How Often Does Direct Real Estate Increase the Risk-adjusted Performance of the US Mixed-asset Portfolio?

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Stephen L. Lee
The University of Reading,
School of Business,
Centre for Real Estate Research (CRER)
Reading, RG6 6AW
England

Phone: +44 118 378 6338, Fax: +44 118 378 8172, E-mail: S.L.Lee@reading.ac.uk

Abstract

The “case for real estate” in the mixed-asset portfolio is a topic of continuing interest to practitioners and academics. The argument is typically made by comparing efficient frontiers of portfolio with real estate to those that exclude real estate. However, most investors will have held inefficient portfolios. Thus, when analysing the real estate’s place in the mixed-asset portfolio it seems illogical to do so by comparing the difference in risk-adjusted performance between efficient portfolios, which few if any investor would have held. The approach adopted here, therefore, is to compare the risk-adjusted performance of a number of mixed-asset portfolios without real estate (which may or not be efficient) with a very large number of mixed-asset portfolios that include real estate (which again may or may not be efficient), to see the proportion of the time when there is an increase in risk-adjusted performance, significant or otherwise using appraisal-based and de-smoothed annual data from 1952-2003.

So to the question how often does the addition of private real estate lead to increases the risk-adjusted performance compared with mixed-asset portfolios without real estate the answer is almost all the time. However, significant increases are harder to find. Additionally, a significant increase in risk-adjusted performance can come from either reductions in portfolio risk or increases in return depending on the investors’ initial portfolio structure. In other words, simply adding real estate to a mixed-asset portfolio is not enough to ensure significant increases in performance as the results are dependent on the percentage added and the proper reallocation of the initial portfolio mix in the expanded portfolio.

Keywords: *Mixed-asset portfolios, tests of significance.*

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Introduction

The "case for real estate" in the mixed-asset portfolio is a topic of continuing interest with the early research suggesting that the addition of real estate offered large reductions in portfolio risk above that achieved from a portfolio of stocks and bonds alone, due to real estates additional diversification benefits (see Seiler et al, 1999 and Hoesli et al, 2001 for comprehensive reviews). Subsequent research has focused on the reasons for such a high weighting to real estate, which is clearly at odds with the actual holdings of real estate in the institutional mixed-asset portfolios in many countries[1]. The consensus is that the appraisal-based real estate data used in the analysis underestimates the 'true' risk characteristics of real estate and so the benefits of real estate as a portfolio diversifier are exaggerated. Nonetheless, even using more acceptable real estate return series the analysis is still performed by constructing efficient frontiers, with and without real estate, using mean-variance analysis techniques and historic data. The two frontiers are then graphed in risk/return space to show that the efficient frontier that includes real estate is above that of the efficient frontier without real estate i.e. provides more return and less risk. In other words, the efficient frontier that includes an allocation to real estate dominates the efficient frontier that excludes real estate.

Such an approach can be criticised on at least two counts. First, historic data by its nature is certain. Consequently the portfolio holdings are those which would be the 'best' that could have been achieved in the past. This is equivalent to playing the portfolio investment game with a marked deck, Madura and Abernathy (1985). Fund managers, however, are hired to construct *ex-ante* portfolios and are therefore forced to play with an unmarked deck. This suggests that very few investors would have held portfolios on the efficient frontier. Indeed, it is more reasonable to assume that the vast majority of investors will have held inefficient portfolios. Thus, when analysing the case for real estate in the mixed-asset portfolio it seems unjustifiable to do so by comparing *ex-post* efficient frontiers with and without real estate, which few if any investor would have held. We should be comparing mixed-asset portfolios containing real estate with mixed-asset portfolios without real estate, which are inefficient.

Secondly, studies rarely apply any statistical tests to see whether there is a significant improvement in portfolio performance from the addition of another asset[2]. All that is shown is that the efficient frontier including real estate is further into the northwest quadrant of the risk/return space than the efficient frontier without real estate. Yet, the difference could be very small, i.e. gains in return and/or reductions in risk of a few basis points. A real estate portfolio, however, presents numerous addition cost disadvantages compared with ones based on capital market securities, such as high informational search costs, large lot sizes, less liquidity and high management costs. Thus, if there is no significant improvement in risk-adjusted portfolio performance from the addition of real estate to an existing mixed-asset portfolio, the case for real estate is at best weak and at the worst maybe mistaken. In other words, the use of graphs of the efficient frontiers including and excluding real estate do

[1] See Hoesli et al (2004) and Chun and Shilling (1998)
[2] Notable exceptions include Rubens et al (1998), Chen and Liang (2000) and Lee and Stevenson (2005)

not make a adequate enough case for real estate to be included in the mixed-asset portfolio.

To overcome these shortcomings the approach adopted here is to analyse the risk/return performance of a number of capital market based mixed-asset portfolios (which may or not be efficient) and then to construct a large number of portfolios with an allocation to real estate (which again may or may not be efficient) to examine the percentage amount of time the inclusion of real estate leads to an increase in risk-adjusted performance and the proportion of times this increase is significant. In this way the case for real estate in the mixed-asset portfolio can be assessed in a more realistic and rigorous fashion.

The remainder of the paper is organised as follows. The next section discusses the data. Section 3 describes the research design employed. Initial results are presented and discussed in section 4. Section 5 tests the sensitively of the results to increases in the risk characteristics of the real estate data. Finally, section six concludes the paper.

Data

The mixed-asset portfolio considered in this study is made up of the annual returns of five asset classes: real estate, large cap stocks, small cap stocks, long-term government bonds, long-term corporate bonds covering the period 1951-2003. The data apart from the returns of real estate taken from Ibbotson Associates (2004), while the returns to real estate are taken from Kaiser (1997), with additions from NCRIEF. The summary statistics for these data series are shown in Table 1 from 1952-2003[3].

Table 1: Summary Statistics for Real Estate, Stocks Bonds and De-smoothed Real Estate: 1952-2003

Statistics	Real Estate	Large Cap	Small Cap	Gov Bonds	Corp Bonds
Mean	9.87	12.90	17.34	6.76	7.05
Std. Dev.	5.03	17.59	25.70	10.83	10.10
Skewness	-0.36	-0.16	0.27	0.97	1.06
Kurtosis	5.05	2.42	2.62	3.71	4.62
Jarque-Bera	10.21	0.93	0.95	9.16	15.43
Probability	0.01	0.63	0.62	0.01	0.00
1st Order Correlation	0.63	-0.06	-0.08	-0.09	0.04
2nd Order Correlation	0.39	-0.19	-0.14	0.18	0.12
3rd Order Correlation	0.25	0.02	0.01	0.13	0.09

As would be expected small cap stocks offered the highest expected returns over this period at the cost of the highest risk. Government bonds showed the lowest return but not the lowest risk. That honour goes to real estate, which also had a return well above bonds but below stocks.

Research Design

Most researchers analyse the case for real estate by calculating the optimal portfolio weights and the efficient frontier using the ex post risk and returns of the individual assets. However, as discussed above most investors will be holding inefficient portfolios, thus instead of computing weights by optimisation, the weight to be assigned to each asset class was randomly drawn from a uniform distribution using the following upper and lower bounds:

3 The reason for only considering the summary statistics from 1952 is that the first observation (1951) is lost in the de-smoothing process used below.

Stocks: 0 to 100%
Bonds: 0 to 100%
Real Estate: 0% to 35% in increments of 5%

In other words, no constraints were placed on the allocations to stocks and bonds except for non-negatively. For real estate a number of allocations were considered by constraining the uniform distribution to have the following lower and upper bounds: 0-5%, 5-10%, 10-15%, 15-20%, 20-25%, 25-30% and 30-35%. The sum of the allocations to stocks and bonds were then normalised and added to that of real estate so that the portfolio weights would sum to unity.

The allocation to the various asset classes and the risk and return of the portfolio were then calculated and the results recorded. We then measured the risk-adjusted returns of the portfolio by calculating the Sharpe index[4] of performance:

$$S_i = \frac{R_i - R_f}{\sigma_i}$$

where: Si is the Sharpe index of portfolio i, R_i is the average annual rate of return of portfolio i over the sample period, R_f is the risk-free rate proxied by the rate of return on Treasury bills, and σ_i is portfolio's standard deviation of the excess returns of portfolio i. A total of 5,000 portfolios were simulated in this way for each of the seven real estate allocations, a total of 35000 simulations[5].

Then in order to test the effectiveness of including real estate into the mixed-asset portfolio the Sharpe index of a number of stock/bond portfolios[6] over the same period were calculated. The Sharpe performance of each mixed-asset portfolio, including real estate, was then compared with all the stock/bond portfolios, excluding real estate, to see how often the inclusion of real estate gave improvements in risk-adjusted performance.

We then used the Jobson and Korkie (1981)[7] test to examine whether these improvements in portfolio performance were significant at the 5% level. The test statistic is formulated as:

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[4] We did not adjust the estimated Sharpe measures for the sample size bias identified by Miller and Gehr (1978), as with a sample size of over 50 annual observations used in this study the bias is negligible.

[5] Simulations using 10,000 runs were also tried with no quantitative difference in results.

[6] The equity/bond portfolio strategies considered were constructed by starting with a 100% allocation in stocks large cap and small cap) and adding bonds (long-term government and long-term corporate) up to a 100% allocation in bonds, see Table 2.

[7] An alternative test is that suggested by Gibbons et al (1989), which initially would seem to be the more logical choice, as it compares the Sharpe ratios for portfolio from an original data set of size N and that of portfolios of size N+1. However, this test statistic suffers from two problems. First, the test, in its' original form, required the weights in the portfolios to be tested to be unconstrained i.e. the authors implicitly assume short selling can occur, an assumption that is unrealistic within most capital market but especially in real estate markets. If no short selling is assumed, however, this means that the distribution of the test is unknown and needs to be approximated using simulations, see Glen and Jorion (1993). The second problem is more problematical for this study as the Gibbons et al (1989) test assumes that the portfolios to be evaluated are the ones with the maximum Sharpe ratios within each data set, i.e. the test only evaluates efficient portfolio in each case, which is not what we are trying to do here.

$$Z = \frac{\sigma_a(\mu_b - R_f) - \sigma_b(\mu_a - R_f)}{\sqrt{\Theta}}$$

where: μ_a, μ_b are the mean returns of portfolios under investigation, R_f is the risk-free rate of return and where Θ is calculated as follows:

$$\Theta = \frac{1}{T}\left[2\sigma_a^2\sigma_b^2 - 2\sigma_a\sigma_b\sigma_{ab} + \frac{1}{2}\mu_a^2\sigma_b^2 + \frac{1}{2}\mu_b^2\sigma_a^2 - \frac{\mu_a\mu_b}{2\sigma_a\sigma_b}(\sigma_{ab}^2 + \sigma_a^2\sigma_b^2)\right]$$

where: T is the number of observations and σ_a, σ_b and σ_{ab} are estimates of the standard deviation and covariance's of the excess returns of the two portfolios over the evaluation period. Jobson and Korkie (1981) show that the test statistic Z is approximately normally distributed with a zero mean and a unit standard deviation for large samples. A Jobson-Korkie Z-statistic exceeding the critical value at 5% will result in the rejection of null hypothesis of equivalent Sharpe performance. Jobson and Korkie (1981) and Jorian (1985) note however that the statistical power of the test is low, especially for small sample sizes, i.e. for a 5% significance level, it fails to reject a false null 85% of time.

Table 2: Summary Statistics for the Six benchmark Portfolios B1-B6: 1952-2001

Benchmark	B1	B2	B3	B4	B5	B6
Panel A: Weights	%	%	%	%	%	%
Large	50	40	30	20	10	-
Small	50	40	30	20	10	-
LT Gov Bonds	-	10	20	30	40	50
LT Corp Bonds	-	10	20	30	40	50
Panel B: Statistics	B1	B2	B3	B4	B5	B6
Mean	15.12	13.48	11.83	10.19	8.55	6.91
Std. Deviation	20.13	16.36	12.99	10.44	9.41	10.34
Sharpe Ratio	0.48	0.49	0.50	0.47	0.36	0.17
Panel C: P-values	B1	B2	B3	B4	B5	B6
B1	-					
B2	-0.378	-				
B3	-0.401	-0.469	-			
B4	+0.441	+0.377	+0.304	-		
B5	+0.206	+0.162	+0.112	+0.070	-	
B6	+0.058	+0.043	+0.027	+0.015	+0.009	-

The mixed-asset benchmark portfolios are shown in Table 2. The weights of the four asset classes, Large and Small Cap Stocks, Long-term Government and Corporate Bonds are shown in Panel A. The first benchmark (B1) stars with 100% allocated to Large and Small Cap Stocks, 50% in each asset. The second benchmark (B2) has 40% each in Large and Small Cap stocks and 10% each in Long-term Government and Long-term Corporate Bonds. The allocation to bonds is increased in each subsequent benchmark, until the last benchmark (B6), which has 100% in bonds with 50% each in Long-term Government and Long-term Corporate Bonds. Such portfolios are unlikely to be efficient in the Markowitz sense but are representative of actual investor holdings; see Brinson et al (1986, 1991) and Hensel et al (1991) among others.

Panel B of Table 2 shows the summary statistics of the six benchmark portfolios. Table 2 highlights a number of issues that will be raised in the discussion of the empirical analysis below. Portfolio B1 has the highest risk and returns over the period portfolio B6 the lowest, as expected. More informative are the Sharpe ratios of the various benchmarks, which show a number of features of interest. First, benchmark portfolio B1 with a 100% allocation stocks (Large and Small Cap) has a lower Sharpe ratio than B2 and B3 but is superior to benchmarks B4 to B6. Second, benchmark portfolios B1 to B4 are all superior to B5 and B6. Finally, B5 (20% Stock, 80% Bonds) has a Sharpe ratio twice that of the all bond portfolio B6. That is, a small allocation to bonds (stocks) leads to an improvement in the risk-adjusted performance of all stock (bond) portfolio. However, a large allocation to bonds is always inferior to any mixed-asset stock/bond portfolio. The p-values of the Jobson and Korkie (1981) tests between the six benchmarks shown in Panel C produced the same conclusions.

When looking down a column a negative value indicates that the risk-adjusted performance of the benchmark being evaluated was inferior to the alternative, i.e. the alternative presented superior risk-adjusted performance. A positive value indicates that the benchmark portfolio being evaluated showed greater risk-adjusted performance, i.e. the risk-adjusted performance of the alternative was inferior. For instance, reading down the column marked B1, with a 100% allocation to large and small cap stocks, the p-values shows that B1 is inferior to B2 and B3 (p-values of -0.378 and -0.401 respectively), as suggested by the figures in Panel B, although not significantly so at the usual levels of significance. In contrast, the Sharpe ratios of B4 and B5 are insignificantly inferior to B1 (p-value = +0.441 and +0.206 respectively). Finally, the Sharpe ratio of benchmark portfolio B6, with a 100% allocation to government and corporate bonds, is significantly inferior to that of B1 (p-value = +0.058). Indeed, benchmark portfolio B6 is significantly inferior to all the other benchmark portfolios, B1 through B5. In other words, an all bond portfolio would have been the least desirable portfolio to hold over this period and a small addition of stocks, large cap or small cap, will typically offer significant improvements in risk-adjusted performance.

But what about real estate will it offer significant improvements in risk-adjusted performance compared to any or all the benchmark portfolios and how often? In order to answer these questions the following sections analyses the proportion of time that a mixed-asset portfolio including Real Estate leads shows a Sharpe Ratio greater than that of the six benchmarks that exclude Real Estate and the percentage amount of time this increase is significant at the 5% level.

Appraisal-based Results

Panel A of Table 3 shows the proportion of time the 35,000 simulated mixed-asset portfolios containing real estate had Sharpe Ratios greater than that of the six benchmark portfolios (B1-B6). Panel B shows the percentage of time that including real estate significantly increased the Sharpe performance of the six benchmark portfolios at the 5% significance level.

Panel A presents a number of features of interest. First, any mixed-asset portfolio containing real estate has a Sharpe ratio greater than that of the all bond portfolio benchmark (B6). This confirms the results in Table 3 that an all bond portfolio would have been an inferior investment over this period and that the introduction of other asset class should lead to significant improvements in risk-adjusted performance. Secondly, as the allocation to real estate increases the percentage amount of time the Sharpe ratios of the mixed-asset portfolio increases also increases.

In contrast, to the results in Panel A, Panel B indicate that a mixed-asset portfolio containing real estate only really outperforms the benchmark portfolios with a substantial allocation to bonds, B4-B6. In the case of the benchmark portfolios with large allocations to Stocks, it is only at allocation levels of over 20% that allocations to real estate start to really significantly increase risk-adjusted performance in any meaningful amount. This suggest that there needs to be substantial differences in risk-adjusted between portfolios before the JK test can detect significance. This confirms the finds of Jobson and Korkie (1981) and Jorian (1985) that the statistical power of the JK test is low.

Table 3: Proportion of the Time Adding Real Estate leads to an increase in the Sharpe Performance and the percentage amount of time this increase is Significant: Appraisal-based Real Estate Data

Weight in Real Estate			**Benchmark**			
Panel A: Increase	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**
0-5%	**61.9**	**48.4**	**41.0**	**72.2**	**96.4**	**100.0**
5-10%	**76.0**	**69.8**	**67.4**	**82.6**	**97.7**	**100.0**
10-15%	**87.2**	**83.6**	**81.8**	**90.8**	**98.8**	**100.0**
15-20%	**93.7**	**91.9**	**91.1**	**95.2**	**99.6**	**100.0**
20-25%	**96.8**	**95.7**	**95.5**	**97.5**	**99.9**	**100.0**
25-30%	**98.5**	**98.2**	**98.1**	**98.9**	**100.0**	**100.0**
30-35%	**99.6**	**99.4**	**99.4**	**99.8**	**100.0**	**100.0**
Panel B: Sig. Increase	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**
0-5%	**-**	**-**	**-**	**-**	**3.7**	**98.8**
5-10%	**-**	**-**	**-**	**-**	**25.9**	**99.6**
10-15%	**-**	**-**	**-**	**6.9**	**49.0**	**99.8**
15-20%	**1.0**	**3.6**	**14.2**	**33.0**	**69.7**	**100.0**
20-25%	**16.8**	**27.4**	**42.1**	**53.8**	**82.7**	**100.0**
25-30%	**40.1**	**50.1**	**61.4**	**70.2**	**90.2**	**100.0**
30-35%	**58.2**	**64.1**	**72.5**	**81.2**	**94.7**	**100.0**

In order to see the type of portfolio compositions that lead to significant/insignificant increases in risk-adjusted performance the average allocations of the five asset classes of the simulated portfolios were calculated for against each benchmark the results presented Table 4.

Table 4 presents a number of interesting results. First, the allocation to real estate for a mixed-asset portfolio to be significantly greater than the various benchmarks is generally only marginally greater than for those that are insignificant. In other words, it is not the allocation to real estate that leads to significant increases in risk-adjusted performance it is the reallocation of the existing portfolio to the other asset classes. In addition this reallocation is different depending on the composition of the original mixed-asset portfolio. For instance, against the stock dominated benchmarks (B1 to B3), it is the increase in the allocation to stocks, especially Small Cap stocks and the fall in allocation to bonds that determines whether a particular mixed-asset portfolio shows a significant increase in Sharpe performance. This is because significant increases in Sharpe ratios are seen for mixed-asset portfolios with higher returns, even at the cost of higher risk, and as stocks have offered the highest returns over this period it is the reallocation to these assets, coupled with the addition of real estate, that leads to significantly greater risk-adjusted performance. In contrast, against the Bond dominated mixed-asset portfolio (B4 to B6) stock allocations need to be reduced and the allocation to bonds increased when real estate is introduced into the mixed-asset portfolio. This is because significant increase in Sharpe performance for these portfolios results from substantially lower risk rather than increases in return.

Table 4: Differences in Portfolio Composition of Mixed-asset Portfolios Containing Real Estate that are Sig/Insig Different from the Six benchmark Portfolios: Appraisal-based Real Estate Data

B1	RE	LC	SC	LTG	LTC	Risk	Return
0-5%	-	-	-	-	-	-	-
5-10%	-	-	-	-	-	-	-
10-15%	-	-	-	-	-	-	-
15-20%	1.9	5.6	15.0	-10.6	-11.9	3.19	1.95
20-25%	0.6	3.8	13.5	-9.4	-8.6	2.62	1.66
25-30%	0.4	0.1	14.0	-7.8	-6.8	2.17	1.48
30-35%	0.3	-0.6	13.9	-7.3	-6.3	1.94	1.42
B2	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	-	-	-	-	-	-	-
5-10%	-	-	-	-	-	-	-
10-15%	-	-	-	-	-	-	-
15-20%	1.7	3.2	10.2	-6.5	-8.6	1.82	1.31
20-25%	0.5	2.4	11.5	-7.5	-7.0	1.94	1.36
25-30%	0.4	-0.3	13.5	-7.1	-6.5	1.91	1.40
30-35%	0.2	-1.1	13.9	-7.0	-6.0	1.80	1.40
B3	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	-	-	-	-	-	-	-
5-10%	-	-	-	-	-	-	-
10-15%	-	-	-	-	-	-	-
15-20%	1.1	-0.7	6.4	-3.0	-3.8	0.55	0.66
20-25%	0.4	-1.7	8.5	-3.7	-3.6	0.75	0.80
25-30%	0.3	-2.2	10.6	-4.9	-3.8	0.98	0.98
30-35%	0.3	-1.8	11.3	-5.4	-4.4	1.08	1.09
B4	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	-	-	-	-	-	-	-
5-10%	-	-	-	-	-	-	-
10-15%	1.5	-6.2	-0.2	3.3	1.6	-1.14	-0.35
15-20%	0.4	-6.4	1.2	3.0	1.7	-0.97	-0.25
20-25%	0.3	-6.1	1.5	2.9	1.4	-0.98	-0.20
25-30%	0.3	-5.7	2.0	1.7	1.7	-0.92	-0.13
30-35%	0.3	-3.4	0.9	0.4	1.7	-0.98	-0.09
B5	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	1.6	-12.2	-4.3	10.7	4.2	-2.12	-1.14
5-10%	0.6	-11.1	-4.8	8.7	6.6	-2.14	-1.15
10-15%	0.4	-9.2	-5.9	7.9	6.8	-2.20	-1.15
15-20%	0.2	-7.7	-8.9	8.7	7.7	-2.66	-1.38
20-25%	0.3	-6.8	-10.0	8.7	7.8	-2.94	-1.44
25-30%	0.2	-7.8	-10.8	9.4	9.0	-3.22	-1.59
30-35%	0.3	-6.8	-12.9	9.4	10.0	-3.62	-1.74
B6	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	0.5	-7.0	-19.8	12.4	14.0	-5.67	-2.47
5-10%	0.7	-16.3	-9.9	13.2	12.3	-5.28	-1.99
10-15%	1.3	13.4	-53.3	19.7	19.0	-9.88	-4.72
15-20%	1.0	-18.7	-19.5	17.9	19.3	-7.16	-3.12
20-25%	-	-	-	-	-	-	-
25-30%	-	-	-	-	-	-	-
30-35%	-	-	-	-	-	-	-

De-smoothed Results

It is often argued that the appraisal process induces "sluggishness" into the volatility of the real estate returns. As such the risk of real estate is underestimated leading to unrealistically large allocations to real estate in the mixed-asset portfolio when using mean-variance analysis. Therefore, while research is divided as to whether smoothing bias exists and whether it can be appropriately corrected, it seems that the issue is of more concern when comparing real estate with market based securities. Hence, the results above need to be re-examined using a Real Estate return series that is probably more acceptable to most investors, by de-smoothing the appraisal-based data. The method chosen was that suggested by Geltner (1993). However, it should be noted that the approach is sensitive to the choice of the de-smoothing parameter. The value used here was 0.4 as this leads to a de-smoothed return series that displays an insignificant 1st order correlation coefficient (0.03) and a standard deviation about twice that of the appraisal based data, inline with the results of previous studies. Thus, the de-smoothed real estate series used here are simulated return series after the inertia, or serial correlation, has been reduced to some acceptable level compared from the original data. This suggests that de-smoothed real estate return series is now more like market valuations. Although these returns should not be taken as actual transaction values, such prices would also reflect the liquidity of the market, and are probably reasonable estimates. The results from de-smoothing the real estate on the parameters needed for portfolio construction are presented in Table 5.

Table 5: Portfolio Characteristics of Appraisal-based and De-smoothed Real Estate: 1952-2003

Statistics	Appraisal-based	De-Smoothed
Mean	**9.88**	**9.72**
Std. Dev.	**5.03**	**9.77**
Correlation with		
Large Cap	**0.118**	**0.117**
Small Cap	**0.720**	**0.068**
Gov Bonds	**-0.077**	**-0.223**
Corp Bonds	**0.952**	**-0.261**

Table 5 compares the portfolio characteristics of the appraisal-based real estate data and the de-smoothed real estate data. The appraisal-based data shows a return between that of bonds and stocks (see Table1), a very low standard deviation, i.e. only half that of bonds but a very high correlation with Small Cap Stock and Corporate Bonds (0.720 and 0.952 respectively) but a very low correlation with Large Cap Stocks and Government Bonds (0.118 and -0.077 respectively).

The de-smoothed Real Estate data, although showing much the same level return as the appraisal-based series, now has a risk level almost the same as bonds (see Table1). However, the greatest change is that now the de-smoothed data shows lower correlations with all the alternative asset classes than the appraisal-based data. This implies that in a mixed-asset portfolio Real Estate should offer substantially greater risk-adjusted performance than that using the appraisal-based data! In the following analysis therefore we examine the case for real estate in the mixed-asset portfolio using the appraisal-based data and after de-smoothing the original series to account for any appraisal bias.

Panel A of Table 6 shows the proportion of time the 35,000 simulated mixed-asset portfolios containing de-smoothed real estate had Sharpe Ratios greater than that of the six benchmark portfolios (B1-B6). Panel B shows the percentage of time that including de-smoothed real estate significantly increased the Sharpe performance of the six benchmark portfolios at the 5% significance level.

In line with the results using the raw data in Table 3, Panel A of Table 6 shows that virtually all mixed-asset portfolios containing real estate have Sharpe ratios greater than the benchmarks (B1-B6). Secondly, as the allocation to real estate increases the percentage amount of time the Sharpe ratios of the mixed-asset portfolio increases also increases.

Table 6: Proportion of the Time Adding Real Estate leads to an increase in the Sharpe Performance and the Percentage amount of time this increase is Significant: De-smoothed Real Estate Data

Weight in Real Estate	Benchmark					
Panel A: Increase	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**
0-5%	99.2	99.0	98.9	99.5	100.0	100.0
5-10%	99.1	98.8	98.6	99.3	100.0	100.0
10-15%	99.0	98.7	98.5	99.3	100.0	100.0
15-20%	99.2	99.0	98.9	99.5	100.0	100.0
20-25%	99.2	98.9	98.7	99.4	100.0	100.0
25-30%	99.3	98.8	98.6	99.6	100.0	100.0
30-35%	99.0	98.9	98.7	99.3	100.0	100.0
Panel B: Sig. Increase	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**
0-5%	15.3	11.0	8.7	27.6	80.2	100.0
5-10%	14.5	11.2	9.7	27.8	80.1	100.0
10-15%	14.1	10.9	9.4	26.7	79.4	100.0
15-20%	14.8	11.4	9.5	27.8	79.6	100.0
20-25%	14.1	11.0	9.2	27.0	80.6	100.0
25-30%	14.4	10.7	8.9	26.6	79.6	100.0
30-35%	15.1	11.6	9.0	27.3	79.9	100.0

However, Panel B of Table 6 shows a number of differences compared with the corresponding results in Panel B in Table 3. First, that the percentage amount of time a mixed-asset portfolio containing real estate significantly outperforms the benchmark portfolios is greater than for the appraisal-based data. Second, even small allocations to real estate can lead to significant increase in performance. This is especially noticeable for bond dominated benchmark portfolios B5 and B6 when performance significantly improvement in performance can be seen for more than 80% of the time. However, against the stock dominated benchmark portfolios B1 to B3, adding real estate leads to improvements in risk-adjusted performance no more than 15% of the time. Third, increasing the allocation to real estate does not increase the percentage amount of time that the Sharpe ratio of the mixed-asset portfolios significantly increases.

Table 7 shows that portfolio compositions of the significant and insignificant mixed-asset portfolios against each benchmark portfolio. Table 7 presents a number of features of interest compared with the same results for the appraisal-based data in Table 4. First, like Table 4 the allocations to real estate in mixed-asset portfolios, that are significantly greater than the benchmark portfolios, are only marginally different from those which are insignificant, again it the allocation to the other asset classes that determine significant increase in Sharpe performance. Second, once again for bond dominated portfolios it is the reduction in risk that leads to increases in significant increases in Sharpe performance, whereas for stock dominated portfolios it is the increase in return. But unlike the results in Table 4 the differences are in reallocation across the asset classes is a lot less clear cut. For instance, against benchmarks with a high initial allocation to stocks (B1 to B3) sometimes more stocks are added other times not, sometimes more bonds are needed other times not. Similar observations can be made for the bond dominated portfolios (B4 to B6).

Table 7: Differences in Portfolio Composition of Mixed-asset Portfolios Containing Real Estate that are Sig/Insig Different from the Six benchmark Portfolios: De-smoothed Real Estate Data

B1	RE	LC	SC	LTG	LTC	Risk	Return
0-5%	-	0.4	-0.3	-0.9	0.8	1.29	1.30
5-10%	-	-0.9	0.5	-0.7	1.1	1.35	1.33
10-15%	-0.1	-0.3	-0.2	-0.8	1.3	1.24	1.29
15-20%	-0.1	-0.5	-0.6	1.1	0.1	1.43	1.36
20-25%	0.0	1.4	-0.9	0.4	-0.8	1.35	1.35
25-30%	0.1	-0.4	1.5	-0.4	-0.8	1.31	1.29
30-35%	-0.2	0.2	0.5	-0.6	-	1.30	1.31
B2	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	0.1	-0.2	-0.5	-1.2	1.7	1.04	1.12
5-10%	0.1	-1.9	-0.4	-1.2	3.5	1.02	1.13
10-15%	-0.3	-0.9	-1.6	1.6	1.2	0.85	1.07
15-20%	-	-1.3	0.5	1.3	-0.5	0.91	1.07
20-25%	-	0.8	0.3	0.3	-1.3	1.01	1.13
25-30%	0.3	-0.3	-0.4	1.4	-0.9	0.87	1.04
30-35%	-0.4	0.8	0.6	-2.6	1.7	0.80	1.02
B3	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	-	1.5	-1.2	-0.2	-0.2	0.28	0.58
5-10%	-	-2.5	1.4	-0.8	1.9	0.05	0.46
10-15%	-0.4	-	-2.7	0.7	2.5	0.18	0.54
15-20%	0.1	-2.4	-1.6	4.7	-0.8	0.36	0.60
20-25%	0.1	-2.1	2.2	0.6	-0.8	0.28	0.60
25-30%	0.3	0.7	-1.8	0.0	0.8	0.36	0.59
30-35%	-0.4	-2.2	0.8	-0.5	2.3	0.24	0.65
B4	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	-	-0.9	-0.7	2.1	-0.5	-0.60	0.03
5-10%	-	-2.0	0.9	0.2	0.8	-0.57	0.06
10-15%	0.1	-	0.3	-0.2	-0.1	-0.59	-0.02
15-20%	-0.2	-0.5	0.8	0.7	-0.8	-0.60	0.02
20-25%	0.0	-1.2	0.2	0.6	0.4	-0.53	0.05
25-30%	-0.2	0.7	-0.8	0.3	-	-0.51	0.06
30-35%	0.1	-0.5	-0.5	0.1	0.8	-0.56	0.04
B5	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	0.0	-0.3	0.1	0.3	-0.1	-1.01	-0.07
5-10%	0.1	-0.2	0.2	-0.1	-0.1	-0.97	-0.08
10-15%	-	-0.2	0.3	-0.1	-0.1	-1.01	-0.11
15-20%	-	-0.2	-0.2	0.7	-0.2	-1.01	-0.07
20-25%	-	-0.8	0.2	0.7	-0.2	-0.97	-0.06
25-30%	-	0.4	-0.4	0.3	-0.2	-0.92	-0.05
30-35%	-	-0.1	0.1	-0.2	0.3	-0.97	-0.08
B6	**RE**	**LC**	**SC**	**LTG**	**LTC**	**Risk**	**Return**
0-5%	0.2	0.4	-1.0	0.4	-	-0.35	0.61
5-10%	-	-0.1	-0.2	-0.3	0.6	-0.32	0.61
10-15%	-	-0.7	0.2	-0.1	0.7	-0.29	0.64
15-20%	-	0.4	-0.6	0.8	-0.6	-0.32	0.63
20-25%	-	-0.4	0.3	0.2	-0.1	-0.29	0.63
25-30%	-0.1	0.1	-0.6	0.4	0.2	-0.33	0.62
30-35%	0.1	-0.9	-0.2	0.8	0.2	-0.24	0.66

Conclusions

The “case for real estate” in the mixed-asset portfolio is a topic of continuing interest to practitioners and academics. The argument is typically made by comparing efficient frontiers of portfolio with real estate to those that exclude real estate. However, most investors will have held inefficient portfolios. Thus, when analysing the real estate’s place in the mixed-asset portfolio it seems illogical to do so by comparing the difference in risk-adjusted performance between efficient portfolios, which few if any investor would have held. Additionally, studies rarely apply any statistical testing to see whether there is a significant improvement in risk-adjusted performance from the addition of real estate. Yet, if there is no significant improvement in performance the case for real estate is at best weak and at the worst maybe mistaken. To overcome these shortcomings the approach adopted here is to compare the risk-adjusted performance of a number of mixed-asset portfolios without real estate (which may or not be efficient) with a very large number of mixed-asset portfolios that include real estate (which again may or may not be efficient), to see the proportion of the time when there is an increase in risk-adjusted performance, significant or otherwise using appraisal-based and de-smoothed annual data from 1952-2003.

So to the question how often does the addition of private real estate lead to increases the risk-adjusted performance compared with mixed-asset portfolios without real estate the answer is almost all the time. However, significant increases are harder to find. Additionally, a significant increase in risk-adjusted performance can come from either reductions in portfolio risk or increases in return depending on the investors' initial portfolio structure. In other words, simply adding real estate to a mixed-asset portfolio is not enough to ensure significant increases in performance as the results are dependent on the percentage added and the proper reallocation of the initial portfolio mix in the expanded portfolio.

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