INTERNATIONAL REAL ESTATE REVIEW
2006 Vol. 9 No. 1: pp.95 - 111

REIT Mimicking Portfolio Analysis

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It is well known that expected returns vary by industry (Lyon et al., 1999), and that REIT-based mimicking portfolios may capture the information in real estate investment trust (REIT) prices (Downs, 2000). This study performs REIT-based mimicking portfolio analysis. The results indicate that when the Capital Asset Pricing Model and the Fama-French (1993) three-factor model are used to evaluate the performance of a REIT portfolio, the probability for making Type I error exceeds its significance level. Performance tests are better specified when mimicking portfolios are constructed with the firms from the REIT industry. In addition, the market beta of REIT portfolios appears to converge to the market beta of the NCREIF Index when REIT-based mimicking portfolios are included into the specification. The result is consistent with the notion that there is a strong linkage between REIT returns and the underlying real estate factor (Ziering et al., 1997).

Keywords

REIT; mimicking portfolio; performance evaluation

Introduction

Sanders (1997), Karolyi and Sanders (1998), among others, show that the comovement of real estate investment trust (REIT) returns with other asset classes declines over time.[1] Downs (2000) suggests that asset pricing models tested without REIT-based mimicking portfolios may fail to capture the information in REIT prices. Lyon et al. (1999) use simulations to show that controlling for firm size and book-to-market ratio alone is not sufficient to yield well-specified performance measures. These results suggest that mimicking portfolios should be constructed with the firms from the REIT industry to measure the performance of a REIT portfolio. The purpose of this study is to perform this mimicking portfolio analysis.

The analysis of REIT returns has traditionally been based on the capital asset priding model (CAPM) of Sharpe (1964) and Lintner (1965). The Fama-French (1993) three-factor model, while subject to endless criticism for lacking a theoretical foundation, has nevertheless taken on a greater role in describing the time-series of equity mutual fund returns and REIT returns (Peterson and Hsieh, 1997; Buttimer et al., 2005; Chiang et al., 2004, 2005; among many others).[2] Casual observation suggests that the need to control for the return effects associated with common trading strategies is worth the criticism that is so frequently applied to the Fama-French (1993) three-factor model as well as many other multi-factor models.

The elaborate simulations in Lyon et al. (1999) show that expected returns vary by industry. It is now commonly accepted in performance measurement that mimicking portfolios should be constructed with firms from the same industry. In addition, in the decentralized investment industry, as noticed by Sharpe (1981), performance measurement should be explicitly accounted for feasible passive trading strategies that are seemingly profitable; without doing so, one cannot reach unbiased assessment about managerial ability to select securities.

To motivate the analysis of REIT-specific mimicking portfolios, this study examines whether REIT portfolio managers are able to use passive trading strategies to generate seeming profits. This study is interested in mitigating

[1] Because of this, investing in REITs is useful in reducing portfolio risk (Mull and Soenen, 1997).

[2] Liu and Mei (1992), Mei and Lui (1994), Ling and Naranjo (1999), Chui et al. (2003) and many others examine the cross-sectional determinants of REIT returns. While these studies help us better understand the sources of risk for investing in REITs, cross-sectional specifications are rarely used for the purpose of performance evaluation because the less desirable fit typically associated with these specifications.

the danger of data mining and, thus, focuses only on previously identified strategies. This leads us to the following three passive trading strategies. The first strategy is an analog to the Fama-French (1993) small-minus-big (SMB) strategy. The REIT version of SMB (SMB_{REIT}) uses a zero-cost portfolio that places long positions in REITs with small market capitalizations and short positions in REITs with large market capitalizations. The second strategy is an analog to the Fama-French value-minus-growth strategy, also referred to as high-minus-low (HML) strategy. The equivalent version of this strategy for REITs (HML_{REIT}) creates a zero-cost portfolio that funds long positions in REITs with high book-to-market ratios by shorting REITs with low book-to-market ratios.[3] The third strategy is an analog to the Carhart (1997) momentum factor which in this context is described as the up-minus-down (UMD) strategy. The equivalent version of this strategy for REITs (UMD_{REIT}) creates a zero-cost portfolio based upon an 11-month cumulative return lagged by one month. Long positions are taken in the top 30% of REITs ranked on this measure and short positions are taken in the bottom 30% of REITs ranked on this measure.

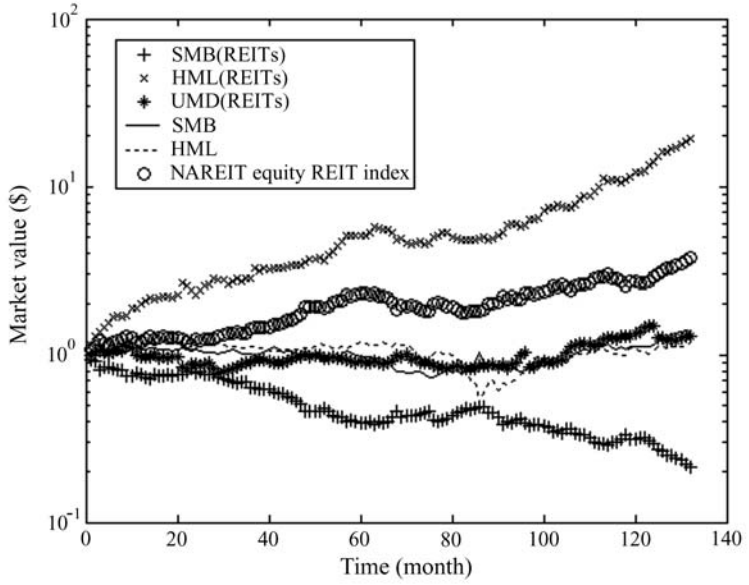
Figure 1 plots the logarithm of the market value of $1 invested in one of six passive strategies. Five strategies are represented by SMB, HML, SMB_{REIT}, HML_{REIT}, and UMD_{REIT}, and the sixth strategy is a long position in the NAREIT equity index. The figure suggests that shorting SMB_{REIT} and longing HML_{REIT} are highly profitable during the 1993-2003 period.[4] Specifically, shorting SMB_{REIT} yields 0.92% and 0.67% monthly abnormal returns under the CAPM and the Fama-French three-factor model, respectively. Longing HML_{REIT} yields 0.22% and 1.97% monthly abnormal returns under the CAPM and the Fama-French three-factor model, respectively. These intercept terms are all statistically significant at the 1% level. It is clear that, without controlling for these zero-cost returns, any

[3] Downs (2000) suggests that REIT-based mimicking portfolios should be the basis for real estate pricing. Although we are reluctant to do so, our specification can be alternatively viewed as an asset pricing model of three risk factors if (1) the REIT market is mildly segmented, and (2) the two mimicking portfolios are proxies for risk factors. It is constantly under debate whether real estate markets and stock markets are perfectly integrated, and the empirical evidence so far is, at best, mixed (Grissom et al., 1987; Ambrose et al., 1992; Ling and Naranjo, 1999; among many others). One can also adopt Fama and French's (1993) argument and claims that the REIT-based mimicking portfolios capture the unique aspects of distress risk in the REIT industry. Brown (2000) documents that in the late 1980s and early 1990s an industry-wide downturn and asset illiquidity resulted in a wealth transfer between less-leveraged equity REITs and more-leveraged mortgage REITs. Because of this effect, mortgage REIT returns are lower than equity REIT returns during this period, although mortgage REITs held a senior claim on underlying properties over equity REITs. However, these attempts can be easily criticized because it is known to be difficult to establish a strong linkage between a risk proxy and the acclaimed risk factor.

[4] Shorting SMB has been profitable after 1983. Longing HML has been mostly profitable for the past 100 years.

REIT portfolio manager who passively adopts either one of the two strategies would yield seemingly abnormal returns under these standard pricing models even when she/he has no skills in selecting REITs. In contrast to the other two REIT-based mimicking portfolios, UMD_{REIT} was not noticeably profitable during the 1993-2003 period.[5] Overall, it is evident that REIT-based mimicking analysis is essential for examining the security selection ability of a REIT portfolio manager.

Figure 1: The growth of $1 using passive trading strategies, 1993-2003



Our empirical results show that using REIT-based mimicking portfolios considerably reduces the abnormal returns of equity REITs during the 1993-2003 period. Performance tests are better specified when mimicking portfolios are constructed with the firms from the REIT industry. The use of REIT-based mimicking portfolios also provides nearly twice the explanatory power in terms of *R*-squared relative to the size and book-to-market factors of Fama and French.

In addition, the market beta of a REIT portfolio appears to converge to the

[5] We report the results with the use UMD_{REIT} throughout the paper because momentum is an important predictor of the cross-section of expected REIT returns (Chui et al., 2003). We also repeat our analysis without the use of UMD_{REIT}, and find that the incremental explanatory ability of UMD_{REIT} is quite minimal.

market beta of the NCREIF Property Index under the new analysis framework. The evidence is consistent with the notion that a high degree of participation from institutional investors in the new REIT era strengthens the linkage between REIT returns and the underlying real estate factor (Ziering et al., 1997). The result is important because it provides evidence about the fundamental linkage between public real estate and private real estate.

Data and Portfolio Formulation

This study focuses on equity REIT returns. This focus is based upon Brown's (2000) result that there are differences in the nature of investment risk between equity and mortgage REITs. The sample period is from January 1993 to December 2003 because the Fama and French (1993) three-factor model performs reasonably well prior to 1993, as suggested by the following analyses.

The study uses the Center for Research in Security Prices (CRSP) database to identify 259 REITs. Sharpe's (1992) return-based style analysis is used to classify whether a REIT is an equity or mortgage REIT.[6] The study assumes a two-asset class factor model: $R_{i,t} = [b_{i,1} F_{1,t} + b_{i,2} F_{2,t}] + e_{i,t}$ where F_1 is the return on the NAREIT equity REIT index, F_2 is the return on the NAREIT Mortgage REIT index, the two strictly nonnegative sensitivity terms, $b_{i,1}$ and $b_{i,2}$, sum to 1, and $e_{i,t}$ is the selection return. The model is solved with a quadratic programming algorithm. A REIT is classified as an equity REIT if the estimate for $b_{i,1}$ is greater than that for $b_{i,2}$. The style analysis classifies 250 of the 259 REITs to be equity REITs. Monthly REIT returns are retrieved from the CRSP database for each sample REIT from July of year t to June of t+1.

To mitigate data mining concerns the study follows the Fama and French (1993) methodology. Specifically, the REIT-based mimicking portfolios are based on size (market value) and the market-to-book ratio.[7] In June of each

[6] It is well known that an investment company's actual investment style may deviate from its self-described style. Return-based analyses are designed to uncover an investment company's true investment style (Sharpe, 1992). The study also uses the list of 155 equity REITs from the NAREIT to repeat the tests. Our results are not sensitive to whether return-based or self-described style classification is used.

[7] Mitigating data mining concerns is critical because the proposed mimicking portfolios are empirically specified. To do so, the study focuses on size and the book-to-market ratio. The use of size and the book-to-market ratio is supported by existing studies and practitioners' perceptions. McIntosh et al. (1991) document size effect among REITs. According to Wingrad (1997), REITs are priced based on returns from their underlying assets and growth estimates that they are able to achieve. Thus, the book-to-market ratio of a REIT may reflect market perception regarding its growth potential.

year *t*, all equity REITs are ranked on size. They are sorted into three groups: the bottom 30%, middle 40%, and top 30% based upon rank ordered size.[8] We then follow Fama and French and use the COMPUSTAT book-to-market definition based on the book value for the fiscal year ending in calendar year $t-1$ and the market value at the end of year $t-1$.[9] Equity REITs are sorted into three groups: the bottom 30%, middle 40%, and top 30% based upon rank ordered book-to-market ratio. The study constructs nine portfolios from the intersection of the three size groups and the three book-to-market groups.[10]

The mimicking portfolio SMB_{REIT} is calculated as the difference between the return on the three small size REIT portfolios and the return on the three large size REIT portfolios. Following Fama and French, the three small and large sized portfolios are equally weighted in the construction of the monthly returns. The mimicking portfolio of HML_{REIT} is calculated as the difference between the return on the three high book-to-market REIT portfolios and the return on the three low book-to-market REIT portfolios. The three high book-to-market and the three low book-to-market portfolios are equally weighted in the construction of the monthly returns.

The mimicking portfolio UMD_{REIT} is calculated as the difference between the average return on REITs with the highest 30% 11-month returns lagged one month and the average return on REITs with the lowest 30% 11-month returns lagged one month. This zero-cost momentum portfolio is rebalanced monthly.

Because the number of REITs is far less than the number of stocks, one cannot construct a fine grouping of REIT portfolios as dependent variables. We group sample REITs based on size and the book-to-market ratio into 3×3 groups, but the breakpoints are set at the 33.33 and 66.67 percentiles.[11] Six dependent variables are constructed: small size portfolio (S_1), medium size portfolio (S_2), large size portfolio (S_3), low book-to-market portfolio (BM_1), medium book-to-market portfolio (BM_2), and high book-to-market portfolio

[8] Fama and French (1993) use the median size to sort stocks into two groups. This study sorts equity REITs into three size portfolios because this design is useful to show the robustness of the testing results, which will become clear in the following sections.

[9] Book value may deviate from market value because of accumulated depreciation. The study repeats the analysis by adding accumulated depreciation back to book value. Our baseline results are not sensitive to this adjustment. REIT-based mimicking portfolios still outperform stock-based mimicking portfolios in providing better test specifications.

[10] After merging the CRSP and the Compustat, the numbers of sample REITs from 1993 to 2003 are 85, 92, 107, 157, 150, 140, 151, 161, 161, 150, and 143, respectively.

[11] The formation of dependent variables uses only size and book-to-market because momentum appears to play a minor role in the time-series of REIT returns.

(BM_3). The reason for not using the nine portfolios based on the intersection of size and book-to-market breakpoint is that size and the book-to-market ratio are correlated. If one were to use nine portfolios, there would be only one REIT sorted into the small size-low book-to-market portfolio and large size-high book-to-market portfolio in some months.

Main Results

Table 1 reports summary statistics. During the sample period of 1993-2003, the average monthly return of the CRSP value-weighted index is 0.63%. The size effect disappears during this sample period. The average return of SMB_{REIT} is −1.09%. In contrast, value REITs yield higher returns than growth REITs. The average return of HML_{REIT} is 2.37%. The average return of UMD_{REIT} is only 0.28%. The standard deviations of the market proxy, SMB_{REIT}, HML_{REIT}, and UMD_{REIT} are quite similar and are approximately 4% per month. The correlation coefficients among the market proxy, SMB_{REIT}, and HML_{REIT}, and UMD_{REIT} are moderate, ranging from –0.3381 to 0.3119. This should not introduce any statistical complications for the following regression analyses.

Table 1: Summary statistics, 1993-2003

	R_m	SMB_{REIT}	HML_{REIT}	UMD_{REIT}
Mean	0.0063	–0.0109	0.0237	0.0028
Standard deviation	0.0450	0.0378	0.0474	0.0408
Correlation coefficient				
R_m	1.000			
SMB_{REIT}	–0.3346	1.000		
HML_{REIT}	0.3119	–0.3381	1.000	
UMD_{REIT}	–0.3318	0.1183	–0.2738	1.000

Note: R_m is proxied by the CRSP value-weighted return. The mimicking portfolio SMB_{REIT} is calculated as the difference between the return on the three small size REIT portfolios and the return on the three large size REIT portfolios. The mimicking portfolio of HML_{REIT} is calculated as the difference between the return on the three high book-to-market REIT portfolios and the return on the three low book-to-market REIT portfolios.

Table 2 reports the ordinary least squares (OLS) time-series regression results under the CAPM (Panel A) and the Fama-French (1993) three-factor model (Panel B). The six dependent variables are the excess returns of the three size portfolios and the three book-to-market portfolios formed from the REIT sample. The independent variables include the CRSP value-weighted risk premium, the SMB factor, and the HML factor. During the sample period of 1993 to 2003, the six dependent portfolios have an average beta of

0.31 under the CAPM. Their market exposures are all statistically significant at the 1% level. The intercept terms range from 0.62% to 1.42% per month, i.e., 7.70% to 18.44% per year. They are all at least statistically significant at the 5% level. If the six intercept terms were used as a proxy of the performance of six hypothetical portfolio managers, one would conclude that they have superior selection skills.

Table 2: Time-series regression results under the CAPM and the Fama-French three-factor model, 1993-2003

	a	*b*	*s*	*h*	Adj. R^2 (%)
Panel A: The CAPM					
S_1	0.0125	0.3436			14.31
	(3.76)**	(4.68)**			
S_2	0.0083	0.3117			13.47
	(2.64)**	(4.52)**			
S_3	0.0066	0.2624			10.61
	(2.18)*	(3.94)**			
BM_1	0.0062	0.2825			13.13
	(2.12)*	(4.45)**			
BM_2	0.0066	0.2762			14.48
	(2.49)*	(4.71)**			
BM_3	0.0142	0.3762			16.53
	(4.25)**	(5.09)**			
Panel B: The Fama-French three-factor model					
S_1	0.0102	0.3835	0.4082	0.3506	30.63
	(3.38)**	(5.53)**	(4.64)**	(4.76)**	
S_2	0.0051	0.3610	0.5803	0.4727	50.80
	(2.14)*	(6.61)**	(8.38)**	(8.15)**	
S_3	0.0042	0.3134	0.3949	0.3813	33.19
	(1.58)	(5.19)**	(5.16)**	(5.95)**	
BM_1	0.0034	0.3465	0.4322	0.4362	43.57
	(1.46)	(6.39)**	(6.29)**	(7.58)**	
BM_2	0.0045	0.3195	0.3634	0.3382	37.07
	(1.94)	(6.05)**	(5.43)**	(6.04)**	
BM_3	0.0112	0.4124	0.5834	0.4296	45.37
	(4.11)**	(6.57)**	(7.34)**	(6.46)**	
Panel C: Quarterly regressions					
NCREIF	0.0121	0.0133			1.72
	(8.39)**	(0.84)			
NCREIF	0.0123	0.0242	–0.0427	–0.0019	8.07
	(8.66)**	(1.35)	(–1.65)	(–0.10)	

Note: These regressions are based on the following two specifications: $R_{p,t} = \alpha + b\,R_{m,t} + \varepsilon_{p,t}$ and $R_{p,t} = \alpha + b\,R_{m,t} + s\,\mathrm{SMB}_t + h\,\mathrm{HML}_t + \varepsilon_{p,t.}$ NCREIF is the quarterly excess return on the NCREIF index. *t*-statistics are in parentheses.

* Significant at the 5% level.

** Significant at the 1% level.

Under the Fama-French three-factor model, the six dependent portfolios have an average beta of 0.36. Their market exposures are all statistically significant at the 1% level. The average estimates for the SMB and the HML factors are approximately 0.46 and 0.40, respectively. These exposures are statistically significant at the 1% level. The intercept terms are economically large, ranging from 0.34% to 1.12% per month, i.e., 4.16% to 14.30% per year. If the six intercept terms were used as a proxy of the performance of six hypothetical portfolio managers, one would conclude that half of them generated abnormally good performance at the 5% level.

Panel C of Table 2 shows the regression results with the use of quarterly excess returns on the NCREIF property index. The market beta estimates for private real estate are 0.01 and 0.02 under the CAPM and the Fama-French three-factor model, respectively. It appears that private real estate is a zero-beta asset. In addition, the SMB and the HML factors are not useful in explaining NAREIT excess returns.

Panel A of Table 3 reports the results of REIT-based mimicking portfolio analysis. That is, the SMB and the HML factors are replaced by the SMB_{REIT} and the HML_{REIT} mimicking portfolios, and the specification is augmented by the use of UMD_{REIT}. The fit of the regressions is substantially improved with the use of the new specification. These regressions have an average *R*-squared of 80.06%, which is about twice that under the Fama-French three-factor model. Furthermore, intercept estimates range from –0.29% to 0.00% per month. The absolute magnitudes of these intercept terms are on average one fourth of those under the Fama-French three-factor model. One out of the six alphas is statistically significant at the 1% level. Overall, consistent with Lyon et al. (1999), our results show that industry-specific mimicking portfolios provide a better test specification than the Fama-French three-factor model.

Repeating the hypothetical exercise of using intercept terms to gauge managerial ability would lead one to conclude that REIT managers, on average, do not outperform the market when REIT-based mimicking portfolios are used. The result is consistent with the notion that the REIT market is relatively competitive and efficient. The intercepts of –0.29% to 0.00% per month are largely in line with the transactions costs and management fees that are necessary to operate REITs.

Another noticeable result is that once REIT-based mimicking portfolios are included, the market beta of equity REITs drops considerably. The average beta estimate of the six regressions is only 0.03. These beta estimates are all statistically insignificant. The result implies that the linkage between REITs and stocks is weaker than the existing literature would suggest. The average

estimates for the SMB_{REIT} and the HML_{REIT} mimicking portfolios are –0.58 and 0.26, respectively. Eleven out of the twelve estimates are statistically significant at the 5% level. The average estimate for the UMD_{REIT} mimicking portfolio is –0.10. Three out of the six estimates are statistically significant at the 1% level. Based on the fit of regressions, this mimicking portfolio provides limited incremental explanation of REIT returns. A parsimonious specification without the use of UMD_{REIT} yields an average adjusted *R*-squared of 78.62. The inclusion of UMD_{REIT} enhances the fit of regressions by an average of 1.44% (80.06%-78.62%).

Table 3: Time-series regression with REIT-based mimicking portfolios, 1993-2003

	a	*b*	*s*	*h*	*u*	Adj. R^2 (%)
Panel A: Monthly regressions						
S_1	–0.0020	0.0220	–0.0987	0.6774	–0.2374	85.09
	(–1.24)	(0.64)	(–2.46)*	(20.93)**	(-6.49)**	[80.32]
S_2	0.0000	0.0548	–0.6856	0.1122	–0.0920	60.83
	(0.00)	(1.04)	(–11.25)**	(2.29)*	(–1.66)	[60.29]
S_3	–0.0025	0.0060	–0.9239	0.0199	0.0313	93.91
	(-2.77)**	(0.31)	(-40.53)**	(1.08)	(1.50)	[93.84]
BM_1	–0.0019	0.0006	–0.8092	0.0558	–0.1302	84.92
	(–1.35)	(0.02)	(–23.10)**	(1.98)*	(–4.09)**	[83.08]
BM_2	–0.0011	0.0638	–0.6605	0.0773	–0.0056	70.68
	(–0.61)	(1.64)	(–14.66)**	(2.13)*	(–0.14)	[70.90]
BM_3	–0.0017	0.0380	–0.3038	0.6362	–0.1463	84.93
	(–1.02)	(1.07)	(–7.38)**	(19.20)**	(–3.91)**	[83.27]
Panel B: Quarterly regressions						
NCREIF	0.0142	0.0205	–0.0090	–0.0336	–0.0012	13.14
	(8.40)**	(1.19)	(–0.37)	(–2.13)*	(–0.06)	

Note: These regressions are based on the following specification: $R_{p,t} = \alpha + b\, R_{m,t} + s\, SMB_{REIT,t} + h\, HML_{REIT,t} + u\, UMD_{REIT} + \varepsilon_{p,t}$. *t*-statistics are in parentheses. NCREIF is the quarterly excess return on the NCREIF Index. The adjusted R-squared values without the use of the UMD_{REIT} mimicking portfolio are contained in brackets.
* Significant at the 5% level.
** Significant at the 1% level.

Why is the market beta of REITs so close to zero when REIT-based mimicking portfolios are added into the specification? As shown in Panel A of Table 2, the market beta of REITs are statistically significant at the 1% level under the CAPM. Therefore, the low correlation coefficient between REITs and stocks alone cannot explain the phenomenon. Another natural explanation is that a high degree of participation from institutional investors in the new REIT era strengthens the linkage between REIT returns and the underlying real estate factor (Ziering et al., 1997). This conjecture is supported by the test results in Panel C of Table 2. That is, private real

estate appears to be a zero-beta asset under the CAPM and the Fama-French three-factor model. To further check for this conjecture, this study runs quarterly regressions of NCREIF private returns using REIT-based mimicking portfolio returns. The test results are shown in Panel B of Table 3. Under the REIT-based specification, the market beta of the NCREIF Index is 0.02. This beta estimate is very close to those in Panel A of Table 3 and to those in Panel C of Table 2. It appears that the use of REIT-based mimicking portfolios makes the market beta of REITs converge to the market beta of private real estate. The result is in line with the notion that there is a strong fundamental linkage between REITs and the underlying real estate in the new REIT era as evident by their similar market exposures.

Further Checks

An obvious criticism of using mimicking portfolios is that dependent portfolios may overlap with factor forming portfolios. This may artificially inflate the fit and statistical significance of the test results. To address this issue, the study forms an alternative dependent portfolio that uses the intersection of the medium size portfolio and the medium book-to-market portfolio ($S_2 \cap BM_2$). This portfolio's constituents REITs are completely different from those of the SMB_{REIT} and the HML_{REIT} portfolios. The testing results are reported in Table 4.

Table 4: Robustness check, 1993-2003

	a	***b***	***s***	***h***	***u***	**Adj. R^2 (%)**
Fama-French	0.0039	0.3774	0.4098	0.4315		35.64
	(1.37)	(5.84)**	(5.00)**	(6.29)**		
REIT-based	–0.0024	0.0643	–0.6839	0.1319	–0.0479	57.22
	(–0.92)	(1.13)	(–40.53)**	(2.49)*	(–0.80)	[57.35]

Note: These regressions are either based on the Fama-French three-factor model or with the use of REIT-based mimicking portfolios. The Fama-French three-factor model has the following specification: $R_{p,t} = \alpha + b\, R_{m,t} + s\, SMB_t + h\, HML_t + \varepsilon_{p,t}$. The alternative specification is: $R_{p,t} = \alpha + b\, R_{m,t} + s\, SMB_{REIT,t} + h\, HML_{REIT,t} + u\, UMD_{REIT} + \varepsilon_{p,t}$. The dependent variable is the intersection of the medium size portfolio (S_2) and the medium book-to-market portfolio (BM_2). *t*-statistics are in parentheses. The adjusted *R*-squared value without the use of the UMD_{REIT} mimicking portfolio is contained in brackets.

* Significant at the 5% level.

** Significant at the 1% level.

Under the Fama-French three-factor model, $S_2 \cap BM_2$ has an intercept estimate of 0.39% per month. The loadings on the market factor, the SML factor, and the HML factor are 0.38, 0.41, and 0.43, respectively. The adjusted *R*-squared is 35.64%. With the used of REIT-based mimicking

portfolios, the dependent portfolio has an intercept estimate of –0.24% per month. Consistent with the baseline results, the dependent portfolio has statistically significant exposures on the SMB_{REIT} and the HML_{REIT} mimicking portfolios, but not on the market factor and the UMD_{REIT} mimicking portfolio. The adjusted *R*-squared is 57.22%. This improvement in the fit of regression is not due to the augmentation of the use of UMD_{REIT}. The adjusted *R*-squared is 57.35% when UMD_{REIT} is dropped from the specification.

We also provide another check that replaces the market factor with the excess returns of the NAREIT equity REIT index. The purpose of this check is to see whether REIT-based mimicking portfolios are useful in an alternative specification.[12] The test results are reported in Table 5. By construction, NAREIT excess returns are more useful in explaining large-cap REIT returns because the NAREIT index is value-weighted. This feature makes the ability of NAREIT excess returns in explaining small-cap REIT returns particularly important. The results suggest that the use of NAREIT excess returns alone cannot provide a well-specified specification. Panel A of Table 5 shows that the small size portfolio (S_1) exhibits seemingly abnormal performance under the one-factor specification. The intercept term, 1.16% per month, is statistically significant at the 1% level.

It is clear that REIT-based mimicking portfolios are also useful in this alternative specification. Panel B of Table 5 shows that intercept terms range from –0.17% to 0.14% per month under the multiple-factor specification. Only one intercept term is statistically significant at the 5% level. Furthermore, 12 out of the 21 point estimates for REIT-based mimicking portfolios are statistically significant at the 5% level.

As a final exercise, Figure 2 depicts a comparison of the *R*-squared values from rolling regressions of the NAREIT equity REIT returns under the Fama-French three-factor model and the REIT-based specification during the sample period of 1982 to 2003.[13] Before 1992, the two specifications provide similar descriptions of equity REIT returns. The Revenue Reconciliation Act of 1993 seems to have altered the similarity in *R*-squared values across models. The result is robust regardless of whether UMD_{REIT} is included in the specification. It appears that the Act may have made REITs more attractive for institutional investors who would be quite capable of implementing hedging strategies.

[12] In the context of asset pricing, the use of excess NAREIT returns makes sense only if REITs are segmented from stock markets.

[13] The cutoff of 1982 is chosen for this analysis because the number of equity REITs is less than 20 before this cutoff.

Table 5: Further check, 1993-2003

	a	*r*	*s*	*h*	*u*	Adj. R^2 (%)
Panel A: One factor						
S_1	0.0116	0.4195				13.04
	(3.42)**	(4.43)**				
S_2	0.0042	0.8219				57.21
	(1.89)	(13.24)**				
S_3	0.0011	0.9716				88.92
	(1.04)	(32.44)**				
BM_1	0.0016	0.8691				74.54
	(1.00)	(19.59)**				
BM_2	0.0026	0.7815				70.83
	(1.68)	(17.83)**				
BM_3	0.0120	0.6241				27.79
	(3.82)**	(7.10)**				
$S_2 \cap BM_2$	0.0024	0.8370				55.46
	(1.00)	(12.77)**				
Panel B: Multiple factors						
S_1	–0.0017	0.1034	–0.0147	0.6792	–0.2505	85.13
	(–1.04)	(0.90)	(–0.14)	(21.27)**	(–6.98)**	[79.64]
S_2	0.0014	0.5135	–0.2518	0.1128	–0.1414	63.14
	(0.61)	(3.03)**	(–1.59)	(2.40)*	(–2.67)**	[61.38]
S_3	–0.0017	0.2861	–0.6750	0.0166	0.0108	94.85
	(–1.99)*	(4.74)**	(–11.92)**	(0.99)	(0.57)	[94.84]
BM_1	–0.0013	0.2164	–0.6197	0.0528	–0.1445	85.47
	(–0.91)	(2.19)*	(–6.69)**	(1.93)	(–4.70)**	[83.09]
BM_2	0.0004	0.5180	–0.2258	0.0792	–0.0578	73.74
	(0.23)	(4.24)**	(–1.97)*	(2.33)*	(–1.51)	[73.48]
BM_3	–0.0010	0.2249	–0.1182	0.6385	–0.1719	85.23
	(–0.63)	(1.92)	(–1.08)	(19.68)**	(–4.71)**	[82.80]
$S_2 \cap BM_2$	–0.0008	0.5743	–0.1999	0.1331	–0.1040	59.89
	(–0.30)	(3.14)**	(–1.16)	(2.62)**	(–1.82)	[59.16]

Note: These regressions are based on the following two specifications: $R_{p,t} = \alpha + r\, R_{\text{REIT},t} + \varepsilon_{p,t}$ and $R_{p,t} = \alpha + r\, R_{\text{REIT},t} + s\, \text{SMB}_{\text{REIT},t} + h\, \text{HML}_{\text{REIT},t} + u\, \text{UMD}_{\text{REIT}} + \varepsilon_{p,t}$, where the six dependent variables are the excess returns of six equity REIT portfolios net of one-month T-Bill rate. These seven equity REIT portfolio are formed based on size and the book-to-market ratio, and they are small size portfolio (S_1), medium size portfolio (S_2), large size portfolio (S_3), low book-to-market portfolio (BM_1), medium book-to-market portfolio (BM_2), high book-to-market portfolio (BM_3), and the intersection of the medium size portfolio (S_2) and the medium book-to-market portfolio (BM_2). $R_{\text{REIT},t}$ is the excess return on the NAREIT Equity Index. The SMB_{REIT}, HML_{REIT}, and UMD_{REIT} mimicking portfolios are formed based on equity REIT returns, but not on stock returns. *t*-statistics are in parentheses. The adjusted R-squared values without the use of the UMD_{REIT} mimicking portfolio are contained in brackets.

* Significant at the 5% level.

** Significant at the 1% level.

Figure 2: *R*-squared values from rolling regressions of NAREIT returns, 1983-2003

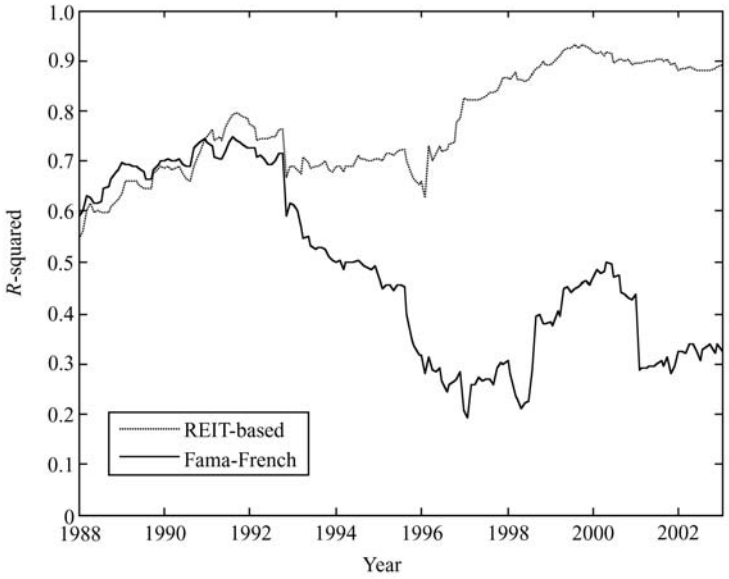
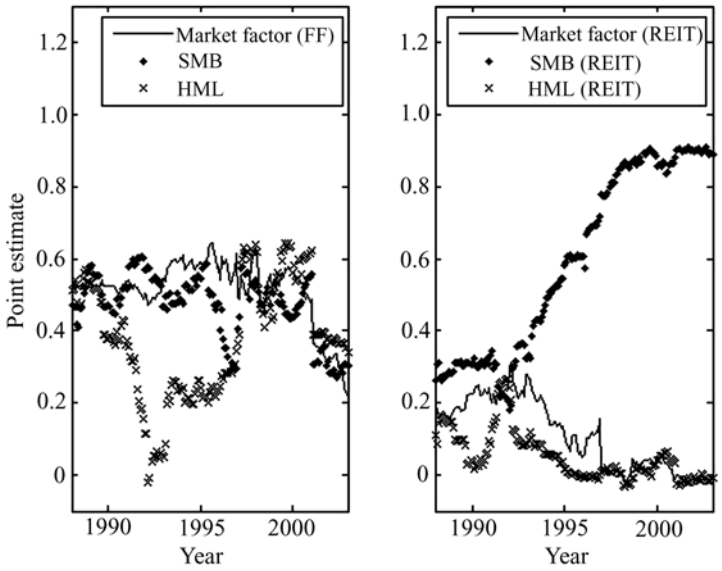


Figure 3 depicts the rolling point estimates from regressions of NAREIT returns. The results supports the notion that the usefulness of hedging returns in explaining REIT portfolio returns is related to the Revenue Reconciliation Act of 1993. Specifically, SMB_{REIT} plays an increasingly important role in explaining NAREIT excess returns. At the same time, the market beta of the NAREIT equity index drops from about 0.2 to almost zero. In addition, the convergence between the market beta of the NAREIT index and the market beta of the NCREIF Index seems to occur first in our REIT-based specification; this process appears to begin in 1993. On the other hand, this process does not occur in the traditional stock-based specification until 2001. Another noticeable observation in Figure 3 is that all three exposures of NAREIT excess returns to the market factor, the SMB factor, and the HML factor decline during the 1993-2003 period. At the beginning of the time period, these exposures range from 0.4 to 0.6. At the end of the time period, these exposures range from 0.2 to 0.4. This explains the finding in Figure 2 that the fit of the regression under the Fama-French three-factor model weakens over time.

Figure 3: Rolling estimates from regressions of NAREIT returns, 1983-2003



Conclusions

This study presents three REIT-based mimicking portfolios that are designed to represent feasible elementary strategies for investing in REITs. When evaluating REIT performance for the decade ending 2003, the use of REIT-based mimicking portfolios provides better test specifications. The economic interpretation of the alpha estimates produced by passively formed REIT portfolios appears to be more plausible in a relatively competitive and efficient market relative to the alphas produced by the CAPM or to the Fama-French three-factor model. Overall, the result is consistent with Lyon et al. (1999) that expected return vary by industry, and with Downs (2000) that asset pricing models tested without REIT-based mimicking portfolios may fail to capture the information in REIT prices.

The results from this study have implications for future research and raise several interesting questions. If REITs are close to being zero-beta assets, would this be attributable to the inflation-proof nature of underlying private properties? It seems plausible that prior to 1993 REIT prices was largely influenced by individual investors who perceived REITs to be more like stocks. Therefore, stock-based factors were useful for explaining REIT returns. With the subsequent influx of institutional investors in the post-1993 era (Chan et al., 1998), the link between REITs and their underlying

properties has strengthened over time. This study provides evidence that the use of REIT-based mimicking portfolios makes the market beta of REITs converge to the market beta of the NCREIT index. We believe that our results have the potential to trigger future research that explores more deeply into this fundamental linkage.

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