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Discovering REIT Price Discovery: A New Data Setting

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Abstract This study decomposes real estate investment trust (REIT) returns into two components: (1) real returns, and (2) public returns. The real returns are based on the changes in the private, appraisal-based net asset values of REITs, whereas the public returns are measured by the variations in REITs' premiums/discounts. This study then investigates the price discovery of REIT prices. The results indicate that lagged public returns are useful in predicting real returns. In addition, the study documents concurrent factor exposures for public returns and lagged factor exposures for private returns under a variety of asset pricing models. Overall, the results are consistent with the notion that public markets are more efficient in processing information.

Keywords REITs · Price discovery · Factor exposures · NAVs · Discounts/premiums

Introduction

One important research question in finance is whether public markets are useful in facilitating information flow. Because of its implications on market efficiency, pricing, and market design, this question has been extensively investigated in real estate literature by examining the lead-lag relationship between public real estate investment trust (REIT) returns and private National Council of Real Estate Investment Fiduciaries Index (NCREIF) returns. This popular approach has been plagued, however, by the implicit assumption of homogeneity in the price discovery process of the underlying properties of NCREIF and those of REITs. The purpose of this study is to recast this research question in a new data setting in which the usual assumption is not required.

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This study proposes a new data setting in which our analytical framework is based on the observation that, by definition, a REIT is an aggregation of two assets: (1) its net asset value (NAV), and (2) its associated premium/discount.[1] We then decompose monthly REIT returns into monthly real returns and monthly public returns, and investigate the lead-lag relationship between the two return components. The real return component is based on the variations in the private, appraisal-based NAVs, whereas the public return component is determined by the supply and demand of REIT shares in the public sector. Therefore, a lead-lag relationship between the two return components provides evidence of information flow between public markets and private markets.

In contrast, the existing approach for examining real estate price discovery has focused on the lead-lag relationship between REIT returns and NCREIF returns. We argue that this research design is inadequate for two reasons. First, REIT returns and NCREIF returns are based on two different sets of underlying properties. The existing framework implicitly assumes that the price discovery processes for NCREIF underlying properties and REIT underlying properties are homogeneous; thus, a lead-lag relationship between REIT returns and NCREIF returns implies information flow between public markets and private markets. However, there is evidence suggesting that the price discovery processes for NCREIF underlying properties and REIT underlying properties are likely to be heterogeneous. For instance, NCREIF underlying properties are mostly appraised annually. In contrast, the private (market) values of REIT underlying properties are constantly monitored by investors and reflected in REIT prices. Many independent advisors revise their estimates of NAVs for REITs and distribute these estimates to their institutional customers on a monthly basis. Therefore, any predictability between REIT returns and NCREIF returns can be simply a manifestation of a lead–lag relationship between the revisions for the market values of REIT underlying properties and those for the market values of NCREIF underlying properties. Second, the existing studies have been conducted using quarterly returns because NCREIF returns are available only at this frequency. As private and public real estate markets have become more institution-driven and competitive over time, this low-frequency data environment appears to be increasingly inadequate for addressing any lead–lag relationship between public and private real estate markets that may occur at higher frequencies.

This study shows that there is a one-way predictability from public returns to real returns in the proposed data setting. That is, lagged public returns are useful in predicting real returns, but not the other way around. The results suggest that price discovery first occurs in public markets, and then transmits to private markets. Furthermore, we show that, under a variety of asset pricing models, public returns and private returns have concurrent and lagged factor exposures, respectively. The results are consistent with the notion that public markets are more efficient in processing information.

[1] Empirical designs based on this observation are abundant in the closed-end fund literature (Bodurtha et al. 1995).

Literature Review

The literature on price discovery is ambiguous about whether commercial real estate price discovery should occur in public markets or private markets. A popular thought is that public markets are more liquid and thus more efficient in incorporating news into prices. This should be particularly true in the new REIT era because increasing institutional participation facilitates information flows in public markets (Bradrinath et al. 1995; Ziering et al. 1997). In contrast, price discovery may occur in private markets because trades in private markets tend to be larger and are usually conducted among sophisticated professional investors.

The existing studies produce mixed empirical results. Gyourko and Keim (1992) document a temporal lead in REIT returns relative to NCREIF returns. Barkham and Geltner (1995) use unsmoothed private real estate returns and correct for leverage in REIT returns. They find that price discovery occurs in public markets in both the USA and the UK. Fu and Ng (2001) and Kallberg et al. (2002) find that Asian private real estate markets are slow in reflecting news. On the other hand, Firstenberg et al. (1988) argue that appraisal-based real estate returns may influence REIT returns. Tuluca et al. (2000) conclude that, in a five-asset co-integration system, private markets lead public markets in information. However, in the authors' error-correction augmented vector auto-regression model, REIT prices are *negatively* influenced by lagged NCREIF returns (Tuluca et al. 2000). The result is at odds with the concept of price discovery that suggests a positive lead–lag price relationship between two markets.

Our study is also related to another strand of the real estate literature. Liu and Mei (1992) show that the real market, as proxied by the cap rate, can predict equity REIT returns. Mei and Lee (1994) find that the real estate premium found in Liu and Mei (1992) captures the systematic risk in the real estate market. Damodaran and Liu (1993) find that NAVs contain information, by showing that insiders buy (sell) after they receive favorable (unfavorable) appraisal news, and this is especially true for negative appraisals.

Data and Statistical Methods

Green Street Advisors Inc. provided us with monthly aggregate NAV and premium/discount to NAV data from January 1994 to November 2005. These aggregate observations are based on Green Street's coverage of REITs, which has expanded in line with the REIT market. By November 2005, there were about 80 REITs in the data. It is generally agreed that Green Street produces the most careful estimates of NAVs in the REIT industry (Clayton and Mackinnon 2003).

Beginning in 1994, Green Street released NAVs at the end of every month; prior to this date, Green Street revised NAVs quarterly. The NAV of a REIT is an estimate of the appraisal-based value of its shares. The returns on NAVs are widely viewed as the returns on real estate fundamentals (Gentry et al. 2004). Thus, in the spirit of Giliberto (1990), one can view these returns as *pure* real returns because they are derived from private appraisals of underlying real estate.

The returns on NAVs are real returns based on private appraisals. In contrast, REIT premium/discount is the difference between REIT share price and NAV, which simply reflects an accounting identity for relating REIT price to NAV. The variations in REIT premiums are determined by the supply and demand in the public sector. The returns on REIT premiums from January 1994 to November 2005 can be obtained by the following accounting identity: $R_{\text{prem}} = ((1 + R_{\text{REIT}})/(1 + R_{\text{NAV}})) - 1$, where R_{prem} is the return on premium, R_{REIT} is the return on the Green Street REIT Index, and R_{NAV} is the return on NAV. The Green Street REIT Index is constructed by using Green Street's NAV and premium/discount to NAV data. This leads to 143 monthly observations of Green Street REIT returns, NAV returns, and premium returns for our time series analyses. Because the returns on premiums are determined in the public sector, they can be viewed as *pure* public returns.

This study uses the Granger causality test to examine the lead–lag relationship between the returns on NAVs and the returns on premiums; i.e., real returns and public returns. The Granger causality test is widely used in the literature (Barkham and Geltner 1995; Kallberg et al. 2002; Tuluca et al. 2000). The strength of the Granger causality test lies in its ability to take the past value of private (public) returns into account when relating the past value of public (private) returns and the current value of private (public) returns.

Baseline Results

Figure 1 plots the growth of $1 invested in Green Street REITs, NAVs, and premiums during the January 1994–November 2005 sample period. It is evident that REIT prices and NAVs grow over time. These two series move fairly together, suggesting a mean-reverting process that binds REIT prices and NAVs in the long run. In contrast, premiums exhibit distinct behavior. This series does not appear to grow over time, suggesting the possibility that the level series of premiums is stationary.

Table 1 reports summary statistics of the returns on the Green Street REIT Index, NAVs, and premiums/discounts for the period January 1994–November 2005. As indicated, the average monthly return on the Green Street REIT Index during this period is 0.68%. The average monthly return on NAVs is 0.66%. It is not surprising that REITs and NAVs have similar returns because they move together in the long run, as shown in Fig. 1. The median return on REITs, 0.93%, is higher than that on NAVs, 0.48%. This suggests that REIT returns skew to the left, whereas NAV returns skew to the right. The stickiness of NAV returns on the downside is evident by the minimum return of -5.59%; the minimum return for REITs, on the other hand, is -14.02%. REITs and NAVs have similar maximum returns, 9.39 and 9.59%, respectively. It is quite surprising that the standard deviation of NAVs, 1.92%, is not far away from that of REITs, 3.69%. It is well known that the standard deviation of the NCREIF Index is much lower than that of the NAREIT Index. The average monthly return of premiums is 0.05%. This small value reflects the fact that premiums simply reflect an accounting identity for relating REITs to NAVs, and that REIT prices and NAVs move together in the long run. Premiums skew to the left, as suggested by a relatively large median, 0.44%. Although the mean value of premium

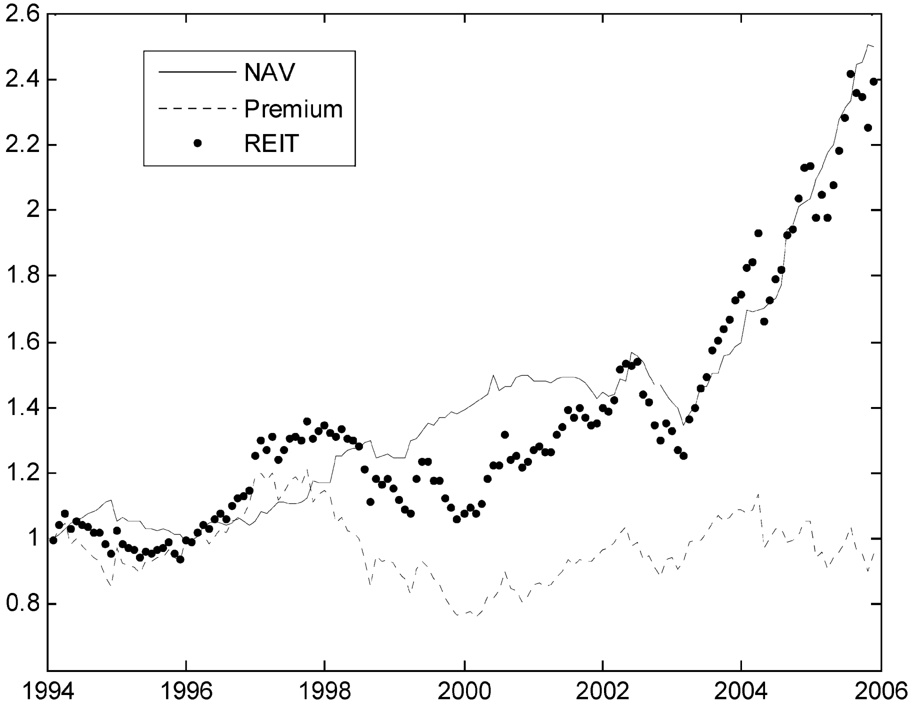

Fig. 1 The growth of $1 invested in Green Street REITs, NAVs and premiums, for the period January 1994–November 2005. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV

returns is practically zero, the maximum return and the minimum return on premiums are large in magnitude and are quite close to those on REITs. Similarly, the standard deviation of premium returns, 3.96%, is not far away from that of REIT returns, 3.69%. Overall, the distributional characteristics of public (premium) returns resemble those of REIT returns, except for the center of location.

The unit root test of Table 1 reports augmented Dickey-Fuller test results. The results show that the null hypothesis of a unit root cannot be rejected for REIT and NAV price levels. That is, REITs and NAVs appear to be non-stationary and contain a unit root. In contrast, premiums appear to be stationary and do not contain a unit root. The null hypothesis of a unit root for premiums is rejected at the conventional levels under a variety of specifications. The test results hold regardless of whether one or two lags are included in the specification. The maximum of two lags is used because the autocorrelation in the three return series decays quickly at the second lag.

Knowing whether both NAVs and premiums contain a unit root is important for testing the Granger causality. Tuluca et al. (2000) demonstrate that testing the lead-lag relationship is sensitive to whether the asset price system is co-integrated. By definition, a price system is co-integrated only if each price component contains the same number of unit root(s). Because the null hypothesis of a unit root in premiums is rejected, our lead-lag investigation can be conducted in a rather straightforward data setting; i.e., non-cointegrated environment. That is, we can directly use the Granger causality test on premium returns and NAV returns to study the lead–lag relationship

Table 1 Summary statistics of the returns on the Green Street REIT Index, net asset values (NAVs), and premiums/discounts for the period January 1994–November 2005

	REIT	NAV	Premium
Descriptive statistics (%)			
Mean	0.68	0.66	0.05
Median	0.93	0.48	0.44
Maximum	9.39	9.59	13.75
Minimum	−14.02	−5.59	−14.31
Standard deviation	3.69	1.92	3.96
Unit root test			
No deterministic part; lag = 1			
Test statistic	6.70	12.85	−5.07[a]
No deterministic part; lag = 2			
Test statistic	5.78	9.22	−5.59[a]
Constant; lag = 1			
Test statistic	0.51	4.35	−3.07[b]
Constant; lag = 2			
Test statistic	0.62	4.04	−2.82[c]

The numbers reported in descriptive statistics (%) are calculated using the monthly returns on the Green Street REIT Index, the monthly returns on NAVs, and the monthly returns on premiums/discounts. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. The augmented Dickey–Fuller test results in unit root test are based on price levels; that is, the index levels of REITs, NAVs, and premiums. The null hypothesis is that the price level contains a unit root

[a] Significant at the 1% level

[b] Significant at the 5% level

[c] Significant at the 10% level

between public and private real estate markets. Though not reported because of obvious redundancy, we also use the Engle and Granger (1987) test to examine whether NAVs and premiums are co-integrated. Consistent with the depiction in Fig. 1, the test results indicate that NAVs and premiums are not co-integrated.

Table 2 reports contemporaneous and lagged correlation coefficients between NAV returns and premium returns for the period January 1994–November 2005. The

Table 2 Contemporaneous and lagged correlation coefficients between NAV returns and premium returns for the sample period January 1994–November 2005

	NAV return	Premium return
Premium return	−0.3799	–
Lag (premium return)	0.1942	–
Lag^2 (premium return)	0.1011	–
Lag^3 (premium return)	0.0473	–
NAV return	–	−0.3799
Lag(NAV return)	–	0.0492
Lag^2 (NAV return)	–	0.0239
Lag^3 (NAV return)	–	−0.0828

Net asset value (*NAV*) returns are the monthly returns on the Green Street NAV Index. Premium returns are the monthly returns on Green Street premiums/discounts. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. Lag (.) denotes one-period lag; lag^2 (.) denotes two-period lag; lag^3 (.) denotes three-period lag contemporaneous correlation coefficient between NAV returns and premium returns is −0.3799. That is, when NAV returns are high (low), the concurrent premium returns are low (high). Given this negative concurrent correlation, it is particularly interesting to see a high correlation coefficient, 0.1942, between NAV returns and one-period lagged premium returns. This suggests return predictability from public returns to private returns. This lead–lag relationship seems to persist for two months, as suggested by the correlation coefficient, 0.1011, between NAV returns and two-period lagged premium returns. In contrast, there seems to be no return predictability from private returns to public returns. The correlation coefficient between premium returns and one-period lagged NAV returns is 0.0492. This lagged correlation turns to negative when three lags are used.

Table 3 reports time-series regression results. These specifications do not take the past values of the dependent variable into account. In dependent variable, NAV returns are regressed on past values of premium returns. Consistent with the results in Table 2, one-period and two-period lagged premium returns are useful in explaining contemporaneous NAV returns. The estimates for the two independent lagged variables are 0.1068 and 0.0725, respectively. The associated *t* statistics are 2.5923 and 1.7304, respectively. They are statistically significant at the 1% level and the 10% level, respectively. The adjusted R^2 value is 0.0605. In contrast, lagged NAV returns are not useful in explaining premium returns. None of the three lagged NAV return variables yield statistical significance. The adjusted R^2 value is only 0.0124.

Table 3 Time-series regressions for NAV returns and premium returns for the test period January 1994–November 2005

	Coefficient	*t* Statistic
Dependent variable = NAV return		
Intercept	0.0065	4.0729[a]
Lag (premium return)	0.1068	2.5923[a]
Lag^2 (premium return)	0.0725	1.7304[b]
Lag^3 (premium return)	0.0394	0.9496
Adj. R^2	0.0605	
Dependent variable = premium return		
Intercept	0.0002	0.0465
Lag (NAV return)	0.1420	0.7944
Lag^2 (NAV return)	0.0563	0.3203
Lag^3 (NAV return)	–0.2046	–1.1432
Adj. R^2	0.0124	

In dependent variable = NAV return, the dependent variable is the monthly net asset value (NAV) return. The independent variables include the one-period lagged premium return, the two-period lagged premium return, and the three-period lagged premium return. In dependent variable = premium return, the dependent variable is the monthly premium return. The independent variables include the one-period lagged NAV return, the two-period lagged NAV return, and the three-period lagged NAV return. NAV returns are the monthly returns on the Green Street NAV Index. Premium returns are the monthly returns on Green Street premiums/discounts. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. Lag (.) denotes one-period lag; lag^2 (.) denotes two-period lag; lag^3 (.) denotes three-period lag

[a] Significant at the 1% level

[b] Significant at the 10% level

Table 4 reports the Granger causality test results with the use of either one or two lags. The Granger causality test takes the past values of dependent variables into account. The number of lags is determined by the correlation structure shown in Table 2. The test results clearly indicate a unidirectional Granger causality from public returns to private returns. The null hypothesis of lagged public returns do not Granger-cause private returns is rejected at the 1% level with the use of one or two lags. In contrast, the null hypothesis of lagged private returns do not Granger-cause public returns is not rejected. The associated test statistics are quite small, 0.0403 and 0.0059, for one and two lags, respectively. Overall, our evidence is consistent with Gyourko and Keim (1992), Barkham and Geltner (1995), Fu and Ng (2001), and Kallberg et al. (2002). Our results suggest that the information contained in the lags of public returns enter into the pricing equation for private returns. It appears that price discovery occurs first in public real estate markets, and then transmits into private real estate markets.

Limitations, Simulations, and Further Analyses

It is well known that appraisal-based returns are subject to smoothing. The resulting biased appraisal-based returns lag and are less volatile than the unobservable, true private real estate returns (Miles et al. 1990). One therefore cannot be completely sure about how much of our documented lead-lag relationship between public returns and private returns is real versus how much of it is due to the measurement error in NAV returns (Barkham and Geltner 1995).

To address this common, unavoidable difficulty, we provide simulations to access the probability that no Granger causality would be inferred from true, unobservable private and public returns when such a statistical causality is found using observed premium returns and NAV returns. Note that our simulations are approximate in

Table 4 Granger causality tests on NAV returns and premium returns, using one and two lags, for the test period January 1994–November 2005

	One lag	Two lags
Test statistic (x^2)		
NAV return → premium return	0.0403	0.0059
Premium return → NAV return	8.2012	14.0966
p Value		
NAV return → premium return	0.8409	0.9971
Premium return → NAV return	0.0042	0.0009

The study runs unrestricted regressions of the tests as follows:

$R_{\mathrm{NAV},t} = \text{intercept} + \sum_i \alpha_i R_{\mathrm{prem},t-i} + \beta R_{\mathrm{NAV},t-1} + e_t$, and

$R_{\mathrm{prem},t} = \text{intercept} + \sum_i \alpha_i R_{\mathrm{NAV},t-i} + \beta R_{\mathrm{prem},t-1} + e_t$

where the maximum value of i is either 1 or 2, R_{NAV} is the monthly return on the Green Street NAV Index, and $R_{\mathrm{prem},}$ is the monthly return on Green Street premiums/discounts. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. The restricted regressions of the tests are as follows:

$R_{NAV,t} = \text{intercept} + \beta R_{NAV,t-1} + e_t$, and

$R_{prem,t} = \text{intercept} + \beta R_{prem,t-1} + e_t$

nature because the quantitative properties of smoothing errors in NAVs are not well understood.

We first generate 144 monthly random (observable) premium returns from $N(0,1)$; i.e., a normal distribution with mean zero and variance one. This procedure leads to a random series of premium returns: $\{R_{\text{prem},0}, R_{\text{prem},1}, ..., R_{\text{prem},143}\}$. Based on these random premium returns, 143 monthly (observable) NAV returns, $\{R_{\text{NAV},1}, R_{\text{NAV},2}, \ldots, R_{\text{NAV},143}\}$,[2] are generated by the following one-way Granger causality relationship from premium returns to NAV returns: $R_{\text{NAV},t} = \alpha \text{R}_{\text{prem,t}-1} + \beta \text{R}_{\text{NAV,t}-1} + \text{e}_{\text{t}}$, where t=1, 2, …, 143, α and β are positive and independently, randomly generated from a uniform (level) distribution between 0.1 and 0.9, and e_{t} is randomly generated from $N(0,1)$.[3] Note that price discovery implies a positive value for α, and that β is set to be larger than zero and less than one because of positive autocorrelation and the stationary nature of NAV returns.

Suppose that Green Street NAVs are subject to measurement errors due to smoothing or other reasons. We define the true, unobservable real return as: $\overline{R}_{\text{NAV}} = \text{R}_{\text{NAV}} - \varepsilon$, where $\boldsymbol{\varepsilon}$ is the error term. Under the usual first-order approximation, one has the following identity: $\overline{\text{R}}_{\text{prem}} = \text{R}_{\text{prem}} + \varepsilon$. The sign changes for the error term in the latter equation because public returns and private returns sum up to REIT returns under the first-order approximation. In this study, $\boldsymbol{\varepsilon}_t$ is randomly drawn from $N(0,1)$ to generate $\left\{\overline{\text{R}}_{\text{NAV}}\right\}$ and $\left\{\overline{R}_{\text{prem}}\right\}$. Note that the size of $\boldsymbol{\varepsilon}_t$ is intentionally set to be large. It has the same size as that of premium returns. By doing this, our simulation results should be more conservative.

The Granger causality test is applied to the following two sets of return series: (1) $\{R_{\text{NAV}}\}$ and $\{R_{\text{prem}}\}$, and (2) $\left\{\overline{R}_{\text{NAV}}\right\}$ and $\left\{\overline{R}_{\text{prem}}\right\}$. Given the statistical significance documented in Table 4, we are interested in those simulations where the Granger causality is statistically established at the 1% level and the 5% level with the use of observable NAV returns and premium returns; i.e., $\{R_{\text{NAV}}\}$ and $\{R_{\text{prem}}\}$. Among the two sets of conditional simulations, we then collect their empirical frequencies in which true, unobservable returns—i.e., $\left\{\overline{\text{R}}_{\text{NAV}}\right\}$ and $\left\{\overline{R}_{\text{prem}}\right\}$—show no Granger causality at the 10% level. We denote these two probabilities as $\text{Prob}\left(\overline{\text{No}, 10\%}|\text{Yes}, 1\%\right)$and $\text{Prob}\left(\overline{\text{No}, 10\%}|\text{Yes}, 5\%\right)$, respectively.

Our simulations are repeated 10,000 times. The results show that $\text{Prob}\left(\overline{\text{No}, 10\%}|\text{Yes}, 1\%\right) = 1.01\%$, and that $\text{Prob}\left(\overline{\text{No}, 10\%}|\text{Yes}, 5\%\right) = 1.67\%$. That is, our specification of measurement errors is associated with a probability of 1.01% (1.67%) that we may falsely, in a statistical sense, establish a lead–lag relationship at the 1% (5%) level. Overall, these probabilities are quite small.

Changing premiums may anticipate future changes in the values of underlying real estate if the measurement error in NAV returns does not drive the documented lead-lag relationship between public returns and private returns. If increased (decreased) premiums contain useful information about subsequent increases (decreases) in underlying real estate value, then, when NAVs later rise (fall), one would expect these increases (decreases) to be accompanied by decreases (increases)

[2] $R_{NAV,\,0}$ is set to be zero. We also experiment with assigning a random value from $N(0,1)$ for $R_{\text{NAV},\,0}$. The results are qualitatively similar.

[3] This study also experiments with a uniform distribution up to 3.0 for α. We do not find the results to be qualitatively different.

Table 5 Contemporaneous correlation coefficients between NAV returns and premium returns and time-series regressions for the test period January 1994-November 2005

	Coefficient	*t* Statistic
Contemporaneous correlation coefficients		
Premium return		
Positive NAV return	−0.2528	
Negative NAV return	−0.5735	
Dependent variable = normalized NAV return		
Intercept	0.0057	3.7621[a]
Lag (normalized premium return)	0.1042	2.6565[a]
Lag^2 (normalized premium return)	0.0689	1.7275[b]
Lag^3 (normalized premium return)	0.0308	0.7809
Adj. R^2	0.0616	
Dependent variable = positive normalized NAV return		
Intercept	0.0146	9.2901[a]
Lag (normalized premium return)	0.0555	1.4498
Lag^2 (normalized premium return)	0.0643	1.5549
Lag^3 (normalized premium return)	0.0491	1.2215
Adj. R^2	0.0494	
Dependent variable = negative normalized NAV return		
Intercept	−0.0093	−5.7854[a]
Lag (normalized premium return)	0.1259	2.5498[c]
Lag^2 (normalized premium return)	0.0827	1.9941[c]
Lag^3 (normalized premium return)	−0.0300	−0.6523
Adj. R^2	0.1761	
Dependent variable = normalized premium return		
Intercept	0.0003	0.0845
Lag (normalized NAV return)	0.1624	0.8665
Lag^2 (normalized NAV return)	0.0928	0.5043
Lag^3 (normalized NAV return)	−0.2137	−1.1383
Adj. R^2	0.0140	

The net asset value (NAV) of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. NAV returns are the monthly returns on the Green Street NAV Index. Premium returns are the monthly returns on Green Street premiums/discounts. Normalized NAV returns are the ratios of the gains (losses) of Green Street NAVs to the total value of Green Street REITs. Normalized premium returns are the ratios of the gains (losses) of Green Street premiums/discounts to the total value of Green Street REITs. Lag (.) denotes one-period lag; lag^2 (.) denotes two-period lag; lag^3 (.) denotes three-period lag

[a] Significant at the 1% level

[b] Significant at the 10% level

[c] Significant at the 5% level

in premiums so long as REIT prices do not change much or their changes are quite independent.[4] Consistent with this pattern of information flow, this study earlier reported a contemporaneous correlation coefficient between NAV returns and premium returns of −0.3799. In contemporaneous correlation coefficients, Table 5, this contemporaneous correlation structure is represented by two correlation coefficients when NAV returns are grouped into positive and negative values. The results show that decreased premiums are more useful in predicting subsequent negative NAV returns. The correlation coefficient of −0.5735 indicates that decreases

[4] We would like to thank an anonymous referee for pointing this out to us.

in NAVs tend to be accompanied by increases in premiums. In contrast, increased premiums seem to contain less information about subsequent changes in NAVs. The correlation coefficient between positive NAV returns and associated premium returns is −0.2528.

In our baseline analyses, we define the public and private return as a percentage change of NAVs and premiums, respectively. This study also experiments with a normalization procedure of expressing the public and private return as a percentage change with respect to the Green Street REIT Index.[5] In particular, for the time-series regression analysis in Table 3, when we use this alternative definition, the coefficient reflects more closely the amount of premium (NAV) return that is later captured in NAV (premium) return. We report the regression results in dependent variable = normalized NAV return and dependent variable = normalized premium return of Table 5.[6] The results show that the coefficients and the associated statistical significance are quite similar to those reported in Table 3. That is, lagged premium returns are useful in explaining NAV returns, whereas lagged NAV returns are not useful in explaining premium returns.

We also use this alternative definition of the public and private return to re-examine the asymmetric responses to previous changes in premiums between positive and negative NAV returns. We run separate time-series regressions for positive and negative NAV returns. The regression results are reported in dependent variable = positive normalized NAV return and dependent variable = negative normalized NAV return of Table 5. The result is consistent with the earlier result that decreased premiums seem to contain more information about subsequent changes in NAVs than increased premiums do. We find statistical significance on lagged premium returns for negative NAV returns in dependent variable = negative normalized NAV return, but not for positive NAV returns in dependent variable = positive normalized NAV return. One possible explanation for this asymmetric response pattern is that public markets are relatively more liquid and more efficient in incorporating market information than their private counterparts during down markets. It is well known that the liquidity in private markets is pro-cyclical; this liquidity dries up when private markets are down (Fisher et al. 2006).

Factor Exposures

Having documented that price discovery appears to occur first in public real estate markets, we turn our attention to the factor exposures of Green Street REITs, NAVs, and premiums. The reason for this check is that, if public returns lead private returns, one would expect concurrent factor exposures for public returns and lagged factor exposures for private returns.

This study uses the three-factor and the five-factor models of Fama and French (1993) to obtain factor exposure estimates. That is, the independent variables include the excess return on the CRSP value-weighted portfolio net of one-month T-Bill rate

[5] With this normalization, REIT return = NAV return + premium return.

[6] We would like to thank an anonymous referee for suggesting this analysis to us.

Table 6 Monthly time-series regressions for REIT, NAV, and premium returns, using the Fama-French three- and five-factor models for the period January 1994–November 2005

	REIT return	NAV return	Premium return
The three-factor model			
Constant	−0.0018 (−0.64)	0.0030 (1.77)[a]	−0.0077 (−2.48)[b]
MKT	0.4045 (5.61)[c]	0.0379 (0.86)	0.3672 (4.57)[c]
SMB	0.3597 (4.71)[c]	0.0023 (0.05)	0.3593 (4.22)[c]
HML	0.5877 (6.03)[c]	0.0599 (1.00)	0.5281 (4.87)[c]
Adj. R^2	0.2719	0.0095	0.2081
The five-factor model			
Constant	−0.0013 (−0.47)	0.0034 (1.97)[b]	−0.0076 (−2.42)[b]
MKT	0.3858 (4.79)[c]	0.0525 (1.07)	0.3302 (3.68)[c]
SMB	0.3441 (4.38)[c]	0.0025 (0.05)	0.3421 (3.90)[c]
HML	0.5865 (5.86)[c]	0.0784 (1.29)	0.5058 (4.53)[c]
TERM	−0.0747 (−0.56)	−0.1559 (−1.93)*	0.0958 (0.65)
DEF	0.2152 (0.53)	−0.1672 (−0.68)	0.4238 (0.94)
Adj. R^2	0.2805	0.0390	0.2131

The net asset value (NAV) of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. REIT returns are the monthly returns on the Green Street REIT Index. NAV returns are the monthly returns on the Green Street NAV Index. Premium returns are the monthly returns on Green Street premiums/discounts. MKT is the difference between the monthly return on the CRSP value–weight portfolio and the monthly return on 1-month Treasury bills. SMB is the difference between the monthly return on small-cap stocks and the monthly return on large-cap stocks. HML is the difference between the monthly return on high book-to-market stocks and the monthly return on low book-to-market stocks. TERM is the difference between the monthly return on long-term US government bonds and the monthly return on one-month Treasury bills. DEF is the difference between the monthly return on long-term corporate bonds and the monthly return on long-term US government bonds. The *t* statistics are in parentheses

[a] Significant at the 10% level

[b] Significant at the 5% level

[c] Significant at the 1% level

(MKT), the difference between the returns on portfolios of small and big stocks (SMB), the difference between the returns on portfolios of high- and low-BE/ME (book-to-market ratio) stocks (HML), the difference between the returns on long-term government bonds and one-month T-Bills (TERM), and the difference between the returns on long-term corporate bonds and long-term government bonds (DEF). Kenneth French provides the first three factor series. The last two factor series are collected from the 2006 *Stocks, Bonds, Bills, and Inflation* yearbook. The Fama-French models are used in this study because they have been widely used in real estate studies (Chiang et al. 2004, 2005; He 2002; Kallberg et al. 2000; Peterson and Hsieh 1997; among many others).

Table 6 reports monthly time-series factor regression results. The dependent variables are the excess returns of Green Street REITs, NAVs, and premiums.[7] The results in the three-factor model are based on the three-factor model. It is not surprising that Green Street REITs are sensitive to the market factor, the SMB factor,

[7] This analysis focuses on factor exposures, and this calls for a uniform treatment of subtracting one-month T-Bill rates from the returns on Green Street REITs, NAVs, and premiums. It is understood that because of this treatment on both NAVs and premiums, the alpha of REITs is not an aggregate of the alphas of NAVs and premiums. Consequently, the alpha of premiums should not be over-interpreted.

and the HML factor because REITs and stocks are traded on the same platform. During the January 1994–November 2005 period, REITs have a market beta of 0.4045. The estimates for the SMB factor and the HML factor are quite high and statistically significant at the 1% level. This suggests that, consistent with Chiang and Lee (2002), REITs exhibit the small stock style and the value stock style.

These factor exposures are driven by the sensitivities of public real estate returns relative to factor returns. The returns on premiums yield statistically significant estimates for the market factor, the SMB factor, and the HML factor at the 1% level. These estimates are similar to those of REITs. In contrast, NAV returns are not sensitive to factor returns. The estimates for the market factor, the SMB factor, and the HML factor are 0.0379, 0.0023, and 0.0599, respectively. They are not statistically significant at any conventional level.

The results in the five-factor model of Table 6 are based on the five-factor model. In general, the regression results are quite similar to those in the three-factor model of Table 6. The only exception is that NAVs show statistically significant, negative relation with the TERM factor. That is, when the risk of unexpected changes in interest rates is high (low), the returns on NAVs are low (high). Overall, public real estate returns exhibit concurrent factor exposures relative to stock market factors, whereas private real estate returns do not.

The monthly time-series regressions in Table 7 are augmented by lagged factors.[8] The results in the three-factor model are based on the three-factor model. The regression results for Green Street REIT returns and premium returns are similar to those in Table 6. That is, they do not show statistically significant exposures to lagged factor series. In contrast, NAVs yield statistically significant estimates for the lagged market factor and the lagged HML factor at the 5% level. This result holds with the use of the five-factor model. Overall, private real estate returns exhibit lagged factor exposures relative to stock market factors, whereas public real estate returns do not. These factor exposure patterns are consistent with the notion that, in terms of information, public real estate returns lead private real estate returns. Price discovery appears to occur first in public real estate markets, and then to transmit into private real estate markets.

Capital Switching

As a final exercise, this section shows how our return decomposition can be used to address other real estate research questions. Lee et al. (2008) find that falling (rising) returns in NCREIF properties lead to subsequent rising (falling) returns in equity REITs. There is a negative relationship between REIT returns and lagged NCREIF returns. The authors' results suggest (1) that institutional investors move in and move out the REIT market as a group, conditioned on the performance of NCREIF properties, and (2) that capital switches between real and public real estate markets. If capital switching is the cause of the negative relation between REIT returns and lagged NCREIF returns, one would expect a sharper negative relation between

[8] For a more concise reporting, one-period lagged factors are used for this analysis. This study also experiments with the use of two lags. The results are qualitatively similar.

Table 7 Monthly time-series regressions for REIT, NAV, and premium returns, using the Fama-French factor models, with lagged factors, for the test period January 1994–November 2005

	REIT return	NAV return	Premium return
The three-factor model			
Constant	−0.0016 (−0.56)	0.0021 (1.21)	−0.0065 (−2.06)[a]
MKT	0.4214 (5.65)[b]	0.0276 (0.61)	0.3946 (4.79)***
SMB	0.3697 (4.56)[b]	−0.0312 (−0.64)	0.4046 (4.52)[b]
HML	0.6130 (5.83)[b]	0.0089 (0.14)	0.6063 (5.22)[b]
MKT_{t-1}	−0.0344 (−0.44)	0.1018 (2.17)[a]	−0.1422 (−1.65)
SMB_{t-1}	−0.0241 (−0.31)	0.0634 (1.34)	−0.0847 (−0.98)
HML_{t-1}	0.0131 (0.13)	0.1385 (2.25)[a]	−0.1275 (−1.13)
Adj. R^2	0.2793	0.0553	0.2289
The five-factor model			
Constant	−0.0013 (−0.44)	0.0028 (1.59)	−0.0069 (−2.12)[a]
MKT	0.4067 (4.85)[b]	0.0445 (0.89)	0.3589 (3.86)[b]
SMB	0.3584 (4.30)[b]	−0.0360 (−0.73)	0.3964 (4.29)[b]
HML	0.6316 (5.78)[b]	0.0312 (0.48)	0.5992 (4.95)[b]
TERM	−0.0787 (−0.58)	−0.1412 (−1.76)[c]	0.0771 (0.51)
DEF	0.1983 (0.48)	−0.1328 (−0.54)	0.3760 (0.82)
MKT_{t-1}	0.0010 (0.01)	0.0998 (1.98)[a]	−0.1054 (−1.12)
SMB_{t-1}	−0.0011 (−0.01)	0.0557 (1.16)	−0.0535 (−0.60)
HML_{t-1}	0.0384 (0.37)	0.1449 (2.42)[a]	−0.1138 (−0.98)
$TERM_{t-1}$	−0.1323 (−0.97)	−0.1150 (−1.42)	−0.0168 (−0.11)
DEF_{t-1}	−0.5100 (−1.23)	−0.0276 (−0.11)	−0.4728 (−1.03)
Adj. R^2	0.2975	0.1038	0.2419

The net asset value (NAV) of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. REIT returns are the monthly returns on the Green Street REIT Index. NAV returns are the monthly returns on the Green Street NAV Index. Premium returns are the monthly returns on Green Street premiums/discounts. MKT is the difference between the monthly return on the CRSP value–weight portfolio and the monthly return on 1-month Treasury bills. SMB is the difference between the monthly return on small-cap stocks and the monthly return on large-cap stocks. HML is the difference between the monthly return on high book-to-market stocks and the monthly return on low book-to-market stocks. TERM is the difference between the monthly return on long-term US government bonds and the monthly return on 1-month Treasury bills. DEF is the difference between the monthly return on long-term corporate bonds and the monthly return on long-term US government bonds. The t statistics are in parentheses

[a] Significant at the 5% level

[b] Significant at the 1% level

[c] Significant at the 10% level

premium returns and lagged NCREIF returns. The reason for this is that, when falling (rising) returns in NCREIF properties introduce higher (lower) demand for REIT shares in public markets, it would bid up only the prices of premiums, but not the prices of NAVs.

This study follows Lee et al. (2008) and compounds the monthly excess returns on Green Street REITs, NAVs, and premiums into quarterly series so that they can be analyzed along with the quarterly NCREIF returns at the same frequency. For these quarterly time-series regressions, the sample period is from January 1994 to September 2005. The Fama-French three-factor and five-factor models are first augmented by the inclusion of the difference between the returns on the NCREIF Index and one-month T-Bills (NCR). The NCREIF property return series is collected from the National Council of Real Estate Investment Fiduciaries.

The regression results are reported in Table 8. The results suggest that stock market factors are useful in explaining REIT returns. The estimates for the market factor, the SML factor, and the HML factor are at least statistically significant at the 5% level under both the three-factor model and the five-factor model. This study also confirms the findings in Clayton and Mackinnon (2003) and Lee et al. (2008) that NCR alone is not useful in explaining REIT returns. Because of premiums' role in price discovery, their factor exposures are similar to those of REITs. The only difference is that premium returns do not show statistical significance to the market factor at any conventional level.

Under the three-factor model, NAV returns show strong sensitivity relative to NCR. A 1% change in NCR is associated with a 1.8836% change in NAVs. This is consistent with the notion that Green Street NAVs are less rigid than the NCREIF property values. In addition, NAV returns show statistical significance to the SMB factor and the HML factor at the 10% level. These results largely hold when the five-factor model is used. Furthermore, a statistically significant exposure to the

Table 8 Quarterly time-series regressions for REIT, NAV, and premium returns, using the Fama-French factor models, with NCR, for the test period January 1994–November 2005

	REIT return	NAV return	Premium return
The three-factor model			
Constant	−0.0191 (−1.32)	−0.0251 (−3.03)[a]	−0.0054 (−0.37)
MKT	0.2305 (2.08)[b]	0.0575 (0.90)	0.1680 (1.51)
SMB	0.6203 (4.11)[a]	0.1619 (1.86)[c]	0.4704 (3.10)[a]
HML	0.4547 (3.39)[a]	0.1287 (1.66)[c]	0.3211 (2.38)[b]
NCR	0.9842 (1.34)	1.8836 (4.44)[a]	−0.757 (−1.02)
Adj. R^2	0.4302	0.3937	0.2880
The five-factor model			
Constant	−0.0186 (−1.26)	−0.0234 (−2.91)[a]	−0.0066 (−0.45)
MKT	0.2387 (2.00)[b]	0.0583 (0.90)	0.1697 (1.42)
SMB	0.6235 (3.94)[a]	0.1427 (1.66)[c]	0.4872 (3.09)[a]
HML	0.4655 (3.28)[a]	0.1573 (2.04)[b]	0.3005 (2.13)[b]
TERM	−0.0687 (−0.29)	−0.2717 (−2.08)[b]	0.2047 (0.85)
DEF	−0.1767 (−0.27)	−0.2761 (−0.78)	0.1773 (0.27)
NCR	0.9772 (1.29)	1.9373 (4.70)[a]	−0.8033 (−1.06)
Adj. R^2	0.4315	0.4612	0.3036

REIT returns are the quarterly returns on the Green Street REIT Index. Net asset value (NAV) returns are the quarterly returns on the Green Street NAV Index. Premium returns are the quarterly returns on Green Street premiums/discounts. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. MKT is the difference between the quarterly return on the CRSP value–weight portfolio and the quarterly return on 1-month Treasury bills. SMB is the difference between the quarterly return on small-cap stocks and the quarterly return on large-cap stocks. HML is the difference between the quarterly return on high book-to-market stocks and the quarterly return on low book-to-market stocks. TERM is the difference between the quarterly return on long-term US government bonds and the quarterly return on 1-month Treasury bills. DEF is the difference between the quarterly return on long-term corporate bonds and the quarterly return on long-term US government bonds. NCR is the excess return on the quarterly NCREIF Index. The t statistics are in parentheses

[a] Significant at the 1% level

[b] Significant at the 5% level

[c] Significant at the 10% level

TERM factor implies that NAV returns are low (high) when the risk of unexpected changes in interest rates is high (low).

The test results of the capital switching hypothesis are reported in Table 9. The test specifications are further augmented by the inclusion of the one-period lagged NCR. Consistent with Lee et al. (2008), Green Street REIT returns are negatively related to lagged NCR at the 10% level under both the three-factor model and the five-factor model. NAVs continue to show statistically significant exposures relative to concurrent NCR, but at a weaker level. Note that the estimates for lagged NCR are 0.9194 and 0.8361 under the three-factor model and the five-factor model, respectively. These positive values suggest that capital-switching demand for REIT shares do not bid up the prices of NAVs.

As expected, focusing on the relation between premium returns and lagged NCREIF returns produces sharper evidence of capital switching. The estimates for lagged NCR are −3.0194 and −2.9898 under the three-factor model and the five-

Table 9 Quarterly time-series regressions for REIT, NAV, and premium returns, using the Fama-French factor models, with lagged NCR, for the test period January 1994–November 2005

	REIT return	NAV return	Premium return
The three-factor model			
Constant	−0.0154 (−1.04)	−0.0302 (−3.45)[a]	0.0027 (0.18)
MKT	0.2233 (2.08)[b]	0.0753 (1.18)	0.1455 (1.36)
SMB	0.5589 (3.80)[a]	0.1750 (2.00)[b]	0.3995 (2.73)[a]
HML	0.4353 (3.37)[a]	0.1411 (1.83)[c]	0.2916 (2.26)[b]
NCR	2.9279 (2.45)[b]	1.2236 (1.72)[c]	1.6957 (1.42)
Lag(NCR)	−2.2965 (−1.87)[c]	0.9194 (1.26)	−3.0194 (−2.47)[b]
Adj. R^2	0.4920	0.4321	0.3814
The five-factor model			
Constant	−0.0149 (−0.97)	−0.0276 (−3.16)[a]	0.0004 (0.03)
MKT	0.2415 (2.09)[b]	0.0684 (1.04)	0.1641 (1.45)
SMB	0.5732 (3.74)[a]	0.1566 (1.79)[c]	0.4269 (2.84)[a]
HML	0.4466 (3.28)[a]	0.1625 (2.10)[b]	0.2779 (2.08)[b]
TERM	−0.0355 (−0.15)	−0.2358 (−1.73)[c]	0.2075 (0.89)
DEF	−0.2855 (−0.45)	−0.2012 (−0.56)	0.0105 (0.02)
NCR	2.9520 (2.40)[b]	1.3131 (1.88)[c]	1.6238 (1.35)
Lag (NCR)	−2.3759 (−1.88)[c]	0.8361 (1.16)	−2.9898 (−2.41)[b]
Adj. R^2	0.4953	0.4822	0.4037

REIT returns are the quarterly returns on the Green Street REIT Index. Net asset value (NAV) returns are the quarterly returns on the Green Street NAV Index. Premium returns are the quarterly returns on Green Street premiums/discounts. The NAV of a REIT is an estimate of the appraisal-based value of its shares. Premium/discount is the difference between REIT share price and NAV. MKT is the difference between the quarterly return on the CRSP value-weight portfolio and the quarterly return on 1-month Treasury bills. SMB is the difference between the quarterly return on small-cap stocks and the quarterly return on large-cap stocks. HML is the difference between the quarterly return on high book-to-market stocks and the quarterly return on low book-to-market stocks. TERM is the difference between the quarterly return on long-term US government bonds and the quarterly return on 1-month Treasury bills. DEF is the difference between the quarterly return on long-term corporate bonds and the quarterly return on long-term US government bonds. NCR is the excess return on the quarterly NCREIF Index. Lag (.) denotes one-period lag. The t statistics are in parentheses

[a] Significant at the 1% level

[b] Significant at the 5% level

[c] Significant at the 10% level

factor model, respectively. That is, a 1% increase (decrease) in this quarter's NCR is expected to have an approximate 3% decrease (increase) in the next quarter's premium. This negative relation is statistically significant at the 5% level. Overall, the evidence suggests that capital-switching demand for REIT shares bid up the prices of premiums. The results are consistent with the notion that institutional investors have been viewing REITs as potential substitutes for private real estate investments and liquid ways to gain exposures to the real estate asset class (Linneman 2000; Clayton and MacKinnon 2001).

Conclusions

This study examines the price discovery of REIT prices. This study differentiates itself from existing studies by decomposing REIT returns into real returns and public returns. Our study of lead-lag relationship between real returns and public returns indicates that lagged public returns are useful in predicting private returns. That is, the information contained in the lags of public returns is subsequently transmitted into the private appraisal-based sector. The result is consistent with the idea that public markets are more efficient in incorporating information into prices.

Our analysis is conducted in a new data environment. This new environment provides the following benefits: (1) data frequency is enhanced, and (2) individual components in the price system are not based on different sets of private properties with presumably different private price discovery processes. We show that the proposed return decomposition can be used to produce sharper evidence of capital switching. We also believe that this new data environment has potential to be adopted for studying other real estate research topics. For instance, a comparison between NCREIF returns and de-levered real returns may shed light about the impact of market features and data frequency on the return and risk characteristics of appraisal-based indices.

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References

Barkham R., & Geltner D. (1995). Price discovery in American and British property markets. *Real Estate Economics, 23*, 21–44.

Bodurtha J. N. Jr., Kim D., & Lee C. (1995). Closed-end country funds and U.S. market sentiment. *Review of Financial Studies, 8*, 879–918.

Bradrinath S. G., Kale J. R., & Noe T. H. (1995). Of shepherds, sheep, and the cross-autocorrelations in equity returns. *Review of Financial Studies, 8*, 401–430.

Chiang K., & Lee M. (2002). REITs in the decentralized investment industry. *Journal of Property Investment and Finance, 20*, 496–512.

Chiang K., Lee M., & Wisen C. (2004). Another look at the asymmetric REIT-beta puzzle. *Journal of Real Estate Research, 26*, 25–42.

Chiang K., Lee M., & Wisen C. (2005). On the time-series properties of real estate investment trust betas. *Real Estate Economics, 33*, 381–396.

Clayton J., Geltner D., & Hamilton S. (2001). Smoothing in commercial property valuations: Evidence from individual appraisals. *Real Estate Economics, 29*, 337–360.

Clayton J., & Mackinnon G. (2003). The relative importance of stock, bond, and real estate factors in explaining REIT returns. *Journal of Real Estate Finance and Economics, 27*, 39–60.

Damodaran A., & Liu C. H. (1993). Insider trading as a signal of private information. *Review of Financial Studies, 6*, 79–119.

Engle R. F., & Granger C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica, 55*, 251–276.

Fama E. F., & French K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*, 3–56.

Fisher, J., Geltner, D., & Pollakowski, H. (2006). A quarterly transactions-based index (TBI) of institutional real estate investment performance and movements in supply and demand. Working paper, MIT.

Fristenberg P., Ross S., & Zisler R. (1988). Real estate: the whole story. *Journal of Portfolio Management, 14*, 22–34.

Fu Y., & Ng L. K. (2001). Market efficiency and return statistics: Evidence from real estate and stock market using a present-value approach. *Real Estate Economics, 29*, 227–250.

Gentry, W. M., Jones, C. M. & Mayer, C. J. (2004). Do stock prices really reflect fundamental values? The case of REITs. Working Paper, Williams College.

Giliberto M. (1990). Equity real estate investment trusts and real estate returns. *Journal of Real Estate Research, 5*, 259–263.

Gyourko J., & Keim D. (1992). What does the stock market tell US about real estate returns? *AREUEA, 20*, 457–486.

He L. T. (2002). Excess returns of industrial stocks and the real estate factor. *Southern Economic Journal, 68*, 632–645.

Kallberg J. G., Liu C. H., & Pasquariello P. (2002). Regime shifts in Asian equity and real equity markets. *Real Estate Economics, 30*, 263–291.

Kallberg J. G., Liu C. L., & Trzcinka C. (2000). The value added from investment managers: An examination of funds of REITs. *Journal of Financial and Quantitative Analysis, 35*, 387–408.

Lee, M., Lee, M., & Chiang, K. (2008). Real estate risk exposure of equity real estate investment trusts. *Journal of Real Estate Finance and Economics 36*(2).

Linneman, P. (2000). Real estate today: New strategic moves. *Commonfund Quarterly*, Fall, 3–6.

Liu C. H., & Mei J. (1992). The predictability of returns on equity REITs and their co-movement with other assets. *Journal of Real Estate Finance and Economics, 5*, 401–418.

Mei J., & Lee A. (1994). Is there a real estate factor premium? *Journal of Real Estate Finance and Economics, 9*, 113–126.

Miles M., Cole R., & Guilkey D. (1990). A different look at commercial real estate returns. *AREUEA, 18*, 403–430.

Peterson J., & Hsieh C. (1997). Do common risk factors in the returns on stocks and bonds explain returns on REITs? *Real Estate Economics, 25*, 321–345.

Tuluca S. A., Myer F. C. N., & Webb J. R. (2000). Dynamics of private and public real estate markets. *Journal of Real Estate Finance and Economics, 21*, 279–296.

Ziering, B., Winograd, B., & McIntosh, W. (1997). The evolution of public and private market investing in the new real estate capital markets. Parsippany, NJ: Prudential Real Estate Investors.