Journal of Real Estate Finance and Economics, 27:1, 39–60, 2003

The Relative Importance of Stock, Bond and Real Estate Factors in Explaining REIT Returns

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Abstract

This paper examines the link between REIT, financial asset and real estate returns, and tests whether it changed subsequent to the ''REIT boom'' of the early 1990s. The main focus is on answering the question do REIT returns now better reflect the performance of underlying direct (unsecuritized) real estate? We develop and implement a variance decomposition for REIT returns that separates REIT return variability into components directly related to major stock, bond, and real estate-related return indices, as well as idiosyncratic or sector-specific effects. This is applied to aggregate REIT sector (NAREIT) returns as well as returns to size and property-type based REIT portfolios. Our results show that the REIT market went from being driven largely by the same economic factors that drive large cap stocks through the 1970s and 1980s to being more strongly related to both small cap stock and real estate-related factors in the 1990s. There is also a steady increase over time in the proportion of volatility not accounted for by stock, bond or real estate related factors. We also find that small cap REITs are ''more like real estate'' compared to larger cap REITs, at least over the 1993–1998 period. We argue that this could be a result of the institutionalization of the ownership of larger cap REITs that took place in the 1990s.

Key Words: REIT boom, variance decomposition, real estate factor, rolling regression, institutional ownership

Introduction

Academics and industry practitioners have long debated the role of REITs in mixed asset portfolios, questioning whether REITs actually provide exposure to the private real estate asset class or simply represent additional exposure to common stocks. Early studies of REIT investment performance generally found there was little connection between quarterly returns to private unsecuritized income-property, as measured by the NCREIF total return index, and NAREIT (public real estate) returns.[1] More recent research suggests that REIT and unsecuritized real estate returns have significantly different statistical properties and that the degree of substitutability of REITs for private real estate in mixed-asset portfolios is quite limited (Seck, 1996 and Seiler et al., 2001). An extensive body of literature shows that macroeconomic variables (or factors) that have been found to

explain stock and bond returns and risks have significant power in explaining REIT returns and risks at monthly and quarterly levels (Chan et al., 1990; Ling and Naranjo, 1997; Peterson and Hseih, 1997; and Karolyi and Sanders, 1998). From these two research avenues emerges a view of REITs as a hybrid of stocks and bonds in terms of risk exposure, with little or no role for direct real estate in REIT pricing.

Another stream of research into REIT pricing, however, reveals a fundamental link between NAREIT (public market) and NCREIF (private, unsecuritized market) returns. Giliberto (1990) finds that quarterly NCREIF and NAREIT returns are significantly positively correlated after ''purging'' or removing stock and bond market influences from the two return series. Giliberto interprets his findings as evidence of a ''pure'' real factor present in both public and private real estate returns.[2] Taking a longer-term view, Barkham and Geltner (1995) show there is strong co-movement between unsmoothed (or de-lagged) NCREIF and lagged NAREIT return series. Their results are consistent with the notion that news about real estate fundamentals is reflected more rapidly in REIT share prices than property values, a result consistent with an efficient public market and less efficient unsecuritized private market for real property. Geltner and Rodriguez (1998) also report a long-term link between securitized and unsecuritized real estate and, in addition, find that while over the short-term securitized property returns display greater volatility, this volatility tends to be transitory or short-lived in nature. Hence, REIT returns appear to exhibit traits of both publicly traded shares and private real estate with public market influences dominating in the short-run and real estate market dynamics in the longer term.

The debate about the determinants of REIT returns and risks has recently gained new momentum. The dramatic growth and maturation of the REIT sector since 1992 led to claims that the link between REIT prices and real estate market fundamentals had become much stronger and made REITs ''more like real estate and less like stock'' (Ziering et al., 1997). Given the wider analyst following and increased sophistication of the investors (institutional versus retail), it was suggested that REIT share prices more accurately reflected property market fundamentals. This argument is consistent with the idea that the REIT market went through a transition or maturation process in which growth and increased analyst following have led to more widely distributed and reliable information about REITs being available. Together with an expanded and more sophisticated investor base, improved information flows about REITs helped REIT prices better reflect the performance of their underlying real estate assets.

Despite the important implications of the nature of the relationship between REIT and unsecuritized property markets, relatively little research has been directed at evaluating the claim that REITs are now ''less like stocks and more like real estate.'' Most of the research on the relationship between private and public market pricing of real estate predates the ''REIT boom'' of the 1990s. Moreover, the primary evidence in support of the claim is the decreased correlation between NAREIT and S&P 500 returns and the inability of stock and bond factors to explain REIT returns since the early 1990s compared to the 1970s and 1980s (Ghosh et al., 1996; Ziering et al., 1997; and McIntosh and Liang, 1998).

This paper examines the link between REIT, financial asset and real estate returns. We attempt to answer the following question: has the short-run link between equity REIT performance and private market real estate returns strengthened since the explosive

growth of the REIT market began in the early 1990s? That is, is there a real estate factor in REIT pricing and has it come to play a larger role as the size of the REIT market has grown? Our research sets out to calibrate the relative importance of macro (economy-wide) bond, stock and real estate factors to REIT returns, and investigate how these vary over time. We employ a multi-factor return generating process for *ex post* REIT returns to quantify the degree to which REIT returns are influenced by stock, bond, and real estate-related effects. We then use the factor sensitivity estimates along with the variances of each asset's return series to estimate the proportion of REIT return volatility due to each of the three factors, as well as an idiosyncratic risk component.

Our paper makes two main contributions to the literature. First, it explicitly incorporates returns to direct real estate as a factor in REIT return regressions and tests for increased sensitivity of REIT returns to real estate in the 1990s. Second, in addition to estimating the sensitivities (the ''betas'') of REIT returns to various factors, we examine the determinants of volatility. This allows us to quantify the relative importance of financial asset versus direct real estate-related influences on REIT returns.

Our results show that over the 1978–1998 time period, the large cap stock factor accounts for the greatest proportion of REIT market (NAREIT index) volatility, followed by small cap stock and then bond factors. Unsecuritized real estate accounts for a negligible proportion of volatility. However, sub-period analysis reveals a maturation process. The large cap stock factor declines precipitously in importance from explaining 72 percent of NAREIT volatility in the early 1980s to only 9 percent in the 1990s. During the late 1980s, a significant small cap stock factor appears. During the 1990s, a significant real estate factor emerges. These findings are consistent with the returns to securitized real estate gradually beginning to reflect the nature of the underlying, unsecuritized assets. There is also a dramatic increase over time in the idiosyncratic volatility that is not explained by any of the factors. Further analysis shows that there are cyclical, as well as structural, changes to REIT return volatility.

Methodology

The existing literature views REITs as a hybrid of stocks and bonds in terms of return and risk exposure in the short-run (Ling and Naranjo, 1997; Peterson and Hseih, 1997; Karolyi and Sanders, 1998), with increased exposure to real estate revealed in longer-term price dynamics (Mei and Lee, 1994; Geltner and Rodriguez, 1998). Intuitively, REIT returns should be related to returns on stocks because REITs are influenced to some degree by the same macroeconomic variables that affect stock returns. The relatively fixed nature of the cash flows derived from income-property with long-term leases and high-credit quality tenants, together with the high dividend yield REITs provide to investors, imply that REIT returns and risks should also be related to macroeconomic variables that affect bond returns. Essentially, this means that returns to stock and bond indices can act as proxies for the unobservable state variables that are common both to REITs, stocks and bonds.

Based on this intuition we employ a multi-factor model in which the return on a REIT

index (or individual REIT or portfolio of REITs), $r_{REIT\,t}$, is specified as a linear function of stock, bond and real estate factors as follows:

$$r_{REIT\,t} = \beta_0 + \beta_1 r_{St} + \beta_2 r_{Bt} + \beta_3 r_{REt} + \nu_t, \tag{1}$$

where r_{St} is the return to the stock market (e.g., S&P 500 and/or other benchmark index), r_{Bt} the return to the bond market (e.g., long-term government and corporate bonds), and r_{REt} the return to unsecuritized real estate (e.g., unsmoothed NCREIF total return index), in period t. The βs measure the sensitivity of REIT returns to the various factors and ν represents the unexplained portion of REIT returns, or idiosyncratic factors.[3]

Two additional comments are in order concerning the specification in equation (1). First, the multi-factor specification is not meant to imply that aggregate stock, bond and real estate return indices drive REIT returns, but rather that the indices proxy for the underlying state variables shared by REITs and the other asset classes. A number of recent papers have looked at multi-factor models in an asset-pricing framework, with the aim of determining to which factors REIT returns are sensitive or exposed, and which of these factors represent systematic risks that are actually priced ex ante (Ling and Naranjo, 1997; Peterson and Hseih, 1997; and Karolyi and Sanders, 1998). It is possible that the factors we examine are not priced in the market. That is, the risks associated with some or all of our factors may be diversifiable and therefore not affect REIT expected returns (prices). However, they may still affect realized returns, and our goal is to examine the link between realized REIT, financial asset and real estate returns. This means that an examination of these factors is important in terms of understanding the nature of REITs, their importance to investors who are not entirely diversified, as well as their role in helping to diversify a portfolio.

Second, in our empirical analysis we do not use equation (1) directly. We require independent or ''pure'' factors to decompose REIT volatility into stock, bond, real estate and idiosyncratic components. To obtain independent factors that are uncorrelated with each other, we ''orthogonalize'' the right-hand side variables (regressors) in equation (1) in first stage regressions as follows:

$$r_{REt} = \delta + \eta r_{Bt} + \phi r_{St} + \varepsilon_t, \tag{2}$$

$$r_{Bt} = \tau + \lambda \hat{\varepsilon}_t + \gamma r_{St} + u_t, \tag{3}$$

where ε and u are mean zero error terms that, by construction, are orthogonal to the right-hand side variables (regressors) in the respective equations. The residuals in equation (2), from a regression of real estate returns on stock and bond returns, represent a ''pure'' real estate factor. The residuals from the OLS estimation of equation (2) are included on the right-hand side of (3). The residuals from equation (3) are used as our proxy for the ''pure'' bond factor. Both residual series are uncorrelated with the stock market return variable. Replacing the bond and real estate returns by their respective orthogonalized

counterparts in equation (1) yields a REIT return generating process based on independent stock, bond and real estate factors,[4]

$$r_{REIT\,t} = b_0 + b_S r_{St} + b_B \hat{u}_t + b_{RE} \hat{\varepsilon}_t + \nu_t. \tag{4}$$

We employ this equation to break down the total volatility of REIT returns into the relative components derived from market-wide (macro-level) common stock, bond and real estate components.[5] From equation (4), we can write the variance of REIT returns as,

$$Var[r_{REIT}] \equiv \sigma^2_{REIT} = b^2_S \sigma^2_{r_S} + b^2_B \sigma^2_u + b^2_{RE} \sigma^2_\varepsilon + \sigma^2_\nu. \tag{5}$$

From equation (5) we can then infer the relative contributions of each factor to total REIT return variability by calculating the proportion of variance due to each factor as follows:

$$\text{stock} = \frac{b^2_S \sigma^2_{r_S}}{\sigma^2_{REIT}}, \quad \text{bond} = \frac{b^2_B \sigma^2_u}{\sigma^2_{REIT}}, \quad \text{real estate} = \frac{b^2_{RE} \sigma^2_\varepsilon}{\sigma^2_{REIT}}, \quad \text{idiosyncratic} = \frac{\sigma^2_\nu}{\sigma^2_{REIT}}. \tag{6}$$

In our empirical analysis we employ stock returns derived from both the S&P 500 and the Russell 2000 return indices to investigate the potential separate influences of both large and small cap stock returns, respectively, on REIT return volatility. The actual model we estimate is:

$$r_{REIT\,t} = b_0 + b_{SP} r_{SPt} + b_{Russ} \hat{e}_t + b_B \hat{u}_t + b_{RE} \hat{\varepsilon}_t + \nu_t, \tag{4a}$$

where *SP* and *Russ* refer to S&P 500 and Russell 2000 stock indices, respectively, and the orthogonalized small cap effect is represented by $\hat{e}_t$, the residual from regressing the Russell 2000 return on the other factors. The orthogonalizing regressions for the bond and real estate factors are augmented with the Russell 2000 so that all four factors are independent.

The first part of our investigation looks at the REIT sector as a whole. That is, we examine the relative contributions of stock, bond and real estate factors to REIT pricing at a macro level over the 1978–1998 period. We also examine sub-periods in order to determine if the relationships have varied over time, with particular emphasis on the post 1992, ''new'' REIT era. If there is a more pronounced real estate factor in REIT pricing we should expect to find a statistically significant sensitivity of REIT returns to unsecuritized real estate returns, b_{RE}, and a relatively large proportion of variance due to real estate in the variance decomposition. The second phase of the investigation estimates the stock, bond and real estate variance proportions for REIT portfolio returns, with portfolios formed on the basis of REIT market capitalization and property type specialization (focus).

Econometric issues

One potential problem with the empirical approach above is the possibility of ''overpurging'' the asset return series in the first stage regressions. It is likely that there are some state variables common to all asset class returns. In the version of the regression shown in (4a), large cap stock returns act as the numeraire or base, with the other asset classes orthogonalized but large cap stock returns appearing directly in the regression. This means that if a portion of REIT return volatility is driven by state variables that are common to all asset classes, the effect of these common variables will be ascribed entirely to large cap stocks.[6]

To control this problem, we estimate two different versions of equation (4a). In the first, as in (4a), large cap stocks act as the numeraire or base. In the second version, we reverse the order of the first stage orthogonalizing regressions so that real estate acts as the numeraire. Since the main research question most often posed in the past deals with the relative influences of the real estate and overall stock markets on REIT returns, we choose to keep bonds and small cap stocks ''in the middle'' in both cases, always being orthogonalized with respect to the chosen numeraire. In one version of our volatility decomposition we therefore under-purge the large cap stock (over-purge real estate) effect, and in our second specification we over-purge the effect of large cap stocks (under-purge real estate). Hence, the resulting estimates actually provide a lower and upper bound on the proportion of REIT volatility attributable to each asset class. The difference between the end points of these ranges represent the effect on REIT volatility of state variables that cannot be uniquely assigned to a single asset class.

A second, and related, potential econometric problem with our approach derives from the use of residuals from first stage regressions as regressors in the second stage return regression [equation (4a)]. Pagan (1984) shows that the standard errors on so called generated regressors are downward biased which can therefore lead to an upward bias in standard *t*-tests of statistical significance and spurious significance of coefficients. To gauge the importance of the generated regressor problem here, each time we estimate the REIT regression with orthogonalized (generated) asset class factors we regress the same REIT returns on the raw, or nonorthogonalized, asset class returns. A comparison of the *t*-statistics on the parameter estimates from the two regressions tells us whether or not we have a spurious significance problem with any of the coefficients on the orthogonalized regressors. In addition, since we conduct the REIT return regressions using the two different orderings of the first stage regressions, first with S&P 500 and then with direct real estate returns as the base, we have coefficient estimates on actual (i.e., non-generated) returns for these two key asset class series, which are not subject to Pagan's generated regressor problem.

Sample and data

We require benchmark return data on REITs, common stock, bonds and unsecuritized (private) real estate, as well as returns to individual REITs and key characteristics that

vary across REITs including market capitalization and property type focus. For financial asset class returns, we employ the following widely known indices: NAREIT equity total return index excluding health care for REITs, S&P 500 index for large cap stocks, Russell 2000 index for small cap stocks, and Lehman Brothers index of returns to long-term government and corporate bonds. For unsecuritized (private) real estate we use an unsmoothed version of the NCREIF total return index. The unsmoothing approach employed is discussed below. The macro analysis covers the 1979–1998 period. The availability of the NCREIF and Russell 2000 return indices dictate the beginning of the study period. Our analysis employs quarterly data, as that is the frequency of the NCREIF data.

The second part of our analysis uses portfolios of REITs formed on the basis of property-type focus and market capitalization. Portfolio returns are derived from those of individual REITs with return data available on CRSP. The portfolio analysis covers the period from the beginning of 1993 to the end of 1998. Quarterly returns are employed. If a REIT was in existence in 1993 but disappeared from the CRSP tapes before the end of our sample period, the REIT was included in the sample if returns were available until at least the second quarter of 1997. This was done to help reduce the potential for survivorship bias while attempting to ensure each REIT had enough data to estimate the regressions reliably. REITs that came into existence during our sample period were included if they had quarterly returns starting in the third quarter of 1994 or earlier. Our final sample consists of 103 REITs. We obtained property-type focus and market capitalization information from COMPUSTAT, various issues of the NAREIT REIT Handbooks, and the SNL REIT Datasource.

Returns to unsecuritized real estate

The most widely used benchmark of institutional-grade property performance is the NCREIF property index (NPI). The NPI is a quarterly return series extending back to 1978. Unfortunately, the NCREIF index is subject to a number of limitations. It is widely suspected that NCREIF returns lag ''true'' market returns, as a result of both appraisal smoothing at the individual property level and the inclusion of ''stale'' (or outdated) appraised values in the index. These problems ''greatly affect the ability of the NCREIF index to provide timely and precise indications of quarterly market direction and behavior'' (Fisher and Geltner, 2000, p. 8).[7] Given its limitations, this study does not employ the raw NCREIF index itself, but ''unsmoothed'' or ''de-lagged'' versions of it.[8] In the macro (index) analysis the transaction value index (TVI) recently introduced by Fisher and Geltner (2000) is employed.[9] For the micro (portfolio) analysis the TVI is unavailable and we use an autoregression-based approach that has been used extensively in previous studies.

The TVI is derived from a three-step process that aims to undo the two types of lag-induced distortions in the NCREIF index and ''back out'' a more realistic index of contemporaneous property returns. The stale appraisal problem results from the fact that while the NCREIF index is quarterly, many of the properties in the index are only

reappraised annually, with a large proportion of the valuations taking place in the fourth quarter of each year. As noted by Fisher et al. (1994) this implies that the quarterly NCREIF index is essentially an annual index that is partially updated each quarter. To circumvent this problem Geltner and Goetzman (2000) devise a ''repeated-measures regression'' (RMR), similar to the repeat-sales methodology that is widely used in the construction of house price indices, that estimates quarterly returns using only those properties that are seriously appraised in any given quarter. By removing properties for which a serious reappraisal was not conducted the stale appraisal problem (partial updating phenomenon) is largely eliminated. Hence, the RMR is a pure appraisal-based return index.

Subsequent to the elimination of stale appraisal effects, the second step in deriving the TVI involves specifying a partial adjustment model of appraiser updating behavior and quantifying the degree of lagging in appraisals at the individual property level. Based on a comparison of actual transaction prices and contemporaneous appraised values of properties sold from the NCREIF index, Fisher and Geltner (2000) report a typical appraisal lag of about three quarters. Combining the RMR version of the index, the model of appraiser behavior and the three quarter lag, the authors are able to back out (''reverse-engineer'') the TVI of property returns.[10]

Empirical results for the NAREIT index

Table 1 reports summary statistics for each of the quarterly return series as well as correlations of S&P 500, Russell 2000, Lehman Bond and TVI Real Estate returns with NAREIT returns, over both the full 1978–1998 sample period as well as over three 7-year sub-periods. Comparing the full sample mean returns and standard deviations with the sub-period statistics reveals considerable variation over time in mean returns and volatility, and shows that the 1992–1998 period is characterized by lower volatility in all the asset class returns. The full sample correlations are consistent with previous studies in that REIT market returns are highly correlated with small cap stocks and essentially uncorrelated with direct real estate returns. Since 1992, however, there has been a dramatic change in the correlations. Specifically, over the 1992–1998 period equity NAREIT returns were positively correlated with the de-lagged NCREIF (and the correlation is statistically significant), while the correlation between REITs and stocks in general fell by a large amount. These results would appear to be consistent with claims made by some market participants that, with growth and maturation in the market, the performance of REITs has become less like the performance of stocks and more like that of the underlying real estate since the REIT boom of 1992 or 1993 (Ziering et al., 1997). It is this claim that we more rigorously test with our variance decomposition framework.

Table 2 reports the slope coefficients (factor sensitivities) resulting from estimating equation (4a), the return generating process for NAREIT returns as a function of orthogonalized large cap stock, small cap stock, bond and real estate factors. Results are presented first for the full sample period and then for three 7-year sub-periods to determine if there have been changes in the sensitivities of REIT returns to the factors over time. In addition, for each time period two sets of estimation results are reported, one with large

Table 1. Summary statistics for NAREIT, S&P 500, Russell 2000, Lehman Bothers Bond Index and TVI version of the NCREIF Index, quarterly data, 1979–1998 and sub-periods.

	Full Sample		Sub-periods					
	1979–1998		1979–1984		1985–1991		1992–1998	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mean and standard deviation of asset class returns (%)								
NAREIT (r_{NAREIT})	3.12	7.22	5.49	8.20	1.33	6.93	2.88	6.23
TVI (r_{RE})	2.31	6.88	3.77	12.02	1.13	3.22	2.24	1.36
Russ 2000 (r_{Russ})	4.54	10.70	4.53	11.63	3.30	12.34	3.21	8.07
S&P 500 (r_{SP})	4.41	7.32	3.87	7.01	4.57	8.75	4.72	6.16
Lehman bond (r_B)	2.49	3.90	2.67	5.86	2.89	2.92	1.92	2.49
Correlation of each return series with NAREIT returns								
TVI (r_{RE})	− 0.03		− 0.14		− 0.05		0.39*	
Russ 2000 (r_{Russ})	0.72*		0.82*		0.84*		0.41*	
S&P 500 (r_{SP})	0.60*		0.85*		0.70*		0.26	
Lehman bond (r_B)	0.48*		0.71**		0.33*		0.26	

Note. SD is standard deviation.
* Indicates the correlation is statistically significant at the 5% significance level.
** Indicates the correlation is statistically significant at the 10% significance level.

cap stocks as the numeraire (column (1) Stock Base), and a second version with the order of the first stage orthogonalizing regressions reversed with real estate as the numeraire (column (2) RE Base).

The regression results support the notion that, overall, state variables that drive stock and bond returns were also the primary drivers of REIT returns over the full sample period. Real estate market fundamentals, as reflected in returns to direct real estate, did not appear to play a role in explaining fluctuations in REIT returns over this period. The results indicate that small cap stock factors exert a separate influence, above and beyond that of large cap stocks. Looking at the sub-period results in Table 2, reveals that the relationship between REIT, financial asset and real estate returns has changed over time. REITs had the greatest sensitivity to large cap stocks in the early years, but this has declined over time. Conversely, the sensitivity of the REIT index to small cap stocks seems to have emerged during the latter half of the 1980s.

Of particular note is the apparent emergence of a real estate factor in the 1992–1998 period. Prior to this period, REIT returns were essentially insensitive to unsecuritized real estate. During the latest period however, a significant relationship established itself. Despite the apparent tighter connection between REITs and real estate, however, the overall model fit declines from nearly 90 percent to under 40 percent over the three periods, as evidenced by the R-squareds.[11] The results are quite robust to the order of the orthogonalization, in terms of the relative changes in magnitude of the coefficients over time. We do observe, however, that the coefficient on the bond (stock) factor increases (decreases) substantially when we switch the numeraire from S&P 500 to real estate,

Table 2. Factor sensitivities from regressions of equity NAREIT returns on orthogonalized large cap stock, small cap stock, bond and unsecuritized property returns, 1979–1998.

	Full Sample		Sub-periods					
	1979–1998		1979–1984		1985–1991		1992–1998	
Coefficient on:	(1) Stock base	(2) RE base	(1) Stock base	(2) RE base	(1) Stock base	(2) RE base	(1) Stock base	(2) RE base
Large cap stocks	0.59	0.48	0.99	0.75	0.56	0.55	0.26	0.12
	(9.04)	(6.89)	(15.2)	(8.13)	(7.32)	(6.91)	(1.55)	(0.71)
Small cap stocks	0.60	0.60	0.37	0.37	0.71	0.71	0.42	0.42
	(6.64)	(6.64)	(3.10)	(3.10)	(5.57)	(5.57)	(2.76)	(2.76)
Bonds	0.62	0.99	0.51	1.09	0.52	0.81	0.58	0.80
	(6.13)	(9.62)	(5.81)	(12.7)	(3.34)	(4.22)	(1.65)	(2.45)
Real estate	0.10	− 0.03	0.05	− 0.10	− 0.30	− 0.11	1.82	1.77
	(1.82)	(0.61)	(0.97)	(2.71)	(1.79)	(0.90)	(3.49)	(3.22)
Constant	0.51	3.19	1.65	5.85	− 1.22	1.44	1.65	− 1.08
	(0.96)	(6.58)	(2.76)	(9.16)	(1.64)	(2.50)	(1.32)	(0.72)
R^2	0.65		0.86		0.79		0.35	
Adjusted R^2	0.63		0.83		0.75		0.24	
No. obs.	80		24		28		28	

Note. The figures in the table are parameter estimates from a regression of the form

$$r_{NAREIT,t} = \beta_0 + \beta_1 r_{SP,t} + \beta_2 r_{Russ,t} + \beta_3 r_{B,t} + \beta_4 r_{RE,t} + \nu_t.$$

In the regressions three of the four regressors are not actual or raw asset class return series but residuals from ''orthogonalizing'' regressions in which the raw return series have been ''purged'' of common elements shared with the other three asset return series. Because there is potential for ''overpurging'', regression results are shown for two different orderings of the orthogonalizing regressions. In model (1) the real estate factor is the residual from a regression of real estate returns on the stock and bond return series. The small cap factor is the residuals from a regression of Russell 2000 returns on the real estate residuals, bond returns and S&P 500 returns. The bond factor is the residuals from a regression of bond returns on the real estate and small residuals and the S&P 500. The large cap factor is represented by actual S&P 500 returns. Hence, large cap returns can be viewed as the base or numeraire in model (1). In model (2), the order of orthogonalizing regressions is changed and real estate returns are the base. In this case the large cap stock factor is the residuals from a regression on Russell 2000, bond and real estate returns, while the real estate factor is represented by the actual real estate returns. The absolute values of *t*-statistics are shown in parentheses. The t-statistics are calculated using White's (1980) heteroskedasticity-consistent covariance matrix. [(1) = large cap stock returns as numeraire, (2) = unsmoothed real estate (RE) returns as numeraire].

especially in the 1979–1984 period, suggesting that we did overpurge common information from the bond returns with the S&P 500 numeraire.[12]

Table 3 presents the estimated variance proportions calculated according to equation (6), using the parameter estimates from Table 2 to estimate the contributions of the orthogonalized asset class returns to REIT return volatility. For the full sample with S&P 500 returns as the base in the first stage regressions, large cap stock, small cap stock and bond-related factors explain 36 percent, 18 percent and 10 percent of REIT volatility, respectively, while real estate appears to play no role at all. Looking at the sub-period

Table 3. Estimates of the relative contribution of ''pure'' large cap (S&P 500) stock, small cap (Russell 2000) stock, bond and real estate factors to REIT return variability, 1979–1998.

	Full Sample		Sub-periods					
	1979–1998		1979–1984		1985–1991		1992–1998	
% of NAREIT Volatility explained by the:	(1) Stock Base	(2) RE Base	(1) Stock Base	(2) RE Base	(1) Stock Base	(2) RE Base	(1) Stock Base	(2) RE Base
Large cap stock factor	35.8	21.4	71.9	29.4	49.4	44.5	6.6	1.36
Small cap stock factor	18.4	18.4	4.2	4.2	23.2	23.2	11.1	11.1
Bond factor	10.1	25.1	9.8	50.8	4.6	10.9	5.2	10.0
Real estate factor	0.8	0.8	0.4	1.9	1.7	0.3	14.7	15.0
Idiosyncratic component	35.1	35.1	13.7	13.7	21.1	21.1	62.5	62.5

Note. The figures in the table are variance proportion estimates given by

$$\frac{\beta_i^2 \mathrm{Var}[r_i]}{\mathrm{Var}[r_{NAREIT}]}$$

for $i =$ large cap stock, small cap stock, bond and real estate returns. β_i is the factor sensitivity estimate derived from a regression of the form $r_{NAREIT,t} = \beta_0 + \beta_1 r_{SP,t} + \beta_2 r_{Russ,t} + \beta_3 r_{B,t} + \beta_4 r_{RE,t} + \nu_t$ (coefficient estimates are shown in Table 2). In the regressions three of the four regressors are not actual or raw asset class return series but residuals from ''orthogonalizing'' regressions in which the raw return series have been ''purged'' of common elements shared with the other three asset return series. Because there is potential for ''overpurging'', regression results are shown for two different orderings of the orthogonalizing regressions. In model (1) the real estate factor is the residual from a regression of real estate returns on the stock and bond return series. The small cap factor is the residuals from a regression of Russell 2000 returns on the real estate residuals, bond returns and S&P 500 returns. The bond factor is the residuals from a regression of bond returns on the real estate and small residuals and the S&P 500. The large cap factor is represented by actual S&P 500 returns. Hence, large cap returns can be viewed as the base or numeraire in model (1). In model (2), the order of orthogonalizing regressions is changed and real estate returns are the base. In this case the large cap stock factor is the residuals from a regression on Russell 2000, bond and real estate returns, while the real estate factor is represented by the actual real estate returns. [(1) = large cap stock returns as numeraire, (2) = unsmoothed real estate (RE) returns as numeraire].

results illustrates the magnitudes of the decreases in the explanatory power of large cap stocks and bonds. The proportion of the variance due to large cap stocks exhibits the most dramatic slip, falling from about 72 percent to 7 percent over the three sub-periods.[13] Since 1992 real estate came to play a bigger role in REIT performance, although it still only contributes 15 percent in the 1992–1998 period. Consistent with the declining R-squareds in the Table 2, idiosyncratic risk appears to dominate in the most recent period. Similar results are obtained with real estate returns as the base; public market factors explain less and real estate more but idiosyncratic or REIT sector risk dominates. Below we examine potential explanations for increased REIT-sector idiosyncratic risk.

Time variation in REIT market dynamics

The changing relationship between REITs, financial assets and real estate, reported in Tables 1 and 2, are indicative of a structural shift in the nature of REIT returns since the

''REIT boom'' of 1993. To investigate time-variation in the relative contributions of the stock, bond and real estate factors in more detail we employ a rolling regression procedure in which the orthogonalizing regressions and the REIT return regression are re-estimated over successive four year (16 quarter) periods. In each estimation, a new observation is added while the first one is dropped. The model is estimated 65 times and the parameter estimates (slope coefficients) in the REIT regressions are used to calculate the variance proportions in each case. Figure 1 plots the rolling four-quarter variance proportions.

Figure 1 reveals substantial time-variation in the variance proportions. The top graph illustrates the emergence of the small cap stock factor in the late 1980s, closely followed by the real estate factor in early 1990s. The importance of both factors appears to have declined somewhat in the latter part of the sample, although the small cap contribution picks up significantly towards the end of 1998. Note that there would appear to be a transitory rise in the real estate component 1988–1989, however an examination of the sensitivities shows that this is due to negative and insignificant (*t*-statistics not reported) coefficients for the real estate factor over this period. Hence, we would argue that most (although not all) of the changes in the real estate factor are structural, rather than cyclical, in nature. The bottom graph reveals the dramatic decrease in the contribution of large cap stock related factors to REIT variability starting in 1993, as well as the sharp rise in REIT market idiosyncratic risk beginning in the early 1990s. There also appears to be a cyclical pattern to both the S&P 500 factor and idiosyncratic risk, as the mid 1980s is also characterized by a period of increased REIT idiosyncratic risk and lower large cap effects on REIT volatility.

Potential explanations for the 1990s shift in REIT pricing

Together, Table 3 and Figure 1 tell a story in which REIT returns were primarily driven by the same state variables that impacted large cap stocks throughout the 1980s, but as the sector matured in the late 1980s, the relevance of large caps declined and a small cap factor arose. In the 1990s the small cap factor remained, but a real estate factor also became important. Simultaneously, idiosyncratic effects rose dramatically over the entire time period.

The finding of increased idiosyncratic REIT-industry level risk is consistent with recent findings of increased volatility in individual and many industry-specific stock returns reported by Campbell et al. (2001). They suggest that increased idiosyncratic stock risk could derive from two forces at work in public markets in recent years: the ''institutionalization'' of stock ownership, and technology. They suggest that the volatility of individual stock returns has increased because firm-specific information is released more frequently which gives investors more opportunity to act on this information. In addition, stock markets today are dominated by institutional investors which, the authors argue, has led to increased volatility because of ''herding'' behavior among these investors as well as a greater turnover in shares traded.[14]

This story appears to be a good fit to the recent REIT experience. The sharp rise in

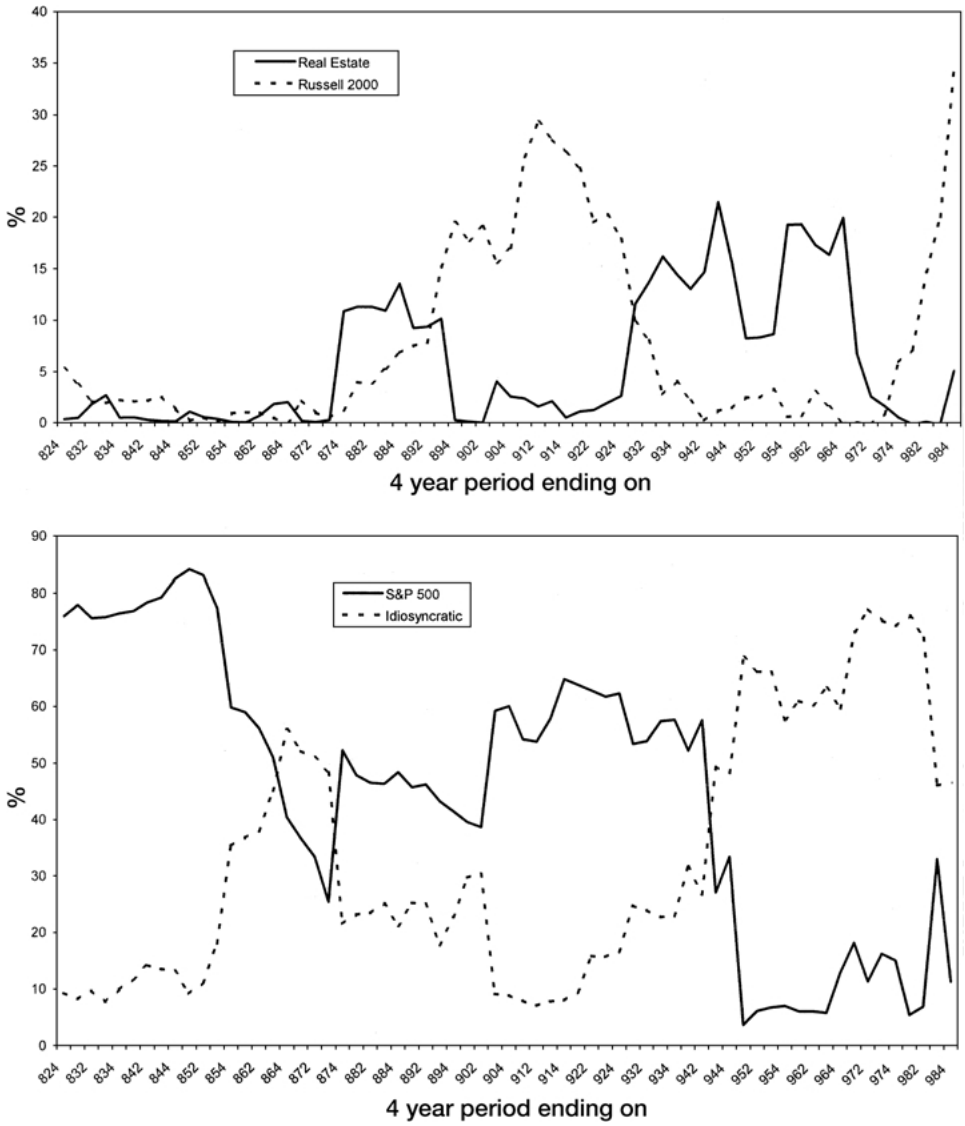

Figure 1. Time paths of relative contributions of stock, unsecuritized real estate and idiosyncratic factors to NAREIT return volatility, 1982:4–1998:4 (based on 16 quarter rolling NAREIT return regressions).

idiosyncratic REIT sector risk coincides with the beginning of the new REIT growth era in the early 1990s. Average market capitalization per REIT grew from about $100 million in 1991 to nearly $1 billion at the end of 1998 (source: NAREIT). Many of the REITs formed in the early to mid-1990s were large private players who went public to gain access to capital to both refinance their own properties and acquire new

ones at attractive yields in a depressed market. This growth was accompanied by a significant increase in institutional ownership of REITs. The proportion of REIT shares held by institutions more than doubled, from 14 to 30 percent, over the 1990–1995 period (Chan et al., 1998), and grew to 53 percent of REIT shares by the end of 1998 (Ciochetti et al., 2000). Larger market caps and a greater presence of institutional investors led to greater analyst following of REITs, and hence more and better firm and industry specific information disseminated.[15]

Additional evidence comes from Graff and Young (1997), who report that the extent to which REIT returns share the qualitative return properties of unsecuritized real estate varies inversely with REIT market capitalization. Because institutional investors tend to show a preference for larger cap, more liquid stocks, Graff and Young (1997) suggest this finding is related to the tendency of institutional investors to change their sentiment about particular REITs at the same time (herding behavior or coordinated trading). They conclude that the increased institutional interest has caused REIT return behavior to diverge increasingly from the returns on underlying REIT property portfolios.[16]

Our aggregate analysis to this point suggests that REITs have become both more like real estate and more like stocks. By ''more like stocks'' we do not mean more highly correlated to a stock index, as evidenced by the declining importance of the S&P 500 factor in our regression results. What we mean is that the information environment in which REITs trade has become more like that in which stocks trade in general. REIT share prices more accurately reflect the performance of REITs properties, yet also exhibit increased idiosyncratic risk consistent with public market maturation.[17] We explore the role of REIT market cap (size) in more detail in the next section by calculating variance proportions for REIT size-sorted portfolios.

The above discussion focuses on informational and ownership structure changes in the REIT marketplace and growth and maturation of the sector as the major cause of changes in the relationship between REITs, real estate and financial asset returns. These structural changes may, however, only be part of the story. Figure 1 reveals cyclical patterns to the factor variance proportions. For example, just like the mid-1990s, the mid-1980s period is also characterized by a period of increased REIT idiosyncratic risk and significantly lower large cap effects on REIT volatility. However, it appears that the magnitudes of the changes in the factor contributions are larger in the more recent period, suggesting that there has been structural change in REIT pricing since 1992. Figure 1 also shows that after the REIT bull market ended in 1997, idiosyncratic volatility dropped somewhat and the proportion of REIT volatility explained by the small cap stock factor increased dramatically during 1998. These observations offer further support for the notion that there is link between the various factors and the stage of the REIT market cycle. Hence, it seems that there are both structural and cyclical changes in the relationship REIT returns and the four factors.

The drop in the importance of real estate at the end of the series in Figure 1 could also be due to cyclical factors. However, it is also possible that this simply reflects increasing efficiency of the REIT market. That is, if REIT prices are now acting as better processors of information, then the REIT market may be reflecting changes in private real estate

values far more quickly than a private real estate price index. At this point we simply note the changing characteristics of the volatility proportions, and leave a full-fledged investigation of cyclical versus structural factors to future research.

Finally, another potential explanation for the inability of financial asset and unsecuritized real estate returns to explain NAREIT returns in the 1990s could be related to the *ex post*, asset-class REIT return regression approach we utilize. Specifically, it might be the case that there is an important state variable that influences REIT pricing, the effect of which is not fully captured by our asset-class return proxies. One candidate is aggregate consumption. Ling and Naranjo (1997, 1999) report that the growth rate in real per capita consumption is an important driver of REIT returns. Hence, it could be that what we have called the REIT sector idiosyncratic risk is in part picking up the omitted consumption state variable.

Results for REIT size and property type portfolios

In an effort to uncover additional insights into changing REIT market dynamics we examine the returns to REIT portfolios formed on the basis of market capitalization (REIT size) and property-type focus. The macro (NAREIT) may mask important relationships that cannot be revealed with aggregate returns (NAREIT). Market capitalization and property type focus are the two dimensions that are important to REIT investors, and may therefore have a systematic influence on how closely particular groups of REITs resemble real estate, how closely they resemble one of the financial asset classes, or the proportion of idiosyncratic volatility. Starting with a sample of 103 individual REITs, equally weighted property type and size-based REIT portfolio returns are derived, with size-based portfolios formed on market capitalization quartiles using market caps as of the end of 1998. Because our analysis of the overall REIT market revealed large changes in the relative influences of the factors over time, we look only at the more recent period in our sample, 1993–1998. As discussed previously, this coincides with the period that is widely regarded as a turning point in the maturation of the REIT sector.

Table 4 reports the results, both sensitivities and variance proportions, of repeating the estimation process we undertook previously for NAREIT index returns for each of the four resulting size-based REIT portfolios. The results for the top three size quartiles are fairly uniform. Idiosyncratic factors account for roughly three-quarters of return volatility in each portfolio, with real estate accounting for about 10 percent on average. Financial asset factors play a small role in explaining portfolio return variability in larger cap REIT portfolios over this period. A different story emerges with the bottom (4th) quartile portfolio. In this case, idiosyncratic risk accounts for less than 50 percent of REIT return variability. In addition, the small cap stock and unsecuritized real estate factors together explain 45 percent of return volatility, with the real estate factor capturing almost one-third by itself. These findings suggest that while small cap REITs have a significant small cap factor they also are ‘‘more like real estate’’, as compared to larger cap REITs, at least over the 1993–1998 growth period.

These findings lend additional support to the notion discussed previously that increased

Table 4. Factor sensitivities and variance proportion estimates for REIT size-based portfolios, quarterly returns, 1993–1998.

	S&P 500	Russell 2000	Real Estate	Bonds	Idiosyncratic
Quartile 1 ($\mu = \$2{,}068\,\text{m}$)					
Coefficient	0.193	0.535	2.15	0.839	
	(0.85)	(1.49)	(1.80)	(1.40)	
Proportion of variance	2.69	8.17	11.95	7.19	70.0
Quartile 2 ($\mu = \$653\,\text{m}$)					
Coefficient	0.077	0.521	2.12	0.963	
	(0.24)	(1.02)	(1.25)	(1.13)	
Proportion of variance	0.43	7.73	6.82	5.56	82.8
Quartile 3 ($\mu = \$374\,\text{m}$)					
Coefficient	0.232	0.310	2.58	0.98	
	(0.92)	(0.77)	(1.94)	(1.46)	
Proportion of variance	3.86	2.74	14.34	8.14	72.1
Quartile 4 ($\mu = \$79\,\text{m}$)					
Coefficient	0.158	0.746	3.44	0.566	
	(0.88)	(2.64)	(3.66)	(1.20)	
Proportion of variance	3.23	12.45	32.22	3.45	45.7

Note. The results reported here use the large cap stock factor (S&P 500) as the numeraire. The absolute values of *t*-statistics are shown in parentheses. The t-statistics are calculated using White's (1980) heteroskedasticity-consistent covariance matrix. Regressions also included a constant term that is not reported. μ is the average (mean) market capitalization of the REITs in the specific quartile.

institutional involvement in the equity markets in general may account for increases in idiosyncratic risk.[18] Increased idiosyncratic volatility could be due to an increased degree of informational efficiency in the market for REITs (as firm specific information is better incorporated in prices). It could also be due to (possibly irrational) herding behavior on the part of institutions. Given that the increase in idiosyncratic volatility is concurrent with an almost identically sized decrease in the proportion of volatility due to unsecuritized real estate fundamentals, it would appear that a case could be made that institutional investors increased volatility without an increase in efficiency. In other words, large institutional ownership may, in fact, de-link REIT prices from fundamental factors, as institutions moving *en masse* in and out of REITs in general. This effect would be consistent with real estate practitioners' perceptions of institutional involvement in REITs over the last few years as well as the arguments in Graff and Young (1997).

The second part of the portfolio-level analysis applies our REIT variance decomposition to returns on REIT portfolios formed on the basis of property type. The macro or aggregate analysis in the first part of the paper revealed that unsecurtized real estate emerged as a significant factor in explaining NAREIT return variability in the 1990s. Given that both NCREIF and NAREIT returns are derived from portfolios of properties and companies that focus on different property types, we might expect to find a stronger relationship between REIT return volatility and unsecuritized real estate at the property-type sector level. To

Table 5. Factor sensitivities and variance proportion estimates for REIT property type portfolios, quarterly returns, 1993–1998.

	Property Type				
	S&P 500	Russell 2000	Specific Real Estate	Bonds	Idiosyncratic
Apartment ($N = 15$)					
Coefficient	0.094	0.759	0.208	1.281	
	(0.24)	(1.27)	(0.05)	(1.29)	
Proportion of variance (%)	0.29	7.26	0.00	7.48	84.99
Industrial ($N = 9$)					
Coefficient	0.294	0.474	2.02	0.462	
	(1.20)	(1.25)	(1.08)	(0.47)	
Proportion of variance (%)	6.73	6.55	4.96	2.30	80.17
Office ($N = 13$)					
Coefficient	0.081	0.714	3.46	0.317	
	(0.36)	(2.19)	(2.94)	(0.55)	
Proportion of variance (%)	0.44	14.63	26.27	0.95	57.76
Retail ($N = 37$)					
Coefficient	0.280	0.435	− 0.055	0.5171	
	(1.48)	(1.56)	(0.04)	(1.08)	
Proportion of variance (%)	9.71	9.83	0.00	4.59	76.88
Diversified ($N = 6$)					
Coefficient	0.3944	1.089	7.24	1.16	
	(1.54)	(2.58)	(2.78)	(1.63)	
Proportion of variance (%)	5.82	17.57	20.31	6.96	49.96

Note: The results reported here use the large cap stock factor (S&P 500) as the numeraire. Unsmoothed NCREIF property-type specific returns are employed for the portfolio return regressions and variance decompositions. The absolute values of *t*-statistics are shown in parentheses. The *t*-statistics are calculated using White's (1980) heteroskedasticity-consistent covariance matrix. Regressions also included a constant term that is not reported.

investigate this we form equally-weighted return series for portfolios of REIT returns by property-sector focus and regress these returns on the orthogonalized financial asset returns and an unsmoothed NCREIF property-sector return series.[19] REITs are classified as specializing in a specific property type if 50 percent or more of their holdings, by dollar value, are in that type of property as of the end of 1998, otherwise they are classified as diversified REITs. We omit REITs that specialize in hotels and other unique sectors like storage facilities, which reduces our sample from 103 to 80 firms.

Table 5 reports the estimation results for five property-type focused portfolios and a portfolio of diversified REITs. The number of REITs in each portfolio is shown beside the property type label. We do not obtain the hypothesized larger proportion of returns explained by sector-specific direct real estate. The results are far from consistent and somewhat difficult to interpret. In general, as with our previous findings there is a high

degree of idiosyncratic or sector-specific risk. Office and diversified portfolios have relatively smaller levels of idiosyncratic risk with greater proportions of portfolio return variability explained by unsecuritized real estate. The diversified portfolio result would appear to be consistent with our previous findings on size-based portfolios, as diversified REITs tend to have smaller market caps than their more focused counterparts. What we suspect is that it is market cap not property type that is the key variable driving variations in the volatility proportions across REITs. Property-type portfolio returns are derived from the returns of REITs with varying market caps, and hence the market cap effect is neutralized to some degree.

Conclusions

A multi-factor return generating approach was utilized in order to break down the proportion of REIT volatility due to large cap stocks, small cap stocks, bonds and unsecuritized real estate. Over the entire sample period, large cap stocks account for the greatest proportion of REIT market (NAREIT index) volatility, followed by small cap stocks and then bonds. Unsecuritized real estate accounts for a negligible proportion of volatility. However, sub-period analysis reveals a maturation process. The large cap stock factor declines dramatically in importance in the late 1980s. Concurrently, a significant small cap stock factor begins to be observed. During the 1990s, a significant real estate factor also emerges. There is also a substantial increase over time in idiosyncratic volatility in the REIT index, unexplained by any of the other factors. When we apply our variance decomposition to REIT portfolio returns, formed on the basis on REIT size (market capitalization), we find that small cap REITs have a significant small cap stock factor but are also are ''more like real estate'', as compared to larger cap REITs, at least over the 1993–1998 growth period. We argue that this could be a result of the institutionalization of the ownership of larger cap REITs that took place in the 1990s.

Overall, the results are consistent with the returns to securitized real estate gradually beginning to reflect the nature of the underlying, unsecuritized assets. It is also consistent with information gathering and dissemination of information on REITs becoming more widespread over time as their returns become less dependent on major stock indices and more akin to real estate and sector effects. However, along with these structural changes there is also evidence of cyclical changes to the nature of REIT returns. These transitory changes may reflect both the stage of the market cycle as well as effects due to ownership structure.

Appendix: Measuring the returns to unsecuritized real estate by property type

The TVI index is available only for aggregate or total returns, and not for property-type sub-indices. To estimate the models of REIT property type portfolio returns we use an alternative approach to unsmoothing appraisal-based returns, based on Fisher et al. (1994). The starting point is to first purge the reported appraisal-based returns of autocorrelation

caused by temporal aggregation and the seasonality of reappraisals, by regressing current NCREIF appraisal-based returns (ar) on NCREIF returns lagged one and four quarters, as follows:

$$ar_t = \alpha_1 ar_{t-1} + \alpha_4 ar_{t-4} + x_t. \tag{A1}$$

The estimated ''true'' property returns (r) are contained in the residuals, x, from the above regression. Specifically,

$$x_t = (\alpha)(r_t), \tag{A2}$$

where r_t represents the ''true'' or unsmoothed returns and α is a scaling factor required to extract the true series from the residuals. One widely utilized approach to estimating α is to employ a volatility condition. For instance, from (A1) it is straightforward to show that the scaling factor $\alpha = \sigma_x/\sigma_r$, where σ_x and σ_r are the standard deviations of the residuals and the ''true'' returns, respectively. Unfortunately, the true volatility of unsecuritized income-property returns is unobservable. Previous research generally relies on making an assumption about this value, for instance assuming that the true standard deviation of unsecuritized returns lies directly in between the actual standard deviation of bonds and stocks, or that it is exactly half that of the S&P 500. In our case, this would be problematic because imposing a condition on the volatility of real estate returns relative to stock and bond returns could directly impact our end results on partitioning the volatility of REIT returns between these factors. This is especially true given that any assumption made would be ad hoc by nature.

An alternative approach that we adopt, however, is to work in terms of the logarithm of ''gross'' returns, or (1 + returns), rather then returns themselves when estimating the asset return regressions and variance decompositions. That is, we redefine the relationship between the AR(1,4) residuals and ''true'' returns in equation (A2) as $(1 + x_t) = (1 + \gamma)(1 + r_t)$.[20] Taking natural logs of both sides yields $\ln(1 + x_t) = \ln(1 + \gamma) + \ln(1 + r_t)$. This formulation separates out the ''true'' return and the residual scaling factor in an additive fashion. This means we can use the log transformed residuals (plus one) from the $\mathrm{AR}(1, 4)$ regression as our proxy for unsecuritized real estate in the return regressions without having to specify a volatility condition for true real estate returns, since the scaling factor will be subsumed in the constant term in the REIT return regressions. This is the approach we take in the property-type regressions in the paper. To implement this we simply use a $\ln(1 + x)$ transformation on all variables in equation (1). We repeat this for each property type series. In deriving the unsmoothed real estate return series we use all the NCREIF data available, back to 1978 for most property types, and then employ the resulting unsmoothed values over the 1993–1998 time frame in the REIT return regressions.

Acknowledgments

We are grateful to the two referees whose comments and suggestions significantly improved the paper. We also thank Ron Kaiser, Michael Giliberto, Glenn Mueller, Andy

Naranjo and Tim Riddiough for helpful comments on earlier drafts. Financial support from the Real Estate Research Institute (Clayton and MacKinnon) and a Saint Mary's University Senate Research Grant (MacKinnon) is gratefully acknowledged.

Notes

1. Corgel et al. (1995) review this literature.
2. Giliberto (1993) and Mei and Lee (1994) provide additional support for the presence of a real estate factor in REIT returns.
3. Our approach can be viewed as an extension of Giliberto (1990), in which we more formally incorporate unsecuritized real estate returns as a factor in REIT pricing. Giliberto's focus was on the correlation of REIT and real estate returns after purging each of stock and bond influences. We extend the analysis to calibrate the importance of real estate relative to financial market influences in REIT pricing, and explore how this varies over time and systematically across REIT property-type and size-based portfolios.
4. In our estimation we allow for time-variation in the coefficients.
5. In essence we are employing a factor analysis procedure to generate independent regressors as is sometimes done to eliminate multicollinearity problems in linear regression analysis. We assume that the return to REITs at time t is a function of the return to unsecuritized real estate, the return to the stock market and the return to bonds, but it is only the portion of each factor that is orthogonal to the others that ultimately affects REIT returns. This approach may suffer from two potential econometric problems: ''overpurging'' of information common to the variables being orthogonalized and spurious statistical significance of coefficient estimates on generated regressors. We address both of these issues at the end of this section.
6. We are grateful to one of the referees for providing significant guidance on this point.
7. Another potential concern in using the NCREIF index is that prior to the 1990s the property-type composition in it differed significantly from that in the NAREIT index. The NCREIF index was weighted more to office property while the NAREIT index was weighted more to retail. We do not believe this is a serious problem since our aim is to determine if index (portfolio) level REIT returns in part reflect a ''real estate factor''. All indices of real estate returns derived from multi-property portfolios diversified to some extent by property type and economic region should share a common real estate factor, despite the composition differences. We do, however, employ property type specific NCREIF return series in our analysis with REIT property type portfolios.
8. A number of previous studies that examine the relationship between REIT and NCREIF returns, including Seck (1996) and Seiler et al. (2001), fail to consider deficiencies of the NCREIF index of this type. For a comprehensive overview of problems with appraisal-based real estate return indices and the methods that have been developed to ''undo'' the problems, including the TVI see Chapter 25, ''Data Challenges in Measuring Real Estate Periodic Returns,'' in Geltner and Miller (2001).
9. See Fisher and Geltner (2000) for additional details on the process they use to de-lag the NCREIF index and generate the TVI.
10. Fisher and Geltner (2000) develop the TVI index as a capital value return index, not a total return index. The TVI we employ in this paper is a total return index provided to us by David Geltner. To move from TVI capital returns to total returns he used NOI values derived the raw NCREIF income returns and combined these with the TVI values index.
11. Our results are similar to those found by industry researchers at Prudential Real Estate. McIntosh and Liang (1998) report that prior to 1992, public market factors (small, mid and large cap stocks, and bonds) capture about 70 percent of the variation in REIT returns, but these same factors only explain about 20 percent of REIT performance over the 1992–1997 period. They argue that the most logical candidate for explaining the remaining 80 percent is the real estate market itself. Our findings do not fully support this notion.
12. To investigate the potential for spurious significance of the generated (orthogonalized) regressors we also estimated the factor sensitivities using the raw or actual returns for right-hand side variables (i.e., without

orthogonalization), except for Russell 2000 returns for which we used the residuals from a regression of Russell 2000 returns on S&P 500 returns, given the high degree of collinearity between the two stock return series ($\rho = 0.89$). The relative magnitudes of the parameter estimates, as well as their associated significance levels, are largely consistent with what we found using the orthogonalized regressors. This suggests that we do not have a serious spurious significance problem.

13. The decrease in the coefficients on the S&P factor and the corresponding drop in the proportion of REIT volatility explained by the large cap stock factor over the 1979–1984 to 1985–1991 period is consistent with the evidence of declining REIT betas over the 1970–1989 period in Khoo et al. (1993). Our estimation results show that the pattern of declining stock market betas exists even after accounting for bond and real estate market factors. Moreover, our 1992–1998 results indicate that stock market betas appear to have continued to decline.
14. Malkiel and Xu (1999) report a significant positive relationship between the level of institutional ownership and idiosyncratic volatility of individual stocks, over the 1989–1996 period. They also find that institutional ownership Granger-causes volatility, but not the other way around.
15. Wall Street was heavily involved in the recent REIT boom and now pays greater attention to the sector. REITs were one of the top five industries in terms of capital raised on Wall Street each year over the 1992–1997 period (Kaiser, 1999). In the late 1980s only 20 percent of REITs had any analyst following whatsoever (Wang et al., 1995). Today, almost all REITs are followed by at least three analysts, with many of the large firms followed by more than 10 (source: SNL REIT Datasource).
16. The term ''herding'' is often associated with investor irrationality, but that is not necessarily the case. More generally, herding refers to an investor group trading in the same direction at the same time. Herding behavior can be the result of rational informational-based trading or alternatively irrational feedback or fad trading (see Nofsinger and Sias, 1999; and Bikhchandani and Sharma, 2000).
17. Consistent with this notion, Ling and Naranjo (1999) report that REITs became significantly more integrated with the general stock market during the 1990s, where integration is defined in terms of common pricing of macroeconomic risk factors in both REIT and common stock markets.
18. Institutional ownership is nearly 60 percent for REITs in the top market cap quartile, but only 36 percent for the bottom (4th) quartile (source: The SNL REIT Quarterly).
19. The TVI version of the NCREIF index is not available at the property type level. As a result we use an alternative approach, based on the work of Fisher et al. (1994) to unsmooth the NCREIF property-type specific return series. Details are presented in the appendix.
20. Working in terms of gross returns (adding one) does not affect the relationship between the residuals and true returns from our perspective since we are only interested in the variances of these quantities residuals. When working with $\ln(1 + \text{returns})$ we have $\sigma_x = (1 + \gamma)\sigma_r$, which implies, $\gamma = \sigma_x/\sigma_r - 1 = \alpha$.

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