How High is the Bar?
Pension Fund Benchmark Choices in Real Assets

Alexander Carlo[1], Piet Eichholtz[1], Nils Kok[1], David C. Ling[2]

[1]Maastricht University's School of Business and Economics

[2]University of Florida's Warrington College of Business

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Abstract

This research studies the choices of performance benchmarks by defined benefit pension funds worldwide, focusing on real assets. Pension fund allocations to non-listed 'alternative' assets, i.e., real estate, infrastructure, commodities, and private equity, have rapidly increased in recent decades, and the benchmarks used for performance measurement have evolved rapidly in quantity and quality, often varying substantially across pension funds. Employing the CEM database, we first study the heterogeneity in benchmark choice across real assets. Subsequently, we analyze the switch from relative to absolute performance benchmarks, as well as changes in benchmark choice within each category, to establish whether pension funds engage in strategic choices (benchmark shopping), driven by past and current investment performance. Finally, we assess the impact of benchmark changes on pension fund performance, benchmark returns, and net benchmark-adjusted returns.

Keywords: Relative performance evaluation; benchmark selection, investment performance, pension funds, real assets, real estate, infrastructure

JEL Classification: G20, G11, G23

Corresponding author: a.carlo@maastrichtuniversity.nl.

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1 Introduction

Over the past decades, many defined benefit pension plans, in search of higher returns, increased their allocations to alternative investments such as real estate, private equity, hedge funds, and infrastructure (Riddiough, 2022). Indeed, Carlo et al. (2021), studying a global sample of over 1,000 pension funds, find that the average allocation to alternative assets has grown from approximately 10 percent to 22 percent between 1991 and 2018. To measure performance and to determine whether the increased allocations to alternative assets are justified on a risk-adjusted basis, the investment management industry performs relative performance evaluation. As a result, the focus on selecting appropriate benchmarks for alternative asset allocations has intensified.

Performance evaluation theory (Holmström and Holmstrom, 1979) therefore suggests that it is of utmost importance to apply proper benchmarks. Yet, the existing literature provides evidence that the choice of benchmarks is not as straightforward and transparent as one might assume. The early literature on relative performance evaluation focused primarily on benchmark choice and relative performance evaluation in the well-established mutual fund industry. Mutual funds are mandated by the U.S. Securities and Exchange Commission (SEC) to disclose a minimum of one "appropriate," broad-based passive market index in their prospectus. The purpose of this rule is to provide investors with a standard against which the fund's performance can be measured and to help them determine how much value the mutual fund manager has added (or subtracted). The same SEC rule allows mutual funds to add or remove benchmark indices with little justification. Consequently, nothing prevents mutual funds from comparing their returns to newly chosen indexes instead of those originally selected (Mullally and Rossi, 2024; Mateus et al., 2019).

Within this principal-agent setting, Sensoy (2009) studies whether mutual funds strategically choose benchmarks that are easier to beat and finds that approximately a third of U.S. equity mutual funds specify a benchmark index that does not match the fund's actual investment style. In so doing, they often report out-performance that is not accurate given their underlying investment style. Furthermore, Sensoy (2009) documents that mutual funds that choose "mismatched" benchmarks do so to increase investor flows into the mutual fund. This is because reported relative performance is a key driver of mutual funds' investor flows. Mullally and Rossi (2024) support these findings by documenting that benchmark changes by mutual funds typically lead to an increase in past benchmark-adjusted returns reported by mutual funds. High-fee mutual funds, broker-sold funds, and funds experiencing poor performance and outflows are more likely to engage in strategic benchmark swapping. Clearly, performance evaluation by investors is complicated when the fund's agent can self-select the fund's performance benchmarks, especially if the principal is an unsophisticated investor. Cremers et al. (2013) provide further evidence that benchmark selection by mutual fund managers can distort performance evaluation and mislead investors. However, there is also evidence that this behavior occurs even when the principal is a sophisticated investor (Phalippou, 2014, 2020).

The seminal work of Phalippou (2014) extends this argument's literature to private equity and shows that the relative performance of private equity buyout funds are highly sensitive to the choice of benchmark. He demonstrates that LBO funds outperform their benchmark, typically the S&P500, by 5.7% per annum but argues that this is predominantly due to inappropriate benchmark choice. The S&P500 reflects the performance of large companies, and not of the investments typically underlying buyout funds – predominantly small- and mid-cap – assets. When benchmarked to an appropriately leveraged small-cap stock index, the average buyout fund underperforms by 3.1% per annum. Phalippou (2020) concludes that private equity fund managers engage in benchmark "shopping" behavior. Shifting the focus to pension funds, a recent study by Augustin et al. (2023) shows that turnover among pension fund consultants predicts changes in private equity benchmarks, and that the private equity benchmarks chosen by pension funds have become easier to outperform over the last 20 years.

The complexities of investing in opaque, illiquid private markets, coupled with information asymmetries and potential agency conflicts among investment managers, consultants, and fund trustees, make it unclear whether the selected performance benchmarks in these markets accurately reflect the underlying risk and return of portfolio investments. The inherent opacity of real asset investments increases the likelihood of strategic behavior in benchmark selection, complicating performance evaluation. Geltner and Ling (2007) discuss the three main purposes of agent evaluation benchmarks in private real estate investments. The first is to aid communication between the principal and agent regarding investment objectives, strategy, and tactics; the second is to help align the interests of the principal and agent. Finally, the ideal benchmark should help identify investment managers. These criteria are consistent with those found in studies on benchmark selection for alternatives such as hedge funds (Heale et al., 2018) and private equity (Beath and Flynn, 2020). While there is growing research on relative performance evaluation in private equity and hedge funds, there is far less focus on the determinants and appropriateness of benchmark selection for real assets—namely private and listed real estate, infrastructure, natural resources, and commodities. An exception is Riddiough (2022), who argues that pension funds often benchmark their real estate portfolios inappropriately, providing anecdotal evidence that these benchmarks typically align with low-risk core strategies. However, many pension funds invest in value-add and opportunistic strategies, making the selected internal benchmarks potentially inadequate for meaningful relative performance assessments, resulting in an 'apples to oranges' scenario. However, no study to date has comprehensively explored the determinants of pension funds' benchmark choices for their real asset portfolios.

This gap in research is notable, especially since real assets constitute the largest segment of alternative investments for the average pension fund (Andonov, 2024). Moreover, the selection of a benchmark is a critical decision that significantly influences the returns earned by pension funds, as highlighted in the literature on return decomposition. Broeders and De Haan (2020) investigate the incremental effect of benchmark choice on overall returns. Their findings indicate that benchmark selection accounts for 33% of the cross-sectional variation in pension fund returns and 11% of the variation in returns over time. However, their analysis is limited to Dutch pension funds and does not explore the potential strategic incentives for choosing benchmarks that are easier to outperform.

This study addresses the gap in the literature by examining the internal, self-declared benchmark choices of pension funds for their real asset portfolios. Specifically, we investigate the factors influencing these choices and whether pension fund trustees strategically select benchmarks that are easier to outperform. We compare the benchmarking decisions for real estate with those used in other real asset classes. This comparison is particularly relevant from a benchmarking standpoint because real estate has well-established benchmarks, whereas investments in infrastructure, natural resources, and commodities have only recently gained popularity and still lack widely accepted benchmarks that accurately reflect their associated risks.

Our results can be summarized as follows. First, our analysis of benchmark adequacy highlights significant variation in how well pension fund benchmarks align with portfolio returns. While benchmarks for fixed income and listed equities exhibit strong correlations with net returns, the same does not hold for real assets, particularly in private markets. Listed real estate (REITs) and commodities show relatively high benchmark correlations, but infrastructure, natural resources, and other real assets display weaker alignment. Some pension funds select benchmarks that are easier to outperform, raising questions about whether these choices serve as objective performance measures or are shaped by strategic considerations. These findings underscore the limitations of current benchmarking practices, particularly in asset classes where standardized benchmarks remain underdeveloped.

Second, for the more established real asset classes, particularly real estate, there is greater consensus on performance benchmarks. Private real estate investments are typically measured against peer-based indices such as the NCREIF-NFI, while listed real estate (REITs) is commonly benchmarked to indices like the Dow Jones Wilshire Real Estate Securities Index. By contrast, benchmarks for infrastructure, natural resources, and other real assets exhibit much greater variation. In the early years, pension funds largely relied on a mix of equity and fixed-income benchmarks for these asset classes, reflecting a lack of tailored alternatives. Over time, however, we observe a shift toward more asset-specific benchmarks, such as the S&P Global Infrastructure Index, as these markets mature.

Third, we find that some pension funds opt for absolute performance evaluation rather than measuring returns relative to a benchmark. Given the growing institutionalization of real assets, one might expect a decline in absolute benchmarking in favor of relative performance evaluation. However, this shift has not materialized. While absolute benchmarking was rare in the early years, by the end of the sample period, approximately 10% of pension funds employed this approach. The use of absolute benchmarks is particularly concentrated in private markets, whereas it is uncommon in listed real asset allocation.

Fourth, benchmark switching occurs more frequently in less mature markets. Infrastructure, natural resources, and other real assets exhibit greater benchmark instability compared to private and listed real estate, suggesting that pension funds are still refining their benchmarking practices as these asset classes develop. While funds adjust their benchmarks in response to the emergence of more specialized indices, we find no evidence that these changes are driven by strategic incentives. More broadly, our model does not explain why pension funds switch between relative and absolute benchmarks, indicating that factors beyond observed variables likely influence these decisions.

Finally, our analysis of agency issues provides no conclusive evidence that governance structures systematically influence benchmark selection. While pension funds with a higher proportion of politically appointed board members appear less likely to use absolute benchmarks, this result is not robust across specifications. Similarly, we find no systematic link between CIO compensation and benchmark choices. While prior studies document performance manipulation in mutual funds and private equity, we find little evidence that pension funds engage in widespread strategic benchmark selection. Instead, benchmark choices seem to be primarily driven by market maturity and the evolving availability of suitable benchmarks.

The remainder of this paper is structured as follows. Section 2 describes the CEM data employed in our analysis. Section 3 evaluates the adequacy of pension fund benchmarks, comparing conventional asset classes to real assets. Section 4 examines the determinants of pension funds' choice between absolute and relative performance evaluation. Section 5 investigates the factors influencing benchmark selection and changes, exploring whether pension funds engage in strategic benchmark selection. Section 6 assesses the impact of benchmark changes on pension fund performance. Finally, Section 7 concludes by summarizing the key findings and their implications.

2 Data

2.1 CEM Benchmarking

The data used in this research is provided by CEM Benchmarking (hereinafter referred to as CEM). CEM is a Toronto-based consultancy firm that provides investment-benchmarking services for institutional investors worldwide, mostly for pension funds and sovereign wealth funds. This paper studies the defined benefit pension plans in the CEM universe. CEM collects information on the portfolio choices of institutional investors in all asset classes, such as investment style, investment costs, performance, both gross- and net-of-fees, and self-declared internal performance benchmarks. The internal performance benchmarks central to this study are all at the asset class level, not the individual investment level. For instance, a pension fund might invest in several private equity real estate funds, each managed by a distinct General Partner (GP) with benchmarks based on factors such as risk profile (e.g., core, value-add, opportunistic), strategy, and investment geography. The internal benchmarks, however, are those the pension fund uses to assess the performance of the entire asset class' portfolio, and these are typically found in annual reports. Finally, CEM gathers data on pension fund characteristics, such as fund size and type (i.e., public or private).

The CEM database covers 1,128 unique defined benefit pension plans from 1991 to 2018 (see Panel A in Table 1). Most pension plans in the database are domiciled in North America, with 609 U.S. and 259 Canadian pension plans. Additionally, there are 227 pension plans in the European region, mostly in the Netherlands (66) and the UK (126). The remaining 33 pension plans are domiciled in Australia, New Zealand, China, South Korea, Saudi Arabia, and the Emirates. The pension funds in the CEM database had more than $9.9 trillion of assets under management in 2018, representing around 25% of total global pension fund assets.[1] The pension plans included in the CEM database invested on behalf of approximately 52 million plan participants in 2018.

We observe that 63% of the pension funds in the CEM database are private, while 37% are public. The largest pension funds in the sample are domiciled in Europe, followed by those in the

[1] This comparison is based on the Towers Watson Global Pension Assets Study 2018

Rest of the World, the U.S., and Canada. To our knowledge, CEM remains the most comprehensive global database on pension fund asset allocation and performance.

From Panel B of Table 1 we observe that approximately 80% of the pension funds in the sample have, at some point, invested in real assets. Across the various regions, the percentage of pension funds that invested in real assets at some point during the 1991-2018 sample period is as follows: 79% in the U.S., 71% in Canada, 93% in Europe, and 97% in the Rest of the World.

CEM classifies six different asset classes as "real" assets. These asset classes are real estate, including both private and listed real estate investments, infrastructure, natural resources, commodities, and "other" real assets. The latter category encompasses specific investments in real assets that are not (yet) big enough to be classified as a separate asset class, such as farmland and timber.

Standardizing and categorizing the self-declared performance benchmarks required significant effort. This process involved manually reconciling various representations of the same benchmark (e.g., S&P500, SP500, sp 500, etc.) to ensure consistency and accuracy across the dataset. To align with the literature, we follow Beath and Flynn (2020) as source for categorizing internal benchmarks in pension funds' private equity portfolios. Their classification delineates benchmarks into eight categories: listed equity, peer, custom, actual, absolute, portfolio, funding, and inflation.[2] We adopt this classification as a foundation, refining it where necessary to better fit the characteristics of different asset classes. Table A1 in the appendix ranks the ten most frequently used benchmarks for all real assets based on usage frequency.

Listed real estate, pension funds in the CEM database commonly rely on benchmarks such as the Dow Jones US Select Real Estate Securities Index and the Wilshire Real Estate Securities Index. These, along with other broad market indices tracking listed real estate performance, are categorized under "Listed Real Estate Benchmarks." A similar approach applies to infrastructure, natural resources, commodities, and other real assets, each forming a distinct internal benchmark category in our analysis.

We observe a steady increase in the number of unique internal benchmark categories used by pension funds over time for each real asset asset class. This trend can be interpreted as follows: early in our sample, when most real asset classes were still relatively immature, industry-standard benchmark indices were limited. As the sectors matured and more institutional capital was allocated to them, the demand for proper benchmarks grew, which benchmarking firms were eager to meet.

[2] For a detailed definition of these categories, see Beath and Flynn (2020).

Consequently, the number of performance benchmarks available to pension funds expanded in each of these emerging institutional asset categories.[3]

We find that increasingly, pension funds are benchmark-agnostic with their real asset portfolios (see Figure 1). That is, they either report no internal benchmark or use an absolute hurdle rate as a performance benchmark (e.g., a hurdle rate of 10%). To study this in more detail, we further aggregate benchmarks into two main categories: (1) relative benchmarks and (2) absolute benchmarks. The absolute benchmark group includes those pension funds that do not report the use of a market benchmark, but rather set an absolute hurdle rate or that are benchmark agnostic (i.e., they do not set any benchmark); the rest are classified as using relative performance benchmarks (e.g., FTSE Nareit All Equity REIT index for listed real estate and Bloomberg Commodity Total Return Index for commodities).

Panel C and D of Table 1 shows that relative benchmarks are used much more frequently across all asset classes. Panel D indicates that absolute benchmarks are more prevalent in private markets, such as private real estate and infrastructure. Additionally, their usage is higher in Europe compared to the U.S.

3 Benchmark Adequacy

This section assesses whether the benchmarks chosen by pension funds for their real asset investments are as appropriate as those applied to other asset classes. Beath and Flynn (2020) outline four key criteria for an effective benchmark—three qualitative and one quantitative. These criteria serve as the foundation for our analysis.

First, an effective benchmark should exhibit a high correlation with the asset class returns to ensure that value-added assessments are not distorted by noise. Second, it should be difficult to outperform; if most investors consistently achieve excess returns, this suggests that the benchmark may not adequately represent the investment challenge, making it difficult to distinguish skill from

[3] We compare private real estate—an established real asset class—with the more emerging infrastructure sector, highlighting key differences. Most pension funds consistently used a private real estate benchmark, often the NCREIF-ODCE index, throughout the sample period. A risk premium of about 80 basis points is typically added to this index to reflect higher portfolio risk. In response to the evolving market, NCREIF-ODCE is currently revising its benchmark methodology, updating the inclusion criteria to better reflect the growing presence of alternative property types within the ODCE portfolio (Dunphy and Steinberg, 2024). In contrast, infrastructure benchmarks were initially limited, with many funds relying on listed equity indices due to the lack of industry-standard infrastructure benchmarks. As the market matured, dedicated indices like the S&P Global Infrastructure index gained popularity.

an easily replicable strategy. Third, the benchmark should have a risk profile similar to that of the asset class, ensuring that return deviations reflect manager skill rather than differences in risk exposure. Finally, a benchmark must be investable, representing a readily available alternative investment opportunity for investors.

To assess benchmark adequacy, we compare real asset benchmarks both among themselves and against those used for traditional asset classes such as fixed income and listed equities. In evaluating volatility comparability and the extent to which benchmarks are difficult to outperform for private equity portfolios, we analyze pension funds with at least five years of data using the following regression model:

$$\bar{R}_{\text{Asset class},i,t} = \alpha + \beta \cdot \bar{R}_{\text{Benchmark},i,t} + \bar{\varepsilon}_{i,t} \tag{1}$$

where $\bar{R}_{\text{Real asset class},i,t}$ represents the return net of fees earned by pension fund i on the portfolio of the real asset class at time t, and $\bar{R}_{\text{Benchmark},i,t}$ denotes the self-selected internal performance benchmark for pension fund i at time t. In essence, these are investor-by-investor regression estimates for each investor with 5 years or more of data. Panel A of Table 2 presents the correlations, and Panel B shows the regression estimates.

The first criterion—high correlations—requires that benchmark returns closely track contemporaneous net returns. If pension funds are selecting appropriate benchmarks, a large fraction of these correlations should be near one. As shown in Table 2, benchmarks for conventional asset classes, such as fixed income and listed equity, exhibit correlations of 0.90 and 0.96, respectively, with the net returns on these asset classes. This result is unsurprising, as fixed income and listed equity are well-established, liquid asset classes with standardized benchmarks. The widespread availability of market indices and continuous trading facilitates accurate performance measurement, ensuring that benchmark returns closely reflect net returns. Moreover, because these investments are publicly traded, they avoid the common measurement challenges associated with private markets, such as data smoothing due to lower reporting frequency. In the context of real estate, for example, the literature (Pagliari et al., 2005; Pagliari, 2017; Ling and Naranjo, 2015) highlights how infrequent valuations in private real estate markets can artificially dampen return volatility, leading to a distorted view of correlations between reported returns and benchmark returns. In contrast, the high-frequency data available for listed assets such as, REITs, provides more precise correlation estimates, reinforcing the reliability of benchmark selection in these asset classes.

In contrast to fixed income and listed equity, less established asset classes and private market assets, such as real assets and private debt, display significantly lower contemporaneous correlations between net portfolio returns and benchmark returns. Among real assets, there is substantial variation. Listed real estate (REITs) and commodities show the highest correlations at 0.90 and 0.88, respectively. As with fixed income and listed equity, these asset classes are both publicly traded and more mature, which facilitates effective benchmarking. Emerging asset classes, such as infrastructure, exhibit relatively low correlations with their benchmarks. This suggests that real asset benchmarks for emerging asset classes and private market alternatives are less reliable than those for traditional asset classes such as fixed income and equities.

Panel B of Table 2 presents the regression estimates from equation 1, which assess benchmark adequacy based on two key criteria: volatility comparability and the difficulty of outperformance. The results indicate that the average and median β values for real assets are comparable to those observed for fixed income and stocks. However, the standard deviation is markedly higher, suggesting increased variability in the relationship between real asset returns and their benchmarks. Although the average and median α values mirror those for fixed income and stocks, they exhibit substantially greater dispersion. It is important to note that real assets encompass six distinct asset classes, and these aggregated estimates conceal significant heterogeneity.

A well-constructed benchmark should be difficult to outperform, meaning a significant fraction of α values should be close to zero. Notably, for private market alternatives—such as private real estate, natural resources, and commodities—the average α tends to be lower, while the standard deviation of α (a proxy for outperformance dispersion) is exceptionally high compared to fixed income and equities. This suggests that the benchmarks for these asset classes are relatively easy to beat, pointing to potential shortcomings in their construction. These findings highlight the inherent challenges in benchmarking real asset portfolios compared to traditional asset classes such as fixed income and listed equities. This may be partially explained by the fact that pension funds are increasingly adopting absolute benchmarks for their real asset portfolios—either by not reporting internal benchmarks or by relying on an absolute hurdle rate.

4 Benchmark Choice

In this section, we examine the decision by defined benefit pension plans to measure performance in absolute terms, i.e., without a benchmark return that varies over time. Interestingly, the share of pension funds that choose an absolute performance benchmark for their real asset portfolios has increased significantly over the years. In 1991, not a single pension fund used absolute internal benchmarks; by 2018, approximately 10% of pension funds used absolute benchmarks for their real asset portfolios. Figure 1 compares the use of absolute versus relative benchmarks for each real asset class. The figure shows that the increased use of absolute benchmarks is primarily driven by asset classes that have only recently gained popularity, most notably infrastructure and natural resources. Additionally, we find that for real assets to which pension funds can get exposure via listed vehicles, pension funds rarely choose absolute benchmarks. For example, although real estate is the most established asset class, there is a clear distinction between the use of private market real estate benchmarks and the benchmarks chosen for listed real estate. Pension funds increasingly opt for absolute benchmarks for their private market real estate investments, a trend not observed in listed real estate. We see a similar trend to that of listed real estate for commodities; as pension funds primarily get exposure to commodities by buying listed derivative contracts such as futures contracts.

One explanation for this finding is that listed markets are inherently more transparent and mature than private markets. As a result, choosing an absolute benchmark for listed investments would be considered unorthodox and raise suspicion, as there is likely a range of better broad-market indices available for benchmarking purposes. In contrast, private market investments are less transparent and are often observed in less mature markets (e.g., infrastructure investments), which increases the likelihood of using absolute benchmarks. To further explore the choice of an absolute benchmark, we estimate and test the following logistic panel regression model of benchmark choice:

$$\begin{aligned} Logit(Y_{i,j,t}) = \beta_0 + \beta_1 \times \text{FundSize}_{i,t} + \beta_2 \times \text{Private}_i + \beta_3 \times \text{X}_j + \beta_4 \times W_i + \beta_5 \\ \times \text{UnderPerformer}_{i,j,t} + \beta_6 \times (\text{UnderPerformer}_{i,j,t} \times \text{X}_j) + \alpha_t + \epsilon_{itc} \end{aligned} \tag{2}$$

Where $Y_{i,j,t}$ is a variable that indicates whether the chosen performance benchmark of pension fund i, asset class j at time t is absolute or relative. $Y_{i,j,t}$ equals 1 if the performance benchmark is absolute, and 0 otherwise.

Pension fund characteristics: $\text{FundSize}_{i,t}$ is the log of the pension fund's assets in U.S. dollars. Private_i is a dummy variable that equals 1 if the pension plan is private. X_j is a vector of dummies for the different real asset classes, with private market real estate as the baseline group. W_i are region dummies, using the U.S. as the baseline.

$\text{UnderPerformer}_{i,j,t}$ is a dummy variable that equals 1 if at time t the pension fund ranks in the bottom 10 percentile based on its cumulative net benchmark-adjusted return over three consecutive years for each asset class, and 0 otherwise. The literature finds that pension fund performance in private market real estate exhibits persistence, while performance in listed real estate does not (Andonov et al., 2015). To investigate whether persistently underperforming pension funds behave differently when selecting internal performance benchmarks, we include the $\text{UnderPerformer}_{i,j,t}$ dummy and interact it with various asset classes.[4] We aim to capture whether funds under stress behave differently from others. For example, Andonov et al. (2017) find that pension funds with greater underfunding tend to take on more risk, which is subsequently linked to poorer performance. Mullally and Rossi (2024) observe this behavior in mutual funds. We, therefore, hypothesize that investment managers (e.g., CIOs) of pension funds experiencing stress from poor past performance are more likely to select less transparent benchmarks, such as absolute benchmarks. Finally, α_t represents year-fixed effects, and $\epsilon_{i,t,c}$ is the error term, with standard errors clustered at the pension fund level.

The results from estimating equation (2) are shown in Table 3. The findings align with the hypothesis we derived from the descriptive statistics when observing the pension fund characteristics and various asset classes. First, we find that the likelihood of using absolute benchmarks for listed real asset classes, such as REITs and commodities,[5] is lower compared to private market real estate investments, which serve as the comparison group. In our most complete specification, model (5), we find that pension funds are 16.66% and 2.65% less likely to use absolute benchmarks for REITs and commodities, respectively.[6] In contrast, for the relatively new or emerging asset classes, such as infrastructure and natural resources, pension funds are significantly more likely to use absolute benchmarks when compared to private market real estate investments. Also, private pension funds are 65.5% more likely to use absolute benchmarks compared to public pension funds, perhaps a result of more intense scrutiny of public pension funds.

Analyzing pension funds in the lowest 10th percentile of net benchmark-adjusted returns across asset classes, we find no statistically significant effect. However, for funds in the bottom 10th per-

[4]The approach of identifying persistently underperforming funds by ranking pension funds based on their benchmark-adjusted returns over the past three years is inspired by Bestinvest's "Spot the Dog" guide. This annual report highlights mutual funds that have underperformed their benchmark by at least 5% over the past three years, aiming to encourage investors to review their portfolios more closely and consider eliminating underperforming equity funds. For more details, visit: Bestinvest — Spot the Dog.

[5]Pension funds typically invest in commodities through the commodity futures markets (Ankrim and Hensel, 1993). This is also reflected in their benchmark choices for commodities as an asset class (see Table A1), where most benchmarks are based on investable indexes linked to commodity futures (e.g., Goldman Sachs Commodity Index).

[6]The coefficients in the regression output tables are the log-odds of a pension fund having an absolute benchmark versus a relative benchmark. To get the probability, we first take the exponent of the coefficient and convert the odds to probability by using the following formula: probability = odds / (1 + odds)

centile within the natural resources asset class, the probability of selecting an absolute benchmark decreases by 16.59%. This suggests that pension funds are more likely to opt for a relative benchmark after a period of poor performance for this relatively less mature asset class. One possible explanation is that during periods of poor performance, choosing a relative benchmark may seem more favorable, as it allows funds to compare their underperformance against a broader market that might also be declining.

When looking across regions, we observe that European pension funds are 88.1% more likely to use absolute benchmarks than their U.S. counterparts. The estimated coefficients for Canada and Rest of World are not statistically significant.[7]

In conclusion, pension funds are more likely to use absolute benchmarks when investing in private market real assets, particularly in emerging asset classes. This practice is more common among European funds compared to their U.S. counterparts. This may be because private markets are much smaller in individual European countries making the construction, and thus the availability of private market benchmarks more challenging.[8]

4.1 Agency issues - board composition

We explore potential agency issues that may influence pension funds to pursue strategic benchmark selection. We first examine whether the composition of pension fund boards influences the choice of internal performance benchmarks in real asset categories. This is motivated by extensive literature suggesting that board composition affects allocation decisions and, ultimately, the performance of institutional investors. For instance, Bernstein et al. (2013) find that sovereign wealth funds subject to greater political pressures are more likely to pursue short-term economic objectives rather than maximizing long-term returns.

Andonov et al. (2018) examine the relationship between board composition and private equity performance of U.S. public pension funds, finding that a higher proportion of state board mem-

[7]The results are robust to defining underperformance using the bottom 25% or bottom 50% of the distribution.

[8]We also test whether a pension fund's level of financial intermediation affects its likelihood of selecting an absolute benchmark. Specifically, investing through various financial vehicles serves as a proxy for holding a highly heterogeneous asset mix, making it difficult to benchmark with a single relative benchmark. However, we find no statistically significant results. Additionally, we examine whether pension funds are more likely to use absolute benchmarks in the initial years of investing in an asset class. During this phase, funds are still building their portfolios, which may incentivize them to adopt an absolute benchmark before transitioning to a relative benchmark once the portfolio is established. Here, too, we find no significant effect.

bers—whether appointed or ex-officio correlates with lower private equity portfolio performance. Shleifer (1996) identifies three channels through which this underperformance may occur: confusion, control, and corruption. Andonov et al. (2018) find evidence for two of these channels: the control and corruption channels. From the control channel, these pension funds tend to invest in private equity real estate, which delivers lower returns compared to other alternatives. They also overweight local in-state investments in real estate and venture capital, consistent with the findings of Hochberg and Rauh (2013), which show these investments tend to underperform. Additionally, they invest in funds managed by inexperienced general partners (GPs) with fewer co-investors. From the corruption channel, pension funds governed by board members who receive more contributions from the financial industry tend to experience lower returns, pointing to possible corruption. Overall, the literature suggests that institutional investors with a higher proportion of state officials on their boards are more likely to make decisions based on personal or short-term economic objectives, rather than focusing on maximizing the long-term returns for the beneficiaries they represent. The estimation is similar to Table 3.

We build upon the dataset on the board composition of U.S. public pension plans, as provided by Andonov et al. (2018).[9] The board composition regression results are summarized in Table 4. We only present the coefficient estimates of the variables of interest as the other explanatory variables align with the findings in Table 3. In our initial model (1), we don't differentiate between board members based on their appointment methods. Participant board members serve as the baseline group. Model (2), on the other hand, distinguishes between appointment methods, with participant-appointed members remaining the baseline. When we don't categorize board members by appointment method (Model 1), we find no statistically significant impact of state appointed board members on benchmark choice. However, in Model (2), we observe that boards with a higher proportion of elected public board members and ex-officio participant board members are less likely to select absolute benchmarks. Although statistically significant, these effects look economically insignificant.

[9] This data was collected from the Comprehensive Annual Financial Reports (CAFRs) of these pension plans for the period from 1990 to 2020. We successfully merged data for 113 pension plans with the CEM database. Following Andonov et al. (2018), we classify board members into three main groups: state, participant, and public representatives. The data can be accessed via Aleksandar Andonov's website: Access here.

5 Benchmark Changes

We next study the decision by pension funds to change their internal performance benchmarks. There are several reasons why a pension fund would change its internal performance benchmark for an asset class. These include changes in investment preferences, risk preferences, and style preferences (Broeders and De Haan, 2020). In short, these motives all suggest that if there is a change in the characteristics of the underlying investments (i.e., risk, style, preferences), the internal performance benchmark should be adjusted to provide an accurate standard of comparison. But of course, reasons for changing a benchmark may also be more conspicuous, e.g., to hide underperformance. Among the pension funds reporting to the CEM database that invest in real assets, 42% have adjusted the benchmark for at least one of their real asset portfolios during the sample.

When broken down by asset class, 37% of pension funds have changed their benchmark for private real estate, 44% for natural resources, 29% for commodities, 34% for REITs, 34% for infrastructure, and 36% for other real assets. Figure 2 illustrates benchmark changes by asset class and year. Notably, changes occur more frequently in emerging asset classes such as infrastructure, natural resources, and other real assets, particularly at the start of the sample. This aligns with expectations that benchmark adjustments are more common in emerging asset classes and earlier in the sample period.

For pension funds that made at least one benchmark change, the most frequent changes occurred in other real assets, followed by natural resources, infrastructure, REITs, and private real estate. The "other real assets" category includes emerging asset classes like farmland and timber, where suitable benchmarks remain limited. We interpret the higher frequency of benchmark changes in these emerging asset classes as pension funds still refining their benchmark selections.

To gain a better understanding of the factors driving pension funds' decisions to change their internal performance benchmarks and to explore whether strategic behavior plays a role in this, we estimate the following logistic regression:

$$\begin{aligned}\text{Logit}(\text{Benchmark Change}_{i,j,t}) = \beta_0 + \beta_1 \times \text{Portfolio Net Return}_{i,j,t-1} + \beta_2 \\ \times \text{Standard Benchmark}_{j,t-1} + \beta_3 \times \text{X}_{i,t} + \beta_4 \times W_{j,t} + \alpha_t + \delta_i + \epsilon_{it}\end{aligned} \tag{3}$$

where, Benchmark $\text{Change}_{i,j,t}$ indicates whether the internal benchmark for pension fund i, asset class j at time t was changed that year. This change could involve moving from an absolute to a relative benchmark, from relative to absolute, between different relative benchmarks, or between different absolute benchmarks. Portfolio Net Return$_{i,t-1}$ reflects the one-year lagged net return of each real asset portfolio, while Standard Benchmark$_{j,t-1}$ represents the one-year lagged return of a broad asset-class-specific market index, capturing the overall return environment from that asset class. Typically, this index reflects the complete opportunity set available in the market. As noted by Broeders and De Haan (2020), standard benchmarks are often provided by commercial vendors, such as NCREIF indices for real estate. In this model, the following indices are used as benchmarks for each asset class: the FTSE Global Infrastructure Index for infrastructure, the S&P Global Natural Resources Index for natural resources, the Dow Jones Commodity Index for commodities, and the S&P Global REIT Index for real estate. $X_{i,t}$ includes control variables such as pension fund size, plan type (public versus private), and regional dummies. $W_{j,t}$ is a vector of asset-class-specific dummy variables, with private market real estate investments serving as the baseline group. Year and pension fund fixed effects are represented by α_i and δ_j, respectively, and $\epsilon_{i,t}$ is the error term, with standard errors clustered at the pension fund level.

Lagged portfolio and market returns: One potential reason pension funds may decide to change their internal benchmarks is the historical performance of their portfolios or the broader market in which they invest. A pension fund that has not been able to beat its chosen index recently (which would be indicated by a negative lagged benchmark-adjusted return) may be tempted to adjust the benchmark. However, it is not clear ex-ante whether the estimated coefficients on Portfolio Net Return$_{j,t-1}$ and Standard Benchmark$_{j,t-1}$ should be positive or negative. However, we are primarily interested in whether they have a statistically significant result at this stage.

Emerging real asset classes: We include a dummy variable for each of the real asset classes, keeping private market real estate investments as the baseline group. This is especially interesting from a benchmarking perspective, because private market real estate has had established benchmarks for decades, while investments in infrastructure, natural resources, and other real assets are only recently gaining in popularity and thus do not yet have a large set of appropriate benchmarks that reflect the risks of these investments. We expect the likelihood of changing internal performance benchmarks to be higher for these emerging asset classes when compared to private market real estate portfolios.

5.1 Results - benchmark changes within relative and absolute

We start by examining the decision of pension funds to change their internal benchmark, focusing on changes within the same category (i.e., from relative to relative or from absolute to absolute).

The results from estimating our logistic regressions (summarized in equation (3)), are presented in Table 5. In contrast, the results for benchmark changes between categories (i.e., from relative to absolute and from absolute to relative) are displayed in Table 6.

First, in Table 5, we observe that the net return earned on the pension funds' real asset portfolios in the previous year does not have a statistically significant effect on the likelihood of changing internal performance benchmarks from relative to relative or from absolute to absolute, across all model specifications.[10] When analyzing the broad-market return environment (Standard Benchmark$_{j,t-1}$), we find a negative and marginally statistically significant relationship only in the most comprehensive model specification (Model 3). For benchmark changes within the absolute category, the relationship is not statistically significant. The key takeaway is that the historical performance of a pension fund's real asset portfolio does not seem to influence the likelihood of changing internal benchmarks. Instead, the overall market return environment is weakly negatively correlated with the likelihood of changing benchmarks. We interpret this as follows: when the market performs well, the likelihood of changing relative benchmarks decreases, whereas, during a market downturn, pension funds may shift their investment preferences and adjust relative benchmarks, which tend to move more closely with the market compared to absolute benchmarks.

Next, we evaluate the dummy variables for emerging real assets and find that the coefficients for infrastructure, natural resources, and other real assets are all positive and statistically significant. This indicates that the likelihood of changing internal benchmarks is higher for these emerging asset classes compared to the more mature private real estate market. This could simply be due to the asset class still being rather immature, with new benchmarks being introduced to the market frequently.

5.2 Benchmark changes: shifts between relative and absolute benchmarks

Next, we examine the decision by pension funds to switch from a relative to an absolute benchmark. It is particularly interesting to understand why pension funds switch to an absolute benchmark for their real asset portfolios when relative benchmarks are readily available. If pension funds engage in strategic benchmark selection, we expect them to choose an absolute benchmark if their net portfolio returns are increasing and a relative benchmark when their net portfolio returns and the returns on the chosen relative benchmark are decreasing. The rationale behind this behavioris that pension

[10] We also test the model using multiple period lags and historic cumulative returns and find similar results.

funds are incentivized to choose a relative benchmark in a down market as they compare themselves against an index that is also heading down: in that case, they may be able to report a positive *relative* return. During an upmarket, a pension fund engaging in strategic benchmark selection is more likely to beat a self-selected absolute benchmark. Thus, if pension funds engage in strategic benchmark selection, we expect a positive coefficient on the standard benchmark variable, which captures the return environment for each asset class in the broad market.

We find, however, that only 8% of pension funds have switched from a relative to an absolute benchmark, or vice versa, for at least one real asset portfolio during the reporting period. This suggests that pension funds are more inclined to stick within the same benchmark category (i.e., relative to relative or absolute to absolute) rather than switching between categories. When breaking this down by asset class, we don't observe any significant outliers regarding the frequency of these changes. Specifically, 5.6% of pension funds have changed their benchmark for private real estate, 5.6% for natural resources, 1.7% for commodities, 1.7% for REITs, 8.2% for infrastructure, and 6.4% for other real assets.

We next run the same logistic regression (as in equation (3)), however Benchmark Change$_{i,j,t}$ now indicates whether the internal benchmark for pension fund i, asset class j at time t was changed that year from relative to absolute or from absolute to relative. These results are presented in Table 6.

We start by investigating whether pension funds exhibit strategic behavior when switching between relative and absolute performance benchmarks (or vice versa). Our analysis reveals that the one-year lagged net return of the real asset portfolio has no statistically significant effect on the decision to switch between these benchmark types across all model specifications. Furthermore, broader market performance (represented by the standard market benchmark), pension fund characteristics, asset class, and regional factors also show no statistically significant influence. However, we do find that private pension plans and European pension plans are more likely to switch between benchmark categories.

In summary, our model does not explain why pension funds switch between benchmark categories, whether from relative to absolute or the reverse. Augustin et al. (2023) show that investment consultant turnover predicts changes in private equity benchmarks for U.S. pension plans. The authors suggest that this benchmark change is driven by the investment consultant's incentive to expand their portfolio of clients. Unfortunately, we do not possess this data, and thus, we cannot explore this potential driver of benchmark changes.

6 The impact of benchmark changes on performance

As a next step, in this section, we examine the impact of a benchmark change on the performance of the real asset investments. The internal benchmark pension funds choose for the asset classes defines their broad investment universe. Under this broad investment universe, the pension funds' investment preferences, risk preferences, and style preferences are selected (Broeders and De Haan, 2020). Thus, a change of benchmark that originates as a result of a change in these preferences will likely impact their investment performance as well. However, pension funds may also change their benchmark for strategic reasons, with the incentive being to display a better net-benchmark adjusted performance. If pension funds are strategically choosing their benchmarks, in the same way that the literature finds for mutual funds (Sensoy, 2009; Mullally and Rossi, 2024) and private equity (Phalippou, 2014), then they tend to choose internal performance benchmarks, with lower hurdle rates.

Figure 3 illustrates the evolution of average absolute and relative benchmark returns over time, aggregated across all real asset classes. At first glance, there is no consistent evidence that benchmark returns have declined over the years, suggesting they have not necessarily become "easier to beat." At the aggregate level, it remains unclear whether the increasing use of absolute benchmarks by pension funds for their real asset portfolios is driven by a declining hurdle rate over time.

However, when examining benchmark returns at the asset-class level, substantial variation emerges. For a more formal analysis of the impact of benchmark changes on the performance of pension funds portfolios (net and net-benchmark adjusted), we run the following OLS regression:

$$\begin{aligned} Y_{i,j,t} = \beta_0 + \beta_1 \times \text{Benchmark Change}_{i,j,t} + \beta_2 \times \text{FundSize}_{i,t} + \beta_3 \\ \times \text{X}_{i,j} + \beta_4 \times \left(\text{Benchmark Change}_{i,j,t} \times \text{X}_{i,j}\right) + \alpha_t + \gamma_i + \epsilon_{itc} \end{aligned} \tag{4}$$

where $Y_{i,j,t}$ is either the net return of the portfolio, the benchmark return, or the net benchmark adjusted return of pension fund i, asset class j at time t. $\text{FundSize}_{i,t}$ is the log of the pension fund's assets in U.S. dollars. $X_{i,j}$ is a vector of dummy variables for the different real asset classes, with private market real estate as the baseline group. $\text{Benchmark Change}_{i,j,t}$ is a dummy variable that equals 1 if the pension fund has changed its benchmark in year t or year t-1. We run the regression at time t for benchmark changes at time t as well as at $t-1$ to examine the potential evolution of the relationship over time. To investigate whether benchmark changes have different impact on performance corresponding to various asset classes, we include the $\text{Benchmark Change}_{i,j,t}$ dummy and interact it with various asset classes. Finally, α_t represents year fixed effects, γ_i denotes pension plan fixed effects, and $\epsilon_{i,t,c}$ is the error term, with standard errors clustered at the pension fund level.

6.1 Results - all changes in benchmarks

The results of estimating Equation (4) are presented in Table 7. First, we find that the net return on real asset portfolios declines by approximately 1.2 percentage points in the year a benchmark change occurs (see Model (1)). A similar effect is observed for benchmark returns in Model (2), where the benchmark return decreases by 1.2 percentage points in the same year a pension fund adjusts its benchmark. However, we find no significant relationship between benchmark changes and net benchmark-adjusted returns. This suggests that a benchmark change results in an equivalent decline in both the benchmark return and the portfolio's net return, rendering the net benchmark-adjusted return unchanged. We re-estimate the model to examine the effect of a benchmark change one year prior, to assess the robustness of our results. Across Models (4) to (6), the findings remain consistent with those observed for a contemporaneous change. These results suggest that pension funds may engage in strategic benchmark swapping, replacing a benchmark preceding a year with negative performance.

The interaction terms between benchmark changes and asset classes provide further insights. In particular, the interaction between benchmark changes and commodities shows a statistically significant negative effect on net returns in Model (1) ($\beta = -4.147$) and on benchmark returns in Model (2) ($\beta = -4.541$). These findings indicate that benchmark adjustments have a disproportionately greater impact on commodity returns compared to other asset classes.

Regarding pension fund size, the results suggest that larger funds are more likely to achieve higher net returns. This aligns with prior literature Andonov et al. (2015), who find that larger pension funds tend to generate higher returns due to greater experience in alternative asset investing, superior resources, and economies of scale.

In conclusion, the findings highlight the importance of benchmark changes, fund size, and asset class allocation in shaping pension fund performance. While larger funds typically perform better, benchmark changes tend to negatively impact both net and benchmark returns. Interestingly, the decline in benchmark returns closely mirrors the drop in net returns, neutralizing the effect on net benchmark-adjusted returns.

6.2 Results - relative to absolute and vice versa

Table 8 presents the regression results on the impact of benchmark changes on net returns (NR), benchmark returns (BMR), and net benchmark-adjusted returns (NBAR) across asset classes. We estimate six models: Models (1) to (3) analyze the transition from relative to absolute benchmarks, assessing its effect on net returns, benchmark returns, and net benchmark-adjusted returns, respectively. Models (4) to (6) examine the shift from absolute to relative benchmarks.

Relative to absolute: In Models 1–3, the estimated coefficients for the shift from a relative to an absolute benchmark (Relative to Absolute$_t$) are -6.469 for net return and -6.021 for benchmark return, both statistically significant at the 1% level. In contrast, the effect on the net benchmark-adjusted return is statistically insignificant, suggesting that switching to an absolute benchmark does not notably influence net benchmark-adjusted returns. When interactions with asset classes are included, the outcomes vary. For REITs, other real assets, and infrastructure, the shift results in a positive and statistically significant impact on benchmark returns, with no significant changes in net returns or net benchmark-adjusted returns. Notably, for natural resources, the effect on net return is positive and marginally significant.

Absolute to relative: Models 4 to 6 explore the reverse shift, from absolute to relative benchmarks. The main coefficient for this transition (Absolute to Relative$_t$) shows no significant effect on net return or benchmark return. However, the interaction terms reveal that REITs and Other real assets experience significant negative effects on benchmark return, at -5.672 and -9.474 respectively, though the effect on net benchmark adjusted return remains insignificant. Notably, commodities exhibit a substantial and highly significant positive effect on net return (40.06***), benchmark return (29.48***), and benchmark-adjusted return (0.1050**).

In summary, these results indicate that the impact of benchmark changes on pension fund performance varies by asset class. Pension funds with considerable allocations to commodities and natural resources are more sensitive to these shifts. Additionally, fund size remains a key factor, with larger funds typically performing better. For certain asset classes, particularly commodities and infrastructure, there is evidence of a positive effect on net benchmark-adjusted returns following benchmark adjustments.

6.3 Agency issues - CIO compensation

We next test whether CIO compensation affects benchmark choices real asset portfolios. Specifically, if a CIO's compensation is tied to fund performance, they may be incentivized to switch benchmarks or window dress benchmark-adjusted performance, thereby influencing their own compensation. Lu et al. (2023) examine U.S. public pension plans and find that higher-paid CIOs outperform their peers by 47–60 basis points per year—largely through increased allocation to real estate investments. They also observe that pension plans offering higher compensation are more likely to retain their CIOs, suggesting an environment that may foster agency issues related to benchmark switching.

To test this hypothesis, we merge data from 80 U.S. public pension plans with the CEM database.[11] The original study obtained detailed CIO compensation data—including each plan's CIO name, total compensation, base salary, and bonus—via FOIA requests covering the period from 2001 to 2018. On average, a CIO serves for 5.8 years, and pension funds changed their CIO approximately 1.5 times over the sample period.

Next, we investigate whether benchmark changes influence CIO compensation at various aggregation levels by examining total compensation and its individual components—salary and bonus. The detailed results are provided in Table 9. Consistent with Lu et al. (2023), our analysis reveals that larger pension funds tend to offer higher salaries to their CIOs. However, our main variable of interest—benchmark change—and its interactions with different asset classes do not yield statistically significant results.

In summary, our analyses of board composition and CIO compensation reveal limited evidence that agency issues significantly drive strategic benchmark selection. Consequently, our findings suggest that factors beyond agency concerns—perhaps linked to market conditions or investment strategies—play a more pivotal role in determining benchmark choices for real asset portfolios.

7 Conclusion

Institutional investors have steadily increased their allocations to real assets increased in past decades. Among these asset classes, real estate has been a core component of institutional portfolios since the 1980s, while infrastructure, commodities, and other alternative assets have been added more recently. As these markets evolve, so has the need for accurate performance benchmarks, shaping how institutional investors assess and report returns.

[11] The data was retrieved from Kevin Mullally's personal website.

In this paper, we investigate how pension funds select and adjust their performance benchmarks for real assets. Our findings can be summarized as follows. First, we analyze the adequacy of real asset benchmarks by assessing their correlation with portfolio returns, their volatility, and how difficult it is to outperform the benchmark. We find that while benchmarks for fixed income and listed equities exhibit strong alignment with net returns, this is not the case for real assets, particularly in private markets. Listed real estate (REITs) and commodities show relatively high benchmark correlations, but infrastructure, natural resources, and other alternative real assets display weaker alignment. Additionally, for certain real asset classes, the self-selected internal benchmarks are easier to outperform, raising questions about whether they serve as objective performance measures or are shaped by strategic motives. These findings underscore the limitations of current benchmarking practices, particularly in asset classes where standardized benchmarks remain underdeveloped.

Second, for the more established real asset classes, particularly private and listed real estate, we find a relatively high degree of consensus on benchmark selection. Most pension funds rely on well-recognized peer benchmarks such as the NCREIF-NPI for private real estate and the Dow Jones Wilshire Real Estate Securities Index for REITs. In contrast, benchmark selection is much more varied for emerging real assets, particularly infrastructure, natural resources, and other alternative investments. In the early years of our sample, pension funds primarily relied on combinations of listed equity and fixed-income indices as proxies for these asset classes. Consistent with Chen et al. (2023), this reflects a lack of specialized benchmarks. Over time, we observe a shift toward asset-specific indices, such as the S&P Global Infrastructure Index, as these markets mature.

Third, we assess whether pension funds engage in strategic benchmark selection, particularly through benchmark switching. Our results indicate that, while benchmark switching is relatively common, particularly in less mature asset classes, we find no systematic evidence that funds switch benchmarks to inflate reported performance. Instead, benchmark changes appear to be driven by market developments and the availability of more suitable indices. However, in some cases—particularly in natural resources—pension funds that have underperformed are more likely to move toward relative benchmarks, suggesting that past returns may influence benchmark choices in specific contexts.

Fourth, we examine how changes in performance benchmarks affect pension fund returns, both before and after adjusting for risk. We find that pension funds experience a decline in net returns in the same year they change their benchmark. However, this decline is accompanied by a nearly equivalent drop in benchmark returns, resulting in no significant impact on net-benchmark-adjusted returns. This suggests that, while benchmark changes occur in response to evolving investment strategies and available benchmarks, they may also serve to offset the appearance of underperformance.

Finally, we explore whether governance structures and agency frictions influence benchmark selection. Although pension funds with a higher proportion of politically appointed board members appear less likely to use absolute benchmarks, this result is not robust across specifications. Similarly, we find no systematic link between CIO compensation and benchmark selection. While prior studies highlight performance manipulation in mutual funds and private equity, our findings suggest that pension funds do not engage in widespread strategic benchmark selection. Instead, benchmark choices are primarily driven by market maturity and evolving industry standards rather than deliberate efforts to enhance reported performance.

Taken together, our findings highlight the complexity of benchmarking real assets. While the increasing standardization of benchmarks for some real asset classes reduces the scope for strategic choices, the continued evolution of emerging asset classes suggests that benchmarking practices will remain an important area for further study.

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8 Tables and Figures

Table 1: **The CEM Database**

	U.S.	Canada	Europe	Rest of World	Total
Panel A: CEM coverage - full sample					
All funds	609	259	227	33	1,128
Fund-year observations	4,758	2,561	1,111	186	8,616
Panel B: CEM coverage - pension funds that invest in real assets					
Funds in real assets	479	183	211	32	905
Fund-year observations	3,637	1,637	1,005	167	6,446
Panel C: Fund-year observations at the benchmark category level					
Absolute	171	131	410	39	751
Relative	5,680	2,212	1,699	355	9,946
Panel D: Observations at the pension fund, year, and asset class level					
Real Estate ex-REITs					
Absolute	69	44	217	15	345
Relative	3,242	1,482	761	127	5,612
Commodities					
Absolute	6	-	-	-	6
Relative	414	67	210	21	712
Infrastructure					
Absolute	20	66	119	15	220
Relative	307	369	291	101	1,068
Natural Resources					
Absolute	48	-	26	-	74
Relative	350	63	69	27	509
Other Real Assets					
Absolute	32	11	30	8	81
Relative	273	67	106	26	472
REITs					
Absolute	2	10	12	1	25
Relative	1,094	164	262	53	1,573

Notes: This table provides descriptive statistics of the pension funds reporting to the CEM database. Panel A shows the coverage of the CEM database for the full sample. Panel B shows the number of pension funds that invest in real assets, broken down by asset type and region, with the corresponding fund-year observations. Panel C presents the fund-year count based on relative vs absolute benchmark classification across different regions. Panel D provides a detailed breakdown of pension fund counts by asset class, region, benchmark classification.

Table 2: **Correlation and Regression Estimates by Asset Class**

Panel A: Correlation Results

Asset Class	ρ	**Sample Size**	**#PFs**
Major Asset Classes			
Fixed Income	0.90	22,826	1,123
Stock	0.96	28,341	1,125
Real Assets	0.78	10,665	905
Hedge Funds & Multi-Asset	0.67	3,452	527
Private Equity	0.43	6,190	649
Private Debt	0.43	1,210	242
Real Asset Classes			
REITs	0.90	1,598	293
Real Estate excl. REITs	0.71	5,928	847
Commodities	0.88	718	177
Other Real Assets	0.68	553	141
Natural Resources	0.44	580	110
Infrastructure	0.43	1,288	263

Panel B: Regression Estimates

	(α)			(β)		
Asset Class	**Average**	**Median**	**St.Dev**	**Average**	**Median**	**St.Dev**
Fixed Income	0.63	0.39	1.53	0.92	0.96	0.27
Stock	0.63	0.40	2.73	0.96	0.98	0.16
Real Assets	0.68	0.26	6.35	0.86	0.96	0.63
Real Asset Classes						
REITs	0.39	0.18	4.35	0.97	1.00	0.55
Real Estate excl. REITs	0.27	-0.51	11.03	0.90	1.01	1.48
Commodities	-0.25	1.19	6.01	1.08	1.03	0.70
Other Real Assets	-1.58	0.41	23.32	0.63	1.01	4.59
Natural Resources	2.42	2.06	14.84	0.62	0.66	2.08
Infrastructure	1.57	3.87	38.39	1.05	0.78	5.92

Note: Panel A presents the correlation (ρ) between benchmark returns and net returns across various asset classes. The sample size represents the number of pension fund-year observations used to compute these correlations, while the #PFs column reflects the number of distinct pension funds in the sample. Panel B reports the average, median, and standard deviation of alpha (α) and beta (β) across the same asset classes. Alpha measures excess returns beyond the benchmark, with negative values indicating underperformance relative to the benchmark, while beta captures the sensitivity to market movements.

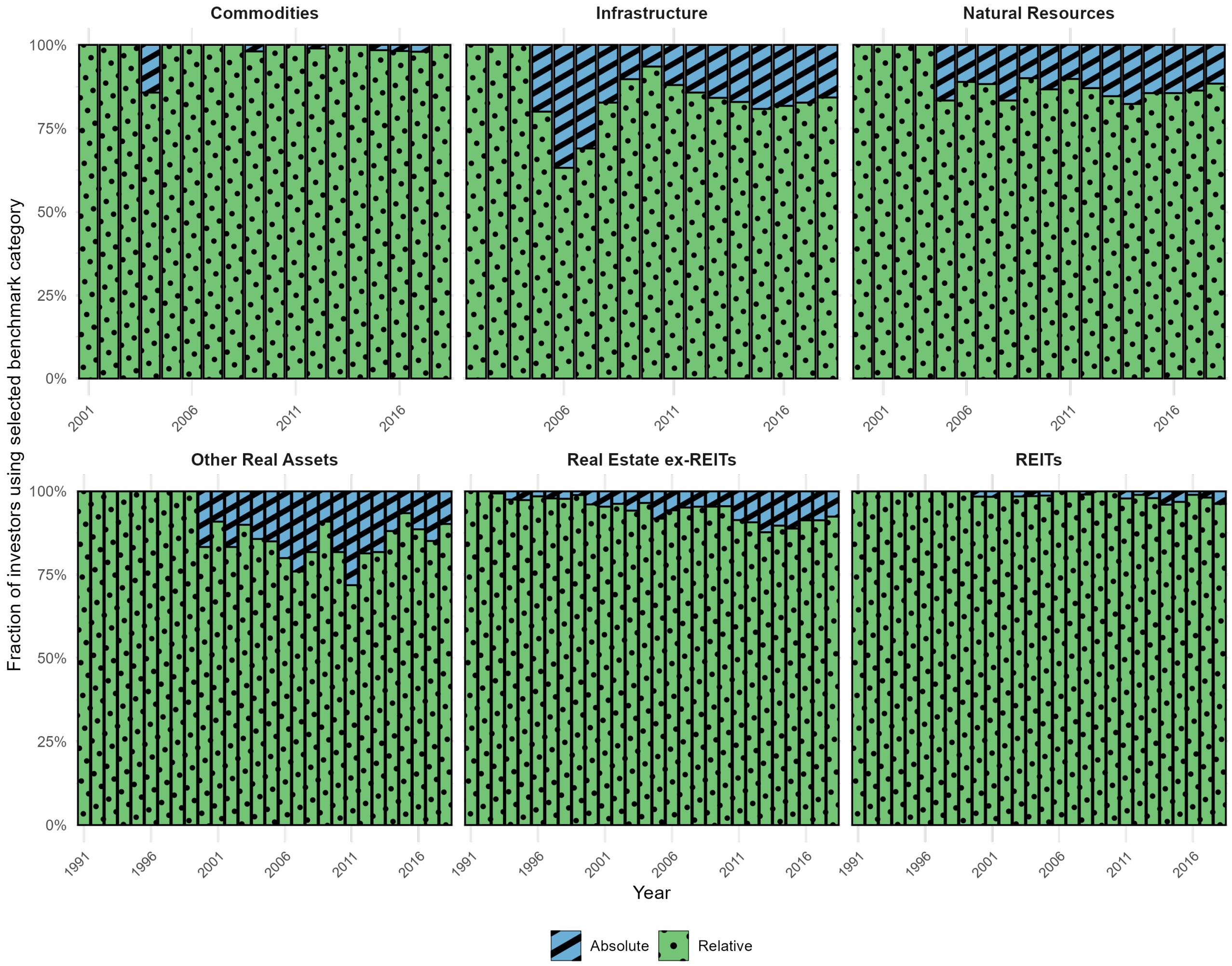


Figure 1: Share of pension funds changing internal benchmark, by asset class and year. The absolute benchmark group includes those pension funds that do not report the use of a market tracking benchmark, but in turn set an absolute hurdle rate (e.g., 10%) or that are benchmark agnostic (i.e., they do not set any benchmark); the rest are classified as using relative performance benchmarks (e.g., FTSE Nareit All Equity REIT index for listed real estate and Bloomberg Commodity Total Return Index for commodities).

Table 3: **Factors driving absolute benchmark selection by pension funds**

	Absolute Benchmark				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
FundSize	-0.0341	0.0078	-0.0078	-0.0809	-0.0763
	(0.0755)	(0.0715)	(0.0780)	(0.0843)	(0.0844)
Private		0.7105*	0.7621**	0.6270*	0.6396*
		(0.2773)	(0.2834)	(0.3031)	(0.3042)
REITs			-1.567***	-1.613***	-1.611***
			(0.3823)	(0.4103)	(0.4803)
Infrastructure			0.8608***	0.7129***	0.7737***
			(0.1979)	(0.2008)	(0.2196)
Other Real Assets			0.8726**	0.8622*	0.7729.
			(0.3024)	(0.3389)	(0.4507)
Natural Resources			0.5694	0.9793**	1.311***
			(0.3476)	(0.3669)	(0.3843)
Commodities			-2.409***	-2.617***	-3.605***
			(0.5262)	(0.5385)	(1.038)
Rest of World				0.9608	1.040.
				(0.6186)	(0.6122)
Canada				0.5251	0.5466
				(0.4236)	(0.4215)
Europe				1.967***	2.003***
				(0.3126)	(0.3075)
Underperformer					0.2083
					(0.2345)
Underperformer x REITs					-0.0907
					(0.6163)
Underperformer x Infrastructure					-0.3794
					(0.3251)
Underperformer x Other Real Assets					0.1934
					(0.5381)
Underperformer x Natural Resources					-1.614**
					(0.5421)
Underperformer x Commodities					2.015.
					(1.174)
Fixed-Effects:					
Year	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered			by: PlanID		
Observations	12,092	12,092	12,092	12,092	12,092
Squared Cor.	0.01396	0.02187	0.05600	0.11855	0.12189
Pseudo R2	0.03130	0.04515	0.11053	0.18876	0.19422
BIC	6,228.6	6,152.6	5,796.4	5,342.0	5,364.8

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

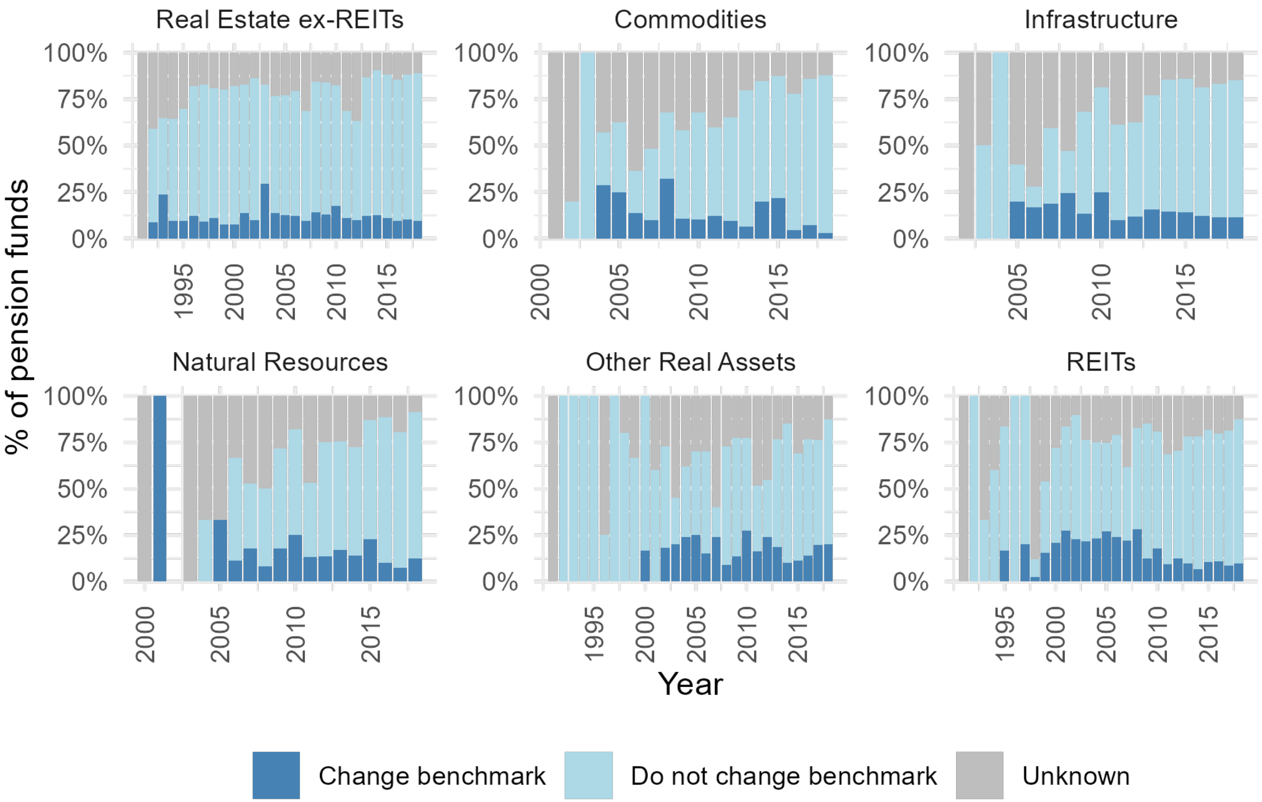
Notes: The dependent variable indicates whether pension fund i, for asset class j at time t, uses an absolute or relative internal performance benchmark for its real asset portfolios. It equals 1 if the performance benchmark is absolute and 0 otherwise. *Private* is a dummy variable that equals 1 if the pension fund is private. Various real asset classes are included, with private market real estate as the baseline group. We include the regions with the U.S. as the baseline group. Standard errors are clustered at the pension fund level.

Table 4: **Pension fund board composition and benchmark choice**

	Absolute Benchmark	
	(1)	(2)
State_share	-2.708	
	(2.712)	
Public	-1.199	
	(1.891)	
State_appointed		-2.754
		(3.569)
State_exofficio		-4.316
		(3.759)
State_elected		0.8718
		(3.476)
Public_elected		-85.56***
		(4.467)
Public_appointed		0.1325
		(1.766)
Participant_elected		1.726
		(2.162)
Participant_exofficio		-97.63***
		(19.03)
Fixed-Effects:		
Year	Yes	Yes
S.E.: Clustered	by: PlanID	by: PlanID
Observations	2,288	2,288
Squared Cor.	0.18132	0.23675
Pseudo R2	0.32005	0.36550
BIC	512.70	530.55

Notes: The dependent variable indicates whether pension fund i, for asset class j at time t, uses an absolute or relative internal performance benchmark for its real asset portfolios. It equals 1 if the performance benchmark is absolute and 0 otherwise. *Private* is a dummy variable that equals 1 if the pension fund is private. Various real asset classes are included, with private market real estate as the baseline group. We include the regions with the U.S. as the baseline group. Standard errors are clustered at the pension fund level.

Figure 2: **Share of pension funds changing internal benchmark, by asset class and by year**



Notes: Figure 2 displays the share of pension funds that have changed their internal performance benchmark by asset class and year. For natural resources, infrastructure, and commodities, the chart starts in later years as early on in the sample, CEM did not have information on these investments.

Table 5: **Factors driving benchmark change within relative and absolute**

	Relative Benchmarks			Absolute Benchmarks		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Portfolio Net Return$_{t-1}$	0.0020	0.0028	0.0038	0.0032	0.0016	0.0206
	(0.0030)	(0.0030)	(0.0035)	(0.0122)	(0.0126)	(0.0224)
Standard Benchmark$_{t-1}$	-0.0031	-0.0045.	-0.0057*	-0.0056	-0.0063	-0.0186
	(0.0024)	(0.0024)	(0.0027)	(0.0087)	(0.0089)	(0.0160)
FundSize	0.1477***	0.1394***	0.3132	0.1302	0.1215	0.0087
	(0.0369)	(0.0302)	(0.2700)	(0.0881)	(0.0952)	(2.334)
Private	0.2312*	0.1287		1.004*	1.036.	
	(0.1110)	(0.0965)		(0.4656)	(0.5287)	
REITs	0.2825*	0.3113**	0.2245.	1.743*	1.641*	1.690
	(0.1165)	(0.1070)	(0.1273)	(0.6909)	(0.7022)	(1.500)
Infrastructure	0.5437***	0.3635**	0.3030*	0.5054	0.4930	-0.3260
	(0.1251)	(0.1293)	(0.1397)	(0.3322)	(0.3024)	(0.5112)
Other real assets	0.8521***	0.7782***	0.9923***	1.460***	1.662***	2.146*
	(0.1995)	(0.2049)	(0.2485)	(0.3895)	(0.4331)	(0.9955)
Natural resources	0.4047**	0.5023**	0.4638**	-0.3882	-0.0708	0.4010
	(0.1541)	(0.1546)	(0.1618)	(0.5662)	(0.6853)	(1.367)
Commodities	0.2083	0.1992	0.1440	17.02***	16.94***	
	(0.1531)	(0.1463)	(0.1627)	(0.5408)	(0.6159)	
Rest of World		0.8440**			-1.239	
		(0.2716)			(1.180)	
Canada		0.5060***			0.6127	
		(0.1133)			(0.5657)	
Europe		0.8656***			0.4937	
		(0.1345)			(0.4860)	
Fixed-Effects:						
Year	Yes	Yes	Yes	Yes	Yes	Yes
PlanID	No	No	Yes	No	No	Yes
S.E.: Clustered			by: PlanID			
Observations	8,333	8,333	6,659	542	542	330
Squared Cor.	0.04669	0.06015	0.14307	0.14010	0.15192	0.38984
Pseudo R2	0.05022	0.06630	0.14241	0.16114	0.17346	0.41101
BIC	6,639.2	6,559.4	8,435.2	547.91	561.33	532.63

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Notes: The dependent variable Benchmark Change$_{i,j,t}$ indicates whether the internal benchmark for pension fund i, asset class j at time t was changed that year, focusing on changes within the same category (i.e., from relative to relative or from absolute to absolute). Portfolio Net Return$_{i,j,t-1}$ reflects the one-year lagged net return of each real asset portfolio, while Standard.Benchmark$_{j,t-1}$ represents the one-year lagged return of a broad asset-class-specific market index, capturing the overall return environment. Standard errors are clustered at the pension plan level.

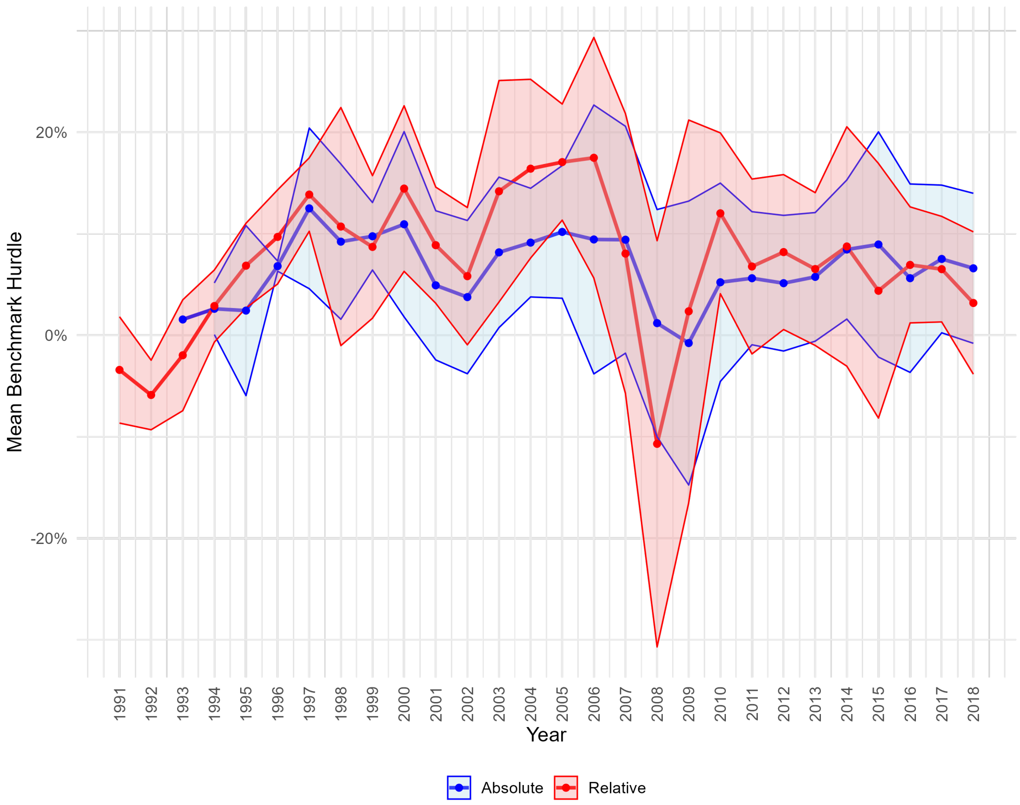
Table 6: **Factors driving benchmark change between relative and absolute**

	Relative to Absolute			Absolute to Relative		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Net Return Portfolio$_{t-1}$	-0.0225.	-0.0139	-0.0146	0.0050	0.0096	-0.0146
	(0.0127)	(0.0133)	(0.0162)	(0.0158)	(0.0173)	(0.0162)
Standard Benchmark$_{t-1}$	0.0009	-0.0015	-0.0008	0.0021	-0.0037	-0.0008
	(0.0121)	(0.0123)	(0.0140)	(0.0074)	(0.0076)	(0.0140)
Fundsize	0.1391	0.0255	2.580	0.1255	0.0170	2.580
	(0.0906)	(0.0818)	(1.762)	(0.1013)	(0.1069)	(1.762)
Private	1.128**	0.8617.		0.8219*	0.5415	
	(0.4166)	(0.4411)		(0.3792)	(0.4049)	
REITs	-0.4251	-0.5395	-0.6539	-0.9202.	-1.050*	-0.6539
	(0.5443)	(0.5653)	(0.5989)	(0.4852)	(0.5236)	(0.5989)
Infrastructure	0.9583**	0.8356*	0.6304	0.7671*	0.5451	0.6304
	(0.3389)	(0.3592)	(0.4885)	(0.3645)	(0.3783)	(0.4885)
Other real assets	1.212*	1.005.	1.641*	0.3619	0.1690	1.641*
	(0.5422)	(0.5897)	(0.7692)	(0.6368)	(0.6921)	(0.7692)
Natural resources	0.7152	1.070	0.8897	0.0815	0.5451	0.8897
	(0.6522)	(0.6648)	(0.8694)	(0.6101)	(0.5986)	(0.8694)
Commodities	-1.088	-1.174	-1.127	-1.037	-1.164	-1.127
	(1.079)	(1.092)	(1.201)	(1.083)	(1.073)	(1.201)
Rest of World		-0.1069			0.1323	
		(1.063)			(1.089)	
Canada		-0.0387			0.5587	
		(0.4634)			(0.4788)	
Europe		1.797***			2.200***	
		(0.4184)			(0.4450)	
Fixed-Effects:						
Year	Yes	Yes	Yes	Yes	Yes	Yes
PlanID	No	No	Yes	No	No	Yes
S.E.: Clustered	by: PlanID					
Observations	7,054	7,054	940	6,286	6,286	940
Squared Cor.	0.00762	0.01494	0.10901	0.00577	0.02020	0.10901
Pseudo R2	0.07134	0.11806	0.18328	0.05608	0.11953	0.18328
BIC	836.51	833.94	775.59	795.86	783.89	775.59

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Notes: The dependent variable Benchmark Change$_{i,j,t}$ indicates whether the internal benchmark for pension fund i, asset class j at time t was changed that year, focusing on changes between relative and absolute benchmarks. Portfolio Net Return$_{i,t-1}$ reflects the one-year lagged net return of each real asset portfolio, while Standard.Benchmark$_{j,t-1}$ represents the one-year lagged return of a broad asset-class-specific market index, capturing the overall return environment. Standard errors are clustered at the pension plan level.

Figure 3: **Average return hurdle trends in real asset benchmarks: absolute vs. relative**



Notes: Figure 3 shows the mean return hurdle and the corresponding standard errors for relative or absolute internal benchmarks used by pension funds for their real asset portfolios over time.

Table 7: **Benchmark change and portfolio performance**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.:	NR	BMR	NBAR	NR	BMR	NBAR
Benchmark Change$_t$	-1.257**	-1.210***	-0.0004			
	(0.3999)	(0.3450)	(0.0033)			
Benchmark Change$_t$ **x REITs**	-0.0388	-0.3095	0.0028			
	(1.044)	(0.9757)	(0.0069)			
Benchmark Change$_t$ **x Infrastructure**	1.209	1.908*	-0.0070			
	(0.8669)	(0.7594)	(0.0077)			
Benchmark Change$_t$ **x Other real assets**	0.6198	0.0363	0.0057			
	(1.968)	(1.006)	(0.0178)			
Benchmark Change$_t$ **x Natural resources**	-0.5554	-0.0137	-0.0054			
	(1.642)	(1.255)	(0.0135)			
Benchmark Change$_t$ **x Commodities**	-4.147*	-4.541**	0.0047			
	(1.767)	(1.605)	(0.0115)			
Benchmark Change$_{t-1}$				-1.375***	-0.9759**	-0.0039
				(0.4028)	(0.3447)	(0.0031)
Benchmark Change$_{t-1}$ **x REITs**				1.490	0.3214	0.0116
				(1.214)	(1.039)	(0.0072)
Benchmark Change$_{t-1}$ **x Infrastructure**				1.580	2.624***	-0.0104
				(0.9845)	(0.7631)	(0.0088)
Benchmark Change$_{t-1}$ **x Other real assets**				3.304*	1.935.	0.0137
				(1.418)	(1.014)	(0.0117)
Benchmark Change$_{t-1}$ **x Natural resources**				1.616	3.523**	-0.0191
				(1.666)	(1.254)	(0.0153)
Benchmark Change$_{t-1}$ **x Commodities**				9.230***	7.027***	0.0216.
				(2.359)	(1.877)	(0.0121)
Fundsize	1.618*	0.5969	0.0101.	1.854*	0.7349	0.0112.
	(0.6863)	(0.5017)	(0.0054)	(0.7986)	(0.5502)	(0.0067)
REITs	-0.5064	-0.5549	0.0005	-0.4727	-0.2285	-0.0023
	(0.4200)	(0.3624)	(0.0032)	(0.4714)	(0.4198)	(0.0032)
Infrastructure	0.7013.	-1.439***	0.0214***	1.130*	-1.602***	0.0274***
	(0.3992)	(0.2494)	(0.0041)	(0.4549)	(0.2993)	(0.0046)
Other real assets	-4.676***	-2.624***	-0.0203*	-5.643***	-3.512***	-0.0212*
	(0.9669)	(0.6763)	(0.0080)	(1.077)	(0.7636)	(0.0094)
Natural resources	-2.909***	-2.806***	-0.0010	-2.791***	-3.288***	0.0050
	(0.7326)	(0.4677)	(0.0072)	(0.7601)	(0.4884)	(0.0079)
Commodities	-8.994***	-10.23***	0.0128**	-12.19***	-13.28***	0.0117*
	(0.7576)	(0.5711)	(0.0045)	(0.7360)	(0.5653)	(0.0046)
Fixed-Effects:						
Year	Yes	Yes	Yes	Yes	Yes	Yes
PlanID	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: PlanID	by: PlanID	by: PlanID	by: PlanID	by: PlanID	by: PlanID
Observations	9,827	9,836	9,827	8,104	8,110	8,104
R2	0.33966	0.33543	0.15923	0.35858	0.35010	0.17516
Within R2	0.04831	0.07164	0.01083	0.06456	0.09137	0.01637

$Y_{i,j,t}$ is either the net return of the portfolio (NR), the benchmark return (BMR), or the net benchmark adjusted return (NBAR) of pension fund i, asset class j at time t. FundSize$_{i,t}$ is the log of the pension fund's assets in U.S. dollars. $X_{i,j}$ is a vector of dummies for the different real asset classes, with private market real estate as the baseline group. Benchmark Change$_{i,j,t}$ is a dummy variable that equals 1 if the pension fund has changed its benchmark in that year.

Table 8: **Benchmark change and portfolio performance**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.:	NR	BMR	NBAR	NR	BMR	NBAR
Relative to Absolute$_{t-1}$	-6.469***	-6.021***	-0.0044			
	(1.937)	(1.675)	(0.0116)			
Relative to Absolute$_{t-1}$ **x REITs**	-0.6424	5.348*	-0.0601			
	(6.155)	(2.666)	(0.0396)			
Relative to Absolute$_{t-1}$ **x Infrastructure**	5.602.	4.479*	0.0112			
	(3.282)	(2.076)	(0.0230)			
Relative to Absolute$_{t-1}$ **x Other real assets**	2.240	7.724**	-0.0550			
	(5.030)	(2.472)	(0.0497)			
Relative to Absolute$_{t-1}$ **x Natural resources**	5.804*	2.776	0.0302			
	(2.307)	(1.998)	(0.0202)			
Absolute to Relative$_{t-1}$				-2.808	-0.7400	-0.0207
				(2.117)	(2.069)	(0.0256)
Absolute to Relative$_{t-1}$ **x REITs**				-4.491	-5.672**	0.0116
				(5.785)	(2.190)	(0.0617)
Absolute to Relative$_{t-1}$ **x Infrastructure**				1.727	3.381	-0.0166
				(4.216)	(4.369)	(0.0337)
Absolute to Relative$_{t-1}$ **x Other real assets**				-4.310.	-9.474***	0.0516.
				(2.465)	(2.515)	(0.0265)
Absolute to Relative$_{t-1}$ **x Natural resources**				21.32.	14.63.	0.0669
				(12.27)	(8.670)	(0.0447)
Absolute to Relative$_{t-1}$ **x Commodities**				40.06***	29.48***	0.1050***
				(2.299)	(2.131)	(0.0267)
Fundsize	1.850*	0.7612	0.0109	1.886*	0.7898	0.0110
	(0.8012)	(0.5493)	(0.0068)	(0.8045)	(0.5478)	(0.0068)
REITs	-0.3214	-0.2703	-0.0004	-0.2865	-0.2150	-0.0006
	(0.4182)	(0.3503)	(0.0033)	(0.4204)	(0.3531)	(0.0033)
Infrastructure	1.289**	-1.253***	0.0254***	1.316**	-1.275***	0.0259***
	(0.4265)	(0.2963)	(0.0046)	(0.4339)	(0.2809)	(0.0046)
Other real assets	-5.075***	-3.305***	-0.0176.	-5.054***	-3.190***	-0.0185.
	(1.084)	(0.7201)	(0.0097)	(1.090)	(0.7101)	(0.0098)
Natural resources	-2.624***	-2.810***	0.0019	-2.688***	-2.881***	0.0020
	(0.7551)	(0.4833)	(0.0070)	(0.7514)	(0.4855)	(0.0070)
Commodities	-11.12***	-12.46***	0.0143**	-11.16***	-12.49***	0.0141**
	(0.8093)	(0.5852)	(0.0052)	(0.7879)	(0.5756)	(0.0051)
Fixed-Effects:						
Year	Yes	Yes	Yes	Yes	Yes	Yes
PlanID	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: PlanID	by: PlanID	by: PlanID	by: PlanID	by: PlanID	by: PlanID
Observations	8,121	8,127	8,121	8,121	8,127	8,121
R2	0.35571	0.34766	0.17353	0.35659	0.34831	0.17353
Within R2	0.06086	0.08795	0.01487	0.06215	0.08885	0.01487

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$Y_{i,j,t}$ is either the net return of the portfolio (NR), the benchmark return (BMR), or the net benchmark adjusted return (NBAR) of pension fund i, asset class j at time t. FundSize$_{i,t}$ is the log of the pension fund's assets in U.S. dollars. $X_{i,j}$ is a vector of dummies for the different real asset classes, with private market real estate as the baseline group. Benchmark Change$_{i,j,t}$ is a dummy variable that equals 1 if the pension fund has changed its benchmark in that year.

Table 9: **Effect of benchmark change on CIO compensation**

	(1)	(2)	(3)
Dependent Variable:	Total Comp	Salary	Bonus
Benchmark Change$_{t-1}$	-0.0778	-0.0633	-0.5249
	(0.0573)	(0.0476)	(0.3033)
Benchmark Change$_{t-1}$ × **REITs**	0.0347	0.1035	0.5341
	(0.1426)	(0.1199)	(0.4491)
Benchmark Change$_{t-1}$ × **Infrastructure**	0.0875	0.0764	-0.0087
	(0.0930)	(0.0582)	(0.4132)
Benchmark Change$_{t-1}$ × **Other real assets**	0.0338	-0.0643	-0.0194
	(0.0793)	(0.0744)	(0.5331)
Benchmark Change$_{t-1}$ × **Natural resources**	0.0298	0.0137	-0.1960
	(0.1446)	(0.1008)	(0.5542)
Benchmark Change$_{t-1}$ × **Commodities**	-0.2772.	-0.0955	0.0308
	(0.1410)	(0.1035)	(0.5313)
Fundsize	0.3319***	0.2450***	0.5421**
	(0.0398)	(0.0241)	(0.1839)
REITs	0.0003	0.0326	0.1129
	(0.0575)	(0.0416)	(0.2161)
Infrastructure	-0.0158	-0.0503	0.2160
	(0.0658)	(0.0430)	(0.3625)
Other real assets	0.0455	0.2190**	1.047.
	(0.1266)	(0.0717)	(0.5096)
Natural resources	0.1012	0.0723	0.7228
	(0.0659)	(0.0483)	(0.4528)
Commodities	0.1705.	0.0462	-0.0092
	(0.0895)	(0.0480)	(0.1835)
Fixed Effects:		Year	
S.E.: Clustered by	PlanID	PlanID	PlanID
Observations	946	714	387
R^2	0.61537	0.76255	0.32698
Within R^2	0.54388	0.67253	0.29113

Notes: $Y_{i,j,t}$ is either the total compensation, the base salary, or the bonus of CIO of pension fund i at time t. FundSize$_{i,t}$ is the log of the pension fund's assets in U.S. dollars.Benchmark Change$_{i,j,t-1}$ is a dummy variable that equals 1 if the pension fund has changed its benchmark in the previous year.

9 Appendix

Table A1: **Top 10 most frequently used benchmarks by asset class**

Asset class	Top 10 most frequently used benchmarks by pension funds reporting to CEM
Real Estate ex-REITs	NCREIF Property Index; Russell Canadian Property Index (RCPI); NCREIF - ODCE; Institute of Canadian Real Estate Investment Managers / International Property Index Canada; Custom; Actual Performance; Your REIT benchmark; Portfolio Performance; IPD UK All Balanced Property Fund Index; CPI + 4%
REITs	Your REIT benchmark; Wilshire Real Estate Securities Index; Morgan Stanely U.S. REIT Index; Custom; Dow Jones US Select Real Estate Securities Index; NCREIF; Morgan Stanely REIT Index; S&P/TSX REIT; Custom REIT Benchmark; S&P REIT
Infrastructure	CPI + 5%; Policy Return; CPI + 4%; Custom; Your Infrastructure benchmark; CPI + 6%; Absolute Return; Infrastructure Index; MSCI All Country World Index; CPI + 4.5%
Natural Resources	NCREIF TIMBERLAND Index; NCREIF TIMBERLAND Index (1 Qtr lag); CPI + 5%; Custom; CPI + 4%; Timber Benchmark; Actual (custom); Actual Performance (net of fees); Actual Return; NCREIF NFI ODCE Index (Net)
Commodities	Dow Jones UBS Commodity Index; S&P Goldman Sachs Commodity Index; S&P Goldman Sachs Commodity Index (TR); Bloomberg Commodity Index; Dow Jones UBS Commodity Index (TR); Bloomberg Commodity Total Return Index; Custom; Custom Commodities Benchmark; S&P Goldman Sachs Commodity Index ex Natural Gas (TR); Credit Suisse Commodities Benchmark / S&P Goldman Sachs Commodity Index ex Natural Gas (TR)
Other Real Assets	Custom - Actual; CPI + 4%; NCREIF TIMBERLAND Index; Custom; CPI + 5%; Russel Canadian Property Index; S&P Master Limited Partnerships (MLP) Index; NCREIF; Alerian Master Limited Partnerships (MLPs) Index; ROZ/IPD Index

Notes: The table lists the top 10 most frequently used benchmarks for the asset classed that are categorized as real assets.