.5
Cash	0.0

Discount rate. The discount rate used to measure the total pension liability was 7.75 percent. The projection of cash flows used to determine the discount rate assumed that plan member contributions will be made at the current contribution rate and that County contributions will be made at rates equal to the difference between actuarially determined contribution rates and the member rate. Based on those assumptions, the pension plan's fiduciary net position was projected to be available to make all projected future benefit payments of current plan members. Therefore, the long-term expected rate of return on pension plan investments was applied to all periods of projected benefit payments to determine the total pension liability. [If there had been a change in the discount rate since the end of the prior fiscal year, the pension plan should disclose information about that change, as required by paragraph 31b(1)(a) of this Statement.]

Authors' note:

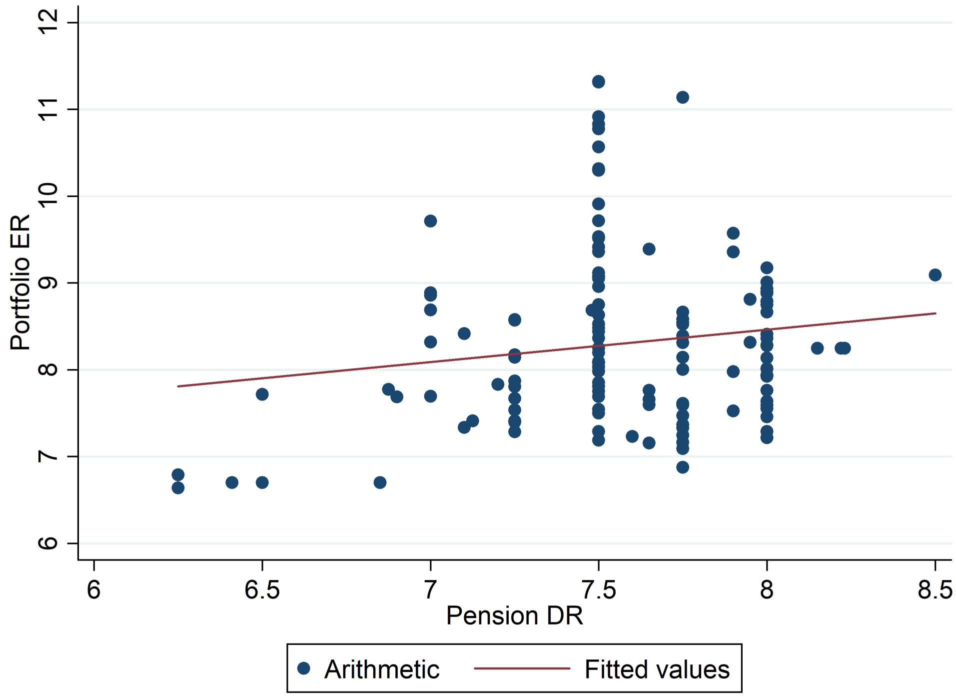
46%*5.4% + 21%*5.5% + 26%*1.3% + 6%*4.5% + 1%*0.0% = 4.25%

4.25% real return + 3.5% inflation = 7.75% ("dot product return" or Portfolio ER)

which in this example provided by GASB equals the system's discount rate (Pension DR).

Figure 2: **Pension discount rate (DR) and portfolio expected return (ER)**

Panel A: Pension plans reporting the Portfolio ER on an arithmetic basis
β=0.372, s.e. = 0.120, R-squared = 0.023



Panel B: Pension plans reporting the Portfolio ER on a geometric basis
β=0.950, s.e. = 0.123, R-squared = 0.190

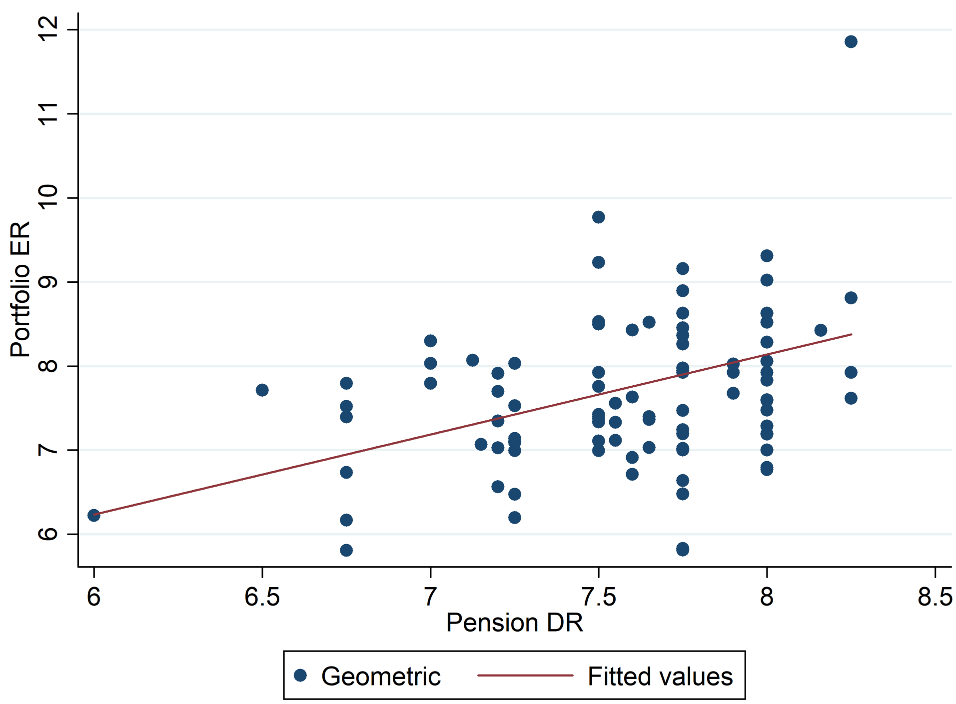
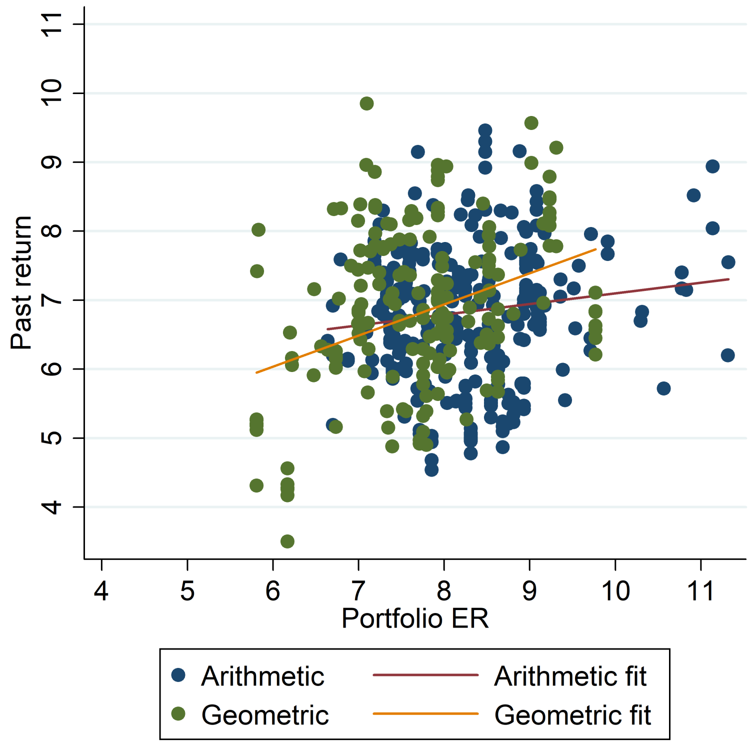


Figure 3: **Portfolio expected return (ER) and past return**

Panel A: Raw portfolio expected return



Panel B: Residual portfolio expected return

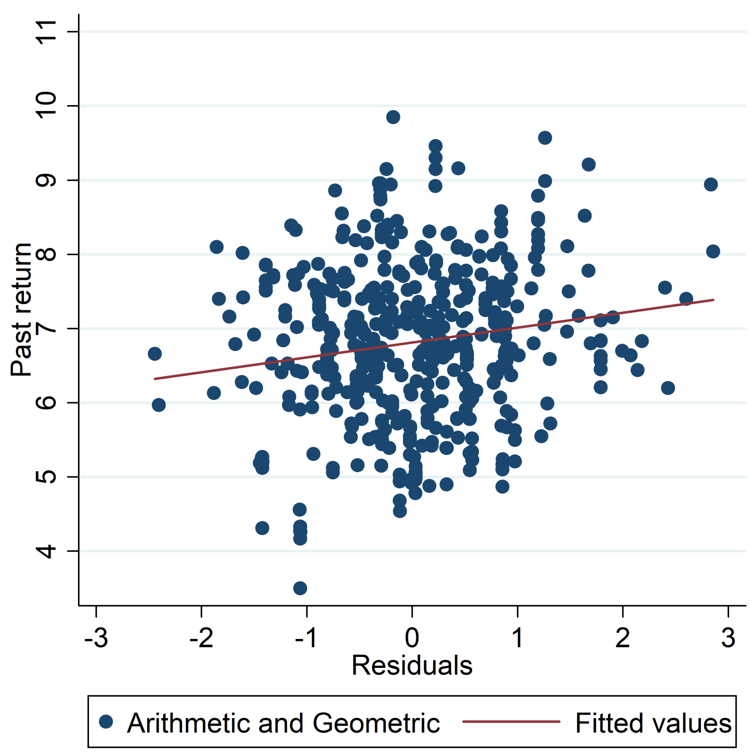


Table 1: **Summary statistics: Differences between portfolio ER and pension DR**

We collect the return expectation of 231 pension plans during the 2014–2016 period. This table compares the portfolio expected return (ER) with the pension discount rate (DR). In Panel A, we analyze pension plans that report an arithmetic expected returns, whereas in Panel B we analyze pension plans that report a geometric expected returns. We consider the Portfolio ER to be equal to the Pension DR if the difference between them is less than 10 basis points. In the other cases, the Portfolio ER is substantially lower or higher than the Pension DR. For every outcome, we present the number of pension funds (PFs), their average Portfolio ER, and their average Pension DR. Columns *Diff* and *SD Diff* report the average difference between the Portfolio ER and Pension DR and the standard deviation of this difference.

	PFs	Portfolio ER	Pension DR	Diff	SD Diff
Panel A: Reporting arithmetic portfolio expected return					
Portfolio ER $<$ Pension DR	72	7.359	7.751	-0.393	0.177
Portfolio ER $=$ Pension DR	30	7.841	7.835	0.006	0.039
Portfolio ER $>$ Pension DR	318	8.558	7.404	1.154	0.916
Panel B: Reporting geometric portfolio expected return					
Portfolio ER $<$ Pension DR	106	6.846	7.460	-0.614	0.384
Portfolio ER $=$ Pension DR	29	7.452	7.453	-0.001	0.036
Portfolio ER $>$ Pension DR	124	8.295	7.462	0.833	0.622

Table 2: **Summary statistics**

Panel A presents summary statistics for the portfolio expected returns separately for pension plans reporting on an arithmetic and geometric basis. The two main components of Portfolio ER are the assumed inflation rate and the expected real rate of return. The Portfolio ER is calculated using the reported weights and expected returns by assets class. We organize the asset allocation in seven asset classes: fixed income, cash, equity, real assets, hedge funds, private equity, and other risky assets. For every asset class, we present the allocation and the expected nominal rate of return. The number of observations decreases when we present the expected returns by asset class as some pension plans do no invest in every asset class. In Panel B, we report summary statistics for the main variables used in our analysis. *Past return* measures the average annual arithmetic return in the previous 10-year period. *Past standard deviation* measures the standard deviation of the returns in the previous 10-year period. *Past state inflation* is the average annual inflation rate in the state in the previous 10-year period. *Past PE IRR recent funds*, *Past PE IRR medium funds*, and *Past PE IRR old funds* capture the average net IRR of investments in private equity funds that were made 3–8 years ago, 9–13 years ago, and more than 13 years ago, respectively. *#Investments PE* measures the total number of investments in private equity funds. *Unfunded liability / Revenue* and *Unfunded liability / GSP* are ratios of unfunded liabilities of state and local pension funds relative to the state revenue or the Gross State Product. *GSP per capita* is the Gross State Product per capita in $ thousand. *Mean* and *Median* present the average and median values of the variables. *SD* column shows the standard deviation of the variables.

	PFs	Mean	Median	SD	PFs	Mean	Median	SD
Panel A: Portfolio ER	**Arithmetic**				**Geometric**			
Portfolio ER	420	8.301	8.249	0.870	259	7.608	7.600	1.064
Inflation rate	420	2.925	3.000	0.315	259	2.825	3.000	0.393
Real return	420	5.376	5.307	0.891	259	4.782	4.699	1.093
%Fixed income	420	0.245	0.235	0.078	259	0.243	0.250	0.093
%Cash	420	0.010	0.000	0.015	259	0.021	0.010	0.097
%Equity	420	0.471	0.445	0.100	259	0.470	0.500	0.150
%Real assets	420	0.100	0.095	0.065	259	0.072	0.075	0.053
%Hedge funds	420	0.068	0.000	0.088	259	0.080	0.000	0.136
%Private equity	420	0.078	0.080	0.066	259	0.058	0.070	0.047
%Other risky assets	420	0.027	0.000	0.059	259	0.056	0.000	0.082
ER fixed income	420	4.814	4.736	1.164	251	4.868	4.900	0.861
ER cash	187	3.384	3.500	1.308	137	3.191	3.000	1.652
ER equity	420	9.589	9.600	1.074	251	8.686	8.625	0.863
ER real assets	360	8.118	8.000	0.937	191	7.684	7.500	1.257
ER hedge funds	198	7.484	7.200	1.442	124	6.880	6.795	0.794
ER private equity	305	12.233	12.110	1.615	168	10.349	9.950	1.356
ER other risky assets	126	9.587	8.550	2.479	111	8.016	9.000	2.572
Panel B: Pension plan and state variables								
Past return	679	6.813	6.820	1.033				
Past standard deviation	679	12.128	12.170	1.435				
Past state inflation	679	1.987	1.990	0.305				
Past PE IRR recent funds	616	13.253	13.161	3.083				
Past PE IRR medium funds	549	9.585	9.486	4.072				
Past PE IRR old funds	507	13.452	14.361	5.120				
#Investments PE	679	124.996	65.000	139.664				
Unfunded liability / Revenue	679	1.476	1.364	0.660				
Unfunded liability / GSP	679	0.190	0.173	0.083				
GSP per capita	679	49.418	46.826	13.662				

Table 3: **Portfolio expected return**

This table presents regressions in which the dependent variable is the portfolio expected return of pension plans during the 2014–2016 period. *Geometric* is an indicator variable for pension plans reporting geometric portfolio expected return (the omitted category is plans reporting arithmetic expected return). *Past Return* and *Past standard deviation* measure the average arithmetic return and the standard deviation of the annual returns in the previous 10-year period. When analyzing the relation with past returns, we control for reporting month fixed effects because pension funds have different fiscal-year ending dates. *Unfunded liability / Revenue* and *Unfunded liability / GSP* are ratios of unfunded liabilities of state and local pension funds relative to the state revenues or Gross State Product. *GSP per capita* is the Gross State Product per capita in $ thousand. *%Equity*, *%Real assets*, *%Private equity*, *%Hedge funds*, *%Other risky assets* measure the percentage allocated to different risky asset classes (the omitted categories are fixed income and cash). We include year fixed effects and independently double cluster the standard errors by pension plan and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

	Portfolio expected return				
	(1)	(2)	(3)	(4)	(5)
Geometric	-0.720***	-0.692***	-0.701***	-0.682***	-0.675***
	[0.111]	[0.103]	[0.106]	[0.101]	[0.099]
Past return		0.317***		0.359***	0.369***
		[0.073]		[0.067]	[0.070]
Past standard deviation			-0.002	-0.075*	-0.081**
			[0.039]	[0.039]	[0.038]
Unfunded liability / Revenue				0.140**	
				[0.065]	
Unfunded liability / GSP					1.123**
					[0.525]
GSP per capita				0.003	0.004
				[0.004]	[0.005]
PF size	-0.030	-0.100	-0.060	-0.140**	-0.141**
	[0.056]	[0.065]	[0.061]	[0.057]	[0.058]
%Equity	5.104***	3.593***	4.849***	3.501***	3.461***
	[0.845]	[1.185]	[0.954]	[1.250]	[1.270]
%Real assets	5.356***	3.878**	4.929***	4.602**	4.558**
	[1.457]	[1.802]	[1.565]	[1.844]	[1.881]
%Private equity	3.052***	2.222*	3.407***	2.419*	2.446*
	[1.077]	[1.283]	[1.153]	[1.253]	[1.265]
%Hedge funds	4.648***	3.847***	4.391***	3.896***	3.858***
	[0.830]	[1.040]	[0.936]	[1.119]	[1.135]
%Other risky assets	6.657***	5.605***	6.548***	6.041***	6.039***
	[1.181]	[1.396]	[1.169]	[1.347]	[1.366]
Reporting Month FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	679	679	679	679	679
Adjusted R-squared	0.289	0.337	0.293	0.346	0.346

Table 4: **Expected inflation rate (component of Portfolio ER)**

This table presents regressions in which the dependent variable is the assumed inflation rate of pension plans during the 2014–2016 period. *Geometric* is an indicator variable for pension plans reporting geometric portfolio expected return (the omitted category is plans reporting arithmetic expected return). *Past Return* measures the average arithmetic return in the previous 10-year period. When analyzing the relation with past returns, we control for reporting month fixed effects because pension funds have different fiscal-year ending dates. *Past state inflation* is the average annual inflation rate in the state in the previous 10-year period. *Unfunded liability / Revenue* and *Unfunded liability / GSP* are ratios of unfunded liabilities of state and local pension funds relative to the state revenues or Gross State Product. *GSP per capita* is the Gross State Product per capita in $ thousand. We include year fixed effects and independently double cluster the standard errors by pension plan and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

	Expected inflation rate				
	(1)	(2)	(3)	(4)	(5)
Geometric	-0.091	-0.090	-0.089	-0.096*	-0.092*
	[0.060]	[0.059]	[0.059]	[0.055]	[0.055]
Past return		0.037	0.039	0.049	0.053
		[0.055]	[0.051]	[0.053]	[0.054]
Past state inflation			-0.066	-0.142	-0.153
			[0.157]	[0.142]	[0.144]
Unfunded liability / Revenue				0.089***	
				[0.025]	
Unfunded liability / GSP					0.771***
					[0.201]
GSP per capita				0.007***	0.008***
				[0.001]	[0.002]
PF size	-0.060***	-0.062***	-0.059***	-0.061***	-0.059***
	[0.017]	[0.014]	[0.018]	[0.016]	[0.016]
Reporting Month FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	679	679	679	679	679
Adjusted R-squared	0.087	0.127	0.127	0.210	0.214

Table 5: **Expected real return (component of Portfolio ER)**

This table presents regressions in which the dependent variable is the expected real rate of return of pension plans during the 2014–2016 period. *Geometric* is an indicator variable for pension plans reporting geometric portfolio expected return (the omitted category is plans reporting arithmetic expected return). *Past Return* and *Past standard deviation* measure the average arithmetic return and the standard deviation of the annual returns in the previous 10-year period. When analyzing the relation with past returns, we control for reporting month fixed effects because pension funds have different fiscal-year ending dates. *Unfunded liability / Revenue* and *Unfunded liability / GSP* are ratios of unfunded liabilities of state and local pension funds relative to the state revenues or Gross State Product. *GSP per capita* is the Gross State Product per capita in $ thousand. *%Equity*, *%Real assets*, *%Private equity*, *%Hedge funds*, *%Other risky assets* measure the percentage allocated to different risky asset classes (the omitted categories are fixed income and cash). We include year fixed effects and independently double cluster the standard errors by pension plan and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

	Expected real return				
	(1)	(2)	(3)	(4)	(5)
Geometric	-0.643***	-0.613***	-0.620***	-0.597***	-0.594***
	[0.096]	[0.092]	[0.097]	[0.093]	[0.092]
Past return		0.291***		0.322***	0.324***
		[0.075]		[0.079]	[0.079]
Past standard deviation			-0.008	-0.067	-0.068
			[0.039]	[0.044]	[0.044]
Unfunded liability / Revenue				0.060	
				[0.058]	
Unfunded liability / GSP					0.399
					[0.496]
GSP per capita				-0.004	-0.004
				[0.004]	[0.004]
PF size	0.044	-0.031	0.004	-0.067	-0.066
	[0.059]	[0.066]	[0.065]	[0.059]	[0.060]
%Equity	5.306***	3.770***	4.941***	3.622***	3.623***
	[0.750]	[1.054]	[0.886]	[1.051]	[1.059]
%Real assets	5.528***	4.237**	5.268***	4.761**	4.737**
	[1.517]	[1.932]	[1.630]	[1.930]	[1.945]
%Private equity	3.996***	3.090***	4.214***	3.441***	3.450***
	[0.881]	[0.977]	[0.973]	[0.999]	[0.995]
%Hedge funds	5.711***	4.858***	5.371***	4.771***	4.766***
	[0.700]	[0.863]	[0.782]	[0.886]	[0.887]
%Other risky assets	7.466***	6.449***	7.354***	6.922***	6.907***
	[1.205]	[1.450]	[1.142]	[1.350]	[1.363]
Reporting Month FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	679	679	679	679	679
Adjusted R-squared	0.283	0.330	0.294	0.335	0.335

Table 6: **Expected real returns by asset class**

The dependent variable is the expected real rate of return by asset class. We focus on the five major asset classes: equity, real assets, private equity, hedge funds, and fixed income. The number of observations differs across the asset classes because not all pension plans invest in every asset class in every year. *Geometric* is an indicator variable for pension plans reporting geometric portfolio expected return (the omitted category is plans reporting arithmetic expected return). *Past Return* and *Past standard deviation* measure the average arithmetic return and the standard deviation of the annual returns in the previous 10-year period. When analyzing the relation with past returns, we control for reporting month fixed effects because pension funds have different fiscal-year ending dates. *Unfunded liability / GSP* is the ratio of unfunded liabilities of pension funds relative to the Gross State Product. *GSP per capita* is the Gross State Product per capita in $ thousand. *%Equity*, *%Real assets*, *%Private equity*, *%Hedge funds*, *%Other risky assets* measure the percentage allocated to different risky asset classes (the omitted categories are fixed income and cash). We include year fixed effects and independently double cluster the standard errors by pension plan and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

	Equity	Equity	RA	RA	PE	PE	HF	HF	FI	FI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Geometric	-0.888***	-0.824***	-0.301***	-0.233*	-1.880***	-1.834***	-0.459***	-0.404***	0.119	0.126
	[0.119]	[0.126]	[0.114]	[0.123]	[0.185]	[0.179]	[0.158]	[0.150]	[0.154]	[0.162]
Past return		0.304***		0.347***		0.685***		0.546***		0.138
		[0.115]		[0.112]		[0.263]		[0.079]		[0.137]
Past standard deviation		-0.087		-0.033		-0.215**		0.077		0.035
		[0.061]		[0.046]		[0.106]		[0.071]		[0.049]
Unfunded liability / GSP		0.384		1.495		3.595*		1.270		1.384**
		[0.518]		[1.142]		[1.891]		[0.926]		[0.593]
GSP per capita		-0.003		0.009**		0.010		-0.011***		-0.005*
		[0.006]		[0.004]		[0.008]		[0.004]		[0.003]
PF size	0.039	-0.054	0.171**	0.074	0.305**	0.088	0.123	-0.302*	-0.080	-0.107
	[0.058]	[0.057]	[0.068]	[0.081]	[0.123]	[0.122]	[0.192]	[0.180]	[0.099]	[0.098]
%Equity	2.333***	0.434	1.255	-0.704	5.364***	1.185	1.964	-3.944**	-3.052***	-4.481***
	[0.747]	[1.286]	[1.600]	[2.437]	[1.889]	[3.576]	[1.904]	[1.848]	[0.995]	[1.254]
%Real assets	2.616**	1.736	2.311	1.233	5.820**	3.394	-2.895	-11.924***	-1.005	-2.331
	[1.095]	[1.390]	[2.150]	[2.846]	[2.654]	[2.871]	[2.348]	[2.725]	[3.246]	[3.373]
%Private equity	-2.664***	-3.593***	-1.333	-3.099*	1.026	1.029	2.869	6.994*	-3.146***	-4.136***
	[1.030]	[1.388]	[1.570]	[1.759]	[2.619]	[2.915]	[4.037]	[3.668]	[1.035]	[1.329]
%Hedge funds	5.191***	4.501***	-0.459	-0.460	8.682***	8.542***	1.243	-3.117*	-0.155	-0.805
	[0.807]	[0.854]	[1.490]	[1.715]	[1.777]	[2.191]	[1.976]	[1.596]	[0.681]	[0.666]
%Other risky assets	2.670**	1.823	-2.088	-2.617	3.744	3.941	6.539**	0.811	0.657	-0.017
	[1.140]	[1.166]	[3.249]	[3.241]	[5.156]	[5.063]	[2.974]	[2.399]	[1.292]	[1.809]
Reporting Month FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	671	671	551	551	473	473	322	322	671	671
Adjusted R-squared	0.238	0.268	0.067	0.132	0.314	0.395	0.103	0.556	0.112	0.129

Table 7: **Expected real returns in private equity**

This table presents regressions in which the dependent variable is the expected real rate of return in private equity during the 2014–2016 period. *Geometric* is an indicator variable for pension plans reporting geometric portfolio expected return (the omitted category is plans reporting arithmetic expected return). *Past PE IRR all funds* is the average net IRR of all past investments in private equity funds. *Past PE IRR recent funds*, *Past PE IRR medium funds*, and *Past PE IRR old funds* capture the average net IRR of investments in private equity funds 3 to 8 years ago, 9 to 13 years ago, and more than 13 years ago, respectively. #Investments PE measures the total number of investments in private equity funds. *Unfunded liability / GSP* is the ratio of unfunded liabilities of state and local pension funds relative to the Gross State Product. *GSP per capita* is the Gross State Product per capita in $ thousand. *%Equity*, *%Real assets*, *%Private equity*, *%Hedge funds*, *%Other risky assets* measure the percentage allocated to different risky asset classes (the omitted categories are fixed income and cash). We include year fixed effects and independently double cluster the standard errors by pension plan and by year. We report standard errors in brackets. *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

	Expected real return in private equity				
	(1)	(2)	(3)	(4)	(5)
Geometric	-1.840***	-1.945***	-1.940***	-1.825***	-2.110***
	[0.172]	[0.174]	[0.262]	[0.273]	[0.353]
Past PE IRR all funds	0.079*				
	[0.042]				
Past PE IRR recent funds		0.047			0.022
		[0.077]			[0.072]
Past PE IRR medium funds			-0.014		-0.008
			[0.032]		[0.045]
Past PE IRR old funds				0.062***	0.081***
				[0.024]	[0.020]
#Investments PE	-0.001	-0.002	-0.003**	-0.004***	-0.006***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Unfunded liability / GSP	3.012*	2.866**	1.037	3.922*	1.524
	[1.741]	[1.371]	[2.359]	[2.035]	[1.452]
GSP per capita	0.011	0.008	-0.003	-0.004	-0.005
	[0.007]	[0.008]	[0.005]	[0.004]	[0.005]
PF size	0.239	0.470*	0.595***	0.752***	1.001***
	[0.200]	[0.242]	[0.184]	[0.213]	[0.210]
%Equity	4.709**	5.407**	2.480	3.511	2.351
	[2.050]	[2.552]	[2.204]	[2.581]	[2.154]
%Real assets	6.635**	6.094**	1.176	11.186***	8.235**
	[2.878]	[2.730]	[2.826]	[3.504]	[3.225]
%Private equity	2.278	2.480	0.855	-0.724	-5.172
	[2.825]	[3.370]	[2.618]	[3.006]	[3.680]
%Hedge funds	8.930***	8.579***	6.321***	7.567***	4.934***
	[1.775]	[1.906]	[1.727]	[2.180]	[1.733]
%Other risky assets	3.724	2.749	1.840	0.868	-3.279
	[5.539]	[6.298]	[4.083]	[4.576]	[4.493]
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	471	459	401	360	342
Adjusted R-squared	0.332	0.359	0.381	0.383	0.531