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Think real assets

Optimizing pension plan outcomes using public and private real assets

In a world of low return expectations and even lower interest rates, pension plans are re-evaluating their portfolios, looking for alternative ways to achieve return targets and improve funded status.

Diversifying portfolios with real assets helps address these challenges. Real assets may reduce portfolio volatility, enhance returns, and generate yield.

However, allocating to real assets is rarely straightforward. Investing in this asset class — whether it is real estate, farmland, timberland, commodities, or infrastructure — is often considered a trade-off between performance and liquidity. In this paper, we highlight how real asset allocation decisions are more nuanced and complex than this perception suggests and we offer a framework to help with those decisions.

Focusing on real estate, farmland and infrastructure, we explore the features of real assets that investors should consider when selecting the appropriate allocation to achieve their investment objectives.

We discuss three different approaches to real asset portfolio construction — the prevailing deal-driven approach with which many institutional investors are familiar, a strategic factor-based approach, and a hybrid approach. We present the factor-based approach in detail. It helps investors understand the sources of risk and return in a portfolio, revealing insights that help answer the questions "are real assets delivering the expected diversification benefits?" and "are investors getting the exposure they are paying for?".

This approach also guides investors to selecting the appropriate investments for implementing their real asset exposure. However, sourcing those investments is a challenge, which is why we present the hybrid approach. It reconciles real life investment opportunities with the risk-factor framework. It allows investors to optimize their allocation to real assets and ensures they are exposed to the risk factors for which they expect to be rewarded.

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The characteristics of real assets

Before the quantitative factor analysis and portfolio construction insights, we highlight some of the considerations for investors when allocating to real assets.

We explore three sub asset classes — farmland, infrastructure and real estate — to understand the opportunities real assets offer, the role they can play in a portfolio and the range of choices investors face. The factor analysis and portfolio construction sections will consider additional real asset classes.

FIGURE 1: **Things to consider when allocating to real assets**

	REAL ESTATE	FARMLAND	INFRASTRUCTURE
Investment philosophy and strategy alignment	Ability to target specific strategies aligned to investor's long-term philosophy.		
Examples	• Impact investing with the provision of affordable housing • Sustainable investing with environmentally friendly buildings	• Growth and rise of middle classes in developing markets; increasing protein consumption and healthy eating trends • Demographics driving increasing demand for food and climate impacting the stability of supply • Natural resource and sustainable investment strategies	• Sustainability themes with mass transport or water and waste management • De-carbonization strategies with renewable energy
Public vs. private considerations	• Decision between public and private often considered a trade-off between liquidity and volatility • Over the long term, returns before fees for public and private should be the same • Challenge to match deal flow for private opportunities with investment objectives • Immediate deployment into publics offers exposure until appropriate private opportunities are available		
	• Public investments include real estate investment trusts (REITs), mutual funds and commercial mortgages • Private investments include joint venture, collective investment funds and separately managed accounts	• Most investments are private, suited to long-term investors • Limited public universe, but fund options are increasing • Derivatives provide commodity exposure, but potential for more volatility and no income stream	• Public, private, equity and debt available • Public tends to offer broad diversification, with some opportunity to tailor to specific themes or strategies • Some assets only available as public entities (e.g., utilities), with government maintaining significant influence
SOURCES OF:			
Diversification	• Global: countries; regions; cities • Sectors, e.g., logistics, office, retail, residential • Categories within sectors	• Global: countries; regions • Crop types: row; horticulture; viticulture • Operating strategy: lease vs. operating • Lack of cyclicality due to inelastic demand for food	• Global: countries; regions • Sectors, e.g., transportation, communications, energy • Lack of cyclicality from inelastic demand, often monopoly supplier and lower cost of capital
Returns	• Mostly from income for core real estate • Split between income and capital appreciation for value add • Mostly from capital appreciation with opportunistic	• Historically balanced between income and capital appreciation • Certain crop sectors and operating strategies offer greater income return than capital. • Scope for capital appreciation with operating assets to add value via capital expenditure and/or greenfield developments.	• Mostly derived from income in core investments • Greenfield and development projects offer mix of greater capital return alongside income • Some opportunities for alpha in cases where market/regulators underestimate demand, or operational/management efficiencies can be introduced
Cash flows	• Rental income	• Crop sales • Leasing land	• Tariffs/revenues from users
Inflation protection	• Opportunities in sectors with short-term leases (e.g., hospitality, some multi-family)	• Rising food prices a component of price indexes	• Often written into long-term contracts
Additional risks to consider	• Climate change • Technological shifts • Demographic trends	• Weather • Climate change • Currency risk • Geopolitical (e.g., trade) and regulatory	• Regulatory/political change • Decarbonization • Unforeseen (e.g., natural disasters)

Three ways to build real asset portfolios

The advantages and disadvantages of three different approaches to real asset portfolio construction.

A common approach to investing in real assets is to commit capital based primarily on the availability of new opportunities. Broad asset class limits tend to serve as a general guide, but the attractiveness of each opportunity drives the investment process.

This pragmatic approach focuses on the merits of individual deals. However, it runs the risk of creating random or unintended factor biases in the portfolio. A factor-based approach overcomes this by developing factor targets before sourcing and investing capital to yield more precise factor exposures. A drawback to this approach is a lengthy implementation process.

We offer a hybrid approach. Its foundation is rigorous factor analysis and targeting, but it is flexible enough to allow opportunistic deal selection. Critical to the execution of this strategy is the use of public real asset strategies in coordination with private investments.

1

The opportunistic deal-driven approach

The private nature of many real assets often means that building a real asset portfolio is driven by deal availability. As general partners raise funds, institutional investors can select the most attractive opportunities for their portfolios.

This opportunistic approach creates a portfolio in which the assets, and as a consequence the risk exposures, are determined by deal flow and by the nature of an investor's relationships with its real asset partners.

The benefits of being able to react quickly to new opportunities and make tactical commitments for the portfolio could come at the cost of introducing unintended factor biases into the portfolio.

2

The strategic factor-driven approach

Incorporating factor analysis is a more strategic approach to real asset portfolio construction. Portfolio composition is driven by targeting specific factor exposures. Investors determine their optimal factor exposures before committing capital. Opportunities are then sourced to populate factor exposure targets.

These targets are developed as part of the overall portfolio's asset allocation, which should also reduce the risk of unintended factor concentrations. However, the rigidity of this approach will lead to missed opportunities, as investors turn down attractive opportunities that do not fully align with the factor exposure targets.

3

The hybrid approach

Our proposed approach combines the strengths of these two approaches. It is a strategic, factor-based approach that is also flexible enough to allow tactical allocations as new investment opportunities arise.

The remainder of this paper outlines the steps involved in the factor-based approach, culminating with a discussion of the hybrid approach and highlighting key considerations for its implementation.

Identifying the factors driving real assets

Aiming to maximize the diversification benefits of real assets and the return premiums specific to those assets.

We used common macro factors that drive a substantial proportion of risk in institutional portfolios — namely global equity, real rates, credit, expected inflation and oil. We also considered lumber as a factor exposure that is likely to feature in a timberland portfolio. Figure 2 provides a definition of each factor.

The exercise revealed the degree of common factor exposures across a range of public and private real assets, using indexes as proxies for both public and private real asset returns. The following section uses real estate to illustrate the factor exposure analysis that was performed for all private assets in this paper. To allow for proper comparison, this factor-based approach de-smoothed the private returns (see box).

De-smoothing returns

Publicly listed assets are marked to market throughout the trading day. We do not, however, have the same pricing transparency with private assets. Private assets do not transact as frequently, and appraisals, which tend to be backward looking, are used to update the market value of the portfolio periodically.

Infrequent and backward-looking appraisals tend to smooth out the reported returns of private assets and, if unadjusted, tend to display lower return variation than what may be occurring in real time.

For our analysis, we de-smoothed returns from private real assets to avoid the risk of understating volatility and correlations across assets.

FIGURE 2: **Risk factors**

Factor	Description
Global equity	A measure of equity risk derived from the returns of a broad-based global equity index
Real rates	A measure of real interest rate risk derived from changes in the 10-year US TIPS yield
Credit	A measure of credit risk derived from changes in investment grade corporate credit spreads
Expected inflation	A measure of expected inflation risk derived from changes in breakeven yields
Oil	A measure of oil price risk derived from the returns of the front WTI futures contract
Lumber	A measure of lumber price risk derived from the returns of the front random length lumber futures

Source: Nuveen. Note: Proxies used: **Global equity:** MSCI All Country World; **Real rates:** 10-year US TIPS yield; **Credit:** Moody's US Corporate BAA 10-year spread; **Expected inflation:** 10-year US breakeven inflation rates; **Oil:** WTI crude futures; **Lumber:** Random length lumber futures.

Common factors explain 63% of the variation in returns.

The common factors driving real estate

We deployed a three-step process to estimate the common factor exposures for a private real asset strategy:

1. Regress public index returns onto selected common factors

2. Regress reported private return series onto lagged (up to three years) common series returns

3. Derive factor exposure estimates from lagged common factor exposures

We used the FTSE EPRA NAREIT Developed index as the public index and the Cambridge Real Estate Index as a proxy for private real estate. We found that common factors explain 63% of the variation in returns and collectively are 79% correlated with the quarterly private real estate returns.

Based on the series of regressions, we estimated the exposures for private and public real estate displayed in Figure 3.

Using the results of our factor analysis, we de-smoothed private real estate returns and compared the risk factors driving public and private real estate.

FIGURE 3: **Factor exposures for private and public real estate**

Factor	Public real estate	Private real estate	Difference [private-public]
Equity	0.77	1.21	0.44
Credit	9.07	14.22	5.15
Real rates	7.37	11.56	4.19
Expected inflation	8.73	13.69	4.96

Sources: Nuveen, Bloomberg, Cambridge. Date: 31 Dec 1998 to 31 Dec 2019. Notes: Oil and lumber factors were not selected for real estate regression. Credit, real rates and expected inflation signs are reversed for comparison.
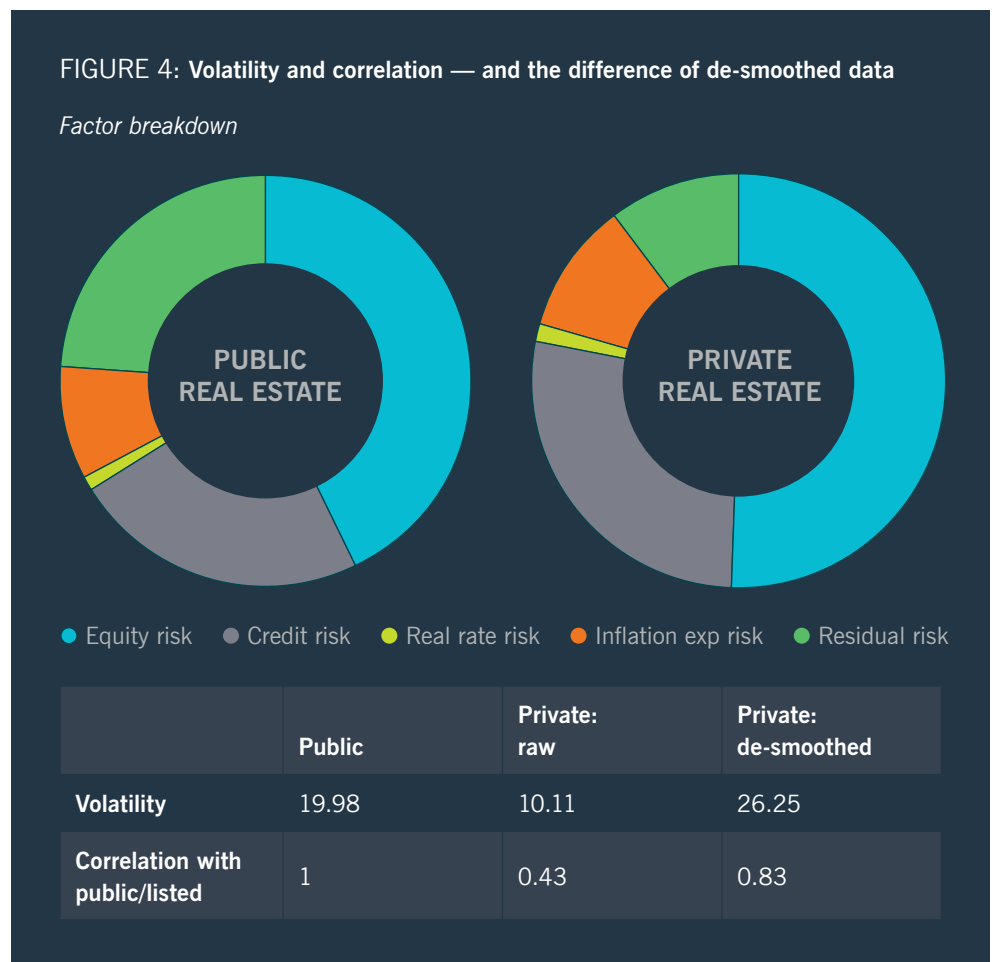
One of the benefits of this analysis is it can be adapted to individual investor requirements.

As Figure 4 shows, the resulting volatility and correlation figures were understated using the raw data. After de-smoothing the returns of private real estate, we found the volatility of the assets increased more than two and a half times, from 10% to 26%. Its correlation with REITs almost doubled, from 0.43 to 0.83. These results are significant given how volatility and correlation data drive asset allocation decisions. Using the raw, unadjusted data could result in suboptimal allocations to real assets and understated risk forecasts.

One of the benefits of this analysis is it can be adapted to individual investor requirements. As mentioned, in this exercise, we used the Cambridge Real Estate Index, which is composed of value-add and opportunistic real estate strategies. Investors who allocate solely to core private real estate strategies can use a different index that reflects their investment preferences (e.g., NCREIF ODCE).

Findings: More than just common macro factors

- In the analysis of public real estate, 70% of the return variation was explained by common macro factors of equity, credit, real rate and expected inflation. The remaining 30% indicated the existence of a real estate factor and other factors not captured by the common factor set.

- Analyzing private real estate in a similar way, we found a material amount of variation (63%) was explained by the same factors that drive public real estate and that there was evidence of an illiquidity and a pure real estate factor.

FIGURE 4: **Volatility and correlation — and the difference of de-smoothed data**

Factor breakdown

● Equity risk   ● Credit risk   ● Real rate risk   ● Inflation exp risk   ● Residual risk

	Public	Private: raw	Private: de-smoothed
Volatility	19.98	10.11	26.25
Correlation with public/listed	1	0.43	0.83

Sources: Nuveen, Bloomberg, Cambridge. Date: 31 Dec 1998 to 31 Dec 2019.

FIGURE 5: **Summary of factor exposures**

	Public energy	Private energy	Public infrastructure	Private infrastructure	Public real estate	Private real estate	Public timberland	Private timberland	Public farmland	Private farmland	TIPS	Commodities
Equity risk	0.19	0.61	0.86	1.05	0.77	1.21	0.68	0.23	0.79	0.41	0.01	0.23
Credit risk	-6.30	-20.52	-3.17	-3.88	-9.07	-14.22	1.50	0.51	-8.40	-4.30	-0.54	0.38
Real rate risk	-7.79	-25.40	-5.65	-6.91	-7.37	-11.56	0.64	0.22	-1.12	-0.57	-8.67	-5.14
Inflation exp risk	-1.75	-5.70	-5.19	-6.36	-8.73	-13.69	0.56	0.19	-2.77	-1.42	-1.14	0.31
Oil price risk	0.15	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
Lumber price risk	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.07	0.00	0.00	0.00	0.00
R2	37%	60%	85%	59%	70%	63%	53%	30%	29%	23%	91%	68%
Volatility (unadj)	18.64	13.39	15.79	9.37	19.98	10.11	18.69	4.40	20.26	7.19	6.15	17.60
Volatility (de-sm)	18.64	40.31	15.79	18.91	19.98	26.25	18.69	5.90	20.26	11.53	6.15	17.60
Correl w/ public (unadj)		0.57		0.62		0.43		0.06		-0.04		
Correl w/ public (de-sm)		0.74		0.89		0.83		0.66		0.40		

Public energy: Alerian MLP Total Return Index, Bloomberg; **Private energy:** Cambridge Private Energy Index, Refinitiv; **Public infrastructure:** S&P Global Infrastructure Total Return Index, Bloomberg; **Private infrastructure:** Cambridge Private Infrastructure Index, Refinitiv; **Public real estate:** FTSE EPRA NAREIT Developed Total Return Index, Bloomberg; **Private real estate:** Cambridge Private Real Estate Index, Refinitiv; **Public timberland:** Custom Public Timberland Index, Nuveen, Bloomberg; **Private timberland:** Cambridge Timberland Index, Refinitiv; **Public farmland:** Custom Public Farmland Index, Nuveen, Bloomberg; **Private farmland:** NCREIF Total Return Farmland Index, Bloomberg; **TIPS:** S&P 10 Year US TIPS Total Return Index, Bloomberg; **Commodities:** Bloomberg Commodity Total Return Index, Bloomberg.

Factor analysis across public and private real assets

We conducted similar analyses across a range of public and private real assets with the results shown in Figure 5. Interesting to note is the difference in volatility and correlation figures for private real assets when using unadjusted data compared with de-smoothed data. In every case, they increase.

Uncommon factors — analysis of the residuals

Having determined how much of the common factors explain public and private real asset returns, the next stage in our analysis explored the residual (i.e., the variation in returns not explained by the common factors). As before we use real estate in the example.

Real assets aid diversification and offer compensation for risk.

Our hypothesis is that the residual is a function of three things:

- A pure real estate return component that is specific to the real asset and unrelated to the common factors

- An illiquidity (or private) return component, which represents the premium or discount from taking illiquidity risk

- Other unexplained factors

This breakdown not only helps investors understand the risks that are specific to the sub asset class, but whether there is a premium associated with those risks. In other words, does the investor believe they will be adequately compensated for taking those risks?

To help answer this, we analyzed the relationship between capitalization rates and

private and public real estate performance (see appendix for details). We found evidence that the residual can be sufficiently explained by an asset-specific real estate factor common to both private and public real estate indices, and also a private, or illiquidity, factor that helps explain performance differences between public and private real estate.

These relationships can help investors estimate the component premiums to determine the attractiveness of the sub asset class and whether illiquidity risk is likely to be sufficiently compensated.

They provide strong evidence that real assets can play a beneficial role in investor portfolios. They offer a source of risk distinct from other assets in the portfolio, aiding diversification, and they offer compensation for taking on that risk.

Factor analysis lays the foundations for building a real asset portfolio that meets specific investment objectives.

A PUBLIC PENSION PLAN CASE STUDY:

Portfolio construction with real asset factors

Building on the factor analysis work in the preceding section, we illustrate how a public pension plan can use this work to construct a portfolio with explicit factor exposure targets. This approach can help maximize the diversification benefits of the real asset portfolio. Furthermore, it can be customized to meet the needs of a range of institutional plans with their own unique objectives and circumstances.

In this example, the investor is a public pension plan with significant exposure to equity risk. Given this, the objective is to construct a real assets portfolio that brings real diversification to the overall portfolio. To do so, the portfolio construction process aims to maximize two elements:

1 The diversification benefits of a custom real asset portfolio

2 The asset premiums beyond those that can be accessed via common factors

To balance these potentially competing objectives, we introduce the following constraints: long-only investments, 20% risk budget limit from any one sub-asset class, and variable equity risk contribution limits to develop a frontier of portfolios that maximize non-common factor premiums and limit equity risk exposure. Also in this example, the investor has no binding liquidity constraint. We recognize that many other institutions will have liquidity requirements. A liquidity constraint can be added to the framework by limiting the amount of private vs. public real asset exposure in the portfolio.

This framework can be used by any institutional investor seeking to target other risk factors. For example, well-funded corporate pension plans following a de-risking strategy may be particularly focused on interest rate risk. The framework is flexible enough to incorporate the macro factor risk most relevant to the institution and also work with different constraints regarding types of investment, risk budgets and liquidity needs.

Initial data requirements and analysis

We begin with the following information:

1. The institution's current portfolio: This is a full breakdown of the assets and the proportion in which they are held in the entire portfolio, required for the factor analysis.

2. The opportunity set of real asset strategies for consideration: This may be the full range of public and private strategies, but it can exclude strategies unsuited to the investor, perhaps due to lack of alignment with investment philosophy or for size. Factor exposures will be estimated for all applicable strategies.

3. The expected asset-specific and illiquidity return premiums: These can be provided by our analysis or the investor may wish to incorporate their own premium estimates.

For this exercise, the institution's current portfolio is based on the average asset allocation weights for state and local pension plans in the United States displayed in Figure 6A. Using the analysis techniques illustrated in the prior section, Figure 6B illustrates the contribution to total risk coming from each of the factors analyzed. Over 99% of the risk is from exposure to the common factors, and the vast majority of the risk in the average public pension plan's portfolio is from equity risk exposure. We use a hypothetical set of premiums that incorporate negative views on energy and positive views on the other real asset classes, illustrated in Figure 7.

FIGURE 6: Current portfolio and risk exposures

A: Average asset allocation: state and local pension plans

- Equities 47.2%
- Private equity 9.0%
- Fixed income 22.9%
- Real estate 9%
- Commodities 1.9%
- Hedge fund 6.7%
- Misc. alternatives 1.5%
- Cash 1.8%

B: Factor risk contributions

● Increase ● Decrease

Equity risk 97.2%, Credit risk 8.2%, Real rate risk -1.9%, Inflation exp risk -5.1%, Oil price risk 0.8%, Residual risk 0.8%
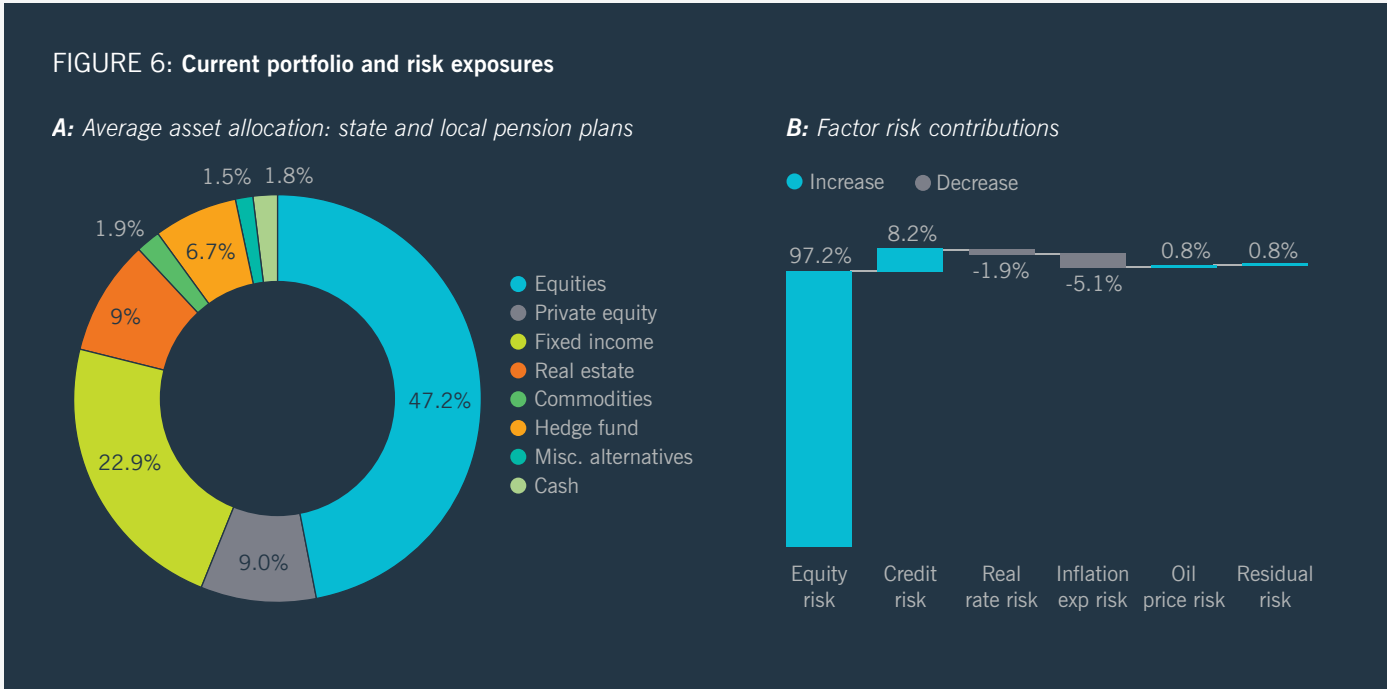
The following indexes were used: **Equities:** MSCI ACWI Net Total Return USD Index; **Private equity:** Cambridge Private Equity and Venture Capital Index; **Fixed income:** Barclays Aggregate Index; **Real estate:** 50% FTSE EPRA NAREIT Developed Total Return Index and 50% Cambridge Real Estate Index; **Commodities:** Bloomberg Commodity Total Return Index; **Hedge funds:** HFR Fund Weighted Composite Index; **Misc alternatives:** HFR Fund Weighted Composite Index.

FIGURE 7: Hypothetical premiums for public and private real assets

	Asset-specific premium	Illiquidity premium	Total premium
Public energy	-5%	–	-5%
Private energy		1%	-4%
Public infrastructure	4%	–	4%
Private infrastructure		2%	6%
Public real estate	2%	–	2%
Private real estate		1%	3%
Public timberland	0.5%	–	0.5%
Private timberland		2%	2.5%
Public farmland	0.5%	–	0.5%
Private farmland		2%	2.5%
TIPS	0%	0%	0%
Commodities	-0.5%	0%	-0.5%

Source: Nuveen. Note: These are hypothetical numbers filled in for illustrative purposes only. **Public energy:** Alerian MLP Total Return Index, Bloomberg; **Private energy:** Cambridge Private Energy Index, Refinitiv; **Public infrastructure:** S&P Global Infrastructure Total Return Index, Bloomberg; **Private infrastructure:** Cambridge Private Infrastructure Index, Refinitiv; **Public real estate:** FTSE EPRA NAREIT Developed Total Return Index, Bloomberg; **Private real estate:** Cambridge Private Real Estate Index, Refinitiv; **Public timberland:** Custom Public Timberland Index, Nuveen, Bloomberg; **Private timberland:** Cambridge Timberland Index, Refinitiv; **Public farmland:** Custom Public Farmland Index, Nuveen, Bloomberg; **Private farmland:** NCREIF Total Return Farmland Index, Bloomberg; **TIPS:** S&P 10 Year US TIPS Total Return Index, Bloomberg; **Commodities:** Bloomberg Commodity Total Return Index, Bloomberg.

> Over 99% of the risk is from exposure to the common factors, and the vast majority of the risk in the average public pension plan's portfolio is from equity risk exposure.

Optimizing the portfolio

Using the inputs developed in the preceding sections, we develop a frontier of optimal real asset portfolios at various equity contribution limits and premiums, illustrated in the top chart of Figure 8.

We see that as we limit the equity factor contribution, different real assets play a role in the portfolio, highlighting their diversification qualities. In this case, allocations to timberland and inflation-linked U.S. Treasury bonds (TIPs) increase substantially with the reduction in equity risk factor contribution. Of course, as we see from the table, limiting equity risk impacts the expected premium. It declines.

We also see an increase in other risks in the lower chart. It shows the changing factor risk profile for the different allocations. In this example, there is a notable increase in oil risk and real rate risk. A key decision for the investor is to determine their willingness to trade equity risk for other risk factors.

FIGURE 8: **Allocations and risk exposures for a real asset portfolio**
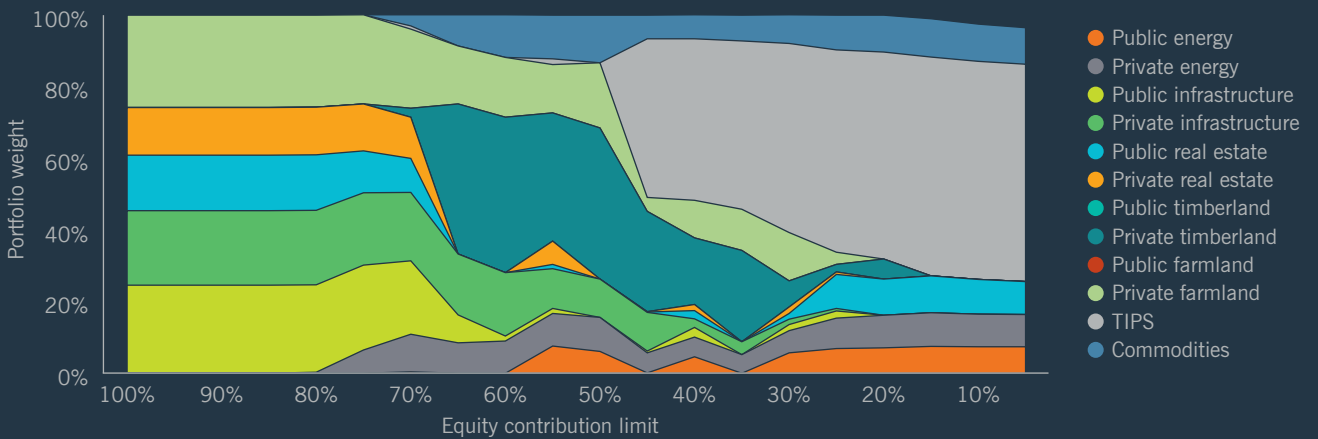
Equity risk contribution	80%	80%	80%	80%	80%	75%	70%	65%	60%	55%	50%	45%	38%	35%	29%	25%	20%	18%	17%	17%
Expected premium	3.6	3.6	3.6	3.6	3.6	3.1	2.7	2.4	2.2	1.4	1.4	1.2	0.6	0.9	0.2	-0.3	-0.4	-0.6	-0.6	-0.6
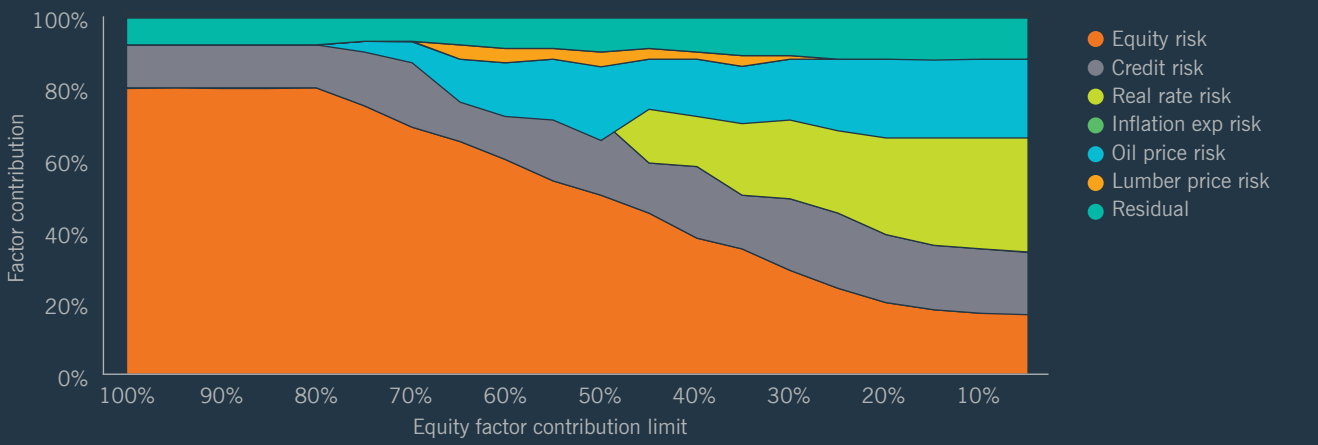
Source: Nuveen

For illustrative purposes, we selected the real asset portfolio in Figure 9. It limits the equity risk contribution to 70% and distributes the residual risk across a wide range of sub asset classes. Infrastructure is the largest exposure, split between public and private investments. Real estate exposure is second, again split between public and private. Public investments

comprise over a third of the portfolio. Private farmland investments are the largest single exposure.

This exercise is based on sample inputs to illustrate the portfolio construction process. However, the framework can be customized with the investor's own return premium expectations, specific investment constraints and existing portfolio composition.

Residual risk is spread across a wide range of sub asset classes.

FIGURE 9: **Asset allocation for the optimal portfolio**

Premium vs. equity contribution

Real asset portfolio

70% EQUITY CONTRIBUTION

	Portfolio weight	Risk contribution
Public energy	0.4%	0.3%
Private energy	10.5%	17.3%
Public infrastructure	20.5%	17.5%
Private infrastructure	19.1%	19.0%
Public real estate	9.5%	8.2%
Private real estate	11.5%	17.2%
Private timberland	2.5%	0.0%
Private farmland	22.1%	17.4%
TIPS	0.9%	0.1%
Commodities	3.1%	3.0%

Source: Nuveen

Implementing real asset allocations
The hybrid approach

In reality, achieving factor exposure targets or getting close to them is a challenge. As highlighted in the previous sections, real asset investing depends on the availability of new, attractive opportunities and fund offerings. This is not just the case for private investment structures but also public vehicles that invest in the same or similar underlying assets as private vehicles.

These investment opportunities need to be assessed to determine if they will meet with the investor's objectives. And should they do so, capital must be available when these opportunities arise.

Completion portfolio and liquidity needs

The hybrid approach addresses these issues. It is designed to focus on explicit factor exposure targets but be flexible so that it can capitalize on new investment opportunities that may not match precisely the factor targets.

The factor targets and resulting optimal asset allocation are the results of the preceding exercises. Implementing this requires running two sub-portfolios. One is the completion portfolio of public, listed assets. The other comprises the remaining, less liquid, private assets. When capital is called, the impact on the total real asset portfolio's factor exposure is analyzed. Any variance from factor targets is then offset by adjustments to the completion portfolio.

The hybrid approach requires significant resource commitment on behalf of the investor and/or their investment managers to manage, monitor and adjust the portfolios over time. But the approach maintains the integrity of the strategic factor-based approach while allowing investors to take advantage of new deals and make tactical commitments when those opportunities arise.

Focus on explicit factor exposure targets, but be flexible to capitalize on new investment opportunities. Counterbalance risk with a liquid completion portfolio.

Conclusion

Investing in real assets is much more complex than a trade between liquidity and performance. They offer many features that can help pension plans achieve their investment goals, and many different investment structures in which to invest.

But the interplay of these different aspects as well as how they relate to the overall portfolio make real asset portfolio construction a significant challenge for even the most sophisticated and experienced investors.

We think a factor-based framework creates a solid foundation for addressing these issues. It maximizes diversification, reduces the risk of unintended factor concentrations, and establishes whether investors are being adequately rewarded for taking on the risks present in the portfolio. It can flex and bend to accommodate the unique demands and constraints of different investors. Furthermore, it supports a practical approach to real asset investing that reconciles optimal allocation plans with real life investment opportunities.

To explore opportunities in real assets or discuss portfolio construction, please contact your Nuveen relationship manager or go to Nuveen.com.

Appendix

Residual analysis — evidence of a real estate factor and an illiquidity factor, and their premiums

We concluded from the residual analysis in section four that there was a factor common to real estate in both private and public data, and also a private, or illiquidity, factor.

We began with the hypothesis that the residual is a function of:

- A pure real estate return component that is specific to the real asset and unrelated to the common factors

- An illiquidity (or private) return component, which represents the premium or discount from taking illiquidity risk

- Other unexplained factors

Our hypothesis was that starting cap rates explain a statistically significant proportion of the variation in future real estate returns. While we saw a wide range of performance across private real estate managers, beginning cap rates explained over 40% of the variation in aggregate vintage performance and exhibited a correlation of 0.64 with average IRRs by vintage.

A principal component analysis of the residual returns uncovered a factor common to both public and private real estate. Furthermore, it found a factor that differentiated private from public real estate, suggesting the existence of an illiquidity factor.

Common real estate factor:

We regressed beginning period capitalization rates against the derived pure real estate factor and found that starting cap rates explain 72% of the variation in future five-year real estate factor returns (0.85 correlation).

FIGURE 10: **Regression results for the pure real estate factor**

NCREIF starting cap rate vs. 5-year forward RE factor return

$$y = 3.5242x - 24.605$$
$$R^2 = 0.72081$$
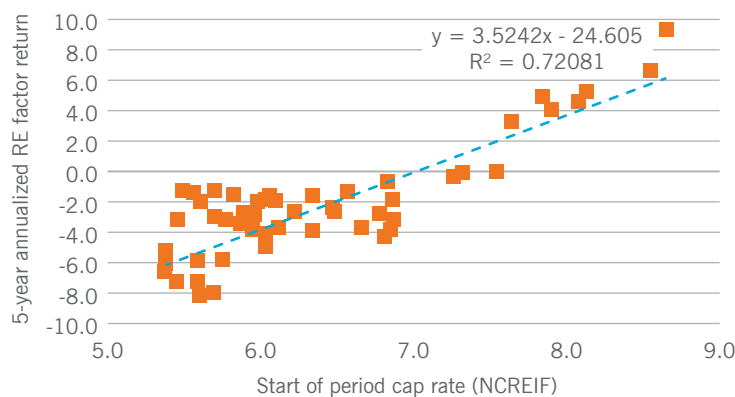
Sources: Nuveen, Bloomberg, NCREIF. Dates: 31 Mar 2002 to 31 Dec 2019.

Private/illiquidity factor:

We regressed the difference between private and public beginning capitalization rates and the private/illiquidity factor and found the difference in cap rates explained 25% of the variation in future five-year illiquidity factor returns (0.50 correlation).

FIGURE 11: **Regression results for the private/illiquidity factor**

NCREIF – NAREIT starting cap rate vs. 5-year forward illiquidity factor return

$$y = 2.9635x + 0.5437$$
$$R^2 = 0.24811$$
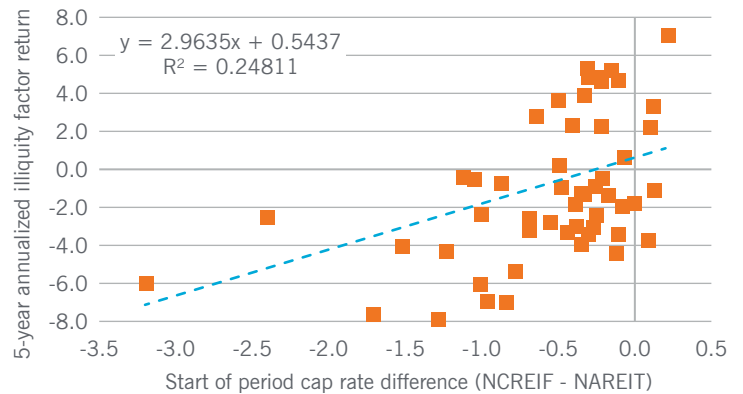
Sources: Nuveen, Bloomberg, NCREIF. Dates: 31 Mar 2002 to 31 Dec 2019.

While cap rate differences may not explain the majority of the variation in return differences, it does explain a statistically significant portion of the variation and can be used as a good starting point to estimate the private/illiquidity premium.

Investing with Nuveen

Nuveen offers solutions for a range of institutional investors. We provide investors access to liquid and illiquid alternative strategies, such as real estate, real assets (farmland, timber, infrastructure), private equity and debt, in addition to both traditional and fixed income assets.

Access to these strategies includes pooled funds, separate accounts and co-investment opportunities.

Our heritage as a pension fund means we understand the challenges other like-minded investors face. We have successfully been investing through market cycles for more than 100 years, for both ourselves and our investment partners.

We work closely with our clients to understand their requirements and develop forward-thinking investment opportunities.

Short-lived market cycles, evolving investor needs and sustainability pressures bring significant opportunities and challenges. We focus on three investor objectives across all of our client solutions:

• Generating income and capital growth.

• Managing risk in a world of ongoing uncertainty.

• Managing assets cost-effectively via optimal scale and access.

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