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TIAA

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Private Real Assets

Improving portfolio diversification with uncorrelated market exposure

John Goodreds
Head of Global Alternative Solutions

Justin Ourso, CFA
Head of Nuveen Natural Resources

Thomas Park
U.S. Strategy and Research
TH Real Estate

IN SEARCH OF ALTERNATIVES

Though U.S. stocks have increased nearly 266% since the end of the financial crisis in 2009,[1] institutional investors continue to face significant challenges.

State government defined benefit pension plans, for example, had an aggregate funding gap of $1.1 trillion in fiscal year 2015, a 17% increase since 2014.[2] Corporate pension plans at the largest U.S. firms had a collective funding deficit of $326 billion in 2016, despite improving modestly in recent years.[3] Moreover, managing portfolio volatility has become more difficult for many institutions striving to match their assets and liabilities through shifting markets.

A significant factor working against institutional investors has been an overreliance on traditional financial assets. Stocks, bonds, and other asset classes, such as commodities, tend to be cyclical and can experience extended periods of underperformance. During the financial crisis, for example, the S&P 500 Index fell more than

EXECUTIVE SUMMARY

• Recent periods of heightened market volatility—often combined with subpar stock and bond performance—have prompted institutional investors to consider alternatives, such as real assets.

• Private investments in relatively illiquid categories of real assets—farmland, timberland and commercial real estate—have exhibited low or negative correlations to stocks and bonds, diversifying portfolio risk. For the past two decades, real assets have generated higher returns than traditional investments, with significantly lower volatility.

• Portfolio optimization using 25 years of returns demonstrated private real assets' potential to improve the risk-adjusted returns of portfolios consisting of stocks and bonds, and diversify risks associated with publicly traded commodities and REITs.

• Results supported combining multiple categories of real assets and constraining overall allocations within practical limits, such as 10% or 20%. Allocation limits are necessary to address limited availability of farmland and timberland, index data limitations, and investor liquidity needs.

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50% from its 2007 peak and didn't fully recover until 2013, more than five years later. While less volatile, bond income returns have declined as interest rates have remained near historic lows amid low inflation and modest Fed interest rate hikes. Forecasts for lower equity returns during the next 10 years only increase the challenge in meeting pension fund liabilities. Furthermore, traditional asset classes have become more highly correlated as a result of global macro shocks since the financial crisis.

The combination of performance volatility and convergence among traditional asset classes spurred institutions to increase allocations to alternatives—including private equity and real assets—offering potential for consistent risk-adjusted returns with low correlations to public markets. Investors are also using alternatives to seek specific outcomes, such as inflation-protected income, rather than outperforming benchmarks.

This paper focuses on private real assets, which we define as private, direct investment in farmland, timberland, and commercial real estate. They belong to a relatively recent category of alternatives that many institutional investors have not fully explored. In addition to explaining potential benefits, we provide guidance on the impact of combining real assets with stocks and bonds in model portfolios representing different investor risk preferences. Finally, we also address the impact of real assets' illiquidity and limited availability—factors that require constraining allocations within practical limits.

Data analysis methodology and limitations

Real asset categories:
We selected three categories of real assets—farmland, timberland, and commercial real estate—based on their history of superior risk-adjusted returns, compared to public investments. They offer low or negative correlations with traditional assets in part because they are relatively illiquid, infrequently traded, or insulated from commodity speculation, such as options trading. These real asset categories also have at least 25 years of index performance data as a reasonable foundation for analysis. More nascent categories, such as infrastructure, were excluded due to shorter track records.

Methodology
The analysis used traditional mean-variance portfolio optimization, based on historical performance, standard deviation, and correlations of returns by asset class. Returns and standard deviation data represent six indexes: three representing private real assets, and three representing publicly traded commodities and REITs (see Appendix A for the list of indexes). Mean-variance optimization is a technique for determining the set of asset allocations designed to provide the maximum return for a given level of risk. This set of portfolio allocations forms a curve known as the "efficient frontier." Quarterly returns measures are calculated using end-of-period rolling annual total returns and standard deviations. Rolling one-year periods are an accepted method for measuring returns generated by annual or quarterly land appraisals. The time series spans 25 years, or a total of 100 quarters, from first-quarter 1992 through fourth-quarter 2016. Separately, we identified portfolios producing the highest risk-adjusted returns by comparing Sharpe Ratios. The latter reflect 1-year total return, minus 1-year Treasury bill rate, divided by the standard deviation of returns.

Data and methodology limitations
Our reliance on historical returns and relatively short index time series requires tempering conclusions. First, higher returns for farmland and timberland may not persist in the future if increased demand and broader trading compress returns. Second, real assets valuation data are not based on publicly reported sales transactions. The National Council of Real Estate Investment Fiduciaries (NCREIF) Index data for private real assets are based on periodic independent external appraisals and internal updates. This methodology tends to smooth the volatility of returns. However, NCREIF data are widely considered an industry standard, given the lack of alternatives. Third, index inception dates vary by asset type, with real estate beginning in 1978, timberland in 1987, and farmland in 1991. This requires limiting our analysis to the 25-year period common to all three categories and excludes periods of heightened market volatility during the 1970s and 1980s. Finally, mean-variance optimization results involving alternative assets may be highly sensitive to changes in input assumptions. As a result, our optimization results should be considered broadly illustrative and directional, rather than predictive or precise.

HOW REAL ASSETS CAN IMPROVE TRADITIONAL PORTFOLIOS

Results of our analysis support the long-term investment thesis that real assets have potential to improve the performance of traditional portfolios in multiple ways:

- **Diversification:** Real assets are powerful diversifiers, with low or negative correlations to traditional stocks and bonds—and to each other (Exhibit 1). As private investments, they tend not to move in lockstep with traditional assets or commodities in part because they are relatively illiquid and not exposed to speculative trading in public markets.

Exhibit 1: Correlations of real assets, commodities and REITs (1992—2016)

Real assets had low correlations to other asset classes—and to each other

Market Indexes	Stocks Russell 3000	Bonds Barclays U.S. Aggregate	Private real assets NCREIF Real Estate	NCREIF Farmland	NCREIF Timberland	Public commodities and real estate NAREIT	GSCI Agriculture	Timber proxy
Russell 3000	1.00	-0.05	0.25	0.03	0.17	0.55	0.22	0.62
Barclays U.S. Aggregate	-0.05	1.00	-0.24	-0.41	0.15	0.14	0.11	-0.11
NCREIF Real Estate	0.25	-0.24	1.00	0.39	-0.05	0.14	0.16	0.03
NCREIF Farmland	0.03	-0.41	0.39	1.00	0.20	-0.04	0.02	-0.12
NCREIF Timberland	0.17	0.15	-0.05	0.20	1.00	-0.03	0.12	0.02
NAREIT	0.55	0.14	0.14	-0.04	-0.03	1.00	0.21	0.64
GSCI Agriculture	0.22	0.11	0.16	0.02	0.12	0.21	1.00	0.18
Timber proxy	0.62	-0.11	0.03	-0.12	0.02	0.64	0.18	1.00

Data for the quarters ended 3/31/1992 through 12/31/2016. Indexes in the matrix represent the following markets: Russell 3000 Index—U.S. public equities; Barclays U.S. Aggregate Bond Index—U.S. investment-grade bonds; NCREIF Real Estate Index—privately-held U.S. commercial real estate; NCREIF Farmland Index—privately-held U.S. farmland; NCREIF Timberland Index—privately-held U.S. timberland; NAREIT Index—publicly-traded U.S. real estate companies; S&P GSCI Agriculture Index—a public index representing a range of agricultural commodities; and Timber proxy—a proxy index created by Nuveen that combines the S&P Global Timber and Forestry Index (2004—2016) with the returns of companies representing 4% or more of the index between 1991 and 2003.

Source: Nuveen, LLC.

- **Higher risk-adjusted returns:** For the past 25 years, real assets have provided similar or higher returns than stocks with much lower volatility, resulting in higher risk-adjusted returns, or Sharpe Ratios (Exhibit 2). Farmland also had higher risk-adjusted returns than bonds, with timberland equal to and real estate lower than bonds. Among publicly-traded counterparts, REITs and timber product companies also had similar or higher returns than stocks, but with greater volatility, resulting in lower risk-adjusted returns than private real assets.

Exhibit 2: Performance of real assets, commodities and REITs (1992—2016)

Real assets had higher risk-adjusted returns versus other asset classes

	Stocks Russell 3000	Bonds Barclays U.S. Aggregate	Private real assets NCREIF Real Estate	NCREIF Farmland	NCREIF Timberland	Public commodities and real estate NAREIT	GSCI Agriculture	Timber proxy
Avg Annual Return	8.78%	6.07%	8.68%	11.98%	10.34%	12.89%	-0.25%	8.29%
Std Deviation	17.00%	4.27%	8.40%	6.90%	9.94%	20.47%	19.96%	21.05%
Sharpe Ratio	0.35	0.75	0.69	1.32	0.75	0.49	-0.16	0.26

Data for the quarters ended 3/31/1992 through 12/31/2016.
Source: Nuveen, LLC.

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- **Liability-matching characteristics:** Real assets have potential to provide bond-like current income from contractual lease obligations and selling commodities, and long-term capital appreciation from rising land values to help meet future liabilities.

- **Inflation hedging:** Real assets have provided a strong hedge against inflation for two reasons: 1) Long-term returns have far outpaced the inflation rate; and 2) Many commodities, such as foodstuffs and raw materials, are components of inflation measures, such as Consumer Price Index (CPI). So when inflation rises, commodity prices also tend to go up. Driven by global demand trends, rising commodity prices increase the profitability of farmland and timberland, causing land values to rise and providing a long-term hedge against inflation. Farmland's track record is illustrative. For the 47-year period, 1970 to 2016, farmland returns averaged 10.27%[4] — more than double CPI's 3.95% average. Farmland's positive correlation with inflation — 0.66 — was higher than government bonds, gold or stocks, which were negatively correlated. Similarly, real estate hedges inflation through annual lease escalations, and the rising value of buildings and land in desirable locations.

LIMITED AVAILABILITY OF FARMLAND AND TIMBERLAND

Real assets' attractive risk/return profile is partly the result of illiquidity and lack of availability, compared to traditional assets. This is particularly true for farmland and timberland, which are far less institutionalized than private commercial real estate. Relative returns among real asset categories may partly reflect differences in asset availability. Farmland, with the highest historical returns and lowest volatility among the three categories, represents only $8.0 billion in the Farmland Index (Exhibit 3). This compares with $23.6 billion in the Timberland Index and $525.3 billion in the Property Index, which had lower returns. The

scarcity of farmland and timberland, compared to commercial real estate, has important implications for investors. Rising institutional interest in these real asset categories is likely to produce return compression in the future. In the near term, demand is likely to exceed available investment capacity, posing challenges for investors seeking exposure to farmland and timberland. Predictably, mean-variance optimization specifies extreme allocations to asset classes with more attractive risk/return profiles. We have therefore chosen to constrain allocations to real assets in several models to reflect real-world capacity constraints and liquidity concerns facing institutional investors.

Exhibit 3: Private real assets represented by NCREIF indexes (billions)

- $8.0   Farmland
- $23.6   Timberland
- $525.3   Real Estate

NCREIF index assets as of December 31, 2016
Source: NCREIF

STRUCTURING A PORTFOLIO OF REAL ASSETS

Attractive investment and demand characteristics make real assets compelling, but also pose difficult implementation questions: How should investors structure a portfolio of real assets? How might allocations change for different investor risk and return preferences?

No single, optimal allocation fits all risk profiles. Allocations should reflect individual investment objectives, risk tolerance, and liquidity needs. We used mean-variance optimization analysis to show the potential impact of real assets on a range of portfolios representing different risk profiles and constraints. Portfolio models used in this analysis are designed to provide

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illustrations—and should not be considered investment recommendations. The analysis is based on the following scenarios:

• Adding real asset classes individually—and as a group—to a portfolio of stocks and bonds

• Comparing real assets with publicly traded commodity stocks and REITs

• Structuring a real assets portfolio for different investment objectives

• Constraining real asset allocations within practical limits in conservative and aggressive portfolios

OBSERVATIONS FROM MEAN-VARIANCE OPTIMIZATION ANALYSIS

Observation 1

Real assets improved the risk-adjusted returns of a portfolio of traditional stocks and bonds

Institutional investors are posing a basic question: How do private real assets impact the risk and return attributes of a portfolio of stocks and bonds? In Exhibit 4 (next page), efficient frontier charts show the impact of adding farmland, timberland, and real estate *individually* to a stock/bond portfolio. To show the impact of combining all three categories, we constrained real assets to 15%, divided evenly at 5% in each.

RESULTS

• Each category of real assets increased returns, with similar or lower levels of risk, resulting in higher Sharpe Ratios.

• Farmland had the greatest impact on returns and received the largest allocation in an unconstrained portfolio at 43%, followed by real estate at 31% and timberland at 27%.

• When combining all three categories, we constrained real assets to a more realistic 15%, divided evenly among the three categories to avoid farmland's dominance.

• Diversifying a stock/bond portfolio with a 15% allocation to real assets increased annual returns by 50 basis points and reduced risk by 70 basis points, producing a higher Sharpe Ratio.
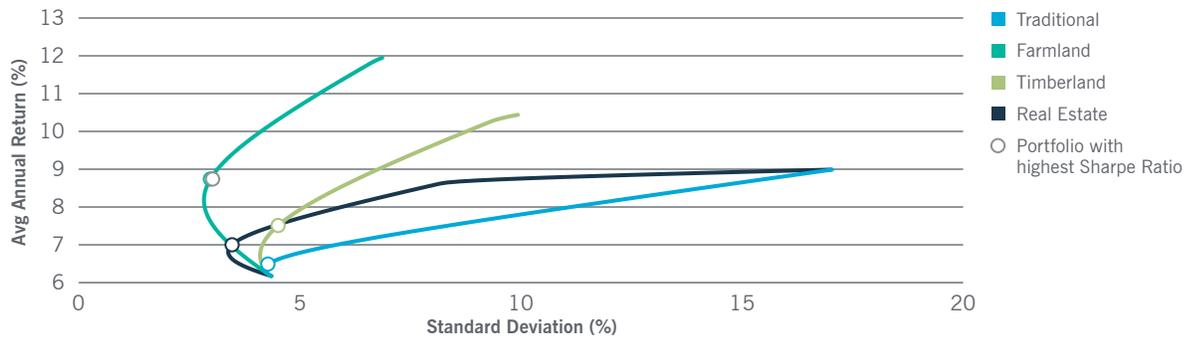
Several factors account for farmland's record of higher returns and lower risk, compared with timberland and real estate. Farmland is the least liquid of the three categories, with relatively few institutional investors, most transactions occurring between individual farmers, and generally long holding periods of 20 years or more. Population growth, rising middle classes, farm productivity gains, and ethanol demand have supported steadily rising land values, while barriers to entry and lack of institutional trading have reduced volatility. Data limitations may also be a factor since the 25-year series excludes a period during the early 1980s when U.S. farmland prices declined following the Soviet grain embargo.

Overall, results support the case for diversifying traditional portfolios with multiple categories of real assets even when constrained within realistic limits. The constraints reflect supply limitations, the relative illiquidity of real assets, their relatively high transaction costs, and the limited history contained in the analysis.
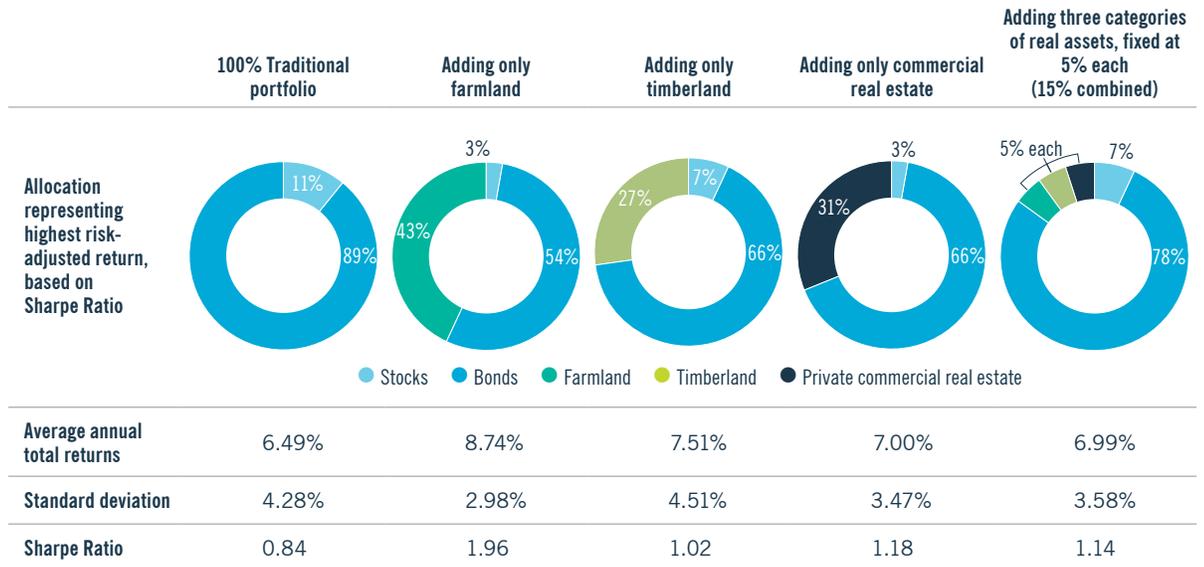
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Exhibit 4: Real assets' performance impact—individually and combined (1992–2016)

Real assets increased risk-adjusted returns of traditional portfolios

Comparing returns, standard deviations and Sharpe Ratios (1992-2016)

	100% Traditional portfolio	Adding only farmland	Adding only timberland	Adding only commercial real estate	Adding three categories of real assets, fixed at 5% each (15% combined)
Allocation representing highest risk-adjusted return, based on Sharpe Ratio					
Average annual total returns	6.49%	8.74%	7.51%	7.00%	6.99%
Standard deviation	4.28%	2.98%	4.51%	3.47%	3.58%
Sharpe Ratio	0.84	1.96	1.02	1.18	1.14

Mean-variance optimization based on historical returns is intended for illustration purposes only and should not be considered investment recommendations.
Source: Nuveen, LLC.

Observation 2

Private real assets provided higher returns with lower volatility than publicly traded commodities and real estate stocks
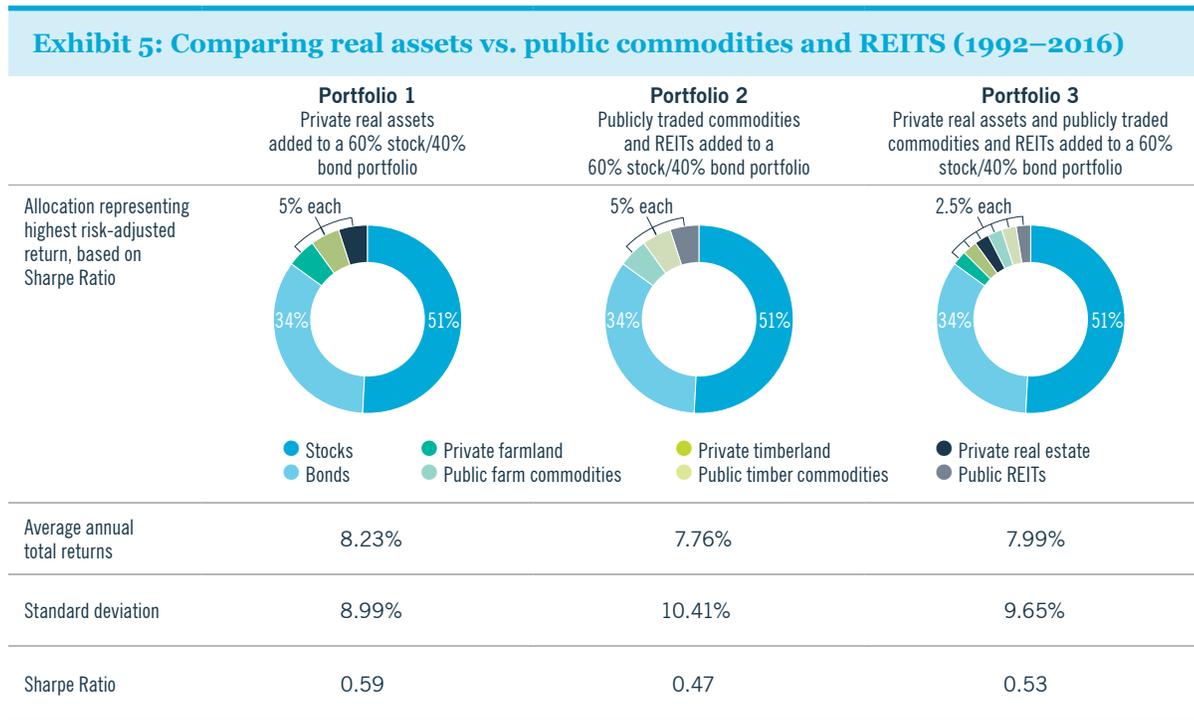
We compared private real assets with publicly traded commodity stocks and commercial REITs to assess diversification benefits against the illiquidity of private assets. Since many institutional investors already have exposure to REITs and commodities, such as metals or oil and gas, we also compared the impact of combining real assets with public stocks. This analysis used fixed allocations and constrained alternatives to 15% of the portfolio, consistent with realistic limits.

Exhibit 5 compares three portfolios consisting of a fixed 85% in stocks and bonds in a 60/40 ratio, and 15% in alternative assets. Portfolio 1 adds three categories of private real assets, divided evenly at 5% each. Portfolio 2 adds

three categories of public commodities and REITS, divided evenly at 5% each. Portfolio 3 combines private and public assets, split evenly at 2.5% each.

RESULTS

- Private real assets increased portfolio returns and reduced volatility, resulting in a higher Sharpe Ratio, versus publicly traded commodity stocks and REITs. This can be seen by comparing the performance of Portfolio 1 and Portfolio 2 in Exhibit 5.

- Private real assets helped to diversify the volatility risk of publicly traded commodities and REITs. This can be seen by comparing the performance of Portfolio 2 and Portfolio 3 in Exhibit 5. The combination of private and public assets in Portfolio 3 increased returns by 23 basis points and reduced volatility by 76 basis points, resulting in a higher Sharpe Ratio, compared to Portfolio 2.

Exhibit 5: Comparing real assets vs. public commodities and REITS (1992–2016)

	Portfolio 1 — Private real assets added to a 60% stock/40% bond portfolio	Portfolio 2 — Publicly traded commodities and REITs added to a 60% stock/40% bond portfolio	Portfolio 3 — Private real assets and publicly traded commodities and REITs added to a 60% stock/40% bond portfolio
Allocation representing highest risk-adjusted return, based on Sharpe Ratio	5% each	5% each	2.5% each
Average annual total returns	8.23%	7.76%	7.99%
Standard deviation	8.99%	10.41%	9.65%
Sharpe Ratio	0.59	0.47	0.53

Legend: ● Stocks ● Bonds ● Private farmland ● Public farm commodities ● Private timberland ● Public timber commodities ● Private real estate ● Public REITs

Source: Nuveen, LLC.

Observation 3

Farmland dominated a portfolio consisting only of private real assets

The next analysis shows how different asset categories work together in a portfolio consisting only of private real assets. We examined how the structure can change based on different investment objectives. An efficient frontier using farmland, timberland, and real estate allowed comparison of three portfolios producing the highest efficiency, lowest risk, and highest return (Exhibit 6).

RESULTS

- The most risk-efficient portfolio was dominated by farmland at 64%, but also included 23%

timberland and 13% real estate, benefitting from low correlations among the categories.

- The lowest-risk portfolio reduced farmland exposure to 42% and increased real estate to 31%, reflecting relatively low or negative correlations between categories.

- The highest-return portfolio consisted of 100% farmland, reflecting higher returns and lower volatility compared to timberland and real estate.

- Overall, the most efficient real assets portfolio generated much higher risk-adjusted returns than the most efficient combination of traditional stocks and bonds. The real assets portfolio produced an additional 467 basis points of return and increased volatility by only 147 basis points.

Exhibit 6: Structuring a portfolio of farmland, timberland, and private real estate

Farmland dominated returns, with timberland and real estate enhancing diversification
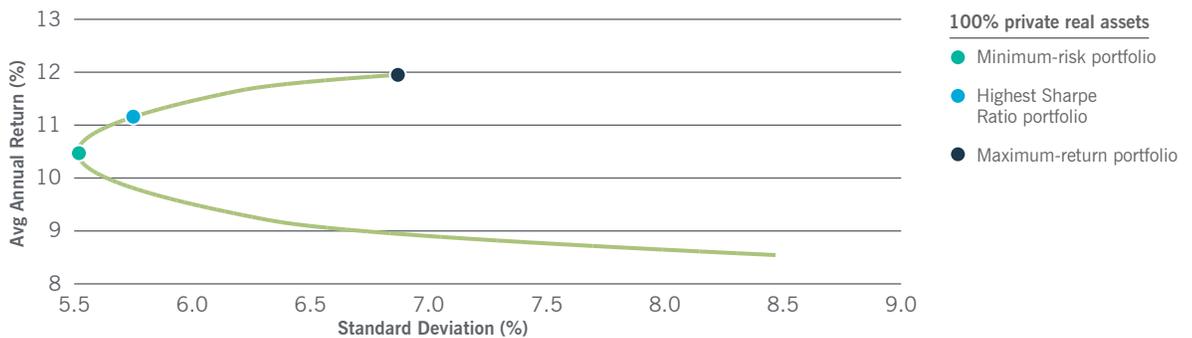
Portfolios on the efficient frontier	Highest Sharpe Ratio portfolio	Minimum-risk portfolio	Maximum-return portfolio
Allocations	Farmland 64%, Timberland 23%, Private commercial real estate 13%	Farmland 42%, Timberland 27%, Private commercial real estate 31%	Farmland 100%
Average annual total returns	11.16%	10.47%	11.95%
Standard deviation	5.75%	5.52%	6.87%
Sharpe Ratio	1.44	1.37	1.32

Mean-variance optimization based on historical returns is intended for illustration purposes only and should not be considered investment recommendations.
Source: Nuveen, LLC

Observation 4

Constraining real assets within practical limits still improved performance

How much real assets exposure is reasonable for institutional investors? Real assets are expected to continue their recent steady growth, with current portfolio allocations generally estimated at 5% to 10%, and endowments ranging up to about 15%. Overall, real assets represented $2.5 trillion out of $44 trillion of global institutional assets under management in 2016, or 5.7%.[5] Real asset investments in North America nearly tripled, from $1 trillion to $2.7 trillion, between 2005 and 2015, according to McKinsey. Their 9.9% cumulative average growth rate during this period exceeded both traditional assets and alternatives overall.[6] Institutions are increasing their exposure to alternatives in efforts to increase current income and risk-adjusted returns, dampen volatility, and meet specific needs, such as inflation protection.[7]

As noted earlier, mean-variance optimization outputs may suggest extreme allocations to individual asset classes based on returns for the time period used as inputs. For most institutions, allocations exceeding 25% to individual real asset categories would be unrealistic. Most portfolios would lack sufficient liquidity to meet near-term spending obligations and investors would have difficulty accessing enough farmland and timberland. Moreover, questions about the limitations and relatively short history of index data would argue against such large holdings in real assets.
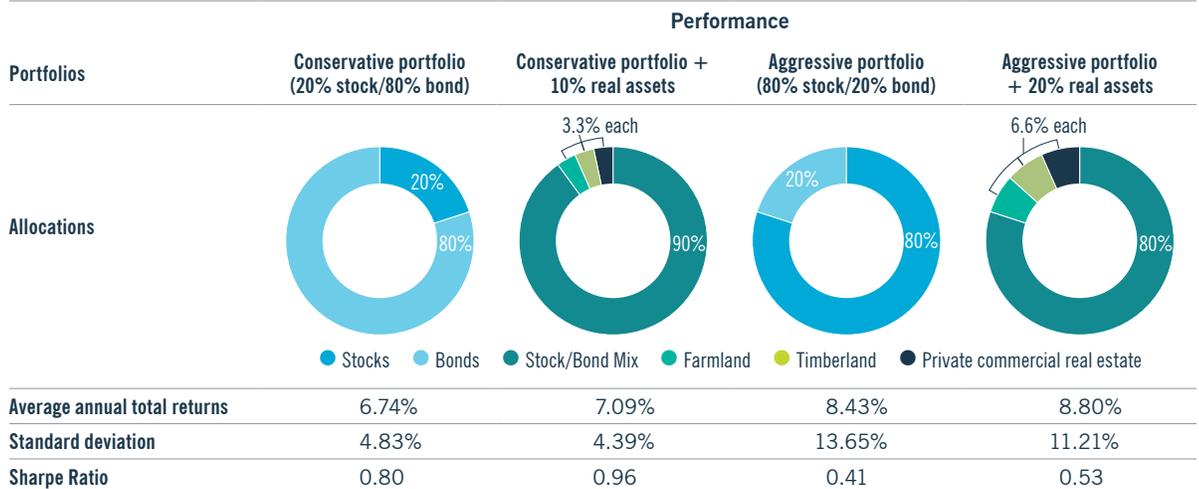
There is no single "optimal" allocation to real assets, which will differ based on the investor's specific risk profile. The next analysis considers two model portfolios representing a conservative allocation of 20% stock and 80% bonds, and an aggressive allocation of 80% stock and 20% bonds. We limit the combined real assets allocation to 10% (3.3% per category) in the conservative portfolio and 20% (6.6% per category) in the aggressive portfolio.

RESULTS

- Despite the allocation limits, real assets increased returns and reduced volatility in both portfolios, resulting in higher risk-adjusted returns (Exhibit 7).

- Overall, results show that based on historical performance, investors could improve portfolio risk-adjusted returns with allocations that were fractions of the unconstrained, but realistic given limited availability.

Exhibit 7: Limiting real assets exposure to 10% and 20% of traditional portfolios

Despite limits, real assets improved performance of conservative and aggressive portfolios

Portfolios	Conservative portfolio (20% stock/80% bond)	Conservative portfolio + 10% real assets	Aggressive portfolio (80% stock/20% bond)	Aggressive portfolio + 20% real assets
Average annual total returns	6.74%	7.09%	8.43%	8.80%
Standard deviation	4.83%	4.39%	13.65%	11.21%
Sharpe Ratio	0.80	0.96	0.41	0.53

Source: Nuveen, LLC.

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INVESTMENT IMPLICATIONS— AND CONCLUSIONS

Private real assets offer institutions compelling potential to enhance risk-adjusted returns, based on low correlations with other asset classes, and serve as inflation hedges. As long-term investments, their benefits provide some compensation for their relative illiquidity. They can combine bond-like income from asset leases and equity-like returns from long-term appreciation in land values to hedge inflation. In sum, real assets can support asset-liability matching, with potential for improved long-term portfolio returns to meet future obligations— and lower volatility of returns to meet current liabilities.

Results provide directional guidance for incorporating private real assets in institutional portfolios:

- Adding private exposure to any single category—farmland, timberland, or commercial real estate—increased portfolio returns and reduced risk, resulting in higher Sharpe Ratios.

- Private real assets offered superior risk-adjusted returns compared with publicly traded commodity stocks and REITs. In combination, private real assets helped to diversify the volatility of publicly traded commodities and REITs, resulting in higher portfolio risk-adjusted returns.

- Unconstrained, farmland and timberland dominated commercial real estate, based on historical returns reflecting their limited availability and less-developed institutional markets. The resulting large allocations suggested by mean-variance optimization— ranging up to 64% for farmland—require practical constraints to address availability, prudent diversification, and liquidity needs.

- Overall, results support the case for diversifying traditional portfolios with *multiple* categories of real assets within realistic limits. A combined allocation of only 10%, evenly divided among the three categories, significantly improved portfolio risk-adjusted returns.

These results should be considered broadly illustrative—not specific investment recommendations. As noted previously, data limitations—relatively short time series, self-reporting, and a "smoothing" effect from periodic appraisals—are likely to understate actual volatility of private real asset returns. Traditional mean-variance optimization has well-known drawbacks, including the assumption that returns are normally distributed and reliance on historical returns that cannot predict future results. While these limitations are important to acknowledge, they do not undermine the potential for real asset benefits to persist in the future. First, long-term capital appreciation depends on inexorable global trends—population growth and urbanization—that drive steadily rising demand and diminishing supplies of food, wood products, and high-quality commercial real estate. Second, real assets' low correlations and capacity to diversify risk are primarily a function of their being private, relatively illiquid, and not subject to public markets and speculative trading.

CHALLENGES OF INVESTING IN PRIVATE REAL ASSETS

High barriers to entry make it difficult for most institutional investors to undertake direct investments in private real assets, particularly farmland and timberland. Gaining access and managing complex risks require proven capabilities to address three major hurdles:

- **Lack of transparency.** Sophisticated due diligence capabilities are essential to analyze the potential profitability and cash-flow profile of assets in diverse regions around the globe.

- **Capital requirements.** Deep financial reserves are necessary to achieve scale economies, provide geographic diversification, and invest in technology and infrastructure.

- **Operational risks.** Investing in farmland and timberland involves a range of operational risks that include weather, pest damage, marketing perishable crops, and complying with local

regulations. Expertise in local markets and access to a network of local operators can allow investors to transfer operational risk and gain steady income through leasing contracts. Commercial real estate requires investment scale for diversification and large staffs to acquire and oversee holdings.

Institutional investors seeking the potential benefits of this alternative asset class should identify asset managers with specialized expertise, strategic partners, national or global scale, and a track record of investment success.

PUTTING REAL ASSETS TO WORK SUPPORTING INSURANCE PRODUCTS

Improving the risk/return profile of a conservative fixed-income portfolio

California vineyards, New Zealand timberlands and New York City commercial real estate might not come to mind as potential holdings of a conservative insurance portfolio. But private real asset investments like these represent a small and growing portion of the TIAA General Account, supplementing investments largely in high-quality bonds.

Why would relatively illiquid alternative investments make sense for a statutory portfolio with about 65% of its assets in low-risk, fixed-income investments supporting contractually guaranteed payments? The answer lies in the powerful diversification and inflation hedging potential of private real assets that can help to reduce overall portfolio risk. Direct investments in real assets represent $17.8 billion,[8] or about 7.3% of the $243.0 billion General Account.[9] (Exhibit 8). Nuveen, LLC, is an industry leader with $113.9 billion[10] in global real asset investments in farmland, timberland, real estate, and energy and infrastructure.

Real assets provide three benefits to the General Account: Potential for current income, long-term capital appreciation, and low correlations with traditional investments.

- **Income generation:** While most traditional fixed-income investments recently have offered low yields, real assets have generated relatively attractive and stable levels of current income. Expected annual income returns range from about 3% to 6%, depending on asset category.[10] Mainly, this income comes from leases—acreage leased to farmers, commercial real estate rented to tenants, and infrastructure leased to municipalities or agencies.

- **Capital appreciation:** The value of land and natural resources is expected to increase over time as a hedge against inflation—protecting the General Account's future purchasing power. Projected annual total returns range from 7% to 10%, depending on asset category.[11]

- **Low correlations:** Real assets tend not to move in lockstep with traditional investments. Their correlations to stocks and bonds are low and sometimes negative, providing diversification that is especially desirable when market volatility causes correlations between traditional assets to converge.

Advantages of private real assets over publicly traded commodity stocks

In seeking to diversify the General Account, TIAA chose direct investments in real assets over publicly traded commodity stocks for important reasons. Real assets tend to be much less volatile because they aren't subject to market speculation, such as options trading. At times when the commodity price cycle is unfavorable, we have flexibility to leave real assets, such as trees or oil and gas, in the ground to await better prices. Unlike bonds that mature or may be called, we can hold real assets indefinitely, selling appreciated property as needed to help meet the General Account's long-term liabilities.

Managing risks inherent in real assets

TIAA has developed solutions to address illiquidity and other risks inherent in holding real assets, which can be difficult to sell when cash is needed. With more than $45 billion in cash and highly liquid Treasury and Agency mortgage-backed securities, the General

Account has the capacity to invest in less-liquid alternatives. Real asset investments can be structured in ways that reduce exposure to operational risks, such as growing and selling crops in unfamiliar regions. In many cases, TIAA and its affiliate, Nuveen, LLC, can avoid these risks by leasing land to local farmers, who provide steady income for the General Account.

Diversification across global regions and asset types helps to address other risks. Agricultural investments, for example, are spread across four continents—Australia, North and South America, and Europe—reducing exposure to drought, pest damage, commodity pricing and other market-specific risks. In real estate, the size and scope of the U.S. market provides ample geographical diversification across regions and metropolitan areas, along with property-type diversification. TH Real Estate has offices across the globe

providing opportunities to diversify in the US, Europe and Asia.

With real asset investment experience dating to 1947 in real estate, 1998 in timber, and 2007 in agriculture, Nuveen, LLC, has a first-mover advantage in establishing scale and developing expertise ahead of most other asset managers. As a result, real asset exposure in the TIAA General Account already provides important contributions to risk-adjusted returns. In continuing efforts to diversify the portfolio and hedge inflation, TIAA expects to maintain healthy allocations to farmland, infrastructure, real estate, and timberland. Investments in real assets offer the potential to combine steady current income and long-term capital appreciation, making them a good fit with the General Account's current and long-term liabilities.

Exhibit 8: Allocations to real assets in the TIAA General Account (as of 12/31/2016)

General Account total assets under management: $243 billion[12]
Private real asset investments in the General Account: $17.8 billion

- Private commercial real estate: $9.5 billion, or 3.9%
- Farmland: $3.7 billion, or 1.5%
- Timberland: $3.3 billion, or 1.3%
- Energy and Infrastructure: $1.4 billion, or 0.6%

TIAA General Account
- Total assets: $282.4 billion[13]
- Total liabilities (including reserves): $246.9 billion (includes $199.8 billion in General Account policy reserves)
- Net Capital and Surplus: $35.6 billion

TC Life
- Total assets: $$11.9 billion
- Total liabilities (including reserves): $11.5 billion (includes $5.8 billion in General Account policy reserves)
- Net Capital and Surplus: $0.4 billion

For more information,
contact your Global Investment Advisory Services representative, or visit us at nuveen.com/RealAssets

Appendix A

Exhibit 9

The analysis used six indexes: Three representing private real assets and three representing publicly traded commodities and REITs

Sub-asset class	Index	
	Private (direct exposure)	Public
Real Estate	NCREIF Property Index	FTSE NAREIT U.S. Real Estate Index
Farmland	NCREIF Farmland Index	S&P GSCI Agriculture Index
Timber	NCREIF Timberland Index	Proxy index based on a combination of S&P Global Timber and Forestry Index (2004—2016) and returns for companies representing 4% or more of the index between 1992 and 2003[14]

Appendix B

Analysis using alternative index for private farmland returns

We have noted limitations of relying solely on the NCREIF Farmland Index as a measure of unlevered agricultural returns. An alternative is the proprietary index of private U.S. farmland returns maintained by the TIAA Center for Farmland Research at the University of Illinois. The University of Illinois (UI) index selected for this analysis comprises the average return for 32 states considered the top crop producing states in the U.S. Exhibit 10 below compares returns, standard deviation, and Sharpe Ratio for the two private farmland indexes.

RESULTS

We compared the impact of the two farmland indexes in portfolios consisting of stocks, bonds, and three categories of private real assets. Exhibit 11 below shows the results of unconstrained mean-variance optimization (MVO), using the UI index in one portfolio and the NCREIF index in a second portfolio for the 25-year period, 1992-2016.

The UI index *increased* farmland's dominance, with the unconstrained allocation rising from 40% to 73% at the expense of bonds, timberland and real estate. Allocations to

farmland became even more dominant due to the UI index's 46% lower volatility and higher Sharpe Ratio, compared to the NCREIF index. Nonetheless, using the NCREIF farmland index increased portfolio returns by 27 basis points, although its higher volatility relative to the UI index resulted in a lower Sharpe Ratio. Two factors may account for performance differences. The UI series represents a broader set of returns data than the institutionally managed properties in the NCREIF series. In addition, the use of *annual* returns, rather than NCREIF's quarterly data, can be a more appropriate measure of returns to agriculture. However, the aggregate nature of the underlying UI data may also result in understating return volatility.

Results using the alternative UI farmland returns measure generally support key conclusions noted in the paper. Nonetheless, results should be evaluated in the context of the following considerations:

- MVO is highly sensitive to changes in data inputs and time periods.

- Allocations to farmland should be constrained to realistic levels, based on asset availability, data limitations, and liquidity needs.

- A balanced approach dividing real asset exposure among multiple categories offers the potential for prudent diversification, based on low correlations between the categories.

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Exhibit 10: Comparing private farmland index returns (1992–2016)

	University of Illinois U.S. Farmland Index (32-state select)	NCREIF Farmland Index
Average annual returns	9.29%	11.97%
Standard deviation	3.75%	6.91%
Sharpe Ratio	1.71	1.32

Exhibit 11: Comparing portfolio returns and allocations for two private farmland indexes (1992-2016)

Unconstrained mean-variance optimization (MVO) outputs for portfolios combining stocks, bonds, and three categories of private real assets.

	Portfolio using University of Illinois U.S. Farmland Index (32-state select)	Portfolio using NCREIF Farmland Index
Average annual returns	8.49%	8.76%
Standard deviation	2.91%	3.32%
Sharpe Ratio	1.96	1.8
Allocations		
Stocks	5%	3%
Bonds	22%	46%
Farmland	73%	40%
Real estate	0%	4%
Timberland	0%	7%

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ENDNOTES

1 Russell 3000 Index change in value between 3/9/2009 and 5/31/2017, without dividends.

2 The Pew Charitable Trusts, "The Sate Pension Funding Gap: 2015," April 20, 2017.

3 Milliman Inc., Milliman 100 Pension Funding Index, January 2017

4 TIAA Center for Farmland Research, proprietary Aggregate U.S. Farmland Index.

5 McKinsey & Company, based on McKinsey Global Performance Lens Global Growth Cube, Prequin, and expert interviews.

6 McKinsey & Company, Thriving in the New Abnormal, North American Asset Management, November 2016.

7 McKinsey & Company, The Trillion-Dollar Convergence: Capturing the Next Wave of Growth in Alternative Investments, August 2014.

8 Invested assets, as of 12/31/2016

9 General Account invested assets, as of 12/31/2016

10 As of 12/31/2016

11 TIAA projections used as inputs for asset allocation modeling. Current income can be episodic and inconsistent for timberland and, to a lesser extent, farmland, depending on investment structures and contracts.

12 Invested assets

13 Total statutory assets

14 Proxy index created by Nuveen, LLC.

Real Asset investments may be subject to environmental and political risks and currency volatility.

RISKS AND OTHER IMPORTANT CONSIDERATIONS

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