“Real estate as a portfolio risk diversifier”

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Real estate as a portfolio risk diversifier

Abstract

This study provides evidence on the investment performance of real estate relative to bonds and common stocks in the U.S. Using quarterly total return data over the years 1978-2012, the analyses show that, over this period, on a risk-adjusted basis real estate was the top performing asset class, outperformed both bonds and stocks. Real estate, in the Eastern U.S., was the top performer, outperforming both bonds and stocks. The results also show that real estate provided a partial hedge against actual and expected inflation, and that, in combinations with bonds and stocks, it made up a major share of optimal portfolios constructed for various target returns within the Markowitz optimization framework.

Keywords: real estate, diversification, portfolio allocations.
JEL Classification: G11.

"If you don't own a home, buy one. If you own a home, buy another one. If you own two homes, buy a third. And lend your relatives the money to buy a home".

John Paulson, investor and multi-billionaire

Introduction

For all of human history, real estate has been a fundamental source of wealth accumulation. Interest in real estate by institutional investors can be traced back to about 50 or 60 years ago for investors in the U.S. and somewhat longer for European institutions. Compared to paper assets, real estate has more unique risks and complexities, such as liquidity risk and high transaction costs; it also offers greater opportunities for positive alpha. Today, real estate is regarded as an important core holding in both individual and institutional portfolios.

Numerous studies have examined real estate investments on their own individual merits, and also for their impact on the investor's overall investment portfolio. These studies compare the returns and risks of real estate relative to other assets, notably, stocks and bonds. Furthermore, they examine the role of real estate as a hedge against inflation (for example, see Fogler, Granito, Smith and Statman, 1985; Hartzell, Hekman and Miles, 1986; Lins, Sherrick and Venigalla, 1992; and Gallo, Lockwood and Rutherford, 2000; and Miles and Mahoney, 1997), as well as the share of real estate in the optimal portfolio (Webb, Curcio and Rubens, 1988; MacGregor and Nanthakumaran, 1992; Goetzmann, 1993; Liang, Myer and Webb, 1996; and Gatzlaff, 2000).

Overall, the evidence shows that common stocks have been riskier than fixed-income securities, such as government or corporate bonds, but the results for real estate are mixed. Some studies show real estate to be riskier than either stocks or bonds, some find real estate to be riskier than bonds only, and others report that real estate is less risky than either stocks or bonds. In terms of return, roughly about half of the studies find that absolute returns on real estate have been higher than returns on stocks, bonds or other assets. A few studies show that real estate outperformed debt securities, but not common stocks on an absolute rate of return basis.

On a risk-adjusted basis, most of the studies indicate that real estate earned a higher return per unit of risk than common stocks, bonds or bills. Some of the studies correctly acknowledge that measurement errors in real estate returns may result in those returns appearing to be less risky than returns on other assets, when, in fact, that might not have been the case. A large portion of these measurement errors can be attributed to the higher transaction costs and lack of liquidity of real estate investments relative to financial assets, like bonds and stocks.

On the question of serving as a protection against inflation, previous studies confirm that debt securities have either been an inadequate inflation hedge or only provided protection for expected inflation only. Common stock returns have, in general, been negatively related to inflation, indicating that common stocks have not served as a good hedge against inflation. There is also evidence showing that real estate has been a fairly good hedge against both expected and unexpected inflation. Overall, previous studies confirm that real estate has been a better hedge against inflation than common stocks, corporate bonds or government bonds. However, it should be noted that the evidence on the efficacy of real estate as an inflation hedge has not been unanimous.

Much of the existing evidence about real estate prices is based on aggregated U.S. property prices at the country level. This evidence may or may not be applicable to real estate prices in different regions of the country. The present study uses a unique dataset

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consisting of commercial property for the US as a whole, as well as its component data representing prices in the four regions of the U.S. (East, Midwest, South and West), to provide evidence about real estate's investment performance nationally and regionally.

The questions examined in the paper are to evaluate 1) the performance of real estate, nationally and regionally, relative to bonds and stocks, 2) its relative weight within select portfolios of bonds, stocks and real estate, constructed according to the Markowitz optimization framework, and 3) the extent to which it provides protection against inflation beyond that which could be expected from a diversified portfolio of bonds and stocks.

1. Data

The study period runs from 1978 through 2012. Quarterly price and total return data were obtained for real estate, stocks, bonds, bills and inflation from a variety of sources. The data on real estate include a national property price index (NPI), representing the entire US market, as well as price indices for the four regions of the country that form this index (East, Midwest, South and West). Produced quarterly by the National Council of Real Estate Investment Fiduciaries (NCREIF), each price index consists of both equity and leveraged properties (non-agricultural, income-producing properties: Apartment, Industrial, Office, and Retail), but they are all adjusted to show the leveraged properties on an unlevered basis. So, the indices analyzed in this study are, essentially, unlevered indices. The total return data are computed by adding the income and capital appreciation return on a quarterly basis.

Quarterly total return data for common stocks (CRSP Value-Weighted Index), bonds (10-year Treasury), and bills (30-day Treasury) were obtained from Morningstar, Inc. Inflation data (Consumer Price Index) were sourced from the U.S. Bureau of Labor Statistics, while expected inflation data were taken from the Quarterly Survey of Professional Forecasters (SPF) conducted by the Federal Reserve Bank of Philadelphia. The data sample runs from the first quarter of 1978 to the last quarter of 2012, yielding 140 quarterly observations.

The SPF survey asks respondents to provide their expected average inflation for the next quarter. The survey is conducted in the middle of the preceding quarter, for which the respondents are asked to give their forecast. This implies that there is roughly a six-week lag between when the forecast data are collected and when the quarter begins. This lag is not ideal, since investors have new information before they purchase assets which enter into the indices used in this study. Unfortunately, these are the most timely expectations data available, arguably better than using proxies, such as the Treasury bill rate or the Livingston survey which are commonly used in other studies. John Carlson (1977) points out several important timing issues regarding the Livingston survey, primarily, concerning the information set of the survey respondents at the time of each survey and the implied time span of their forecasts. The Livingston survey was published biannually in December and June, but the surveys themselves were conducted two months prior to the publication date. The survey asked respondents to forecast the CPI six months out from the publication date, i.e., to forecast the June CPI for the December survey. This time inconsistency led Carlson to believe that the reported forecasts should be interpreted as eight-month rather than six-month forecasts, as they are commonly used.

One issue concerning the SPF inflation forecasts is that the data are only available in annualized, seasonally adjusted form. Unfortunately, there is no documentation as to how the data were deseasonalized. This creates some inconsistency within the data set, due to some of the data being seasonally adjusted (CPI and expected inflation), while the remaining asset return data are not. One of the issues in resolving this is whether deseasonalizing the remaining data will create more problems than doing nothing[1]. In order to match the data set, the quarterly rate change of the indices is calculated as the log ratio of t and t-1. The SPF data are reported as the quarterly expected inflation rate in annualized terms. These data are converted to quarterly returns by raising each observation to the one-fourth power. All regressions are estimated using the natural log of one plus the rate of return.

Annual returns were calculated as the quarterly compounded rate of return over four quarters for all variables, except expected inflation and unexpected inflation. Unexpected inflation is still calculated as the difference between actual inflation and expected inflation. Expected inflation is the one-year-ahead forecast made at the same time as the one-quarter-ahead forecast discussed earlier. The one-year-ahead forecast is calculated as the geometric mean of the annualized inflation forecast for the four quarters following the one in which the survey was conducted. This is reported by the Philadelphia Federal Reserve as the seasonally adjusted expected average annual rate of inflation.

2. Methodology

Basic statistics (return and risk) for real estate indices, stocks, bonds, bills serve as the basis for

[1] This is a minor issue, because re-running the quarterly regressions with seasonal dummies yields nearly identical estimation results. The seasonal dummies, when significant, were of very small magnitudes.

much of the analysis conducted in this study. Risk-adjusted returns for real estate indices are calculated and compared against stocks and bonds. Further, the significance of real estate in the optimal portfolio of risk assets (bonds and stocks) is determined using Markowitz optimization constrained by short-selling.

The effect of actual, expected and unexpected inflation on asset returns is estimated using Cochrane-Orcutt regressions, as employed in Rubens, Bond and Webb (RBW) (1989). Using the natural log of one plus the rate of return, the following regressions are run for each asset class (R_i) relative to actual (CPI), expected (EXP) and unexpected (UNEXP) inflation, respectively:

1. $ln\, R_{it} = a_0 + b_i\, ln\, CPI + e_t$.
2. $ln\, R_{it} = a_0 + b_i\, ln\, EXP + e_t$.
3. $ln\, R_{it} = a_0 + b_i\, ln UNEXP + e_t$.

The sign and magnitude of the b_i term determines the hedging effectiveness of each asset class for different types of inflation. Following RBW, the following definitions can be applied:

- *complete positive hedge* – positively signed b_i that is not statistically different from positive one;
- *partial positive hedge* – positively signed b_i that is statistically different from both zero and positive one;
- *partial negative hedge* – negatively signed b_i that is statistically different from both zero and negative one;
- *complete negative hedge* – negatively signed b_i that is not statistically different from negative one;
- *indeterminate hedge* – b_i that is not statistically different from zero.

3. Results

For the assets included in the study, cumulative wealth indices (CWI) with a base value of $1,000 investment at the end of 1978 are depicted in Figure 1. As can be seen in the figure below, a $1,000 initial investment in stocks in 1978 would have compounded to nearly $42,000 by December 2012. This compares to a CWI value in 2012 of $18,340 for real estate, $22,760 for bonds and about $5,900 for bills. As shown by the graph, bills posted the lowest CWI value and they were also far less volatile than investments in other assets. As for the CWIs for the four regions of the U.S. (not displayed in Figure 1 for purposes of simplicity), at the end of 2012 they amounted to $27,484 for East, $12,770 for Midwest, $12,944 for South, and $20,860 for West.

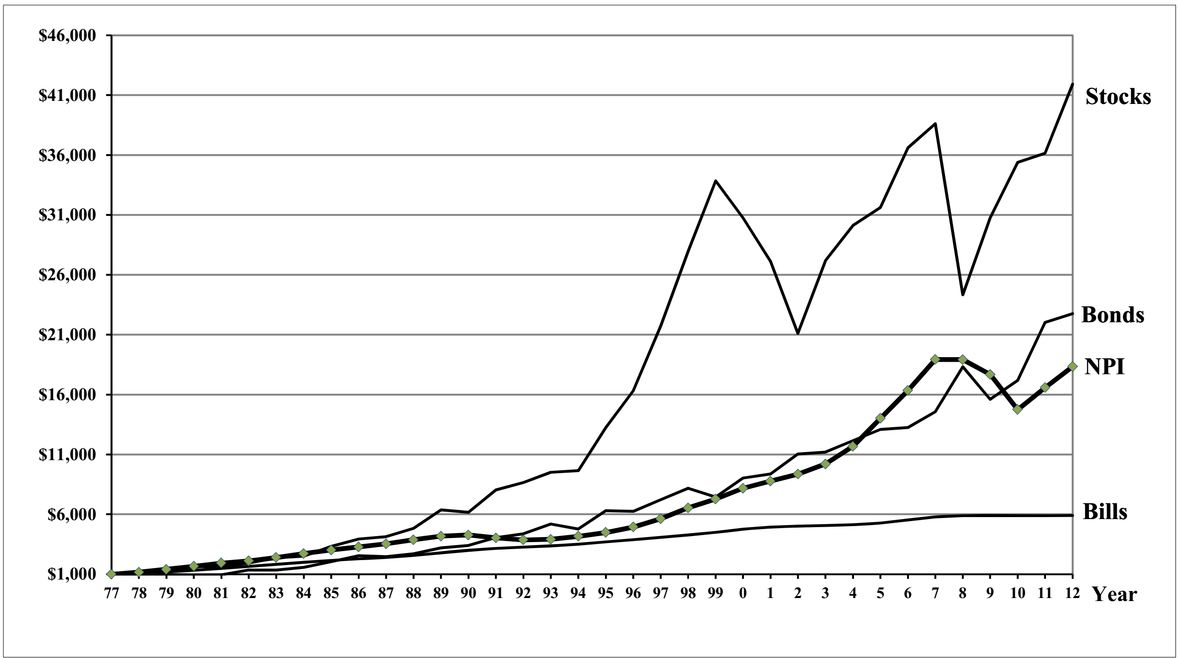

Fig. 1. Cumulative wealth index (compounded value) of asset classes: 1978-2012

Risk and return data for the asset classes are presented in Table 1. As shown in Table 1, over the 1978-2012 period, stocks earned the highest annual average (arithmetic) return of any asset class: 12.63% versus 10.05% for bonds, 9.40% for real estate, and 5.26% for bills. Stocks also had the highest annual standard deviation: 16.70% versus 12.78% for bonds, 8.01% for real estate, and 3.55% for bills. Among the regions of the country, real estate in East (Midwest) had the highest (lowest) average return as well as the highest (lowest) standard deviation of returns. Table 1 also shows the maximum and the minimum returns for each asset class, as well as the difference between the maximum and the minimum values. This difference gives the same information that is revealed by standard deviation, showing that stocks were the riskiest asset class, followed by bonds and real estate.

Table 1. Summary statistics – bills, bonds, stocks and real estate, 1978-2012

This Table gives the arithmetic mean return (AMR), geometric mean return (GMR), standard deviation, beta and sharpe ratio for bills (T-bills), bonds (T-bonds), stocks (S&P 500) and real estate. Except for the East region, real estate indices all have lower returns than bonds or stocks, but they all have lower standard deviations than either bonds or stocks. The Sharpe ratio shows that, over the study period, diversified real estate in East produced the highest reward per unit of standard deviation. Stocks had the highest average return, but they also have the most volatililty.

				Real estate				
	Bills	Bonds	Stocks	NPI	East	Midwest	South	West
AMR (annual)	5.26%	10.05%	12.63%	9.4%	10.73%	8.11%	8.26%	9.98%
Risk premium (bills)		4.79%	7.37%	4.14%	5.48%	2.85%	3%	4.72%
Risk premium (bonds)			2.58%	-0.65%	0.68%	-1.94%	-1.79%	-0.07%
GMR (annual)	5.88%	8.59%	10.84%	8.67%	9.93%	7.55%	7.59%	9.07%
Risk premium (bills)		2.71%	4.96%	2.79%	4.05%	4.05%	1.67%	1.71%
Risk premium (bonds)			2.25%	0.07%	1.34%	-1.04%	-1%	0.47%
Std. deviation	3.55%	12.78%	16.7%	8.01%	9.42%	6.19%	7.2%	9.1%
Beta	0.04	-0.03	1	0.06	0.07	0.06	0.04	0.06
Sharpe ratio	0	0.38	0.44	0.52	0.58	0.46	0.42	0.52
Max	14.71%	40.36%	37.43%	20.46%	25.68%	15.15%	24.13%	21.04%
Min	0.04%	-14.9%	-37%	-16.85%	-17.19%	-12.98%	-14.35%	-19.07%

Taking both return and risk into account, from January 1978 through December 2012 real estate had the highest risk-adjusted performance of any asset class. Measured by the Sharpe ratio, which gives an overall measure of reward (excess return) to variability, diversified investment in real estate outperformed the diversified investments in bonds or stocks. Among the regions, diversified real estate investments in East and West both outperformed bonds and stocks, with East producing the biggest bang (excess return) for the buck (risk). Table 2 shows correlation coefficients of the assets' returns. Stocks are negatively correlated with bonds (correlation of -0.04), but positively with real estate (correlation of +0.13 with NPI). Real estate is negatively correlated with bonds (correlation of -0.02). These low correlation coefficients suggest that portfolios consisting of stocks, bonds and real estate can yield substantial benefits from a diversification perspective.

Table 2. Correlation coefficients – bonds, stocks and real estate, 1978-2012

This Table shows correlations of quarterly returns for bills, bonds, stocks and real estate over the period 1978-2012. Stocks are negatively correlated with both bonds (correlation of -0.04), but positively with real estate (correlation of +0.13 with NPI). Real estate is negatively correlated with bonds (a correlation of -0.02).

				Real estate				
	Bills	Bonds	Stocks	NPI	East	Midwest	South	West
Bills	1							
Bonds	0.04	1						
Stocks	0.18	-0.04	1					
NPI	0.36	-0.02	0.13	1				
East	0.4	-0.1	0.13	0.97	1			
Midwest	0.35	0.08	0.17	0.94	0.91	1		
South	0.3	0.03	0.1	0.93	0.85	0.82	1	
West	0,36	-0.03	0.11	0.99	0.94	0.90	0.91	1

The next Section of the paper deals with the allocation of assets within the Markowitz optimal investment portfolio set. Limiting risky assets to stocks, bonds and real estate, the optimal allocation of the assets along the efficient frontier is derived with short-selling as a constraint. Not allowing for short-selling produces similar results to those reported in the paper. For brevity, those results are not reported in the paper (they can be obtained from the author upon request).

Table 3 presents the standard deviation and the corresponding asset mix for optimal portfolios formed to achieve a set of annual average target returns. As mentioned above, the optimal portfolios presented in this table allow for short-selling.

Panel A serves as the base case in both Tables, presenting the results for portfolios consisting of bonds and stocks only. As shown in these panels, achieving higher targeted returns requires taking on more risk (higher standard deviation) and allocating more of the funds into the riskier asset, stocks.

Panels B, C, D, E and F show the results for portfolios consisting of bonds and stocks combined with real estate. As can be seen, for each target rate of return given in the table, adding real estate to the base portfolio results in a significant reduction in the portfolio risk, and, generally, a higher Sharpe ratio of reward to variability (a comparison of the results in panels A and B clearly shows this effect). More importantly, for reasonable target rates of return (roughly, 9% to 10%, given the current market conditions), real estate captures the lion's share of the optimal portfolio. Focusing on the highest Sharpe ratio reported in each panel, we can see that real estate accounts for a strong weight of 60.1%, 49.77%, 40.95%, 42.51%, and 96.47%, respectively, in panels B-F. These results clearly show that real estate greatly expands the efficient frontier of investments and constitutes a major holding in the optimal portfolio of risky assets.

Table 3. Optimal risky portfolios at various target returns, 1978-12 (short sale allowed)

This Table shows select target rates of return along with standard deviations and portfolio weights required to achieve each target rate to return. Panel A confines the portfolio to bonds and stocks only. Panel B combines bonds and stocks with real estate, as measured by NPI (national property index). Panels C-F combine real estate in each of the major regions of the country with bonds and stock. As can be seen, to achieve the desired target returns given in the Table, real estate plays a major role in the optimal portfolio. The column farthest to the right shows the weights for the minimum variance portfolio (MVP).

Panel A: bonds and stock								MVP
Target annual return		8%	9%	10%	11%	12%	13%	11.01%
Required std. deviation		26.53%	19.17%	12.85%	9.83%	12.71%	18,98%	9.83%
Optimal mix	Bonds	179.53%	140.74%	101.95%	63.17%	24.38%	-14.41%	62.64%
	Stocks	-79.53%	-40.74%	-1.95%	36.83%	75.62%	114.41%	37.36%
Sharpe ratio		0.1	0.2	0.37	0.58	0.53	0.41	0.59
Panel B: bonds, stocks and NPI								
Target annual return		8	9%	10%	11%	12%	13%	9.95%
Required std. deviation		12.18%	8.1%	6.32%	8.45%	12.66%	17.5%	6.31%
Optimal mix	Bonds	22.18%	23.94%	26.71%	29.48%	32.25%	35.01%	26.57%
	Stocks	=47.66%	-17.23%	13.19%	43.61%	74.04%	104.46%	11.62%
	NPI	126.48%	93.29%	60.1%	26.91%	-6.28%	-39.47%	61.81%
Sharpe ratio		0.22	0.46	0.75	0.68	0.53	0.44	0.74
Panel C: bonds, stocks and East region real estate								MVP
Target annual return		8%	9%	10%	11%	12%	13%	10.77%
Required std. deviation		22.78%	15.43%	9.02%	6.96%	11.8%	18.82%	6.71%
Optimal mix	Bonds	107.94%	80.83%	53.72%	26.61%	-0.51%	-27.62%	32.94%
	Stocks	-105.39%	62.39%	-19.38%	23.62%	66.63%	109.63%	13.57%
	East	97.45%	81.56%	65.66%	49.77%	33.88%	17.99%	53.49%
Sharpe ratio		0.12	0.24	0.53	0.83	0.57	0.41	0.82
Panel D: bonds, stocks and Midwest region real estate								
Target annual return		8%	9%	10%	11%	12%	13%	8.75%
Required std. deviation		6.06%	5.6%	6.9%	9.24%	12.02%	15.01%	5.54%
Optimal mix	Bonds	8.55%	19.35%	30.15%	40.94%	51.74%	62.54%	16.61%
	Stocks	-6.05%	11.43%	28.91%	46.38%	63.86%	81.34%	7%
	Midwest	97.50%	69.22%	40.95%	12.67%	-15.6%	-43.88%	76.39%
Sharpe ratio		0.45	0.67	0.69	0.62	0.56	0.52	0.63
Panel E: bonds, stocks and South region real estate								MVP
Target annual return		8%	9%	10%	11%	12%	13%	9.13%
Required std. deviation		7.29%	5.99%	6.78%	9.13%	12.17%	15.50%	5.97%
Optimal mix	Bonds	11.35%	20.65%	29.95%	39.24%	48.54%	57.84%	21.86%
	Stocks	-10.63%	8.46%	27.54%	46.63%	65.72%	84.91%	10.95%
	South	99.28%	70.9%	42.51%	14.12%	-14.26%	-42.65%	67.19%
Sharpe ratio		0.38	0.62	0.7	0.63	0.55	0.5	0.65
Panel F: bonds, stocks and West region real estate								
Target annual return		8%	9%	10%	11%	12%	13%	10.38%
Required std. deviation		17.11%	11.34%	7.2%	7.91%	12.67%	18.6%	6.75%
Optimal mix	Bonds	49.52%	41.59%	33.67%	25.74%	17.81%	9.88%	30.67%
	Stocks	-76.01%	-38.06%	-0.11%	37.84%	75.8%	113.75%	14.23%
	West	126.49%	96,47%	66.44%	36.42%	6.39%	-23.63%	55.1%
Sharpe ratio		0.16	0.79	0.66	0.73	0.53	0.42	0.76

The final section of the paper presents evidence on the effectiveness of real estate, as well as bonds and stocks, as an inflation hedge, with the results reported in Tables 4, 5, and 6. These results are based on regression analyses of quarterly data for bonds, stocks and real estate over the study period.

Table 4 reports the estimated beta coefficients from equations 1, 2 and 3 for the full sample, starting from the fourth quarter of 1981 through the fourth quarter of 2010. These results are interpreted using the RBW methodology mentioned earlier in the paper. Looking at these results, it can be seen that against actual inflation, bills are a weakly positive hedge, bonds are a complete negative hedge, and NPI is a partial positive hedge against actual inflation with similar results reported for expected and unexpected inflation.

Table 4. Full sample

	Actual inflation	Expected inflation	Unexpected inflation
S&P 500	1.294	3.013	0.682
	(-1.25)	(-2.89)	(-1.21)
T-bill	0.048***	-0.026	0.044**
	(-0.02)	(-0.13)	(-0.02)
T-bond	-3.023***	3.856**	-3.528***
	(-0.77)	(-1.67)	(-0.73)
NPI	0.331*	0.925	0.280*
	(-0.17)	(-1.08)	(-0.16)
East	0.314	0.994	0.261
	(-0.20)	(-1.27)	(-0.20)
Midwest	0.459**	1.077	0.288
	(-0.20)	(-1.00)	(-0.17)
South	0.261	1.698*	0.196
	(-0.16)	(-0.97)	(-0.15)
West	0.321*	0.17	0.288
	(-0.18)	(-1.16)	(-0.17)

Note: significance Levels: * p < 0.1, ** p < 0.05, *** p < 0.01.

A closer look at the data shows a high degree of variation of the beta estimates over time. For a simple look at the time variation, we can compare the results for the first half and the second half of the sample. Tables 5 and 6, respectively, report these results, with the sample split at 1996-Q1. Looking at these results, one can easily see a large change in the statistical significance of the variables and some changes in the magnitudes.

These results show that the conclusions reached by this study about the assets' efficacy as an inflation hedge are very dependent on the sample period being used. Looking at Figure 2, which shows the results for NPI against actual inflation, it can be seen that, for much of the time, NPI is a negative hedge against actual inflation, only becoming positive for samples ending in the early 2000s and in late 2008-2009. This type of variation is displayed for nearly all the variables against actual, expected and unexpected inflation.

Table 5. First half of sample

	Actual inflation	Expected inflation	Unexpected inflation
S&P 500	-3.153	0.926	-3.25
	(-2.16)	(-4.31)	(-2.14)
T-bill	0.149***	-0.091	0.131***
	(-0.04)	(-0.25)	(-0.04)
T-bond	-3.274*	4.704	-4.558***
	(-1.66)	(-3.39)	(-1.58)
NPI	-0.148	0.397	-0.149
	(-0.37)	(-1.45)	(-0.35)
East	-0.289	-0.378	-0.236
	(-0.44)	(-1.97)	(-0.41)
Midwest	0.123	1.118	-0.098
	(-0.53)	(-1.36)	(-0.38)
South	-0.304	1.602	-0.404
	(-0.37)	(-1.13)	(-0.35)
West	-0.121	-0.167	-0.098
	(-0.41)	(-1.48)	(-0.38)

Note: significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 6. Second half of sample

	Actual inflation	Expected inflation	Unexpected inflation
S&P 500	2.289	0.418	1.945
	(-1.62)	(-6.08)	(-1.52)
T-bill	0.02	0.069	0.017
	(-0.02)	(-0.13)	(-0.01)
T-bond	-3.320***	3.396	-3.105***
	(-0.84)	(-2.87)	(-0.78)
NPI	0.475**	2.17	0.405**
	(-0.18)	(-1.46)	(-0.17)
East	0.490**	2.631	0.408*
	(-0.23)	(-1.74)	(-0.22)
Midwest	0.517***	1.658	0.400**
	(-0.14)	(-1.21)	(-0.18)
South	0.422***	2.321*	0.354**
	(-0.16)	(-1.26)	(-0.15)
West	0.464**	1.817	0.400**
	(-0.19)	(-1.55)	(-0.18)

Note: significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01.

Rolling regressions of 25 and 60 observations display similar variation. Figure 3 shows the 25-period rolling regression results for NPI as a hedge against actual inflation. Once again, we can see that the conclusions reached are very dependent on the sample period used.

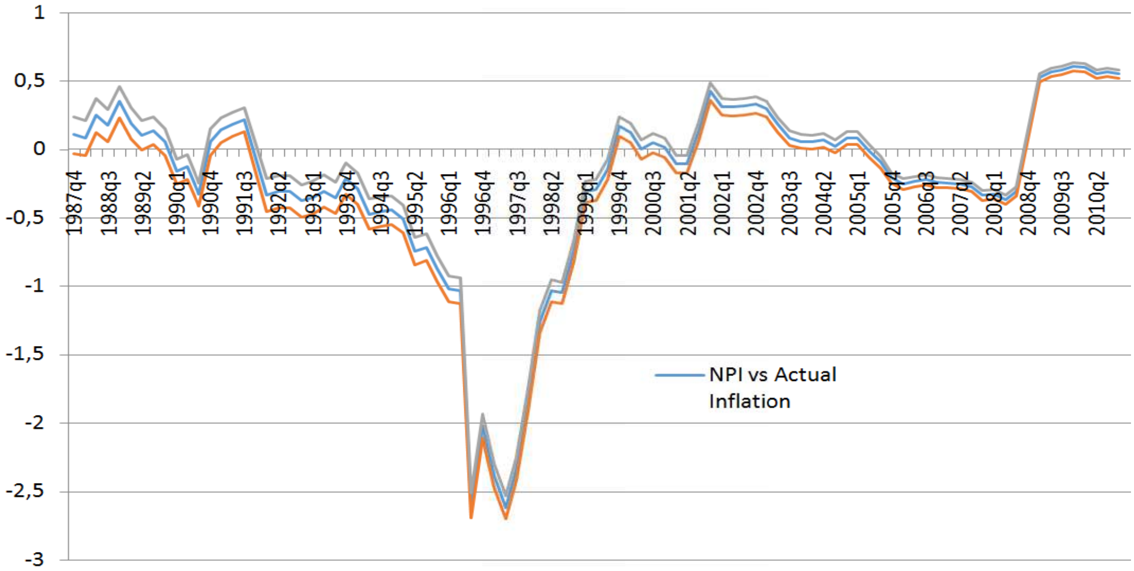

Fig. 2. NPI recursive estimates versus actual inflation

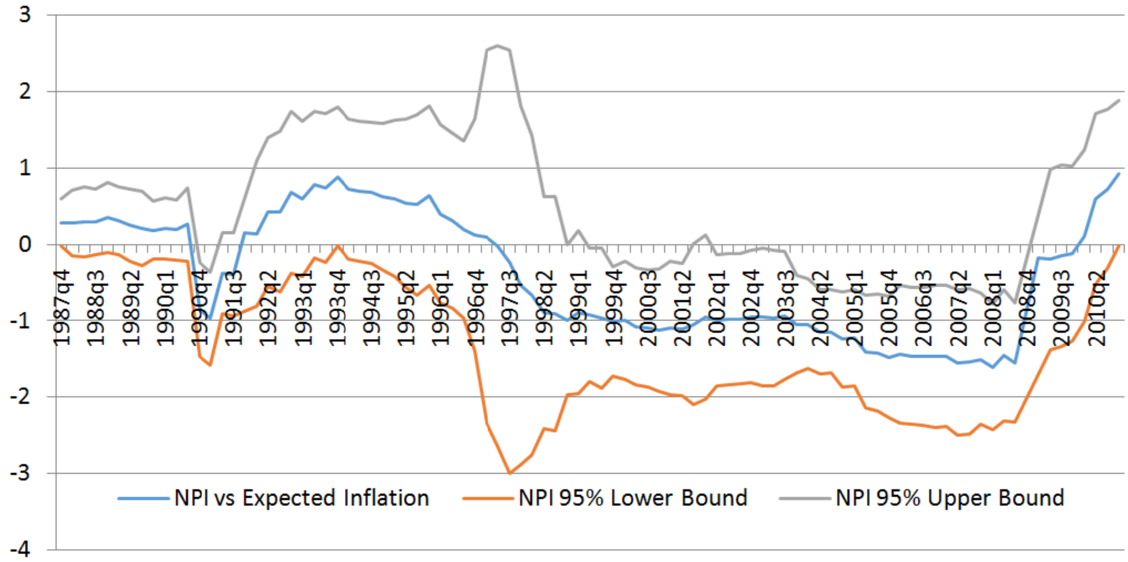

Fig. 3. NPI 25-period rolling regression vs expected inflation

Conclusion

This study provides evidence on the performance of real estate nationally and within the four regions of the U.S. (East, Midwest, South and West), as compared to stocks and bonds, over the period 1978-2012. Over this period, stocks earned the highest annual average (arithmetic) return of any asset class (12.63% versus 10.05% for bonds, 9.40% for real estate, and 5.26%), but they also had the most standard deviation of any asset class (16.70% versus 12.78% for bonds, 8.01% for real estate, and 3.55% for bills). The East (Midwest) region had the highest (lowest) average annual return among the regions, as well as the highest (lowest) standard deviation of returns. On a risk-adjusted basis, real estate outperformed both stocks and bonds, indicating that real estate is a highly effective diversifier within investment portfolios.

Real estate's role as a distinct asset class was further confirmed, as it captured a major share of the optimal portfolio constructed within the Markowitz optimization framework. In terms of protection against inflation, the results over the entire study period showed that, per the methodology in Rubens, Bond and Webb (1989), bills were a weakly positive hedge, bonds were a complete negative hedge, and real estate (NPI) was a partial positive hedge against actual inflation with similar results reported for expected and unexpected inflation. However, further analyses of these relationships showed that they were not consistent throughout the entire period and the effectiveness of the hedge against inflation depended on the time period studied.

These results clearly show that real estate greatly expands the efficient frontier of investments and constitutes an essential asset class in the optimal portfolio of risky assets.

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