The Time-Varying Nature of the Link between REIT, Real Estate and Financial Asset Returns

Executive Summary. *This study examines the sensitivity of equity real estate investment trust (REIT) returns to returns on other asset classes, including real estate, using an estimation method that explicitly allows for variation over time in the sensitivities. The results show that the relationship between REIT returns and returns to bonds, small cap stocks, large cap stocks and unsecuritized real estate has changed over time. During the 1990s, REITs began to exhibit a direct link to real estate returns, indicating that REITs do provide portfolios with some exposure to the real estate asset class. The strength of this link, however, is cyclical in nature. The sensitivity of REIT returns to large cap stocks has declined through time. REIT returns exhibit a sensitivity to small cap returns that has a strong cyclical component, with the two becoming more closely linked in REIT market downturns.*

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Introduction

The relationship between the performance of unsecuritized and securitized property investment vehicles has intrigued both academics and practitioners for some time.[1] Understanding the link(s) between the two markets has become increasingly important in recent years, as institutional investors have looked to the public markets (real estate investment trusts or REITs) for a more liquid way to gain exposure to the real estate asset class.[2] During the REIT market "boom" over the 1993–1997 period, it was claimed by many market commentators that the dramatic growth and maturation of the REIT sector was making REITs more like real estate and less like stock.[3] REIT share prices, it was suggested, more accurately reflected property market fundamentals, given the wider analyst following and increased sophistication of the investors (institutional versus retail). Essentially, this line of reasoning suggests that the REIT sector went (and continues to go) through a maturation process in which the information available about REITs has become better and more widely distributed. This has resulted from increased investor interest in REITs (especially from institutional investors) and the concomitant increase in analyst following. With better information about REITs available, REIT returns can begin to better reflect their "true" nature and therefore have a stronger relationship to unsecuritized real estate returns. The idea that the REIT market has matured informationally, in this sense, is consistent with evidence presented in Clayton and MacKinnon (2000) who report structural changes in

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the nature of REIT returns. It is also consistent with Khoo, Hartzell and Hoesli (1993) who find that equity REIT betas underwent a structural change in the 1980s, with REIT betas (with respect to the overall equity market) decreasing. They argue that this is related to the changing information environment for REITs.

This study aims to provide additional evidence on and new insights about the changing dynamic of the relationship between REIT performance and returns to direct property investment and financial (stock and bond) markets. Specifically, it examines the sensitivities of REIT returns to returns on four broad asset classes (bond, large cap stock, small cap stock and real estate) over the 1978–1998 period, and evaluates whether these sensitivities of REIT returns vary over time. A simple multi-factor return model is employed in which REIT returns are regressed on stock, bond and real estate returns.

The approach taken in this study is similar to those followed by Liang, McIntosh and Webb (1995) and Goldstein and Nelling (1999) in their investigations of the links between REIT and financial asset returns. Liang, McIntosh and Webb use a two-index (large cap stocks and bonds) model of the return generating process for REITs to investigate the stability of stock and bond sensitivities (betas) over the 1973–1989 sample period. They find evidence of a structural break in the return generating process for equity REITs in the 1983–1984 period and also report that the stock market beta decreases following this shift. More recently, Goldstein and Nelling use a multi-factor approach to examine differences in REIT performance during bull and bear stock markets. They find that equity REIT betas are higher in bear stock markets than in up markets. Together these two studies provide evidence that the sensitivity of equity REIT returns to financial asset returns varies over time, possibly due to both structural and cyclical influences.

This study differentiates itself from, and hence adds to, the previous literature in a number of ways. The study by Liang, McIntosh and Webb (1995) extends only to 1989 and hence does not include the 1990s as this study does. The focus in Goldstein and Nelling (1999) is an evaluation of the ability of REITs to "hedge" against general market declines, whereas this study is a broader based investigation of the link between REITs and the four asset classes. Further, these studies only examine the sensitivity of REIT returns to financial asset returns. To directly evaluate the claim that REITs are now more highly linked with direct property markets, this study includes unsecuritized real estate returns as one of the factors in the REIT return regression. Specifically, a new series of unsecuritized real estate returns developed in Fisher and Geltner (2000) is utilized. In addition, to investigate the sensitivity of REIT returns to real estate and financial market factors, an econometric methodology (flexible least squares) is employed, which allows direct observation of how the relationships between REITs and the other markets change over time.

The nature of the relationship between REITs and the bond, stock and real estate markets is important both to our understanding of the nature of REITs as well as to practicing portfolio managers. In forming a portfolio that may include REITs, a portfolio manager must have an understanding of what exactly REITs are in an investment context. More specifically, in optimizing and evaluating portfolios, it is important to know how sensitive REIT returns are to returns on other asset classes because this determines the type and degree of risk exposure in the overall portfolio. If, as an example, REITs are highly sensitive to small cap stock returns, then the addition of REITs as a new part of the portfolio will increase the overall exposure to the small cap asset class. Also, if REITs are being used as a proxy for exposure to unsecuritized real estate it is obvious that the nature of the relationship between the two markets needs to be understood. Finally, if the relationship between REITs and the other broad asset classes changes over time (for either structural or cyclical reasons), then an understanding of the nature of these changes is important for portfolio updating and the control of risks under different market conditions. Hence, understanding the relationship between REITs and the other asset classes is crucial to forming an overall asset allocation that includes REITs.

The results show that over the entire 1978–1998 period, REIT returns exhibit the greatest sensitivity to small cap stocks, followed by bonds then large cap stocks. Unsecuritized real estate does not appear to play much of a role in driving REIT returns when the entire time period is used for estimation. However, when the sensitivity of REIT returns to each factor is allowed to vary over time, very different results emerge. First, the sensitivity of REITs to large cap stock returns has declined substantially over time. Second, while a statistically significant link between REIT and small cap stock returns is observed, there is a cyclical component to this relationship, as REIT returns appear to be much more sensitive to small cap stock returns when the REIT market is in a downturn, and less sensitive in REIT bull markets. Third, REIT returns exhibit an increasing sensitivity to real estate returns through time. This, along with the decreased importance of large cap stock returns to REITs, is consistent with the conjecture that the information environment surrounding REITs has matured as the sector has grown.

Methodology and Data

The methodology is based on a multi-factor model in which NAREIT (equity, excluding healthcare) returns, r_{REITt}, are described by the following return-generating process:

$$r_{REIT,t} = \alpha + \beta_{SP} r_{SPt} + \beta_{Russ} r_{Russt} + \beta_B r_{Bt} + \beta_{RE} r_{REt} + \varepsilon_t, \quad (1)$$

where r_{SPt} is the return to the S&P 500 large cap stock index, r_{Russt} is the return to the Russell 2000 small cap index, r_{Bt} is the return to the Lehman Brothers long-term government and corporate bond index, and r_{REt} is the return to unsecuritized real estate (an "unsmoothed" or delagged version of the NCREIF total return index, to be discussed below), in period t. Stock returns derived from both the S&P 500 and the Russell 2000 return indices are included to investigate the potential influences of large and small cap stock returns, respectively, on REIT returns. Equation (1) is estimated with quarterly data over the 1978–1998 period, since the NCREIF and Russell 2000 indices are available from 1978 onwards and the NCREIF index is quarterly.

Prior to estimation, it is important to consider the potential for multicollinearity among the stock, bond and real estate return series. Since all the asset class returns share, to some extent, common underlying state variables or macroeconomic drivers (e.g. interest rates, term structure, GDP, consumption), it is possible that there may be a high degree of correlation (linear dependence) among two or more of the explanatory variables in Equation (1). Linear dependence between any of the explanatory variables included in a regression equation implies that there is redundant information. In this situation, it is difficult for standard linear regression (OLS) to accurately determine the separate roles of the individual variables. That is, multicollinearity generally prevents precise estimation of the impact of individual regressors and limits the accuracy of statistical inference associated with the coefficient estimates.

To explore the possibility of multicollinearity we first examine the correlations among the bond, large cap stock, small cap stock and real estate returns, shown in Exhibit 1. The most obvious, and not surprising, result is the very high correlation between the Russell 2000 small cap index and the S&P 500. This makes inclusion of both variables directly in the regression problematic. Because of this, in the regressions, the Russell 2000 returns themselves are not used, but the residuals of a regression of Russell 2000 returns on S&P 500 returns is. This provides a "pure" small cap factor, independent of the broader market. The correlations between the other asset class returns are not particularly large. As a final means to investigate

Exhibit 1

Correlations Among Returns to the S&P 500, Russell 2000, Lehman Brothers Bond and Transaction Value Version of the NCREIF Property Index

	S&P 500	Russell 2000	Bond Index	TVI
S&P 500	1.00			
Russell 2000	0.88	1.00		
Bond Index	0.30	0.22	1.00	
Real Estate (TVI)	0.01	0.02	−0.34	1.00

Note: Quarterly data, 1979–1998.

possible multicollinearity, four regressions in which each explanatory variable was regressed on the other three were run to check for more complicated relationships between the variables. The R^2s from these regressions are of interest because they indicate the degree of collinearity between the right hand side variables. The resulting R^2s (after orthogonalization of the Russell with respect to the S&P 500) range from .06 to .21. It would appear from the low R^2s that there is little need to worry about the effects of multicollinearity.

Standard linear regression assumes that the coefficients are constant over time. As noted, a number of studies have reported that the sensitivities of REIT returns to financial asset returns vary over time. To examine the time-varying nature of REIT return sensitivities, a version of Equation (1) is estimated using the flexible least squares (FLS) method of Tesfatsion and Veitch (1990). This approach allows the coefficient estimates on the returns to each asset class to vary over time. FLS is a generalization of ordinary least squares (OLS). Details of the methodology are provided in the appendix.

Returns to Unsecuritized Real Estate

An important contribution of this study is the inclusion of unsecuritized real estate returns as one of the explanatory variables in the REIT return regression, Equation (1). This requires a time series of income-property returns. The most widely known institutional benchmark is the NCREIF index. 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, 2000:8].[4] Given its limitations, this study does not employ the raw NCREIF index itself, but an "unsmoothed" or "de-lagged" version of it.[5] Specifically, the Transaction Value Index (TVI) recently introduced by Fisher and Geltner (2000) is employed.[6]

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. Hence, not all properties in the index are seriously appraised every quarter. As noted by Fisher, Geltner and Webb (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 Goetzmann (2000) devise what they call 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 appraisals 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.[7] Combining the RMR version of the index, the model of appraiser behavior and the three quarter lag, the authors are able to back out (what they call "reverse-engineer") the TVI index of property returns.[8]

Empirical Results

Exhibit 2 reports the summary statistics for each of the quarterly return series. Exhibit 3 reports the correlations of S&P 500, Russell 2000, Lehman Bond and TVI Real Estate returns with equity

Exhibit 2
Summary Statistics

	Full Sample		Subperiods					
	1979–1998		1979–1984		1985–1991		1992–1998	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
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

Notes: Data for NAREIT, S&P 500, Russell 2000, Lehman Bothers Bond and Transaction Value version of the NCREIF Property Index Return Series. Quarterly data for 1979–1998 and subperiods. Mean and standard deviation of return series (%).

Exhibit 3
Correlation of Each Return Series with NAREIT Returns

	Full Sample	Subperiods		
	1979–1998	1979–1984	1985–1991	1992–1998
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

Notes: Data for NAREIT, S&P 500, Russell 2000, Lehman Bothers Bond and Transaction Value version of the NCREIF Property Index Return Series. Quarterly data for 1979–1998 and subperiods.
*Correlation is statistically significant at the 5% significance level.
**Correlation is statistically significant at the 10% significance level.

NAREIT returns over the entire 1978–1998 sample period as well as over three seven-year subperiods. The subperiods correspond with the timing of structural change reported in previous studies. Liang, McIntosh and Webb (1995), using a two-factor (stocks and bonds) model of equity REIT returns, provide evidence of a structural shift around 1983/1984. Glascock, Lu and So (2000) report that the relationship between REIT and financial asset returns changed in the early 1990s. Looking at the full sample mean returns and standard deviations, there are no real surprises in terms of relative magnitudes. The subperiod statistics reveal considerable variation over time in mean returns and volatility, and show 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 are consistent with claims made by many 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, Winograd and McIntosh, 1997).

Exhibit 4 presents estimation results for the REIT return regression in Equation (1). Two sets of results are presented. First, for the entire time

Exhibit 4

Regressions of Equity REIT Returns on Stock, Bond and Unsecuritized Property Returns

Period:		S&P 500	Russell 2000	Bonds	Real Estate (TVI)	Constant
1979–1998		0.470	0.603	0.752	0.101	−1.059
		(6.61)	(6.28)	(5.28)	(1.31)	(1.57)
R^2	0.65					
Adj. R^2	0.63					
1992–1998		0.242	0.417	0.938	1.54	−3.21
		(1.32)	(2.02)	(2.16)	(1.94)	(1.44)
R^2	0.37					
Adj. R^2	0.27					

Notes: Quarterly data for 1979–1998.

$$r_{REITt} = \alpha + \beta_{SP} r_{SPt} + \beta_{Russ} r_{Russt} + \beta_B r_{Bt} + \beta_{RE} r_{REt} + \varepsilon_t,$$

where r_{SP} is the return on the S&P 500, r_{Russ} is the component of the return on the Russell 2000 small cap stock index that is independent of the return to the S&P 500 (*i.e.,* it is the residual from a regression of Russell 2000 returns on S&P 500 returns), r_{bonds} is the return on the Lehman Bond Index, and r_{RE} is the return to the Fisher/Geltner Transaction Value Index (TVI) of property returns. *t*-Statistics (absolute value) are shown parentheses. For 1979–1998, $N = 80$. For 1992–1998, $N = 28$.

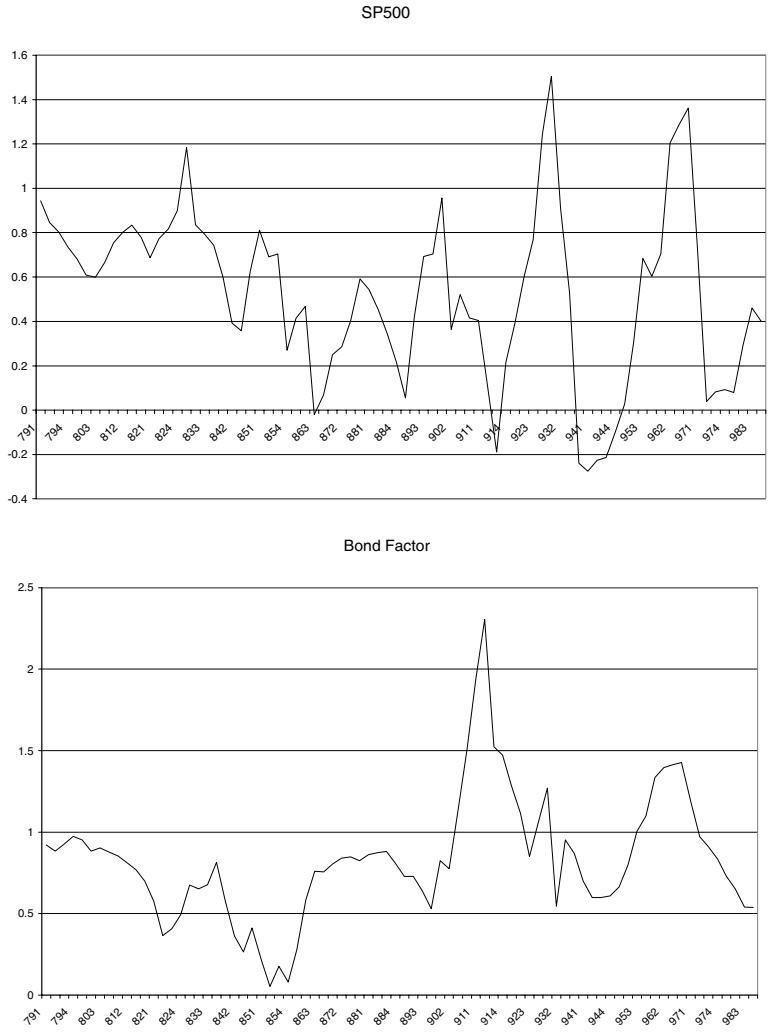
period (assuming constant sensitivities over the period), and then for 1992–1998 period, as a means to examine whether the factor sensitivities changed in the 1990s. REIT returns over the 1979–1998 period appear to have a very small and statistically insignificant sensitivity to direct real estate returns. The coefficients on the other three asset class returns are all significantly positive with REITs being the most sensitive to bond returns, followed by small cap stocks and then large caps. Together, the four asset class returns explain 65% of the variation in equity REIT returns. Looking at the 1992–1998 results reveals the apparent emergence of a real estate factor in REIT pricing, and a weakening of the link between NAREIT returns and stock returns, as both stock factor sensitivities decrease in magnitude and significance. The explanatory power of the asset class returns decreases substantially from 65% to 38%. Hence, even though REIT returns are more sensitive to direct real estate returns, together the financial and real estate return series fail to account for nearly 65% of the variation in REIT returns in this period.[9]

Time Variation in Factor Sensitivities

The time variation in the factor sensitivities indicates that the full sample estimation is misspecified.[10] To examine time-variation in the relationship between REIT, financial asset and direct real estate returns, a time-varying regression technique called flexible least squares (FLS) is employed. FLS is similar to ordinary least squares but relaxes the assumption that the parameters are constant or time invariant and allows the coefficient estimates in the model to evolve over time. The FLS method is primarily a descriptive tool that provides information on the timing of parameter value shifts and also on the relative variability of the coefficients in a regression model. It provides a convenient way to examine the potential for systematic time-variation in the parameter estimates. It is a useful complement to the more traditional Chow and CUSUM structural change tests, as it is quite powerful in detecting turning points in parameter value changes.[11] Details on the estimation technique are provided in the Appendix.

Exhibit 5 plots the estimated FLS coefficient estimates on the stock, bond and real estate factors in the REIT return regression. The results provide evidence of substantial variability in the parameter estimates, especially since the "REIT boom" of the early 1990s. For example, the coefficients on both the bond and the S&P 500 factors exhibit increased variability starting in 1992. Most noteworthy, the coefficient estimate on the unsecuritized real estate factor hovered around zero until 1992, after which it exhibited a significant increase at

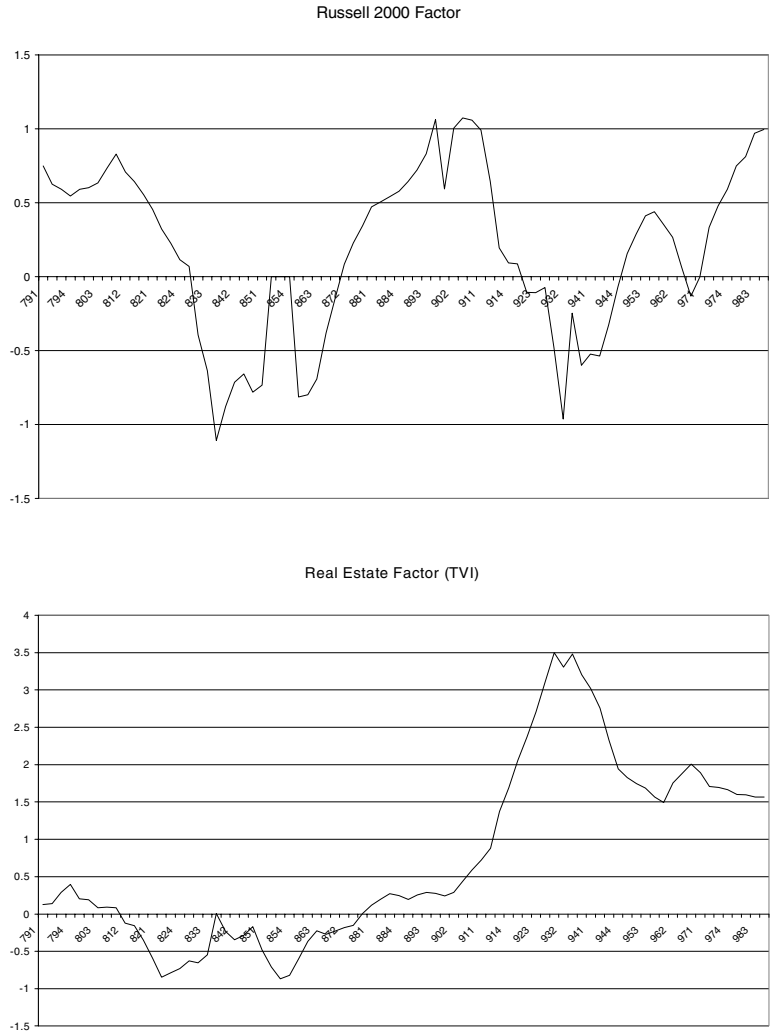
Exhibit 5
Time Paths of Flexible Least Squares Coefficients in the REIT Return Regression



the same time the bond and S&P 500 coefficients increase in volatility. The parameter values on the small cap factor displays fairly consistent cyclical variation throughout the sample period. With the exception of the S&P 500 coefficient, the other three seem to indicate a potential structural break in the REIT return process in late 1986 in addition to 1993.[12] The cyclical variations in factor sensitivities (the coefficient estimates) in Exhibit 5 raise the possibility that there are both cyclical (market related) and structural (permanent) changes underlying the changing dynamics in the relationship between REIT returns and those to the other asset classes.

To investigate the impact of cyclical (market) effects on time-variation in the coefficients, one can examine the relationship between the FLS parameter variation and the state of the REIT market. This will help determine if there is systematic relationship between REIT returns and the importance of the stock, bond and real estate factors in explaining them. Exhibits 6 and 7 compare annual NAREIT equity returns with the FLS parameter estimates on the small cap and real estate factors, respectively. While there does not appear to be a consistent systematic relationship between REIT returns and the Russell 2000 coefficient, there is a tendency for REIT returns to become increasingly

Exhibit 5 (continued)
Time Paths of Flexible Least Squares Coefficients in the REIT Return Regression



responsive to small cap returns in market downturns, and less responsive in market upswings. This suggests that to some extent, REITs become detached from small caps during rising markets and are more aligned with small cap stocks in bad times. This is consistent with Goldstein and Nelling (1999) who find that equity REITs are more closely aligned with the general stock market (have higher betas) when it is falling than when it is rising. That is, REITs have relatively lower betas in bull stock markets.[13] Chatrath, Liang and McIntosh (2000) refer to this phenomenon as the "asymmetric-REIT-beta-puzzle."[14]

It is noteworthy that this study reaches essentially the same conclusion as Goldstein and Nelling (1999) regarding the cyclical nature of the REIT-general stock market dynamic yet employs quite different approaches. Specifically, they look at REIT stock betas over pre-defined up and down stock markets (*i.e.*, periods chosen ex post), whereas this study employs a time-varying parameter econometric technique that lets the data do the talking, yet the outcomes are essentially the same.

The relationship between NAREIT returns and the FLS parameter estimate on the real estate factor in Exhibit 7 clearly shows a structural shift, beginning in late 1992. Prior to this point, the two series are essentially uncorrelated. Starting in 1991, the two series are positively correlated, which would

Exhibit 6
Time Path of Flexible Least Squares Coefficient on Russell 2000 Returns vs. Annual Equity NAREIT Returns

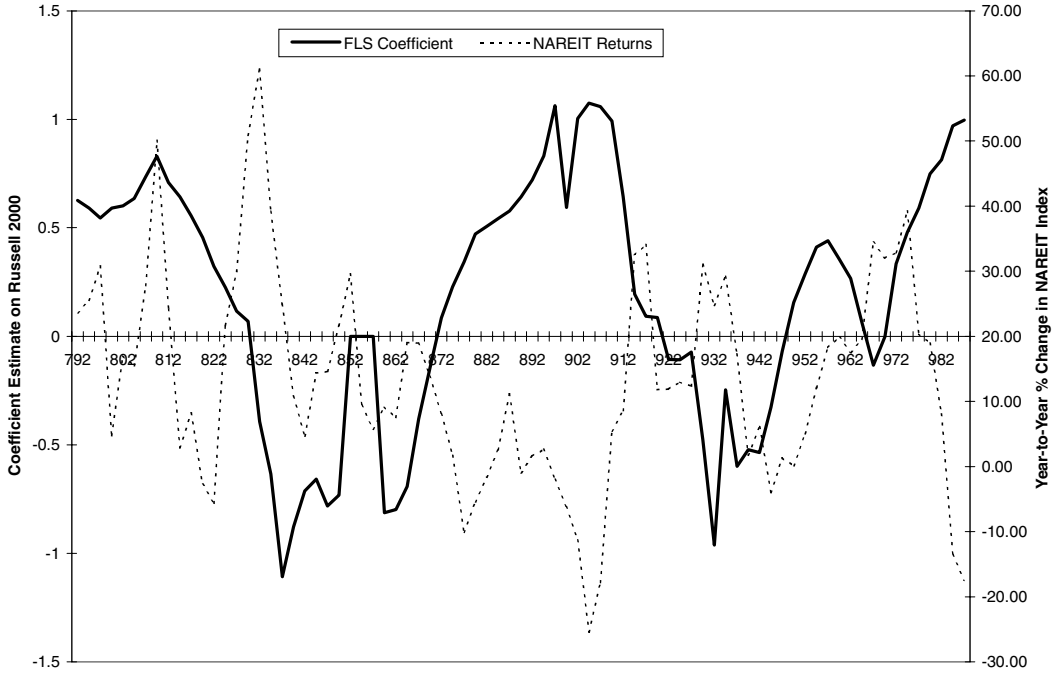
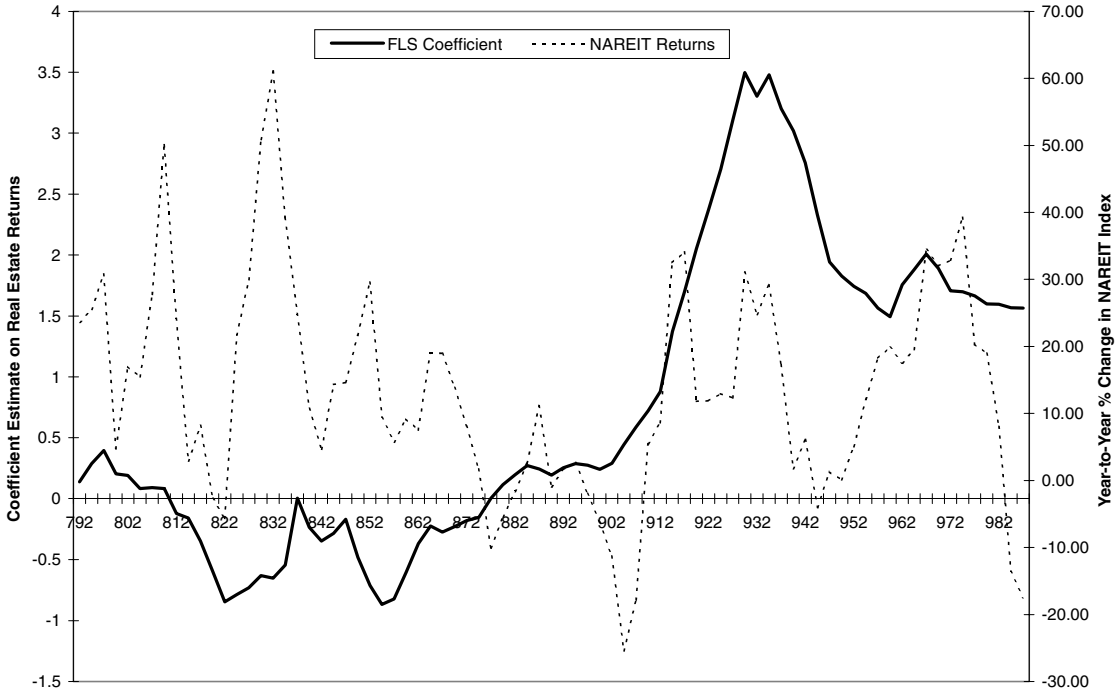


Exhibit 7
Time Path of Flexible Least Squares Coefficient on Unsecuritized Real Estate Returns vs. Annual Equity NAREIT Returns



seem to provide further evidence that REIT returns are more closely aligned with the performance of the underlying real estate. The relationship is not perfect, however, as the two series begin to diverge significantly once the REIT market turns down in early 1998. Again, the evidence is consistent with a structural shift in REIT pricing. However, one must be careful not to overstate the extent of it because part of the changing dynamics of the link between REITs, real estate and financial assets is due to normal cyclical considerations.

Conclusion

A multi-factor return generating approach was used to empirically investigate the sensitivity of NAREIT returns to large and small cap stock returns, bond returns and returns to unsecuritized real estate. The results show that, over the entire 1978–1998 sample period, REIT returns exhibited the greatest sensitivity to bonds and stocks (both small and large cap). After accounting for these public market factors, there was no role for unsecuritized real estate in explaining REIT returns. However, analysis of REIT sensitivities over time reveals a maturation process. The sensitivity of REIT returns to large cap stock returns declines substantially over time, and importantly, a significant positive relationship between real estate and REIT returns is observed in the 1990s.

The results also reveal that the time-varying nature of the link between REIT, real estate and financial asset returns has both structural and cyclical components. There are indications of a structural change in the parameters (factor sensitivities) of the REIT return generating process after 1992, the so-called new REIT era. The evidence also suggests that the coefficient estimates vary systematically with the stage of the REIT and general stock market cycles; there is a cyclical component to the factor sensitivities.

The results of this study have important practical implications for institutional investors interested in REITs either as an asset class in themselves, or as a substitute for unsecuritized real estate in a mixed-asset portfolio. The findings are consistent with the notion that due to growth and maturation in the REIT market since 1992, REITs are now more highly integrated with the unsecuritized property market. Hence, investors do appear to gain some exposure to the real estate asset class by investing in REITs, even over the short-term. However, this link does not appear to be as strong as some market participants claimed during the height of the REIT boom, as some of what was perceived to be structural is in fact partly cyclical. In addition, REITs remain linked with small cap stock factors and the strength of this relationship is also subject to cyclical fluctuations. The cyclical nature of REIT sensitivities implies that portfolio managers must be vigilant in monitoring the proportion of REITs within a portfolio because the nature of the portfolio risks will change over time.

Appendix

Flexible Least Squares

This section provides additional details on the flexible least squares (FLS) estimation method employed to derive the time-varying coefficient estimates (factor sensitivities) in the REIT return regression. The flexible least squares method developed by Kalaba and Tesfatsion (1989) is a generalization of ordinary least squares that permits coefficients in a linear regression to vary over time.[15]

Too illustrate how the FLS estimation method works, consider the general linear regression model with time-varying coefficients that can be written in the form $y_t = x_t\beta_t + w_t$ where x_t is a vector of period t observations on the explanatory variables and β_t is the vector of associated period t coefficient estimates. In contrast to ordinary least squares (OLS) estimation, that assumes the elements of β_t are time invariant, FLS allows the coefficients to evolve change or evolve over time. FLS is based on minimizing the sum of two types of error. The first source of error is the usual regression errors, or the difference between the dependent variable and predicted value at each point in time, except that now the coefficients are not necessarily fixed through time. The second source of error is the variation through time in the estimated coefficient estimates. More formally, FLS

estimation yields the time path of coefficient estimates that minimizes the "loss" or "incompatibility" function given by:

$$\sum_{t=1}^{T} (y_t - x_t\beta_t)^2 + \lambda \sum_{t=1}^{T-1} (\beta_{t+1} - \beta_t)'(\beta_{t+1} - \beta_t).$$

The first term is the sum of squared residuals (difference between the actual and fitted values, or *measurement errors*). The second term is the sum of squared *dynamic errors*, where the dynamic error at each point in time is the difference between successive coefficient estimates. The FLS technique involves determining the sequence of coefficient estimates that minimize the weighted sums of squared measurement and dynamic errors. λ is a "smoothness" weight that penalizes coefficient variation, and is supplied by the user. In the limit, FLS becomes OLS if $\lambda = 1$. Clearly, the value assumed for λ in the estimation impacts on the coefficient variation. Following Tesfatsion and Veitch (1990), the FLS parameter estimates shown in Exhibit 5 of the present study weight the two sources of error equally (*i.e.*, use a weight of 0.5).

Endnotes

1. Studies that investigate the relationship between REIT and unsecuritized property returns include Giliberto (1990, 1993), Barkham and Geltner (1995) and Geltner and Rodriguez (1998).
2. Lieblich and Pagliari (1997) provide evidence on the increased interest shown by institutional investors in REITs. Chan, Leung and Wang (1998) report that the proportion of REIT shares held by institutions more than doubled, from 14% to 30%, over the 1990–1995 period.
3. Ghosh, Miles and Sirmans (1996) and Ziering, Winograd and McIntosh (1997) report that the correlation between NAREIT index returns and NCREIF returns has increased in the post-boom period. See also McIntosh and Liang (1998).
4. Another potential concern in using the NCREIF index is that until the early 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, however, believe this creates serious problems for our macro level analysis. 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.
5. 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).
6. Only a brief overview of the rationale for the methodology employed by Fisher and Geltner is presented here. Fisher and Geltner (2000) detail the process they use to de-lag the NCREIF index and generate the TVI.
7. Clayton, Geltner and Hamilton (2000) provide empirical support for the partial adjustment of appraiser behavior at the individual property level using a database comprised of repeat appraisals of individual properties. They find that the average appraisal lag in their sample is three months, consistent with the transaction based approach employed by Fisher and Geltner (2000).
8. Fisher and Geltner (2000) develop the TVI index as a capital value return index, not a total return index. The TVI we employ 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.
9. Clayton and MacKinnon (2000) suggest that this unaccounted for volatility could be due to a REIT sector factor. As the information environment in which REITs trade changed as the market grew and attracted increased institutional investor interest, REIT share prices more accurately reflected the performance of REIT properties, yet were also characterized by higher idiosyncratic risk. Part of the explanation could also be due to the pricing of REITs as a growth stocks for a time in the mid 1990s.
10. CUSUM and CUSUMSQ recursive residual-based tests of structural change were used to examine the potential for structural breaks in the REIT return regression over the full 1979–1998 sample period and indicate a structural shift in late 1992/early 1993. Harvey (1990, Chapter 5) provides details on these tests. Liang, McIntosh and Webb (1995) present a detailed overview of these tests and use them to test for structural shifts in the relationship between REIT, stock and bond returns over the 1973–1989 period.
11. Traditional tests of structural change or parameter instability are generally global in nature in that they are based on the residuals of a model. Hence, they provide evidence of a shift in regime but do not identity the source of the instability. In contrast, FLS allows for systematic variation in each coefficient, which can help the researcher to identify the source of the shift.
12. Of the four series of FLS coefficient estimates, the time paths of the Russell 2000 small cap coefficient and the coefficient on the unsmoothed proxy for the real estate "factor" exhibit the most variability. The coefficient of variation (standard deviation divided by the mean) for the coefficients on the S&P 500, and the Russell 2000, Lehman Bond Return and unsmoothed NPI are 0.73, 3.92, 0.48 and 1.63, respectively. This would seem to be an interesting finding given that, for a number of years, academics and practitioners alike viewed the majority of REITs as essentially small cap operating companies with some small component of real estate.
13. On the other hand, our results somewhat contradict those reported by Glascock, Lu and So (2000) who conclude that

REITs are more integrated with stocks and less with bonds after the early 1990s. These authors, however, base their conclusion on changes in bivariate cointegrating relationships among REITs, stocks and bonds after 1992.

14. Kaiser (1999) suggests that this is a general phenomenon and that declining correlations between REIT and stock returns, which led to claims that post 1991 "new" REITs were less like stocks than "old" REITs, were simply picking up this bull market phenomenon.
15. Tesfatsion and Veitch (1990) provide a detailed exposition of the FLS method and investigate the stability of coefficients in a money demand model. Lutkepohl (1993) provides an interesting application of flexible least squares to the study of instability in short-run money demand functions.

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