Inflation and Real Estate Investments

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Forthcoming

Introduction

This paper analyzes the inflation sensitivity of real estate investments, comparing them to other inflation-sensitive assets. The most transparent source of real estate investment returns comes from publicly traded stocks of real estate investment trusts (REITs). The authors examine the available return data, with an emphasis on their relationship to US inflation, although conclusions may apply elsewhere as well.

Consumer price inflation (CPI) in the U.S. was 13.5% during 1979, the worst year since 1947. Dividend income from REITs traded through the stock exchange averaged 21.2% that year, and total returns amounted to 24.4%, more than preserving for REIT investors the purchasing power that they had lost to inflation. Inflation averaged 11.6% per year during 1978-1980, the worst three-year period in six decades; again, however, publicly traded equity REITs outpaced inflation with income and total returns averaging 12.2% and 23.1% per year, respectively. The period 1974-1981 was the most inflationary eight years in the history of the Consumer Price Index at 9.3% per year, but equity REIT returns easily preserved purchasing power, with income and total returns averaging 10.2% and 16.3% per year.

During the first eight months of 2011 annualized consumer price inflation was 5.1%. Again, equity REIT returns protected purchasing power with annualized total returns averaging 8.4%, however dividend income - during a period of extraordinary weakness in real estate operating fundamentals - fell short of inflation at 3.4% per year.

The rate of growth of equity REIT dividend payments averaged 7.71% per year from the beginning of 1978 through August 2011, while consumer price inflation over the same period averaged just 3.92%, and equity REIT dividend income exceeded the inflation rate in 306 of the 404 individual months during that historical period. Thus over this entire period REIT returns preserved purchasing power. This of course raises the question of how well REITs hedge inflation during sub-periods and in comparison with other assets.

In the analysis which follows, the authors compare real estate investments to other inflation-sensitive assets, and point out that the common approach to evaluating sensitivity, by computing correlation between asset returns and inflation, fails to address directly the question of whether returns from a given asset actually protect consumers from loss of purchasing power. The relevance of this fact stems from the observation that

many investors do not hedge their exposure to inflation formally by computing the optimal hedge ratio and acquiring long or short positions to implement the hedge: rather, they typically rely on some informal combination of strategic and tactical asset allocation, deploying capital into asset classes that are expected to perform well during inflationary regimes, and doing so more aggressively when high inflation is anticipated.[1]

In response to this observation, the authors employ a direct measure of the effectiveness of the passive inflation protection provided by a given asset. The discussion also notes that, given the difference in asset returns in high- versus low-inflation periods, choosing a tactical asset allocation specific for a high-inflation regime exposes investors to considerable directional risk. A balanced approach that provides similar risk-adjusted return in both low- and high-inflation regimes may be preferable for investors who do not possess superior inflation forecasting abilities.

In addition to investing in commercial real estate through ownership of stock in publicly traded equity REITs, investors can also invest in illiquid real estate assets such as shares in private equity real estate investment funds (including non-listed equity REITs) or direct ownership of properties. This paper notes the substantial pitfalls of using return estimates based on appraised property values for evaluating inflation sensitivity of illiquid assets, and reviews the available evidence on illiquid real estate as an inflation hedge. Finally, the authors consider why certain property types may be more sensitive to inflation than others, and review evidence on inflation sensitivity by property type.

Real Estate as a Hedge Against Inflation

We begin by considering conceptually the extent to which real estate can be expected to hedge against inflation. The Gordon growth model suggests that real estate can be considered a perfect hedge against inflation - unlike, for example, most fixed income products - because real estate is a long-lived asset with income that adjusts to inflation (cf. Gordon [1962]). The model, despite its obvious limitations,[2] clearly illustrates this relationship. Real estate asset prices (or, similarly, REIT equity prices) are given by the net present value (NPV) of the future rent cash-flow stream, which is assumed to grow indefinitely at a constant rate g and is discounted by the appropriate nominal rate r:

$$\text{Real Estate Price} = \text{NPV (Future Rent Income)} = \text{Next Period Rent}/(r - g)$$

$$\text{REIT Equity Price} = \text{NPV (Future Dividends)} = \text{Next Period Dividend}/(r - g)$$

Assuming no change in the real economy,[3] inflation will affect the discount rate r and the rent (equity dividend) growth rate g in equal measure, and thus will have no impact on capitalization rates in inflation-adjusted terms, or on real estate asset values. In other words, the inflation-adjusted return from holding real estate assets is invariant to inflation, at least in this simple model. Of course, models aside, the question needs to be tested, and settled, by empirical evidence, which we will do in the following sections.

Real estate prices may, of course, change in response to several factors other than inflation itself, and these may be difficult to isolate in the empirical analysis. Most notably, exogenous supply/demand shocks (as well as endogenous cycles within the real estate market) will affect asset prices as well as imputed rents (or, equivalently, the growth rate g) differently. Specifically, positive demand shocks will tend to increase real estate asset prices and rents, while positive supply shocks (which increase costs) will act in the opposite direction. For example, as discussed below, energy related supply shock inflation episodes such as the oil shocks of the 1970s will affect real estate returns differently than demand shock inflation deriving from either monetary or fiscal policy. Moreover, over the real estate cycle, the inflation-adjusted return of real estate assets will increase when real estate assets are in demand, and decrease when supply is plentiful.

In practice, although many REITs have contractually specified step-up clauses, actual responsiveness of rents, especially to short-run and intermediate-run effects associated with shocks and cycles, tends to be dampened by the use of leases.[4] As typical lease structures differ by property type, the dampening effect on rent adjustments will also differ, a topic that will be investigated empirically later in the paper.

Another conceptual issue, which we briefly consider here relates to the debt structure of real estate investments. It is plausible to assume that, if an asset were financed with long-term fixed-rate debt, higher inflation would be beneficial to the liabilities of the real estate owner, as the loss to the debt investor is mirrored as a gain to the borrower. This suggests an empirically testable hypothesis: REITs holding relatively large amounts of long-term fixed-rate debt will tend to have stronger returns than REITs holding small amounts of long-term fixed-rate debt, during periods of high inflation. Unfortunately, while data on total debt are readily available through sources such as SNL Financial (www.snl.com), data on the composition of debt - long-term *vs.* short-term, and fixed-rate *vs.* variable-rate - are more difficult to collect consistently, which is why we have only briefly examined this here.

As a proxy for detailed information on REIT use of debt, the authors identified 41 equity REITs that generally used relatively high leverage and 41 that generally used relatively low leverage, and compared their returns during months of high vs. low inflation during the period 1991-2010, where high-inflation months were identified relative to the median monthly CPI over the study period.[5] The empirical data support the hypothesis, though not strongly enough to reject the null: the median monthly total return of high-leverage REITs (1.26%) exceeded that of low-leverage REITs (1.16%) during months of higher than median inflation, but fell short (1.05% vs. 1.76%) during months of lower inflation.

Having considered conceptually how real estate can be thought of as a hedge against inflation, the remainder of the paper develops empirical techniques for analyzing the inflation sensitivity of real estate assets.

Hedge Effectiveness and Inflation Sensitivity

An approach to evaluating the relationship between investments and inflation that is fairly standard in the investment community (although less so in the academic literature) is to compute the contemporaneous correlation between inflation (e.g., change in consumer price inflation, available monthly) and asset returns at the same frequency (cf. Bhardwaj, Hamilton & Ameriks [2011]; Lomelino, Gillett & Komarynsky [2011]; and Ralls [2010]). A correlation approaching 100% is considered a sign of high sensitivity to inflation, and therefore of an asset with good inflation hedging properties.

There are three problems with this standard approach, as applied by investors and investment advisers (many of whom do not hedge but rather use strategic and tactical asset allocation to protect against inflation). First, the correlation coefficient gives equal weight to all historical periods without regard to whether inflation was high or low in those periods, whereas many investors seek inflation protection specifically during periods of high inflation. Possible solutions to this problem include computing a semi-correlation coefficient using data from only those months in which inflation was relatively high, or weighting each month according to the level of inflation during that month.

Second, use of the contemporaneous correlation implies that only those assets whose returns respond to inflation during the same month are of value to investors as inflation protection. Returns of some assets, though, may be sensitive to inflation with a lag, especially when inflation is unexpected. For example, even U.S. Treasury Inflation Protected Securities (TIPS), which provide income explicitly linked to realized inflation through a monthly adjustment to the bond principal, have a two to three month lag in their indexation to CPI[6]. Note however that the market price of TIPS will respond in synchronicity with changes in relevant market variables - most notably (real) interest rates (which in general will display correlation with inflation). Because of this, the investor's horizon remains a relevant empirical issue in the study of inflation sensitivity; ways to address this issue include computing the correlation between asset returns and lagged inflation, developing a distributed-lag model of the relationship between inflation and asset returns, or estimating a vector autocorrelation (VAR) model of the same relationship.

Third, the correlation coefficient is a measure of co-movement but not a measure of whether returns preserve purchasing power or provide what the authors term here an "effective" inflation hedge. That is, correlation measures whether asset returns move in the same direction as inflation, but to establish an effective inflation hedge one needs to use the correlation coefficient as an input, along with the volatilities of different asset returns, to compute the appropriate hedge ratio.[7] In practice, the stability of the correlation coefficient is often the most challenging aspect in determining the optimal hedge ratio and employing a hedge strategy.

As an alternative to the optimal hedge ratio, then, investors may consider other forms of inflation protection. One approach is to establish a strategic portfolio allocation with significant positions in assets that preserve purchasing power during high-inflation

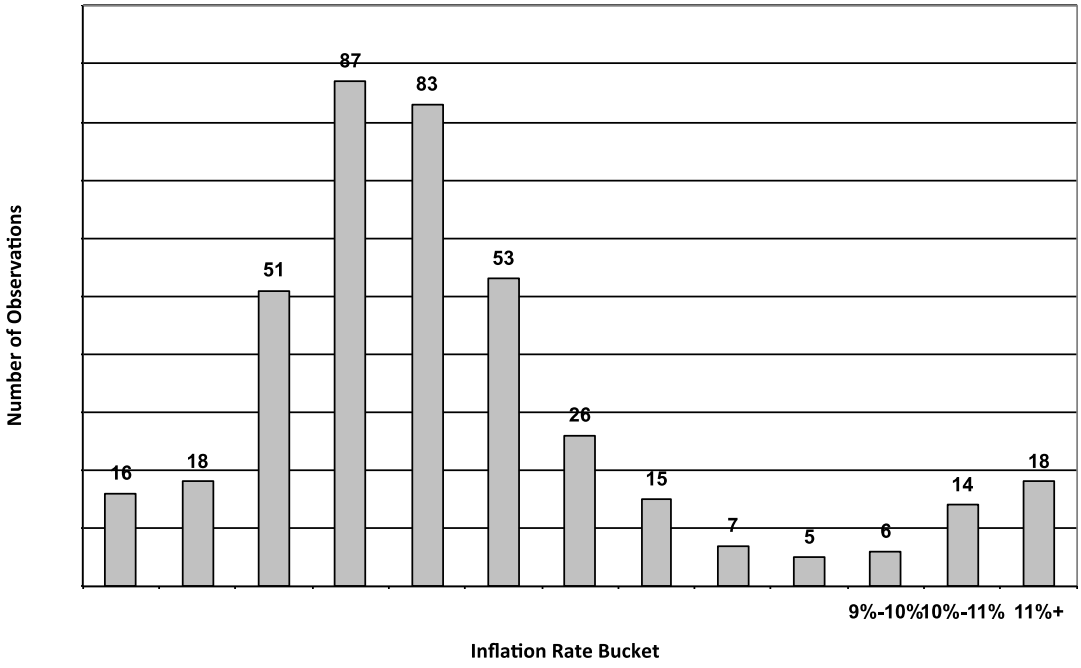
regimes; in the next two sections the authors introduce a direct measure of inflation protection dependability based on the success rate of a given asset in accomplishing this goal, and test the findings for robustness. A strategic allocation appropriate to high-inflation regimes, however, may produce poor returns during low-inflation regimes. In the following sections, the authors consider the opportunities and risks inhering in a strategy of shifting tactically between portfolios optimized for high- and low-inflation scenarios, and suggest an approach toward developing a strategic portfolio balanced between optimal performance in both inflation regimes.

Effectiveness of Tactical Asset Selection for Inflation Protection

A fundamental problem with using correlation to evaluate the inflation protection provided by an investor's choice of asset classes is that the correlation coefficient measures whether asset returns co-move with inflation (and therefore its value as an input in developing an optimal inflation hedge), not whether they protect directly against inflation, in the sense of protecting against purchasing power loss. In order to develop a direct measure of inflation protection, we propose the following:

1. Define the investment horizon over which inflation protection is desired - in our analysis, a six-month period. Our study covers the window from January 1978 to August 2011, thus including 399 overlapping[8] semesters summarized in Figure 1. Among the 399 observations in our sample, the median annualized inflation rate was 3.2%. In a following section, we will also consider how the results change if inflation protection is measured at different horizons (monthly, bi-monthly, annually).

Figure 1. Distribution of Annualized Six-Month CPI Inflation Rates



Data Source: US Bureau of Labor Statistics

2. Specify the inflation scenarios under which protection is sought. Our analysis focuses on high-inflation periods, defined as semesters during which annualized inflation exceeded 3.2%, our sample's median. By construction, half of the observations in our dataset satisfy this criterion; of course, other demarcation lines are possible, as discussed in a following section.
3. Define how to measure the effectiveness of inflation protection. We use the "success" rate: that is, the relative frequency with which returns equaled or exceeded inflation during the 199 semesters of high inflation in our sample, thereby accomplishing the usual goal of protecting purchasing power.

Table 1 presents the proposed measure of inflation protection using six-month periods constructed from monthly data for a selection of five asset classes: (1) publicly traded equity REITs as measured by the FTSE NAREIT All Equity REITs Index; (2) commodities as measured by the S&P Goldman Sachs Commodity Index (GSCI); (3) TIPS as measured by the Ibbotson Associates synthetic U.S. TIPS series, which is equal to the Barclays Capital U.S. Treasury TIPS Index from January 1997 onward, but is backfilled by Ibbotson prior to that; (4) US equities, as measured by the S&P 500 Index; and (5) gold as measured by the S&P GSCI Gold Index.[9] All indexes measure total returns (i.e. income plus price appreciation).

Table 1: Inflation Protection Success Rate

REITs	**Commodities**	**Stocks**	**TIPS**	**Gold**
65.8%	70.4%	60.8%	53.8%	43.2%

As Table 1 shows, the two assets providing the most dependable inflation protection (by our measure) have been commodities and equity REITs, with commodities providing total returns that equaled or exceeded inflation during 70.4% of high-inflation semesters and equity REITs close behind at 65.8%. Stocks and TIPS have provided somewhat weaker inflation protection by this measure, with stocks protecting purchasing power during 60.8% of high-inflation six-month periods and TIPS even lower at 53.8%[10]. By our measure, the weakest inflation protection among this group of assets has been provided by gold, which successfully protected purchasing power during only 43.2% of high-inflation six-month periods.[11]

As a note of caution in interpreting these results going forward, we stress that one key issue to choosing an asset class for tactical protection against inflation is not just forecasting correctly high (or low) periods of inflation, but having insight on the specific cause driving prices higher (or lower). For example, if inflation is caused by higher energy costs through an oil supply shock, it is plausible that energy commodities will be the winning sector in terms of tactical allocation (and later be the losers when the price spike corrects itself). This might not be true in the case of a dis-anchoring of inflation

expectations driven by ineffective monetary or fiscal policies. This caveat applies, of course, to any historical study of inflation sensitivity of different asset classes, given that high-inflation periods in the U.S. from the 1970s onwards have been mostly commodity-driven.

Robustness of Tactical Asset Selection for Inflation Protection

There are four main modeling decisions that may affect the empirical results shown in Table 1: (1) the six-month investment horizon chosen to measure inflation protection effectiveness; (2) the definition of "high-inflation" semesters as those during which annualized inflation exceeded the sample's median; (3) the choice of the S&P GSCI Index to measure commodity returns; and (4) the use of the Ibbotson Associates synthetic U.S. TIPS series.

The choice of six months as the investment horizon was motivated by the observation that TIPS adjust explicitly to the inflation rate but pay interest only every six months. A shorter investment horizon can generally be expected to favor those assets whose returns respond most quickly to unexpected inflation, while a longer investment horizon should favor those assets whose returns most closely track expected inflation.

Table 2: Inflation Protection Success Rates Under Different Modeling Decisions

	REITs	**Commodities**	**Stocks**	**TIPS**	**Gold**
Base scenario (Table 1)	**65.8%**	**70.4%**	**60.8%**	**53.8%**	**43.2%**
(1) 1 month	51.5%	55.4%	53.0%	51.0%	50.0%
(2) 2 months	58.2%	61.7%	56.2%	50.2%	44.8%
(3) 12 months	68.9%	75.5%	71.4%	56.6%	46.4%
(4) 67th percentile = 4.29%	59.4%	70.7%	54.9%	42.9%	46.6%
(5) 80th percentile = 4.89%	55.0%	66.3%	50.0%	41.3%	52.5%
(6) 90th percentile = 8.65%	65.0%	55.0%	55.0%	27.5%	60.0%
(7) S&P GSCI Energy Index		75.3%			
(8) S&P GSCI Non-Energy Index		61.0%			
(9) Barclays Capital TIPS Index				56.3%	

Surprisingly, row (1) of Table 2 shows that, when the analysis is conducted using returns in the same month as inflation (that is, no acceptable delay in asset responsiveness to inflation), the success rates of the assets included in the comparison differ only slightly: the best-performing inflation protector remains commodities at 55.4% followed by stocks at 53.0%, REITs at 51.5%, TIPS at 51.0%, and gold at 50.0%. As row (2) of Table 2 shows, however, the assets differ much more substantially over two-month periods of relatively high inflation: the most dependable inflation protection has been provided by commodities (61.7%) followed by equity REITs (58.2%) and stocks (56.2%), with TIPS (50.2%) lagging slightly. Gold (44.8%) successfully protected purchasing power in fewer than half of high-inflation two-month periods.

A longer investment horizon should favor assets with stronger expected returns that are more sensitive to expected inflation. Row (3) of Table 2 shows that, during 12-month periods of relatively high inflation, the most dependable inflation protection has been provided by commodities (75.5%), stocks (71.4%), and equity REITs (68.9%), with TIPS (56.6%) somewhat weaker; again, gold (46.4%) historically has covered the inflation rate in fewer than half of high-inflation 12-month periods.

The "high-inflation" scenarios were defined for Table 1 as those semesters during which inflation exceeded the annualized median 3.2% of the 399 observations in the sample period. As noted, however, inflation during the 1970s and early 1980s reached much greater severity, up to a maximum of 16.26% during the first six months of 1980. Rows (4)-(6) of Table 2 summarize the inflation protection provided by each asset class during progressively more severe inflationary environments: the 67^{th} percentile (corresponding to an annualized inflation rate of 4.3% in our sample), 80^{th} percentile (that is, a 4.9% annualized inflation rate), and 90^{th} percentile (8.7% annualized inflation). The numbers indicate that commodities and TIPS are progressively less likely to provide returns covering the inflation rate during more severe inflationary periods. Only gold provides monotonically more dependable inflation protection during progressively more severe inflationary environments; the success rates of REITs and stocks change non-monotonically with respect to the severity of the inflation regime. For those periods when inflation exceeded its 90^{th} percentile - a condition last experienced during June-November 1981 - returns on gold equaled or exceeded inflation 60.0% of the time, while returns on REITs performed even better with a 65.0% success rate. It is important to remember, of course, that the statistical relevance of these results decreases both with the number of applicable sample points (inflation was higher than the 90^{th} percentile during only 40 semesters out of the total 399 in our sample), and with the possibility that a regime change since 1981 may have rendered the older data obsolete.

Commodity returns were measured using the S&P GSCI, for which data are available over the full historical period but which is dominated by energy prices; in contrast, other indexes such as the Dow Jones-UBS commodity index attach significantly less weight to energy prices but are available over a much shorter historical period. To investigate the differential contributions of energy and non-energy commodities, rows (7) and (8) of Table 2 summarize the inflation protection dependability of the GSCI Energy Index and the GSCI Non-Energy Commodities Index over the period since February 1983 during which both have been available. The numbers show that, in the sample considered, energy investments provided much more dependable inflation protection than non-energy commodities, with returns that equaled or exceeded inflation in 75.3% of high-inflation six-month periods compared to just 61.0% for non-energy commodities.

Finally, U.S. TIPS have been available only since January 1997, so the performance of TIPS in providing inflation protection cannot be evaluated using actual returns during the inflationary periods of the 1970s and early 1980s. The analysis shown in Table 1 used the synthetic TIPS return series estimated by Ibbotson Associates, while row (9) of Table 2 tests the robustness of the TIPS results by reporting the inflation protection dependability computed using an alternative synthetic TIPS return series

estimated by Barclays Capital. As the numbers show, results are not very sensitive to the TIPS return series used, with the Barclay Capital synthetic TIPS index returns equaling or exceeding inflation in 56.3% of the 199 high-inflation periods in our sample, comparable to the 53.8% computed using the Ibbotson synthetic TIPS index. The fact that the two synthetic indexes show similar results does not, of course, rule out the possibility that both indexes may be affected by common methodological biases in backfilling historical returns.

Using Tactical Portfolio Allocation for Inflation Protection

Many investors may choose to shift asset class selections tactically over time based on their outlook on inflation and other relevant variables. The asset classes considered display substantial differences in returns during high- versus low-inflation periods, making this tactical asset selection option both valuable and risky. In other words, correct insight on future inflation (and its root causes) can greatly enhance investment returns, while forecasting mistakes can prove costly. During the overlapping six-month periods that we have identified as high-inflation semesters the average annualized rate of inflation was 6.1%, compared to 1.8% during low-inflation semesters.

As Table 3 shows, during high-inflation semesters commodities have provided by far the strongest average annualized returns at 19.2% per year. This should not be surprising, as commodities not only account for a substantial share of the CPI but also have been a driver of short-term inflation spikes[12] in the historical window of our study. Equity REITs and stocks also provided strong returns, averaging 12.3% per year for equity REITs (with income-only returns averaging 8.6%) and 10.2% per year for stocks. The average return on TIPS barely beat the inflation rate at 6.9%, while gold fell short of the inflation rate at 6.0%.

Table 3. Average Annualized Returns in High-Inflation Semesters

CPI	6.1%
Commodities	19.2%
Equity REITs	12.3%
Equity REITs (Income Only)	8.6%
Stocks	10.2%
TIPS	6.9%
Gold	6.0%

How much the ability to discern between high- and low-inflation regimes affects the outcome is clear by comparing the previous results with the average returns in low inflation periods (see Table 4). During the latter, equity REITs and stocks have provided the strongest annualized returns, averaging 13.7% and 13.0% respectively. (REIT income-only returns averaged 6.9% per year, far more than the average inflation rate.)

The returns on TIPS and gold, too, have exceeded the inflation rate at 9.2% and 7.2% per year, respectively.

By far the worst performing asset class is commodities, with total returns averaging -2.4% per year during low-inflation regimes – again, not surprising given the share of commodities in the CPI. Clearly, the large variance in commodity returns is, in part, the consequence of the high volatility and self-corrective nature of energy price spikes (for example oil supply shocks), which are virtually impossible to predict but whose effects tend to average out over longer investment horizons.

Table 4. Average Annualized Returns in Low-Inflation Semesters

CPI	1.8%
Commodities	13.7%
Equity REITs	13.0%
Equity REITs (Income Only)	6.9%
TIPS	9.2%
Gold	7.2%
Commodities	-2.4%

These results (as shown in table 4), if taken at face value, suggest that, at least in the historical period considered, the winning allocation strategy would have been to shift the portfolio aggressively into commodities during periods of high inflation, shifting back to assets that fulfill other investment goals (e.g., income, risk-adjusted returns, diversification), such as equity REITs or TIPS, during periods of low inflation. Of course, the difficulty with successfully implementing such a strategy rests in the ability to predict the inflation regime during the next several months; the consequences of being wrong are eloquently showcased by the variance in asset class returns that characterizes different inflation regimes.

Although investors typically focus on the risk of high inflation, low inflation (or even deflation) can be equally insidious for the returns of a portfolio. While insightful asset allocation by the active investor has the potential to enhance portfolio returns in either regime considerably, the objective of a strategic asset allocator or hedger is not to select each period's best performing asset class but, quite to the contrary, to build effective protection against both inflation and deflation shocks, thus minimizing or eliminating any reliance on the difficult and risky task of correctly forecasting inflation going forward.

A Balanced Approach to the Inflation-Protected Portfolio

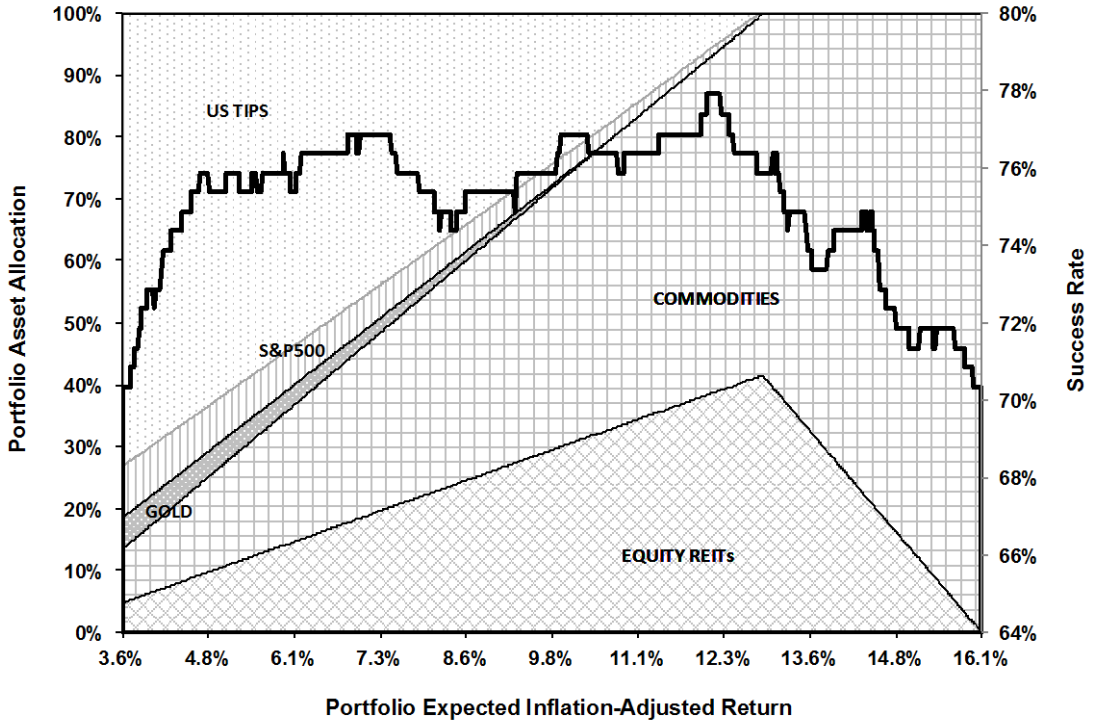
The fact that various assets respond differently to inflation suggests that a blended portfolio of assets with differing inflation protection properties may provide a better bulwark against inflation than any asset in isolation. To illustrate this point, Figure 2

summarizes the results of a Markowitz (1952, 1959) mean-variance portfolio optimization exercise conducted using historically realized real returns (that is, returns in excess of inflation) for the five inflation-sensitive assets considered during the 199 high-inflation semesters in our data sample.

Each point in Figure 2 shows an optimal asset allocation, from the minimum-variance portfolio at the left edge (annualized average real return 3.6%, volatility 9.4%, Sharpe ratio[13] 0.31) to the maximum-return portfolio at the right edge (annualized average real return 16.1%, volatility 27.9%, Sharpe ratio 0.55). The Sharpe ratio is defined as the ratio of portfolio return in excess of the risk-free rate, divided by portfolio volatility. In the analysis, the monthly risk-free rate is given by the return on the Citigroup BIG 1-month Treasury bill index.

The jagged line in Figure 2 (right-hand axis) shows the success rate for each portfolio: that is, the relative frequency with which the nominal returns on each portfolio equaled or exceeded the inflation rate during high-inflation semesters in our historical sample. For example, a portfolio comprising a 55.1% allocation to commodities with 39.1% invested in equity REITs, 4.6% in TIPS, and 1.2% in stocks (with no gold) would, over the historical period of our analysis, have generated nominal returns equaling or exceeding the inflation rate during 77.9% of the 199 high-inflation semesters – substantially outpacing the most dependable asset in isolation, commodities at just 70.4%.

Figure 2. Optimal Portfolio Allocation and Success Rates in High-Inflation Semesters



Maintaining that maximum-effectiveness (as per our definition) portfolio as a strategic asset allocation, however, would have exposed the investor to considerable directional risk to inflation. As Table 5 reports, the average annualized real return during high-inflation periods was 12.3% over the historical period, with volatility of 18.0%, and a Sharpe ratio of 0.65. During low-inflation periods, however, the portfolio would have generated significantly lower real returns (8.2% on average) with significantly higher volatility (23.2%), for a Sharpe ratio of just 0.27.

Over the entire historical period (encompassing both low-inflation and high-inflation periods) the maximum success rate portfolio would have generated real returns averaging 10.2% per year with 20.9% volatility for a Sharpe ratio of 0.43. The explanation for this directional risk can be seen by comparing Figure 2 with Figure 3, which summarizes the results of an equivalent Markowitz mean-variance portfolio optimization exercise conducted using historical real returns during the 200 low-inflation semesters in our data sample.

During high-inflation periods (see Figure 2), the largest roles in optimized portfolios are played by commodities, TIPS, and REITs, with optimal allocations to TIPS declining as portfolio return and volatility increase, while optimal allocations to both commodities and REITs increase. Stocks and gold have very small (and declining) allocations in portfolios optimized over high-inflation historical periods. In contrast, during low-inflation periods the largest roles in optimized portfolios are played by TIPS, REITs, and stocks; commodities play no role in portfolios optimized over low-inflation periods except at the lowest levels of portfolio volatility, while gold accounts for small allocations throughout the risk/return spectrum.

In short, portfolios that include substantial allocations to commodities have historically provided dependable protection against inflation during high-inflation periods, but have exposed investors to substantial directional risk. In contrast, the historical data suggest that TIPS and equity REITs play important roles in optimized portfolios during both low- and high-inflation periods.

Table 5: Historical Performance of Optimized Investment Portfolios

Optimization Criterion	Periods	Annualized Return	Annualized Volatility	Sharpe Ratio	Success Rate
Maximum Success Rate (High-Inflation Periods)	**Allocation: 55.1% Commodities, 39.1% REITs, 4.6% TIPS, 1.2% Equities, 3.3% Gold**				
	High-Inflation	12.3%	18.0%	0.65	**77.9%**
	Low-Inflation	8.2%	23.2%	0.27	
	All	**10.2%**	**20.9%**	**0.43**	
Maximum Sharpe Ratio (All Periods)	**Allocation: 48.9% TIPS, 16.9% REITs, 14.6% Commodities, 13.9% Equities, 5.8% Gold**				
	High-Inflation	5.6%	10.5%	0.48	**74.9%**
	Low-Inflation	9.5%	12.4%	0.60	
	All	**7.5%**	**11.7%**	**0.54**	
Maximum Sharpe Ratio (High-Inflation Periods)	Allocation: 58.1% Commodities, 41.3% REITs, 0.5% Equities, 0% TIPS, 0% Gold				
	High-Inflation	12.8%	18.8%	**0.65**	**75.9%**
	Low-Inflation	8.2%	24.3%	0.26	
	All	10.5%	21.9%	0.42	
Maximum Sharpe Ratio (Low-Inflation Periods)	Allocation: 78.7% TIPS, 10.8% Equities, 5.4% Gold, 5.0% REITs, 0% Commodities				
	High-Inflation	2.4%	9.8%	0.19	**57.8%**
	Low-Inflation	9.0%	8.9%	**0.79**	
	All	5.7%	9.9%	0.45	
Minimum Variance (All Periods)	**Allocation: 80.9% TIPS, 8.4% Commodities, 5.8% Gold, 4.9% Equities, 0% REITs**				
	High-Inflation	3.1%	9.6%	0.25	**67.3%**
	Low-Inflation	7.6%	8.3%	0.67	
	All	**5.3%**	**9.3%**	**0.44**	
Minimum Variance (High-Inflation Periods)	Allocation: 73.3% TIPS, 8.6% Commodities, 8.4% Equities, 5.0% Gold, 4.8% REITs				
	High-Inflation	3.6%	9.4%	0.31	**69.3%**
	Low-Inflation	8.3%	9.0%	0.7	
	All	5.9%	9.5%	0.49	
Minimum Variance (Low-Inflation Periods)	Allocation: 90.4% TIPS, 5.3% Gold, 2.6% Commodities, 1.7% Equities, 0% REITs				
	High-Inflation	2.0%	10.0%	0.14	**59.8%**
	Low-Inflation	7.7%	8.1%	0.71	
	All	4.9%	9.5%	0.38	
Equal Sharpe Ratios in High- and Low-Inflation Periods	**54.1% TIPS, 21.8% Commodities, 14.5% REITs, 6.4% Equities, 3.3% Gold**				
	High-Inflation	6.0%	10.4%	0.52	**75.4%**
	Low-Inflation	8.3%	12.0%	0.52	
	All	**7.1%**	**11.3%**	**0.52**	

Indeed, as Figure 4 shows, TIPS and REITs together account for half or more of the optimized investment portfolio over nearly every part of the risk/return spectrum in a

Markowitz mean-variance optimization conducted using real returns for the entire historical period included in the analysis, with TIPS especially important in low-volatility portfolios and REITs playing the dominant role in high-return portfolios.

Figure 3. Optimal Portfolio Allocation in Low-Inflation Semesters

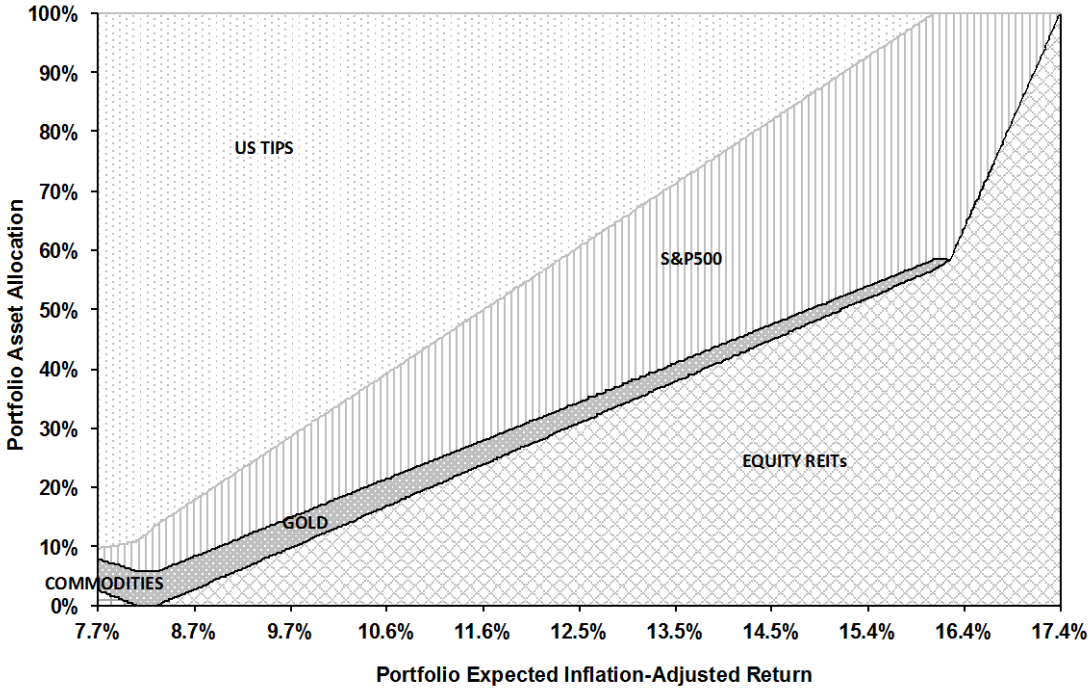
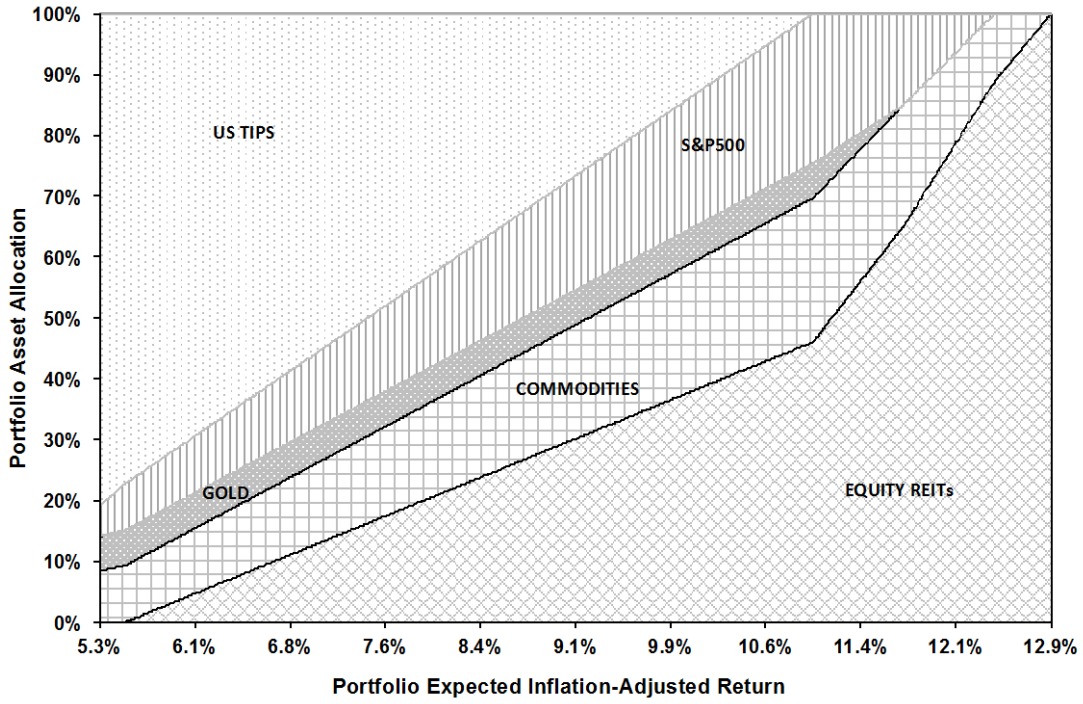


Figure 4. Optimal Portfolio Allocation: All Semesters



For investors seeking to reduce directional risk associated with the realized inflation rate, an alternative to the effectiveness-maximizing investment strategy presented earlier – under which directional risk is considerable – might be to select the strategic asset allocation that generated the strongest risk-adjusted returns over the entire historical period.

Table 5 identifies this portfolio as being composed of 48.9% TIPS, 16.9% equity REITs, 14.6% commodities, 13.9% stocks, and 5.8% gold: this portfolio generated historical real returns averaging 7.5% per year, with a 11.7% volatility, and a Sharpe ratio of 0.54. Moreover, this portfolio was quite successful in protecting against inflation, providing nominal returns that equaled or exceeded the inflation rate in 74.9% of high-inflation six-month periods. While not as effective as the maximum success rate portfolio (77.9%), the effectiveness of this portfolio is superior to the best asset in isolation, i.e. commodities at 70.4%.

Investors using the maximum Sharpe ratio asset strategic allocation, however, would still have been exposed to directional risk related to the inflation rate (see Table 5). During low-inflation periods, this strategic asset allocation would have generated real returns averaging 9.5% per year, with volatility of 12.4%, and a Sharpe ratio of 0.60. During high-inflation periods, however, the maximum Sharpe ratio allocation would have produced substantially lower annualized average real returns (5.6%) with only moderately lower volatility (10.5%), and a Sharpe ratio of 0.48.

Investors seeking to eliminate directional risk altogether (at least on an expected basis) could have instead chosen a portfolio comprising a 54.1% allocation to TIPS along with 21.8% in commodities, 14.5% in equity REITs, 6.4% in stocks, and 3.3% in gold. Across the entire historical period, this portfolio would have generated real returns averaging 7.1% per year with 11.3% volatility, for a strong Sharpe ratio of 0.52; the portfolio would also have provided very dependable protection against inflation, with nominal returns covering the inflation rate in 75.4% of high-inflation periods. Moreover, the risk-adjusted returns of this portfolio would not have depended on the inflation rate: during high-inflation periods real returns would have averaged 6.0% with 10.4% volatility (see Table 5), while during low-inflation periods both real returns (8.3%) and volatility (12.0%) would have been commensurately higher, resulting in no difference in returns on a risk-adjusted basis (i.e. Sharpe ratios).

Inflation Sensitivity of Different Property Types

The value of income-producing real estate in protecting against inflation arises from the adjustment process by which lease rents respond to changes in inflation. Different types of property, however, are characterized by significant differences in lease provisions, and these give rise to differences in their inflation sensitivity.

Perhaps the most important provisions for inflation sensitivity are the lease term and, consequently, the frequency of lease turnover and negotiation. At one extreme, hotels have typical lease terms of only one, or a few, nights, implying that rents can be adjusted almost continuously in response to changes in inflation, as well as other factors.

Rental apartments typically employ 12-month leases, perhaps with monthly lease extensions after the first year, implying that rents can be adjusted annually, if not monthly; self-storage facilities typically have similarly short lease terms.

For hotel, apartment, and self-storage properties, the fact that lease rents are typically fixed during the entire duration of the contract term is mitigated by the fact that contract terms are typically short, potentially enabling property owners to adjust rents in response to inflation. Other property types may employ automatic adjustments to changes in inflation, whether explicit or implicit. For example, many retail leases specify monthly rental payments as a function of the sale revenues generated by each store; thus, as inflation affects the sale prices of consumer goods, it affects lease rents as well.

In some cases, especially with tenants that are government agencies, office leases may include an explicit adjustment in response to inflation; in these cases, office property returns may be sensitive to inflation even with long lease terms. A slightly different mechanism may affect lease rents for health care properties, including long-term care facilities: if health care reimbursement rates are regulated, then inflation may be accounted for in determining payments for various health care services, and therefore pass through to owners of health care properties.

Table 6: Inflation Protection Success Rates by Property Type

	Success Ratio
Self-Storage	81.0%
Residential	77.8%
Shopping Centers	73.0%
Equity REITs	**71.4%**
Industrial	71.4%
Office	69.8%
Regional Malls	69.8%
Lodging	68.3%
Health Care	68.3%
Free-Standing Retail	61.9%
Commodities	**81.0%**
TIPS	**63.5%**
Equities	**58.7%**

Table 6 presents the same analysis of inflation protection effectiveness shown in Table 1, but focuses on publicly traded equity REITs across different sectors over the historical period from January 1994 for which data are available.[14] As Table 6 shows, the two property sectors that provided the most effective inflation protection, with returns greater than or equal to inflation during high-inflation semesters, were self-storage (81.0%) and residential (77.8%) - that is, two of the property types characterized by short lease terms, and therefore frequent lease turnover and renegotiation. Lodging, however—the third property type characterized by short leases—demonstrated a success

rate of just 68.3%, less than the equity REIT industry as a whole (71.4%). Shopping centers, too, provided inflation protection dependability above that of the industry as a whole, at 73.0% - but the other two retail property types, regional malls (69.8%) and especially free-standing retail (61.9%), fell short of the industry average, as did other property types including office (69.8%) and health care (68.3%)[15].

Inflation Hedging and Illiquid Real Estate Investments

The authors have measured real estate investment returns using the returns on publicly traded equity REITs, but several other real estate indices are available including the NCREIF Property Index (NPI) of unlevered core property returns published by the National Council of Real Estate Investment Fiduciaries, the Open-End Diversified Core Equity (ODCE) Fund Index also published by NCREIF, and indexes of private equity real estate fund investments published jointly by NCREIF and The Townsend Group (see www.ncreif.org). All of these indexes measure the returns of illiquid investments, either in commercial properties themselves (held directly or through separate accounts with investment managers), or in non-traded shares of private equity real estate funds.

The illiquidity of such real estate investments means that their periodic returns, unlike the returns of publicly traded REIT equities, cannot be measured directly on the basis of price discovery from actual transactions.[16] Instead, returns on unlisted real estate investments are appraisal-based - that is, appraisals are conducted (whether internally or externally) and used to periodically (typically quarterly) estimate the capital appreciation component of total returns. For the purpose of evaluating non-traded real estate holdings as an inflation hedge, this introduces a critical problem, as current or estimated inflation is a typical input in the appraisal process, or in the extrapolation between appraisals. Thus, comparing appraisal-based returns to inflation as a means of analyzing sensitivity to inflation becomes tautological.[17]

Circumstantial evidence for this problem can be seen in Table 7, which shows the correlation between quarterly inflation and quarterly capital appreciation and income returns on illiquid real estate, as measured by the NPI and the ODCE. For both indexes, correlation between capital appreciation and inflation (31%) is greater than correlation between income and inflation (27% from the ODCE, and just 17% from the NPI). This suggests that the appraisal-based values of commercial properties fluctuate more strongly in response to inflation than does the quarterly income produced by the same properties (as measured by actual rents received).

Table 7: Correlations of Private Real Estate Return Measures with Inflation

Return Component	Measure	Correlation with Quarterly CPI Inflation
Capital Appreciation	NPI	31%
	ODCE	31%
Income Return	NPI	17%
	ODCE	27%
Total Return	NPI	32%
	ODCE	33%
	TBI	10%

Additional evidence is uncovered by comparing correlations computed from appraisal based total returns with correlations computed from actual transaction values. Table 5 also shows the correlations of quarterly inflation with quarterly total returns measured by the NPI, the ODCE, and the Transaction Based Index (TBI) calculated until recently by the Center for Real Estate at the Massachusetts Institute of Technology. The TBI is computed using all transactions of properties that are also in the database used to compute the NPI, which itself has substantial overlap with the database used to compute the ODCE, implying that differences among the assets underlying the three indexes are slight. The computed correlations, however, are different: just 9.8% using actual transaction values as measured by the TBI, compared to 32% using appraised values from the NPI, and 33% using appraised values from the ODCE.

To summarize, the authors caution against the use of appraisal-based estimates to evaluate the sensitivity of asset returns to inflation. While the evidence reviewed here is specific to the REITs, the conclusion seems equally applicable to other illiquid real estate assets whose values and returns are estimated by appraisal: however, if valuations are influenced in part by the appraiser's awareness of current or expected inflation, then evaluating inflation sensitivity may amount to tautology.

Conclusions

According to the Gordon growth model, real estate can be considered a perfect hedge against inflation, under the strong assumption that future rent growth and discount rates move in line with expected and actual inflation rates. In this paper, the authors examine the historical performance of real estate as an inflation hedge in the period from 1978 to 2011, and compare it to other inflation-sensitive asset classes.

In the historical sample, looking at single asset classes first, commodities provide the best inflation protection, as per the measure of hedge effectiveness adopted here, with an overall success rate of 70% in high-inflation semesters (75% for energy commodities, and 61% for non-energy commodities). These results are only slightly sensitive to differences in the time horizon used to calculate returns, the demarcation line used to define high-inflation periods, and the choice of synthetic TIPS return series.

During low-inflation periods, however, commodities generated the lowest returns of any asset class considered. This large performance difference highlights the utility of constructing a balanced portfolio if performance in both high- and low-inflation regimes is the goal.

Historically, a Markowitz mean-variance optimization suggests that a blended portfolio, invested 49% in TIPS, 17% in equity REITs, 15% in commodities, 14% in stocks, and 6% in gold, achieves the maximum Sharpe ratio (0.54) across all semesters in our sample. The success ratio of this multi-asset-class portfolio is quite high 75%, but it also has considerable directional risk.

To mitigate the latter, historically, one could have invested slightly more in TIPS (54%) and commodities (22%), and slightly less in equity REITs (14%), stocks (6%), and gold (3%). Historically, this portfolio has provided not only a similar success rate (75%) in high-inflation semesters, but also a similar Sharpe ratio (0.52), with the advantage that the latter is identical in both high- and low-inflation periods.

Finally, investors seeking to maximize the success rate in high-inflation semesters, without regard to directional risk, would have chosen a more aggressive portfolio with 55% in commodities, 39% in REITs, 5% in TIPS, 1% in stocks, and no gold holdings. Historically, this portfolio has a success rate of 78% in high-inflation semesters, but considerable directional risk.

Different property types provide different levels of inflation protection, depending on the extent to which rents adjust to inflation. The property types expected to provide the strongest inflation protection are the ones characterized by short-duration leases, or by rents linked to revenues. Empirical data generally support these expectations, with self-storage, residential properties, and shopping centers having a success ratio from the mid-70% to the low-80% range in high-inflation semesters, higher than the industry average (71%), (see table 6).).

Although the authors have used publicly traded equity REIT returns in this paper, similar empirical analysis could in principle be conducted using returns on illiquid investments, i.e. properties themselves or private equity real estate investment funds. Unfortunately, the latter are typically estimated by appraisals, which are linked to inflation, thus making an analysis of their price sensitivity to inflation amount to tautology.

The empirical evidence examined in this paper suggests that a variety of assets have inflation-protecting characteristics. Real estate, considered a strong inflation hedge on conceptual grounds, has in fact performed as well as, or better than, other inflation-sensitive assets, in the historical sample considered, and has not exposed investors to significant directional inflation risk. Indeed, based on both empirical results and theoretical arguments, real estate, accessed through publicly traded equity REITs,

provides attractive return characteristics and deserves consideration in diversified inflation-protected portfolios.

REFERENCES

Bhardwaj, Hamilton & Ameriks [2011]: Geeteesh Bhardwaj, Dean J. Hamilton, and John Ameriks, "Hedging Inflation: The Role of Expectations," published by Vanguard, available at https://www.vanguardinvestments.de/content/documents/Articles/Insights/hedging-inflation.pdf.

Bond & Slezak [2010]: Shaun A. Bond and Steve L. Slezak, "The Optimal Portfolio Weight for Real Estate with Liquidity Risk and Uncertainty Aversion" (October 4, 2010), available at SSRN: http://ssrn.com/abstract=1691503.

Geltner, Miller, Clayton & Eichholtz [2007]: David M. Geltner, Norman G. Miller, Jim Clayton, and Piet Eichholtz, *Commercial Real Estate: Analysis & Investments* (2nd edition, 2007), Thomson South-Western.

Gordon, Myron J. [1962]: The Investment, Financing and Valuation of the Corporation. Homewood, Ill. Irwin.

Cheng, Lin & Liu [2010]: Ping Chen, Zhenguo Lin, and Yingchun Liu, "Illiquidity and Portfolio Risk of Thinly Traded Assets," *Journal of Portfolio Management* 36(2):126-138 (Winter 2010).

Lin & Vandell [2007]: Zhenguo Lin and Kerry Vandell, "Illiquidity and Pricing Biases in the Real Estate Market," *Real Estate Economics* 35(3):291-330 (Fall 2007).

Lomelino, Gillett & Komarynsky [2011]: Dan Lomelino, Kim Gillett, and Marko Komarynsky, "Inflation Hedging With Inflation-Linked Bonds," published by Towers Watson, available at http://www.towerswatson.com/assets/pdf/4125/1101-TIPS-FIN.pdf.

Markowitz: Harry Markowitz, "Portfolio Selection," *The Journal of Finance* 7(1):77–91 (1952), and *Portfolio Selection: Efficient Diversification of Investments*, New York: John Wiley & Sons (1959).

Ralls [2010]: Bills Ralls, CFA, "Inflation or Deflation: Prepare for Either," published by Fidelity Investments, available at https://guidance.fidelity.com/viewpoints/inflation-vs-deflation.

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[1] Strategic asset allocation is the choice of a set of portfolio weights that are not expected to change in response to market conditions, requiring only that the portfolio be rebalanced periodically to the strategic weights. Tactical asset allocation is the choice of portfolio weights in response to current market conditions, overweighting assets or asset classes that are expected to outperform while underweighting those expected to underperform.

[2] Discussing the limitations of this simple valuation model is outside the scope of the paper. For a discussion with reference specifically to real estate and REITs see Geltner, Miller, Clayton & Eichholtz [2007].

[3] Clearly, this is a very strong assumption that may not generally hold in reality, but it is a useful baseline for illustrating the relevant issues.

[4] Demand shocks also affect real interest rates in the short run.

[5] The empirical data support the hypothesis, though not strongly enough to reject the null: the median monthly total return of high-leverage REITs (1.26%) exceeded that of low-leverage REITs (1.16%) during months of higher than median inflation, but fell short (1.05% vs. 1.76%) during months of lower inflation. If the analysis is restricted to the historical period January 1990 – September 2008, thereby excluding the

liquidity crisis of 2008-2009, then during months of higher than median inflation the median return of high-leverage REITs (1.14%) is slightly less than the median return of low-leverage REITs (1.17%); during months of lower than median inflation, returns to high-leverage REITs were more markedly less than returns of low-leverage REITs (1.34% vs. 1.92%).

[6] That is, month n principal is linked to an interpolated value of the CPI published in month n-1 and n-2, which measure inflation in month n-2 and n-3 respectively. Moreover, TIPS income is paid only every six months, a consideration relevant to some retail investors.

[7] For example, one might define the most effective hedge as the one that minimizes the variance of the overall position. In this case, if series Y and X have correlation ρ and volatilities σ_Y and σ_X respectively, the optimal hedge ratio is given by $h = \rho \, \sigma_X / \sigma_Y$, which means that, to obtain the optimal (minimum variance) hedge, one needs to sell h units of asset Y for each unit of X.

[8] Note that the observations are not statistically independent.

[9] January 1978 is the first date for which the S&P GSCI Gold Index is available. Data for the other assets is available from January 1972 (the starting date of the FTSE NAREIT Equity REITs Index); over the longer historical period the success rate was about 67% for both REITs and commodities, and about 55% for both stocks and TIPS.

[10] Although TIPS income return is linked to, and thus increases with, inflation, the TIPS index also has real rate duration, i.e. its price decreases with an increase in real rates. This effect is especially important before TIPS first issuance, where real rates have no observable market dynamics, and are re-constructed by subtracting realized inflation to market-observable nominal rates. Since nominal rates typically increase more than one-to-one with inflation, these historically back-filled synthetic real rates will also tend to increase with inflation and decrease index price, thus underestimating the hedging performance of the asset class in high inflation scenarios.

[11] This ranking may seem intuitive given that higher–volatility, higher-return assets such as commodities, REITs, and equities will have a greater chance to satisfy our inflation protection criterion during high-inflation periods. As noted in the next section, however, this intuition does not hold firmly. The reader should bear in mind that the measured performance of TIPS may be sensitive to the methodology used to construct a synthetic TIPS return index for periods preceding TIPS issuance (i.e., before 1997), as discussed in the next section.

[12] This is mirrored by the fact that commodities become the worst performing asset in low inflation months. Also note that one would expect their over performance to smooth out on horizons longer than one month.

[13]

[14] The historical period for the analysis of inflation protection dependability by property type begins in January 1994, the inception date for the FTSE NAREIT family of property-type indexes.

[15] Other property types for which separate historical data are not available include timberland and specialized data centers.

[16] Transaction-based indexes of commercial property values and returns do exist, including the TBI employed later in this section. Several researchers including Lin & Vandell [2007]; Cheng, Lin & Liu [2010]; and Bond & Slezak [2010], however, have noted that transaction-based index methodologies applied to illiquid assets provide biased measurements of both the average and the volatility of returns or changes in value.

[17] The same, or an analogous, problem may affect the back filling of returns on TIPS prior to December 1997.