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Returns and Information Transmission Dynamics in Public and Private Real Estate Markets

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This paper examines U.S. public and private commercial real estate returns at the aggregate level and by the four major property types over the 1994–2012 time period. Returns are carefully adjusted for differences between public and private markets in financial leverage, property type focus and management fees. Unconditionally, we find that passive portfolios of unlevered core real estate investment trusts (REITs) outperformed their private market benchmark by 49 basis points (annualized) over the 1994–2012 sample period. Our baseline vector autoregression results suggest that REIT returns do not embed additional commercial real-estate-specific information useful in predicting private market returns. These results strongly suggest that equity REIT returns react to fundamental (latent) asset pricing information more quickly than private market returns given their greater liquidity and price revelation. REITs therefore serve as a fundamental information transmission channel to private market returns when asset pricing variables are omitted.

Investors can hold ownership positions in commercial real estate (CRE) both through direct private investment and public real estate securities. Purchasing individual properties directly in the private market gives investors complete control of the asset: who leases it, who manages it, how much debt financing is used and when it is sold. With publicly traded real estate securities, individuals and institutions invest capital in a real estate company which, in turn, purchases, manages and holds title to the real estate. In contrast to private real estate markets, exchange-traded real estate securities provide investors with a relatively high degree of liquidity and transparency and relatively low transaction costs. Nevertheless, returns in both private and public CRE markets should be driven, at least in the long run, by the net cash flows derived from leasing space to tenants in local property markets.

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Although both the private market and the public securities market can provide investors with exposure to the same underlying local property markets, public and private real estate returns as commonly measured have exhibited significantly different risk-return characteristics, especially in the short run. According to several recent studies, for example, investments in direct private real estate have produced lower average returns than comparable investments in publicly traded real estate investment trusts (REITs), even after controlling for differences in financial leverage, property mix and management fees (Riddiough, Moriarty and Yeatman 2005, Tsai 2007). However, these and other studies also document that the measured volatility of returns on private real estate portfolios is lower than the volatility of returns on REIT portfolios.[1]

It is also well known that public and private real estate returns display limited correlation over quarterly and annual horizons (*e.g.*, Morawski, Rehkugler and Fuss 2008, Boudry *et al*. 2012). For example, the contemporaneous correlation between quarterly returns on equity REITs (as measured by the FTSE NAREIT All Equity REIT Index) and the returns on direct property investments (as measured by the NCREIF NPI) was 0.22 over the 1994–2012 time period. In contrast, the corresponding return correlation between equity REITs and small-cap value stocks (as measured by the Russell 2000 Value Index) was 0.81. Thus, some investors expect REITs to deliver investment returns similar to those of small cap value stocks because of this high correlation, their relatively high dividend yields and their inclusion in several broader benchmarks of stock market performance. However, recent research suggests the correlation of equity REIT returns with those of other equities declines as the investment horizon lengthens, whereas the correlation of REIT returns with those of the NCREIF NPI, as well as other private market benchmarks, increases as the investment horizon lengthens (*e.g.*, Morawski *et al.* 2008, Boudry *et al*. 2012, Yunus, Hansz and Kennedy 2012). Moreover, recent research consistently documents a long-run equilibrium relation between public and private returns; that is, the two markets appear to be cointegrated (*e.g.*, Morawski *et al.* 2008, Boudry *et al*. 2012, Hoelsi and Oikarinen 2012, Yunus *et al.* 2012).

We employ a two-stage approach to measure the relative performance of public and private real estate investment vehicles. First, we use an unconditional approach that consists of adjusting the composition and risk characteristics of publicly traded REIT portfolios to match as closely as possible the composition

[1] The usual estimate of return volatility, the average of squared deviations over the sample period, provides an unconditional estimate of volatility because it treats the variance as constant over time. In contrast, a conditional statistic allows the variance to change over time based on changes in available information. To the extent that liquidity differences affect volatility, the unconditional volatility estimate will be biased.

and characteristics of our benchmark private market portfolios. In particular, we unlever REIT returns at the firm level each quarter before aggregating into portfolios to match the unlevered returns on our benchmark private market portfolios. In addition, when aggregating returns across property types to create representative portfolios, each major property type is assigned the same weight in each quarter in both the public market and private market portfolios we construct.

Our unconditional results show that passive portfolios of U.S. office and retail REITs outperformed their private market benchmarks over our 1994–2012 sample period; in contrast, in the multifamily market we provide evidence of modestly higher average returns in the private market. Cumulative returns in public and private industrial markets are nearly identical. In the aggregate, unlevered core REITs outperformed their private market benchmark by 49 basis points (annualized) over the 1994–2012 sample period.

In addition to the extant literature on the relative risk and return performance of public and private CRE investments and their long-run cointegrating relationship, a number of studies have examined how information is transmitted between the two markets (*e.g.*, Okunev, Wilson and Zurbruegg 2000, Li, Mooradian and Yany 2009, Carlson, Titman and Tiu 2010). Without exception, these studies find that returns in the public REIT market predict returns in the private market over subsequent quarters (*e.g.*, Li *et al.* 2009, Oikarinen, Hoesli and Serrano 2011, Yunus *et al.* 2012). However, these studies do not include standard asset pricing control variables. If both public and private market CRE returns are driven in part by these omitted fundamental control variables, it may be that the observed predictive power of public market returns simply reflects the relative liquidity and timelier price revelation of REITs. Additional research is needed to determine the extent to which REIT returns contain any marginal information useful in predicting private market returns, after controlling for a broad set of asset pricing variables.

In our second stage analysis, we use vector autoregression (VAR) techniques and various fundamental control variables to examine the short-run dynamics between public and private real estate returns. This dynamic analysis allows us to answer several important questions, including the extent to which each market is influenced by fundamental risk factors and the degree to which public market returns predict returns in the private market, after controlling for such factors.

Consistent with the existing literature, our baseline bivariate VAR results without asset pricing controls suggest REIT returns possess information on future private market returns; in contrast, private market returns have no predictive power in our REIT return regressions. However, when standard asset pricing control variables are included in the VARs, the significance of lagged REIT returns in the private market return equations is eliminated. That is, REIT returns do not appear to embed additional CRE specific information useful in predicting private market returns. These results strongly suggest that equity REIT returns react to fundamental (latent) asset pricing information more quickly than private market returns given their greater liquidity and price revelation. REITs therefore serve as a fundamental information transmission channel to private market returns when asset pricing variables are omitted.

The paper proceeds as follows. In the next section, we describe our benchmark private market return indices and present summary statistics on their performance. We then describe the construction of our initial equity REIT sample, the merger of this sample with Compustat data to obtain the accounting information necessary to deliver firm-level REIT returns, the methods used to construct indices of levered and unlevered REIT returns, and other nonparametric adjustments we make prior to analyzing the relative performance of public and private real estate market returns. In the third section we describe the VAR models and data used to examine the dynamics of public and private market returns. The fourth section contains a summary and some concluding thoughts.

Public versus Private Market Real Estate Returns

We first adjust the composition of our public and private market returns to make them more directly comparable; we then examine their return relations and volatility at both the aggregate level and by the four “core” property types: multifamily, office, industrial and retail. In order to render returns on our equity REIT portfolios comparable to the corresponding unlevered private market benchmarks, we (1) remove the effects of financial leverage from firm-level REIT returns, (2) exclude from the final analysis those REITs that do not invest in “core” property types, (3) use the same time-varying property-type weights as found in the benchmark private market index each quarter when creating our aggregate REIT portfolio/index and (4) adjust downward the returns on our benchmark private market portfolios to reflect the fact that these returns are reported gross of asset management fees, whereas REIT returns are reported net of all firm-level management expenses.[2]

[2]Many retail and institutional investors participate in the REIT market through actively managed funds, which do include some management costs. This issue is discussed in more detail below.

Benchmark Private Market Returns

Our primary source of return data in the private CRE market is the National Council of Real Estate Investment Fiduciaries (NCREIF). Established in 1982, NCREIF is a not-for-profit industry association that collects, processes, validates and disseminates information on the risk/return characteristics of CRE assets owned by institutional (primarily pension and endowment fund) investors (see www.ncreif.org). NCREIF's flagship index, the NCREIF Property Index (NPI), tracks property-level quarterly returns on a large pool of properties acquired in the private market for investment purposes only. The property composition of the NPI changes quarterly as data-contributing NCREIF members buy and sell properties. However, all historical property-level data remain in the database and index.[3]

Any analysis of the relative return performance and the lead-lag relations between public and private real estate returns must overcome the well-known smoothing and stale appraisal problems associated with the NCREIF NPI.[4] Our solution is to employ the NCREIF Transaction Based Index (TBI) as our primary measure of private real estate returns. The capital gain component of the TBI in each quarter is based only on the constituent properties in the NCREIF database that were sold that quarter.[5] The TBI indices are available from NCREIF at the national level back to 1994Q1 for multifamily, office, industrial and retail properties; this availability dictates the beginning of our sample period. NCREIF's All-Properties TBI Index includes hotel properties. We therefore construct a Core-Properties TBI Index that excludes hospitality properties.

[3]In the fourth quarter of 2012, the NCREIF database contained 7,270 properties with an estimated market value of $320 billion.

[4]Unless a constituent property happens to sell during the quarter, the reported quarterly capital gain on an individual property within the NCREIF NPI is based on the change in the property's appraised value. Appraisal-based indices are thought to suffer from two major problems. First, estimated price changes lag changes in "true" (but unobservable) market values; this smoothing of past returns understates return volatility. Second, formal appraisals of constituent properties in the NCREIF index by third-party appraisers are usually conducted annually; the property's asset manager is responsible for updating the appraisal internally in the intervening quarters. This leads to what is commonly called the "stale" appraisal problem.

[5]Detailed information on the construction of the NCREIF TBI is available at www.ncreif.org. Prior to the second quarter of 2011, the TBI was produced by the MIT Center for Real Estate on behalf of NCREIF. Beginning in the second quarter of 2011, NCREIF took the production of the TBI in house, revised the index construction methodology and provided a restated set of quarterly indices from 1994Q1 to 2011Q1. We use the new family of NCREIF TBI indices. The restated indices yield very similar results to the MIT produced TBI, except for in the early 1990s where there were fewer transactions.

Comparisons of public and private market return performance are sensitive to the time period selected for the analysis. In this case, the constraint imposed on our analysis by the lack of TBI indices prior to 1994Q1 requires us to exclude the early 1990s, a period that includes the beginning of the most recent complete real estate cycle and during which public REIT markets generally outperformed private markets. This sample selection issue is addressed in more detail below.

We first calculate quarterly property type weights for the construction of our aggregate portfolio using the total market value of all properties in each of the four core property type categories contained in the NCREIF NPI database. More specifically, the portfolio weight assigned to property type f in quarter t is:

$$w_{f,t}^{NPI} = \frac{mval_{f,t-1}}{\sum_{f=1}^{4} mval_{f,t-1}}, \tag{1}$$

where $f = 1 \ldots 4$ for apartment, office, industrial and retail properties, respectively, and $mval_{f,t-1}$ is the total market value of property type f at the end of quarter $t-1$. The return in quarter t on our Core-Properties TBI Index is therefore defined as:

$$R_t^{TBI} = \sum_{f=1}^{4} w_{f,t}^{NPI} r_{f,t}^{TBI}, \tag{2}$$

where $r_{f,t}^{TBI}$ is the TBI return for property type f in quarter t. Note the required use of NPI property type weights, $w_{f,t}^{NPI}$, in the construction of our Core-Properties TBI Index.[6] This weighting and aggregation process is repeated each quarter to produce a time-series of aggregate Core-Properties TBI returns.

Finally, we adjust downward quarterly TBI returns because they are reported gross of management fees, whereas reported firm-level REIT returns are net of all firm-level management fees. According to industry sources, investment management fees as a proportion of assets under management range between 50 and 120 basis points per year in the direct private market (see, for example, Riddiough *et al.* 2005). The mean quarterly difference between gross and net (of management) total returns on NCREIF's Open-End Diversified Core Equity (ODCE) fund is 96 basis points per year. We conservatively estimate

[6]Quarterly NPI property type weights must be used because the aggregate TBI series reported by NCREIF is estimated by including all properties in the database in that quarter; thus, it is not possible to determine the property type weights associated with NCREIF's estimation of their aggregate TBI return series.

total advisor/management fees to be 80 basis points per year (20 BPS per quarter) in our formal analysis.

Figure 1 displays cumulative total returns, net of estimated asset management fees, on our All-Properties TBI Index over the 1994–2012 sample period, along with the constituent multifamily, office, industrial and retail NPI indices obtained directly from NCREIF. Summary statistics for these five return indices are reported in Panel A of Table 1. Figure 1 reveals the prolonged bull market experienced by the private CRE market that began in early 1993. From 1994Q1 through 2007Q3, our Core-Properties TBI Return Index produced a geometric mean quarterly return of 2.9%, or 11.1% annually.[7] After peaking in late 2007, our Core-Properties TBI Index produced a mean quarterly return of −3.3% (−12.6% annually) from 2007Q4 through 2009Q4. This sharp drop in return performance reduced the average annual TBI return over the full 1994–2012 sample period to 8.80% with a standard deviation of 11.09%. The autocorrelation of the Core-Properties TBI Return Index is −0.13.

According to the TBI, multifamily properties produced a mean annualized return of 9.49% over the full sample; the corresponding mean returns for office, industrial and retail properties are 8.43%, 9.00% and 8.96%, respectively. Thus, direct private investments in multifamily properties produced significantly higher mean returns than the other core property types over the 1994–2012 sample period.

REIT Data and Levered Returns

Our initial sample of publicly traded U.S. equity REITs is obtained from the CRSP-Ziman database. We collect the following data for each REIT at the beginning of each quarter: REIT identification number, property type and subproperty type focus and also equity market capitalization.[8]

Column (A) of Table 2 displays the total number of independent equity REITs used by CRSP-Ziman to construct their equity REIT return index in the first quarter of each year over the 1994–2012 sample period. Column (B) contains

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[7] All reported mean returns are geometric means.

[8] Most prior studies that use firm-level data to compare the risk-return characteristics of public and private real estate use a combination of NAREIT constituent lists for each property type and SIC classification codes to identify REITs and their property type specialization. Return data for the REITs are then obtained from CRSP data. We obtain both our property type constituent lists and return data from CRSP-Ziman. It is important to note that relying on the SIC classification code for REITs (6798), as almost all prior studies have done to select REITs from the CRSP database, results in a number of REITs being misclassified and left out of the analysis.

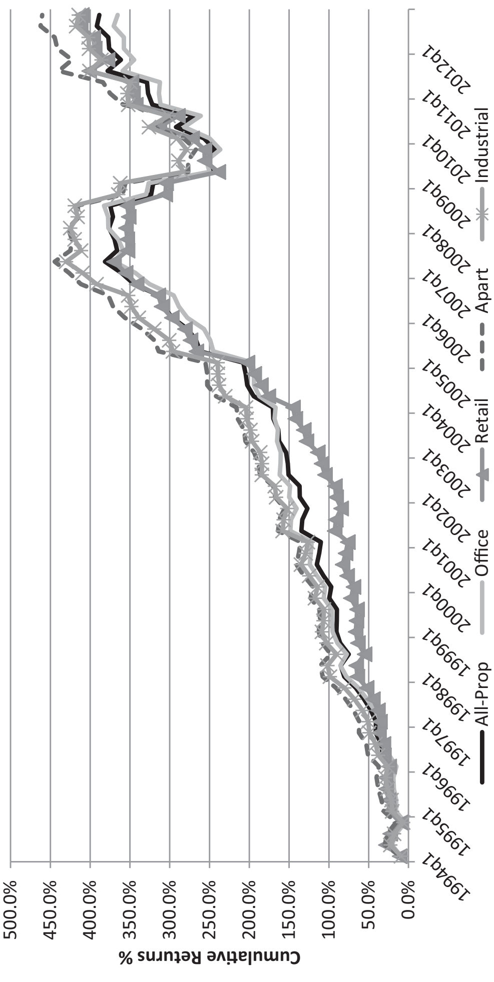


Figure 1 ■ NCREIF-TBI cumulative returns.

Table 1 ■ Return statistics: Public and private real estate markets.

	Mean Return	Standard Deviation	Autocorrelation
Private Market Returns			
Panel A			
Aggregate NCREIF TBI: Core-Properties	8.80%	11.09%	−0.13
Apartment	9.49%	11.42%	−0.07
Office	8.43%	10.97%	−0.11
Industrial	9.00%	11.14%	−0.14
Retail	8.96%	11.54%	−0.12
Levered Equity REIT Returns			
Panel B:			
Aggregate: All-Properties	10.55%	20.86%	0.16
Apartment	11.77%	20.69%	0.13
Office	10.49%	23.78%	0.22
Industrial	9.57%	23.46%	0.24
Retail	12.04%	23.73%	0.11
Unlevered Equity REIT Returns			
Panel C:			
Aggregate: All-Properties	8.97%	10.31%	0.14
Apartment	9.08%	9.50%	0.09
Office	9.37%	10.58%	0.21
Industrial	9.02%	11.65%	0.15
Retail	9.90%	10.03%	0.06
Panel D:			
Aggregate: Core-Properties	9.29%	9.71%	0.16

Notes: This table provides summary statistics for private real estate market returns (Panel A) and levered and unlevered equity REITs returns (Panels B, C and D, respectively) over the 1994–2012 sample period. Panel A reports summary statistics for total returns, net of management fees, on our constructed aggregate Core-Properties TBI Index, along with the constituent multifamily, office, industrial and retail TBI indices. Panel B reports descriptive statistics for our All-Properties Levered REIT Index, obtained directly from FTSE-NAREIT, and for each levered property type index. Panel C contains summary statistics on our constructed, unlevered, all-property-types index as well as on the four core property type indices; Panel D reports summary statistics for our unlevered core index. Geometric means and standard deviations are reported on an annualized basis. Autocorrelations are based on quarterly returns.

the number of REITs from the CRSP-Ziman database used to construct our initial return index in the first quarter of each year; column (C) displays the difference between columns (A) and (B). A positive difference indicates our initial index contains fewer REITs at the beginning of that quarter than are used to calculate the CRSP-Ziman Index return in the quarter. Over the 76 quarters in our sample period, the difference in the number of REITs in the two samples ranges from –1 to 9. These quarterly variations reflect the use

Table 2 ■ Number of REITs in our constructed real estate indices.

Year	(A) CRSP-Ziman REIT Universe	(B) Self-Constructed Sample Before Compustat	(C) (A)–(B)	(D) Self-Constructed Sample After Compustat	(E) (B)–(D)	(F) Number of Core Focused REITs	(G) (D)–(F)
1994	163	154	9	153	1	78	75
1995	194	196	−2	192	4	111	81
1996	193	194	−1	186	8	111	75
1997	187	185	2	181	4	111	70
1998	197	193	4	186	7	120	66
1999	193	191	2	187	4	119	68
2000	183	184	−1	182	2	112	70
2001	171	171	0	168	3	102	66
2002	160	161	−1	159	2	93	66
2003	155	155	0	152	3	88	64
2004	154	151	3	145	6	87	58
2005	161	161	0	157	4	87	70
2006	157	156	1	149	7	80	69
2007	135	136	−1	130	6	69	61
2008	119	120	−1	119	1	63	56
2009	112	112	0	112	0	59	53
2010	117	113	4	113	0	59	54
2011	127	125	2	125	0	65	60
2012	131	129	2	128	1	66	62

Notes: This table lists the number of REITs using various data filters at the beginning of each year over the 1994–2012 sample period. Column (A) reports the number of REITs used in the construction of the Equity REITs Value Weighted Index reported by CRSP-Ziman. Column (B) reports the number of equity REITs in our constructed sample at the beginning of the fourth quarter of each year before merging with Compustat. Column (D) reports the number of equity REITs in our constructed sample at the beginning of the fourth quarter of each year after merging with Compustat. Column (F) reports the number of equity REITs in our Core-Properties Index in the fourth quarter of each year based on quarterly property type classifications from CRSP-Ziman.

of different methodologies. The quarterly returns reported by CRSP-Ziman are "built up" from compounding daily returns. This means that the CRSP-Ziman equity REIT portfolio is "rebalanced" every day; firms can enter and exit the index daily and the firm-level equity market capitalizations used to value-weight returns also vary daily.

In contrast, we take the equity REITs in the CRSP-Ziman index at the beginning of each quarter and hold those REITs constant for the entire quarter. In essence, our index is built on the assumption that investors are rebalancing their portfolios quarterly; that is, we assume a quarterly “buy-and-hold” strategy. In addition, the weights we use to construct the value-weighted return in each quarter are based on the market capitalization of each REIT at the beginning of the quarter.[9] Given the trading expenses investors would face with daily portfolio rebalancing, our quarterly buy-and-hold assumption is likely more consistent with the trading behavior of most investors than daily rebalancing. Moreover, NCREIF does not include in their indices in a particular quarter properties added to the database during that quarter. Thus, the NCREIF indices also implicitly assume a quarterly buy-and-hold strategy.

The number of equity REITs in our initial sample ranges from 111 (2009Q2) to 198 (1995Q4). The latter number reflects the culmination of the 1993–1994 REIT IPO boom. The reduction in publicly traded REITs to 111 in 2009Q2 reflects the wave of REIT mergers and acquisitions that occurred in 2005–2007 and the sharp downturn in REIT share prices that occurred in 2008 and the first quarter of 2009.[10] The average number of REITs across our initial 76 quarter sample is 157.

To obtain the balance sheet and income statement information necessary to unlever quarterly returns at the firm level, our initial REIT sample is merged with data collected from the quarterly CRSP/Compustat database. In particular, we require the following firm-level data at the beginning of each quarter: debt in current liabilities (DLCQ), long term debt (DLTTQ), preferred dividends (DVPQ), interest and related expenses (XINTQ) and total assets (ATQ).[11] Preferred stock-liquidation values (PSTKL) are obtained from Compustat on an annual basis.

Column (D) of Table 2 displays the number of equity REITs in our merged sample at the beginning of the fourth quarter of each calendar year. The number of REITs lost each quarter is reported in column (E). On average, 3.2 REITs are lost due to a lack of required accounting information in Compustat.

Levered monthly total returns for each REIT in our All-Properties sample are downloaded from CRSP-Ziman and then compounded to produce the levered

[9]If a REIT is delisted during a quarter, its total return is included in that quarter and weighted by its beginning-of-quarter market capitalization.

[10]The wave of REIT mergers and acquisitions that occurred in 2005–2007 is discussed in detail in Ling and Petrova (2011).

[11]Note that, unlike Riddiough, Moriarty and Yeatman (2005), we do not require REITs to have a full calendar year of data to be included in the sample.

total return on equity for REIT i in quarter t, or $r^e_{i,t}$.[12] We create an index of equity REIT returns for each quarter by weighting the total return of each constituent REIT in quarter t by its equity market capitalization at the end of quarter t – 1. The index weight for REIT i in quarter t is therefore:

$$w^e_{i,t} = \frac{\left(mcap^e_{i,t-1}\right)}{\sum_{i=1}^{N_t}\left(mcap^e_{i,t-1}\right)}, \tag{3}$$

where $mcap^e_{i,t-1}$ is the equity market capitalization of firm i at the end of quarter t – 1. The total number of equity REITs in the index in quarter t is denoted as N_t.

Finally, the total levered return on our All-Properties Equity REIT Index return in quarter t is defined as:

$$R^E_t = \sum_{i=1}^{N_t} w^e_{i,t} r^e_{i,t}. \tag{4}$$

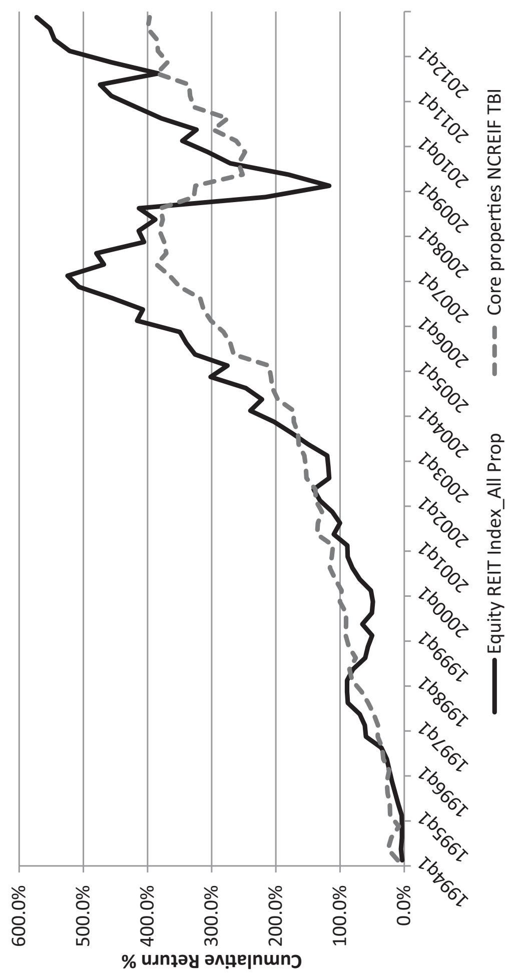
This weighting and aggregation process is repeated each quarter to generate a time-series of levered REIT returns.

The mean levered total return on our All-Properties REIT Index is 10.55% (Panel B of Table 1); the corresponding returns on the CRSP-Ziman and FTSE NAREIT All Equity REIT Indices are 10.65% and 10.66%, respectively. The correlation of our levered quarterly REIT returns with the CRSP-Ziman and FTSE NAREIT Indices are 0.9999 and 0.9982, respectively. Thus, our All-Properties Return Index closely mirrors the returns on two widely reported equity REIT indices, despite the use of a quarterly buy-and-hold methodology and the loss of several firms most quarters due to a lack of accounting information in Compustat.

Figure 2 displays cumulative returns on our levered All-Properties REIT Index. For comparison, we also plot the cumulative returns on our Core-Properties NCREIF TBI Index. Equity REITs entered a 16-year bull market in late 1990, approximately three years before the private market began its recovery. From 1994 through 2006, equity REITs produced somewhat higher returns than private markets, albeit with more measured volatility. However, the REIT bear market that began in the second quarter of 2007 was even more severe than the downturn captured by the TBI for the private market. The recovery in the REIT market, however, began at least three quarters earlier than the recovery in the

[12] CRSP calculates monthly returns for each REIT by compounding daily returns. Thus, although we assume quarterly buy-and-hold investment strategies, firm-level returns assume daily compounding.

Figure 2 ■ Cumulative returns: All-Properties REIT Index vs. Core-Properties NCREIF-TBI.



private market. Over the full sample period, the 10.55% mean return on our levered All-Properties REIT Index exceeds the corresponding Core-Properties TBI return of 8.80% by 175 basis points.

We also use the methodology described above to create levered REIT return indices for each of the four core property types. The property type focus of each REIT at the beginning of each quarter is obtained from CRSP-Ziman.[13] Over the 76 quarter sample period, the apartment, office, industrial and retail indices contain an average of 21, 19, 9 and 40 REITs, respectively.

Our levered return indices for multifamily, office, industrial and retail REITs are displayed in Figure 3. Summary statistics for these four levered property type indices are reported in Panel B of Table 1. Over the 1994–2012 period, multifamily REITs produced an average annualized levered return of 11.77%. The corresponding levered returns on office, industrial and retail REITs were 10.49%, 9.57% and 12.04%, respectively. Interestingly, the (annualized) standard deviation of levered apartment returns is somewhat lower than the standard deviation of returns on office, industrial and retail REITs. Thus, multifamily REITs outperformed the other core property types on a simple return-per-unit-of-risk basis over the 1994–2012 sample period.

Unlevering REIT Returns

The first step in delevering REIT returns at the firm level is to calculate the firm's unlevered return on assets (weighted average cost of capital) in each quarter. We estimate the unlevered return on total assets for REIT i in quarter t, $r_{i,t}^{TA}$, as:

$$r_{i,t}^{TA} = \left(r_{i,t}^{e}\theta_{i,t}^{e}\right) + \left(r_{i,t}^{d}\theta_{i,t}^{d}\right) + \left(r_{i,t}^{p}\theta_{i,t}^{p}\right), \tag{5}$$

where $r_{i,t}^{e}$ is the levered total return on equity, $r_{i,t}^{d}$ is the total return earned by the firm's long-term and short-term debt holders in quarter t, and $r_{i,t}^{p}$ is the return earned by preferred shareholders. The time-varying quarterly weights corresponding to equity, debt and preferred shares in the firm's capital structure

[13]More specifically, a REIT is included in our retail index if it is classified by CRSP-Ziman as having a property type focus of 9 (retail) and a subproperty type focus of 5 (freestanding), 14 (outlet), 15 (regional), 17 (shopping center) or 18 (strip center). Our industrial index includes REITs classified by CRSP-Ziman as having a property type focus of 4 (industrial/office) and a subproperty type focus of 8 (industrial). Our quarterly office sample includes REITs with a property type focus of 4 (industrial/office) and a subproperty type focus of 13 (office). Finally, a REIT is included in our apartment index in a given quarter if it is assigned by CRSP-Ziman a property type focus of 8 (residential) and a subproperty type focus of 2 (apartments).

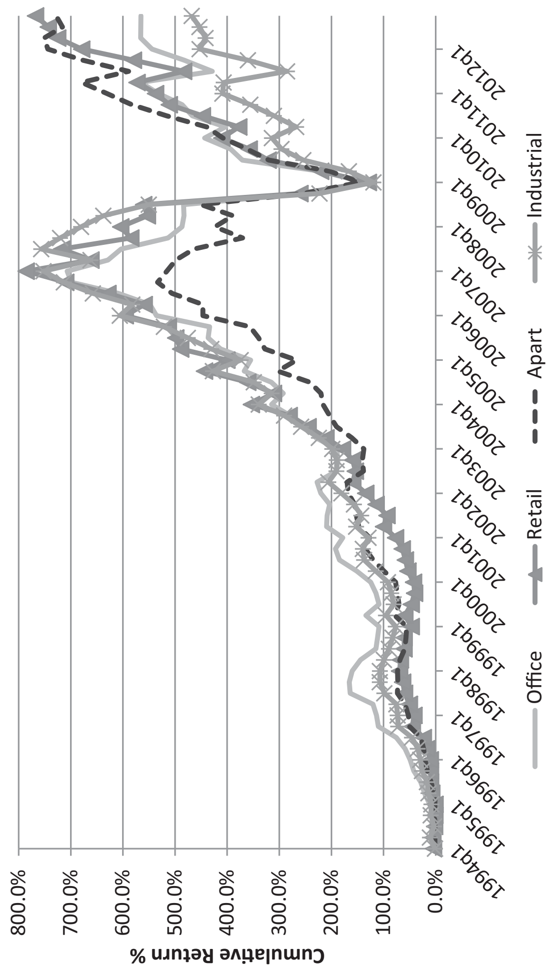


Figure 3 ■ Cumulative returns: Levered REITs.

are denoted as $\theta_{i,t}^{e}$, $\theta_{i,t}^{d}$ and $\theta_{i,t}^{p}$, respectively. The appendix contains a detailed discussion of our quarterly calculations of $r_{i,t}^{e}$, $r_{i,t}^{d}$, $r_{i,t}^{p}$, $\theta_{i,t}^{e}$, $\theta_{i,t}^{d}$ and $\theta_{i,t}^{p}$,

An index of unlevered returns on total assets in quarter t, R_t^{TA}, is constructed by summing over the weighted unlevered returns earned by each constituent REIT; that is,

$$R_t^{TA} = \sum_{i=1}^{N_t} w_{i,t}^{TA} r_{i,t}^{TA}, \tag{6}$$

where $r_{i,t}^{TA}$ is REIT i's unlevered (total) return on assets Equation (5) and

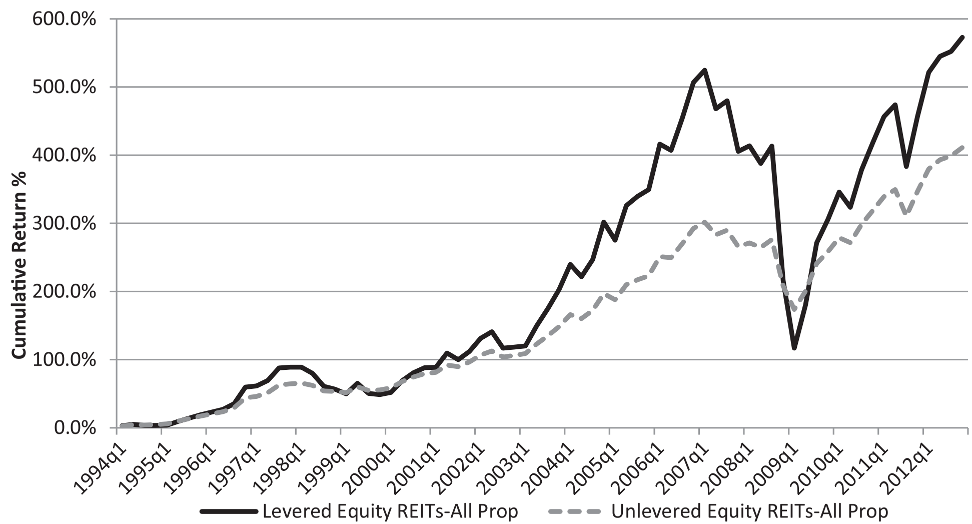
$$w_{i,t}^{TA} = \frac{(TA_{i,t-1})}{\sum_{i=1}^{N_t} TA_{i,t-1}}, \tag{7}$$

where $TA_{i,t-1}$ is the total asset value for REIT i at the end of quarter t – 1 (see the Appendix). When constructing the aggregate All-Properties Index, N_t equals the total number of REITs in the sample at the beginning of quarter t. When constructing an index of returns on office REITs, for example, N_t equals the number of office REITs in the sample. Unlevered quarterly returns are compounded to obtain an index of cumulative returns for both our All-Properties REIT Index and our four core property type indices.[14]

Figure 4 displays cumulative returns on our unlevered All-Properties REIT Index. For comparison, cumulative returns on our levered All-Properties REIT

[14]Riddiough, Moriarty and Yeatman (2005) derive their annual capital structure weights by averaging, for example, the equity market capitalization of a firm at the beginning and end of each year. However, using the market capitalization of each REIT at the end of the year along with the beginning-of-year market capitalization to construct average yearly stock market capitalizations can create a significant "look-ahead" bias. More specifically, REITs that perform well during the year will have higher average market capitalizations for the year. This, in turn, will cause the weight applied to their equity return, $\theta_{i,t}^{e}$, in Equation (6) to be overstated. This artificially high weight biases upwards the estimated return on total assets for this REIT. In contrast, REITs that perform poorly during the year will have lower average market capitalizations. This, in turn, will cause the weight applied to this REIT's equity return, relative to the weights applied to debt and preferred stock, to be understated in that year. In short, using (unknown) end-of-period data when unlevering returns creates an upward bias in the calculation of the return on assets of "winners" and a downward bias in the calculation of the return on assets of "losers." In addition, when an index of unlevered returns in a given time period is constructed by summing over the weighted unlevered returns earned by each constituent REIT during that period, this look-ahead bias places too large a weight on the unlevered returns earned by winners and too low a weight on the unlevered returns earned by losers. This look-ahead bias accounts for at least a portion of the REIT outperformance, relative to private markets, reported by Riddiough, Moriarty and Yeatman (2005). We avoid this look-ahead bias by weighting only by beginning-of-period equity market capitalizations.

Figure 4 ■ Cumulative returns: Levered vs. unlevered REITs.



Index are also displayed. The annualized mean quarterly return on the unlevered All-Properties Return Index is 8.97%; the annualized quarterly standard deviation is 10.31% (Panel C of Table 1). As previously reported, the corresponding mean return and standard deviation for the levered return series are 10.55% and 20.86%, respectively. Thus, the levered index (unconditionally) outperforms the unlevered index by 158 basis points annually over the full sample. However, the standard deviation of levered REIT returns is 2.0 times as large as the volatility of unlevered returns.

The impact of leverage on returns and volatility is most pronounced after 2002. During 2003–2006, levered REIT returns were significantly higher than their unlevered counterparts. However, the downturn in the REIT market that began in 2007 and ended in 2009Q1 was much more pronounced on a levered basis. Similarly, the upturn in the REIT market that began in 2009Q2 and persisted through 2011Q3 boosted levered returns more than unlevered returns.

Unlevered mean returns, standard deviations and autocorrelations for our four core property type REIT indices are also reported in Panel C of Table 1. Consistent with our All-Properties Index, our unlevered property focused indices display lower mean returns than their levered counterparts, but also significantly less volatility. The effect of leverage on mean returns, however, varies noticeably across property types. On a simple return-per-unit-of-risk basis, levered REITs appear to have significantly underperformed their (hypothetical) unlevered benchmark.

Adjusting REIT Returns for Differences in Property Focus

Similar to the institutional investors who are the data-contributing members of NCREIF, publicly traded REITs typically focus their investments in institutional quality properties. However, the NCREIF TBI Index is more heavily weighted toward office and industrial properties than the CRSP-Ziman and FTSE NAREIT Indices, which have higher concentrations of retail and apartment properties. In addition, self-storage, timber, infrastructure and other specialty REITs typically account for approximately a fourth or more of the FTSE NAREIT equity market capitalization, but they have no presence in the core-orientated TBI index. Failure to account for these differences in property type focus when aggregating return data across REITs could lead to erroneous conclusions about differences in the risk-return characteristics of public and private CRE markets.[15]

[15] Pavlov and Wachter (2011) utilize the Moody's/REAL Commercial Property Price Indices (CPPI) to create a "shadow" portfolio of the indices that matches precisely the

To adjust for differences in property type focus, we use information from the CRSP-Ziman database to identify REITs focused on the four major property types. As discussed above, this classification is performed quarterly, and CRSP-Ziman re-categorizes a REIT's property type focus if it changes. This information allows us to construct quarterly REIT returns for the four core property types. We then aggregate these four series in each quarter using the same property type weights we employ to construct our aggregate Core-Properties TBI Return Index (see Equations (1) and (3))[16].

The number of core-focused REITs at the beginning of the fourth quarter of each calendar year is shown in Table 2, column (F). Column (G) contains the difference between our final sample of equity REITs that meet our data requirements for calculating unlevered returns (column (D)) and the number of core-focused REITs. Figure 5 reveals that the percentage of equity REITs classified as core investors hovered near 60% during the mid-to-late 1990s. Beginning in the early-to-mid 2000s, this percentage drifted downward; by 2012Q3, just 50% of equity REITs were focused on one of the four core property types. This underscores the importance of controlling for the mix of property types when comparing the performance of REIT and private market return indices.

Panel D of Table 1 displays summary statistics for our aggregate Core-Properties REIT Index. The mean unlevered return on our Core-Properties REIT Index averaged 9.29% over the sample period with an annualized standard deviation of 9.71% (Panel D). The corresponding mean and standard deviation for the unlevered All-Properties REIT Index are 8.97% and 10.31%, respectively. Thus, on a simple return-per-unit-of-risk basis, REITs invested in core properties appear to have outperformed non-core REITs.

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property type and regional exposure of each REIT. They then follow the evolution of the shadow portfolio over time to estimate the return to the underlying real estate for each REIT using data from 2001 to 2007. In addition to a short sample period that does not include the dramatic recovery of REIT share prices that began in early 2009, the Moody's/REAL CPPI captures price appreciation but not periodic income returns. However, Muhlhofer (2013) argues that REITs are primarily a property income vehicle due to constraints on their ability to sell properties and realize gains from short-term price appreciation. Thus, the exclusion of periodic income from the analysis of Pavlov and Wachter (2011) compromises their ability to find a link between REIT returns and private market returns.

[16]This weighting procedure ensures that the weights of the four major property types are identical in our public and private market return series. However, the subproperty type mix within each of the four major property type categories likely varies in public versus private markets. For example, if retail REITs hold, in the aggregate, a different percentage of their assets in regional malls in a given quarter than do NCREIF investors, this could account for a portion of any difference in the performance of retail REITs relative to the NCREIF retail benchmark.

Figure 5 ■ Core focused REITs as a percentage of total.

Unconditional Results: Public versus Private Market Returns

Now that adjustments have been made for financial leverage, property type focus and portfolio/asset management fees, we turn next to an analysis of the relative performance of public and private CRE. Cumulative unlevered returns on our aggregate Core-Properties REIT and TBI indices are plotted in Figure 6. From 1994 through 2006, we observe little difference in the return performance of core public and private real estate at the aggregate level.[17] However, unlevered core REITs outperformed their private market benchmark by 49 basis points (annualized) over the sample period.[18]

Similar to the aggregate indices, the return performance of publicly traded industrial, office and retail REITs varied little from the return performance of their private market benchmarks until later in the sample period (see Figures 8–10). However, distinguishable differences in the performance of multifamily REITs and privately held multifamily portfolios began to appear as early as the mid-1990s (Figure 7). In fact, privately held multifamily properties produced higher cumulative mean returns than multifamily REITs until 2010. Over the full sample period, privately held multifamily properties produced an annualized mean return of 9.49%; the corresponding unlevered return on multifamily REITs was 9.08%, a difference of 41 basis points. However, the measured standard deviation of returns on privately held multifamily properties was 11.42%, somewhat higher than the 9.50% standard deviation of multifamily REIT returns. Thus, on a return-per-unit-of-risk basis, multifamily REITs appear to have slightly outperformed privately held multifamily portfolios over the sample period.

Over the full sample period, industrial REITs produced an annualized unlevered mean return of 9.02%; the corresponding return on privately held industrial

[17]The relative performance of core-focused REITs is enhanced when the NCREIF NPI is used as our private market benchmark in place of the TBI.

[18]It is customary to use the larger private market as the benchmark when analyzing the relative performance of public and private markets. However, when aggregating across property types, the public–private comparison may be affected by the use of private market property type weights to construct both the aggregate core NPI portfolio and the REIT portfolio. As a robustness check, we calculate the quarterly weights for each core REIT property type from Equation (7). Over 1994–2012, the average quarterly weights for apartment, office, industrial and retail properties in the core REIT portfolio are: 26%, 21%, 10% and 43%, respectively. The corresponding average quarterly weights for apartment, office, industrial and retail properties in the private market portfolio are: 20%, 37%, 17% and 26%, respectively. When the REIT market quarterly weights are used to construct returns on the core REIT portfolio, instead of the private market weights, the mean annualized return on core-property REITs declines from 9.29% to 9.19%. In contrast, when the REIT market weights are used to construct returns on the core NCREIF NPI portfolio, the mean annualized TBI return on core properties increases from 8.80% to 9.13%. Thus, the outperformance of REITs decreases from 49 to 6 basis points (annualized) over the sample period.

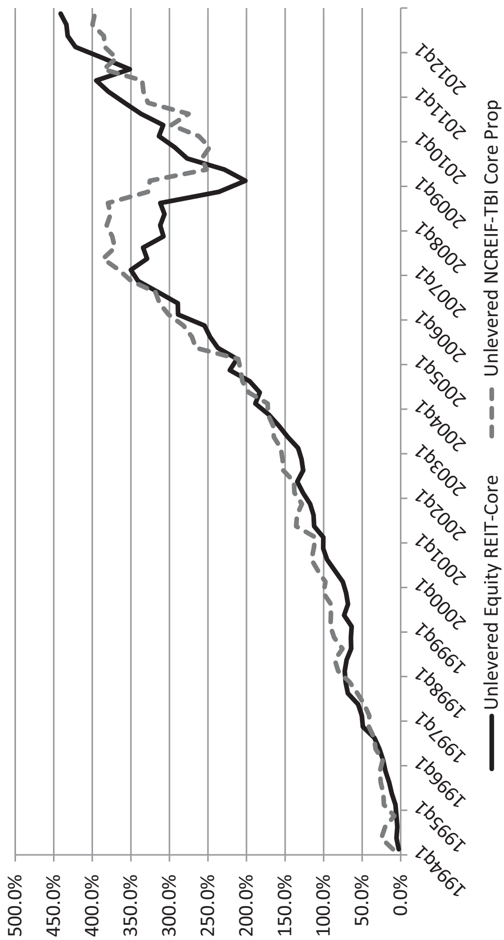


Figure 6 ■ Cumulative unlevered returns on core-properties: REITs vs. NCREIF TBI.

Figure 7 ■ Cumulative unlevered apartment returns: REITs vs. NCREIF.

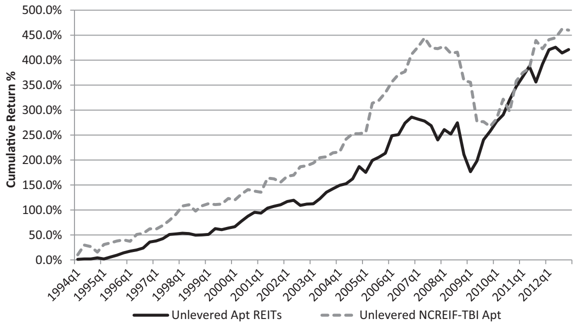


Figure 8 ■ Cumulative unlevered industrial returns: REITs vs. NCREIF TBI.

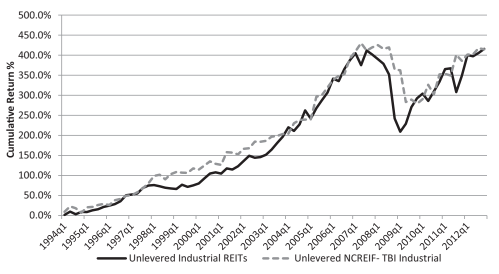
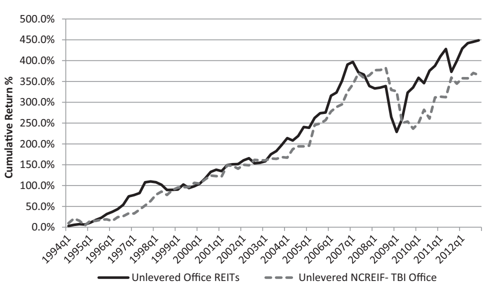
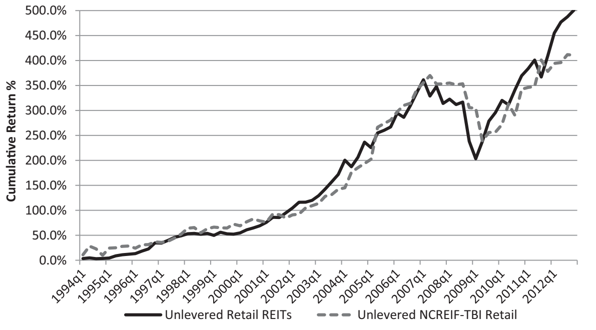


Figure 9 ■ Cumulative unlevered office returns: REITs vs. NCREIF.



properties was 9.00%, a difference of just two basis points. Cumulative returns on both public and private market industrial properties are displayed in Figure 8.

Figure 10 ■ Cumulative unlevered retail returns: REITs vs. NCREIF TBI.



As can be seen in Figures 9 and 10, office and retail REITs produced higher average returns than their private market benchmarks over the full sample, with most of the (unconditional) outperformance coming after 2008. Over the full sample period, office REITs outperformed their private benchmark by 94 basis points; retail REITs also outperformed their private market benchmark on a raw return basis by 94 basis points. Clearly, the observed outperformance of our unlevered Core-Properties REIT Index, relative to the Core-Properties TBI Index, is driven by office and retail REITs, tempered by the relative underperformance of apartment REITs.

The constraint imposed on our analysis by the lack of TBI indices prior to 1994Q1 requires us to exclude the early 1990s, a period during which public REIT markets outperformed private markets. More specifically, from 1990 to 1993 the annualized mean return on the CRSP-Ziman REIT Index was 11.37% (Table 3). The corresponding mean return on the NCREIF NPI was –1.60%, an annualized difference of 12.97%. Over the 1994–2012 sample period, the CRSP-Ziman Index outperformed the NCREIF NPI by 140 basis points (annually). However, over the 1990–2012, this outperformance increases to 349 basis points before any adjustments for leverage, property type focus, or management fees. In short, excluding 1990–1993 from the analysis substantially decreases the measured outperformance of equity REITs.

Finally, although TBI indices are preferred to the use of appraisal-based indices, as robustness checks we also make use of NCREIF's Open-End Diversified Core Equity (ODCE) fund as a private market benchmark. The ODCE is an index of investment returns earned by 33 open-end commingled funds pursuing a core real estate investment strategy. Similar to the NCREIF TBI Index, the ODCE Index is time- and capitalization-weighted. However, returns are reported net of management fees.

Table 3 ■ Sensitivity of results to selected sample period.

	Annualized Total Returns		
	1990–1993	1994–2012	1990–2012
CRSP-Ziman Equity REITs	11.37%	10.66%	10.78%
NCREIF NPI	−1.60%	9.26%	7.29%
Difference	12.97%	1.40%	3.49%

Note: This table reports annualized quarterly returns over three sample periods. Our benchmark for property-level quarterly returns in the private commercial real estate market is the NCREIF Property Index (NPI) produced by the National Council of Real Estate Investment Fiduciaries (NCREIF: www.ncreif.com). Our benchmark for quarterly returns in the equity REIT market is obtained from the CRSP-Ziman database (www.crsp.com/products/ziman.htm).

Figure 11 plots cumulative unlevered returns on our Core-Properties REIT Index along with NCREIF ODCE returns. Over the full sample period, the NCREIF ODCE fund produced a mean annualized return of 7.14%. This annualized return is 215 basis points lower than the 9.29% mean return on our unlevered Core-Properties REIT Index. Thus, the outperformance of equity REITs is further magnified when the NCREIF ODCE fund is used as our private market benchmark.

The Dynamic Relation between Public and Private Market Real Estate Returns

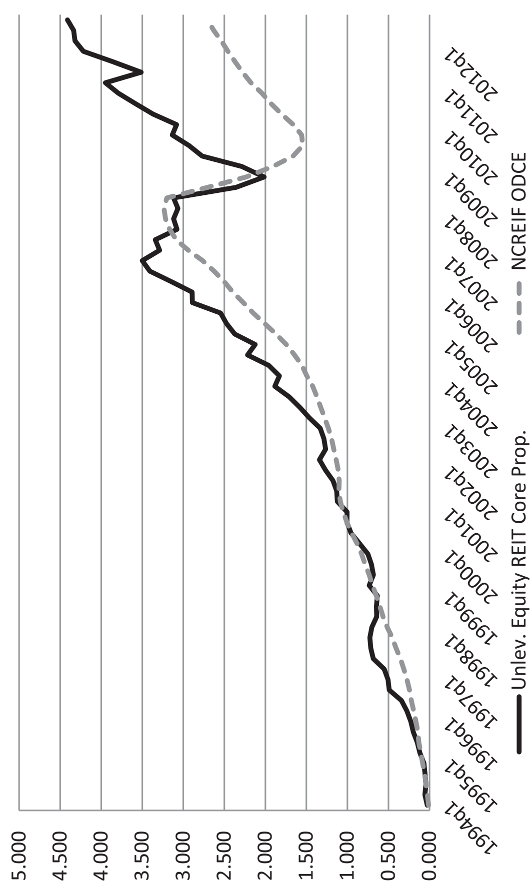
Empirical Methodology: VAR Models

We employ VAR models to measure the dynamics between public (REIT) and private market (TBI) returns, while controlling for the influence of asset pricing factors. In its simplest form, a VAR model is composed of a system of regressions where two or more dependent variables are expressed as linear functions of their own and each other's lagged values as well as some potential exogenous control variables. In more technical terms, a VAR model is the unconstrained reduced form of a dynamic simultaneous equations model. An unrestricted pth-order Gaussian VAR model can be represented as:

$$Yt = \mu + \Phi_1 Y_t -_1 + \Phi_2 Y_t - 2 + \cdots + \Phi_k Y_t -_p + e_t, \tag{8}$$

where Y_t is a $k \times 1$ vector of endogenous variables, μ is a $k \times 1$ vector of intercepts, $\Phi_1, \Phi_2, \ldots, \Phi_k$ are k x k matrices of parameters with all eigenvalues of Φ having moduli less than one so that the VAR is stationary. e_t is a vector of uncorrelated structural shocks [$\sim NID(0, \Omega)$]. We obtain maximum likelihood

Figure 11 ■ Cumulative unlevered returns: Core-Properties REIT Index vs. NCREIF ODCE.



estimates of Φ and Ω using iterated least squares. In our empirical implementation, we augment our VAR models with a vector of exogenous asset pricing control variables to capture other potential sources of variation in both sets of returns. We choose the number of quarterly lags in the VAR system based on examination of the Akaike Information Criteria (AIC) for various choices of p, and we confirm that this lag length selection is also robust to using the Schwarz Bayesian Information Criteria (SBIC) and the likelihood ratio selection criteria.

In a bivariate framework consisting of only REIT and TBI returns as endogenous variables, the diagonal coefficients of Φ represent conditional momentum in REIT and TBI returns, while the off-diagonal coefficients of Φ represent conditional positive feedback and anticipation effects (changes in TBI returns following changes in REIT returns and vice versa). In addition to quantifying the dynamic relation between REIT and TBI returns and controlling for important factors such as a potential smoothing bias in TBI, the VAR model allows us to estimate impulse response functions for the variables of interest. Impulse response functions provide the time path of the short-run dynamic relations that result from a shock to a variable in the system.

Return Data

As discussed earlier, two key differences between REIT and NCREIF TBI returns are that REIT returns are levered and the property mixes/weights differ across the two sets of returns. To address these differences, we carefully unlever REIT returns at the firm level and construct REIT portfolios with property type weights identical to the TBI portfolios we use as benchmarks in our analysis. However, there are likely other variables that differentially influence REIT and TBI returns, such as liquidity effects and standard asset pricing factors.

Previous studies either compare adjusted returns as we do in our second section (*e.g.*, Pagliari, Scherer and Monopoli 2005, Riddiough *et al.* 2005) or perform conditional analyses using unadjusted returns and/or few or no asset pricing controls (Morawski *et al.* 2008, Li *et al.* 2009, Oikarinen *et al.* 2011, Yunus *et al.* 2012). We next examine the conditional dynamic relation between private and public real estate returns using our All-Properties, Core-Properties and by-property-type return indices, while also controlling for a host of asset pricing variables shown to affect asset returns.

Asset Pricing Control Variables

We include the following standard asset pricing control variables in all of our quarterly bivariate VAR specifications: the yield on three-month U.S. Treasury securities (*TBILL3M*), the slope of the Treasury term structure of interest rates measured by the difference between ten-year and three-month constant maturity U.S. Treasury yields (*TERMSPREAD*), the spread between yields on BAA rated and AAA rated corporate bonds (*DEFSPREAD*), the rate of inflation (*INFL*) and the excess return on the market portfolio (*MKT*) (*e.g.*, Chen, Roll and Ross 1986, Ferson and Harvey 1991, Fama and French 1993, Fama and Schwert 1977). In addition, we include the remaining Fama–French risk factors, *SMB* (returns on portfolios of small minus big stocks) and *HML* (returns on portfolios of high book-to-market minus low book-to-market stocks), augmented by a return momentum factor, *MOM* (*e.g.*, Jegadeesh and Titman 1993, Fama and French 1996, Carhart 1997, Liew and Vassalou 2000, Lettau and Ludvigson 2001). To capture liquidity effects, we also include Pastor and Stambaugh's (2003) liquidity innovation factor, *LIQ_PS*.[19]

Prior research has shown that dividend (current) yields are also a significant predictor of subsequent asset price changes (Ghysels, Plazzi and Valkanov 2007, Fama and French 1988). Therefore, as additional control variables, we include the dividend yield on equity REITs (*DIVYLD*) and the aggregate capitalization rate (*CAPRATE*) for commercial properties (*i.e.*, the ratio between a property's annual net rent and its price) as proxies for current yields. *CAPRATE* is each quarter's weighted average capitalization rate across apartment, industrial, office and retail properties. Dividend yields and capitalization rates are obtained from NAREIT and from the *Real Estate Report* published quarterly by the Real Estate Research Corporation.[20] Table 4 reports descriptive statistics for the asset pricing control variables over our 1994–2012 sample period. The mean dividend yield (*DIVYLD*) for equity REITs is 5.9% and ranges from 3.4% to 9.4%. The average cap rate (*CAPRATE*) for commercial properties over our sample period is 8.1%, ranging from a low of 6.1% to a high of 9.4%. Both *DIVYLD* and *CAPRATE* display significant first-order autocorrelations.

[19] The focus of the paper is on the dynamic relations among public and private real estate returns, not the in-sample effect of a particular control variable. In our analysis, we therefore use the standard set of asset pricing controls to be comprehensive and careful in our asset pricing controls, rather than being ad hoc in the selection of a particular control or deciding to include a particular control based on in-sample significance tests. Joint tests on the significance of our controls also show that our standard asset pricing controls are jointly significant in our specifications. However, if we instead do various in-sample optimal model tests to eliminate controls in various specifications, our reported results on the dynamic relations between public and private real estate returns do not change.

[20] In contrast to our asset pricing control variables, Li, Mooradian and Yany (2009) use a limited number of economic controls in their VAR framework (*i.e.*, GDP, credit spread, term spread and Fed funds rate), while Oikarinen, Hoesli and Serrano (2011) do not use any asset pricing controls in their cointegration and VEC analysis.

Table 4 ■ Descriptive statistics on asset pricing variables.

Variable	Mean	Median	Std. Dev.	Min.	Max.	Autocorrelation (−1)
TBILL3M	0.030	0.035	0.022	0.0001	0.062	0.96***
TERMSPREAD	0.017	0.016	0.012	−0.006	0.036	0.92***
DEFSPREAD	0.010	0.009	0.005	0.006	0.030	0.84***
INFL	0.006	0.006	0.009	−0.039	0.025	−0.15
MKT	0.017	0.024	0.090	−0.223	0.206	0.04
SMB	0.008	0.003	0.053	−0.108	0.191	0.03
HML	0.005	0.003	0.079	−0.320	0.239	0.16
MOM	0.014	0.016	0.093	−0.398	0.261	0.10
LIQ_PS	0.003	0.020	0.112	−0.286	0.333	−0.07
DIVYLD	0.059	0.061	0.016	0.034	0.094	0.90***
CAPRATE	0.081	0.085	0.011	0.061	0.094	0.96***

Notes: This table reports descriptive statistics for our asset pricing control variables: the annualized yield on three-month U.S. Treasury securities (*TBILL3M*), the annualized slope of the Treasury term structure of interest rates (*TERMSPREAD*), the annualized spread between yields on BAA rated and AAA rated corporate bonds (*DEFSPREAD*) and quarterly inflation (*INFL*). We also include the three Fama–French risk factors *MKT*, *SMB* and *HML* augmented by a return momentum factor, *MOM*, and a liquidity factor, *LIQ_PS*. *MKT* is the total return on the value-weighted stock market portfolio, as measured by the Center for Research in Securities Pricing (CRSP), minus the corresponding quarterly return on U.S. Treasury securities from CRSP. *SMB* is defined as the total return on a portfolio of small cap stocks in excess of the return on a portfolio of large cap stocks. *HML* is the total return on stocks with book-to-market value ratios in excess of the returns on a portfolio of stocks with low book-to-market ratios. *MOM* is the total return on a portfolio of stocks with high prior returns in excess of stocks with low prior returns. *LIQ_PS* is Pastor and Stambaugh's (2003) liquidity innovation factor. *DIVYLD* is the dividend yield on equity REITs from NAREIT, and *CAPRATE* is each quarter's weighted average capitalization rate across apartment, industrial, office and retail properties where the weights are the proportion of total market value corresponding to each property type. Capitalization rates are obtained from quarterly publications of the *Real Estate Report* published by the Real Estate Research Corporation. The sample period spans 1994:Q1–2012:Q4. Descriptive statistics are reported in decimal form. *** represents 1% significance level.

Unit Root Tests

A potential problem arises with the VAR framework if the variables in the system are non-stationary. In general, a series is non-stationary if its mean, autocovariances or other higher moments are time dependent. If a series is non-stationary, simple time-series techniques can result in misleading (or spurious) values of inferential statistics (*i.e.*, *t*-statistics, R^2 and DW) that may cause one to erroneously conclude that a meaningful relation exists among the regression variables.

Table 5 ■ Unit root tests on return series.

Return Series	Augmented DF	DF-GLS	Phillips–Perron	Autocorrelations (−1)	Autocorrelations (−2)
Unlevered Equity REIT Returns					
All-Properties	(0.00)	(0.00)	(0.00)	0.14	−0.06
Core-Properties	(0.00)	(0.00)	(0.00)	0.16	−0.07
Apartment	(0.00)	(0.00)	(0.00)	0.09	−0.01
Industrial	(0.00)	(0.00)	(0.00)	0.15	−0.07
Office	(0.00)	(0.00)	(0.00)	0.21*	−0.07
Retail	(0.00)	(0.00)	(0.00)	0.06	0.00
TBI Returns					
All-Properties	(0.00)	(0.00)	(0.00)	−0.13	0.06
Core-Properties	(0.00)	(0.00)	(0.00)	−0.13	0.06
Apartment	(0.00)	(0.00)	(0.00)	−0.07	0.07
Industrial	(0.00)	(0.00)	(0.00)	−0.14	0.05
Office	(0.00)	(0.00)	(0.00)	−0.11	0.10
Retail	(0.00)	(0.00)	(0.00)	−0.12	0.04

Notes: This table reports Augmented Dickey-Fuller, DF-GLS and Phillips-Perron unit root tests on the various return series. The null hypothesis is that the return series contains a unit root. The sample period spans 1994:Q1–2012:Q4. *P*-values are reported in parentheses. For the autocorrelations, * represents 1% significance level.

Table 5 reports Augmented Dickey–Fuller (DF), DF-GLS and Phillips–Perron unit root test results for the various unlevered equity REIT and TBI return series used in our VAR analysis. The null hypothesis is that the return series contains a unit root. We also report the first and second autocorrelations to further document each return series' time dependency. The sample period for the tests spans 1994:Q1–2012:Q4.

In all test cases, the null of a unit root is rejected at the 1% significance level. The REIT return autocorrelations are relatively small and insignificant for each of the unlevered REIT return series, except for unlevered REIT office returns, which have a first-order autocorrelation of 0.21 and are significantly different from zero at the 10% level. Similarly, each of the NCREIF TBI return autocorrelations are small and insignificantly different from zero. In sum, the results from the unit-root tests suggest that each of the return series we use in our unconstrained bivariate VAR specifications are stationary, so a vector error correction (VEC) model is not the appropriate model for our analysis.[21]

[21] Consistent with the asset pricing and return performance literature, our variable of interest is returns—not *index* levels or first differences of the index levels. Some earlier

Baseline Dynamic Relations between TBI Returns and Unlevered REIT Returns

Table 6 contains our baseline VAR results using TBI returns and unlevered REIT returns as endogenous variables; exogenous asset pricing control variables are excluded from the specifications. The first set of results in Panel A contains the individual coefficient estimates and *p*-values from using the All-Properties REIT and All-Properties TBI Indices; the second set of results contains the individual coefficient estimates obtained from estimating the models using our Core-Properties indices. Using the Akaike Information Criteria (AIC) for various choices of *p*, we find that the optimal number of quarterly lags in our VAR system is four; we confirm that the four lag selection is robust to the use of the Schwarz Bayesian Information Criteria (SBIC) and the likelihood ratio selection criteria. In Panel B of Table 6, we report the sum of the four lagged coefficients of the endogenous variables and test for their joint significance. *P*-values associated with these joint tests are reported in parentheses.

Quarterly REIT returns (*REITRET*) predict TBI returns (*TBIRET*) in subsequent quarters using both the All-Properties and Core-Properties indices. However, lagged TBI returns have no predictive power in the *REITRET* equations. In fact, the adjusted R^2s for the *REITRET* equations are negative; in contrast, they range from 29% in the All-Properties *TBIRET* return equation to 31% in the Core-Properties *TBIRET* return equation.

The sum of the four lagged estimated coefficients on *REITRET* in the *TBIRET* equation is positive and highly significant (Panel B). The sum of the four lagged coefficients on *TBIRET* is negative and significant in both *TBIRET* equations. However, the magnitude of this TBI return effect is small in comparison to the impact of REIT returns. Overall, the results reported in Table 6 suggest that lagged REIT returns are highly predictive of returns in the private market, but private market returns have no predictive power in public market REIT returns.

In Table 7 we report the results obtained from separately estimating our VAR model for each of the four core property types. Standard asset pricing controls are again excluded. To examine the cumulative effects of the lagged endogenous variables, we report the sum of the estimated coefficients on the four lags of

studies have used public and private real estate return *indices*, which are non-stationary and require the use of cointegration and VEC procedures. Our unit root and redundant cointegration tests show that our return series are all stationary, and a VAR model is therefore appropriate for our analysis. Li, Mooradian and Yany (2009) also use a VAR framework. Oikarinen, Hoesli and Serrano (2011) use a cointegration and VEC framework, although they do not use leverage and property-type adjusted returns or asset pricing controls in their analysis.

Table 6 ■ VAR results: Unlevered equity REIT and TBI returns using all- and core-properties.

	All-Properties		Core-Properties	
Variables	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*
Panel A: Individual Lags				
Constant	0.025***	0.001	0.024***	−0.001
	(0.003)	(0.925)	(0.004)	(0.995)
$REITRET_{t\text{-}1}$	0.141	0.282***	0.177	0.291***
	(0.237)	(0.005)	(0.139)	(0.004)
$REITRET_{t\text{-}2}$	−0.069	0.374***	−0.070	0.388***
	(0.571)	(0.000)	(0.564)	(0.000)
$REITRET_{t\text{-}3}$	−0.031	0.272**	−0.019	0.310***
	(0.805)	(0.011)	(0.879)	(0.004)
$REITRET_{t\text{-}4}$	0.079	0.228**	0.095	0.232**
	(0.554)	(0.042)	(0.482)	(0.043)
$TBIRET_{t\text{-}1}$	0.031	−0.447***	0.014	−0.479***
	(0.806)	(0.000)	(0.911)	(0.000)
$TBIRET_{t\text{-}2}$	−0.081	−0.058	−0.085	−0.088
	(0.525)	(0.590)	(0.500)	(0.415)
$TBIRET_{t\text{-}3}$	−0.165	0.154	−0.166	0.138
	(0.140)	(0.105)	(0.134)	(0.143)
$TBIRET_{t\text{-}4}$	0.013	0.109	0.034	0.106
	(0.904)	(0.225)	(0.744)	(0.232)
Adjusted R^2	−0.058	0.289	−0.045	0.308
Panel B: Joint Significance				
$REITRET_{t\text{-}1\ to\ t\text{-}4}$	0.119	1.156***	0.182	1.221***
	(0.706)	(0.000)	(0.555)	(0.000)
$TBIRET_{t\text{-}1\ to\ t\text{-}4}$	−0.202	−0.241***	−0.202	−0.322***
	(0.633)	(0.000)	(0.595)	(0.000)

Notes: This table presents results obtained from estimating our unrestricted bivariate VAR models using REIT and TBI returns for All- and Core-Properties as endogenous variables. The lag-length of the VAR is chosen by using the AIC criterion for various choices of p. We find that four lags provide the best fit. With four lags and a TBI return series starting date of 1994Q1, the estimated sample period spans 1995:Q1–2012:Q4. Panel A contains the individual coefficient estimates and p-values. In Panel B, we report the sum of the four lagged coefficients of the endogenous variables and tests of their joint significance. P-values are reported in parentheses. *** and ** represent 1% and 5% significance levels, respectively.

Table 7 ■ VAR results: Unlevered equity REIT and TBI returns by property type.

	Apartment		Industrial		Office		Retail	
Variables	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*
$REITRET_{t\text{-}1\ to\ t\text{-}4}$	−0.058	1.251***	−0.009	1.103***	0.333	0.906***	−0.022	1.211***
	(0.848)	(0.000)	(0.321)	(0.000)	(0.283)	(0.000)	(0.960)	(0.000)
$TBIRET_{t\text{-}1\ to\ t\text{-}4}$	−0.051	−0.210***	0.199	−0.532***	−0.443	0.031***	0.118	−0.373***
	(0.577)	(0.002)	(0.538)	(0.000)	(0.204)	(0.001)	(0.757)	(0.001)
Adjusted R^2	−0.066	0.287	−0.025	0.311	0.022	0.261	−0.093	0.283

Notes: This table presents joint coefficient results obtained from estimating our unrestricted bivariate VAR models using REIT and TBI returns for apartment, industrial, office and retail property types as endogenous variables. The lag-length of the VAR is chosen by using the AIC criterion for various choices of p. We find that four lags provide the best fit. With four lags and a TBI return series starting date of 1994Q1, the estimated sample period spans 1995:Q1–2012:Q4. We report the sum of the four lagged coefficients of the endogenous variables and tests of their joint significance. P-values are reported in parentheses. *** represents 1%, joint significance level.

REITRET and *TBIRET* and associated tests of joint significance. Similar to the All-Properties and Core-Properties results reported in Table 6, lagged REIT returns are highly predictive of TBI returns across each of the four property type specifications. However, TBI returns have no predictive power in the *REITRET* equations. Across property types, lagged TBI returns have significant predictive power in the *TBIRET* equations. However, the magnitude and significance of the lagged coefficients on *REITRET* in the *TBIRET* equations are much larger and more significant. With the exception of the office returns equation with a small positive adjusted R^2 of approximately 2%, we also find that each *REITRET* equation has a negative adjusted R^2. These results further suggest that neither lagged REIT returns nor lagged TBI returns are able to predict current REIT returns.

Although not separately tabulated, Granger causality tests confirm the influence of REIT returns on TBI returns using our baseline bivariate VAR model. In each bivariate VAR specification, we can reject the null hypothesis that REIT returns do not cause TBI returns at the 5% level. In contrast, we cannot reject the null hypothesis that TBI returns do not cause REIT returns for any of the four property types. These findings are consistent with Li *et al.* (2009) and Oikarinen *et al.* (2011).

Adding Asset Pricing Control Variables

Our baseline VAR results do not control for movements in standard asset pricing variables known to influence asset returns. However, given their greater liquidity, REIT share prices are likely quicker than private real estate market values to embed changes in market fundamentals. Therefore, adding exogenous asset pricing control variables could serve as a direct channel, thereby resulting in a reduction in the predictive ability of REIT returns in our *TBIRET* equations. This alternative channel, however, does not take away from our earlier results on the predictive power of REITs, but rather provides evidence on the sources of that predictability. We therefore include in an enhanced specification quarterly lags of the exogenous, discussed above and listed in Table 4, in both the REIT and TBI return equations.

Looking first at the estimated effects of lagged endogenous variables in Panel A of Table 8, we see that lagged REIT and TBI returns have no significant influence on contemporaneous REIT returns across both the All-Properties and Core-Properties specifications. These results are consistent with our baseline specification results without exogenous controls. However, in contrast to our baseline results, we do not find evidence in Panel A that lagged REIT returns are predictive of TBI returns in the All-Properties *TBIRET* equation. Moreover, in our All-Properties specification the sum of the four lagged coefficients on

Table 8 ■ VAR results with asset pricing control variables: Unlevered equity REIT and TBI returns using all- and core-properties.

Panel A: Individual Lags

	All-Properties		Core-Properties	
Variables	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*
Constant	−0.030	0.038	−0.056	0.033
	(0.738)	(0.608)	(0.518)	(0.656)
$REITRET_{t\text{-}1}$	0.143	−0.036	0.168	−0.035
	(0.526)	(0.846)	(0.428)	(0.847)
$REITRET_{t\text{-}2}$	0.004	0.131	0.001	0.119
	(0.980)	(0.350)	(0.995)	(0.406)
$REITRET_{t\text{-}3}$	0.052	0.170	0.063	0.184
	(0.692)	(0.123)	(0.638)	(0.106)
$REITRET_{t\text{-}4}$	0.055	0.183	0.066	0.152
	(0.679)	(0.100)	(0.625)	(0.191)
$TBIRET_{t\text{-}1}$	−0.001	−0.617***	−0.001	−0.610***
	(0.995)	(0.000)	(0.996)	(0.000)
$TBIRET_{t\text{-}2}$	−0.008	−0.209*	0.008	−0.199*
	(0.952)	(0.071)	(0.950)	(0.085)
$TBIRET_{t\text{-}3}$	−0.116	0.031	−0.110	0.044
	(0.347)	(0.765)	(0.357)	(0.669)
$TBIRET_{t\text{-}4}$	0.081	0.027	0.097	0.034
	(0.443)	(0.755)	(0.349)	(0.703)
$TBILL3M_{t\text{-}1}$	−1.175	−0.270	−0.871	−0.245
	(0.153)	(0.694)	(0.279)	(0.723)
$TERMSPREAD_{t\text{-}1}$	−0.842	−0.465	−0.584	−0.316
	(0.491)	(0.648)	(0.623)	(0.757)
$DEFSPREAD_{t\text{-}1}$	−0.979	−5.539**	−0.283	−5.301**
	(0.720)	(0.015)	(0.916)	(0.021)
$INFL_{t\text{-}1}$	0.973	0.202	0.930	0.266
	(0.157)	(0.725)	(0.169)	(0.647)
$MKT_{t\text{-}1}$	0.046	−0.000	0.045	−0.003
	(0.677)	(0.997)	(0.673)	(0.971)
$SMB_{t\text{-}1}$	−0.293**	0.092	−0.275**	0.091
	(0.042)	(0.442)	(0.042)	(0.434)
$HML_{t\text{-}1}$	−0.057	−0.038	−0.078	−0.032
	(0.689)	(0.751)	(0.558)	(0.780)
$MOM_{t\text{-}1}$	−0.158	0.015	−0.176	0.022
	(0.173)	(0.880)	(0.112)	(0.820)
$LIQ\_PS_{t\text{-}1}$	0.099	0.000	0.093	0.005
	(0.134)	(0.994)	(0.146)	(0.922)
$CAPRATE_{t\text{-}1}$	0.539	1.922	0.749	1.910
	(0.747)	(0.167)	(0.655)	(0.184)
$DIVYLD_{t\text{-}1}$	1.068	−1.633	0.869	−1.643
	(0.384)	(0.110)	(0.477)	(0.117)
Adjusted R^2	−0.043	0.317	−0.024	0.313

Table 8 ■ Continued

Panel B: Joint Significance

	All-Properties		Core-Properties	
Variables	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*
$REITRET_{t\text{-}1\ to\ t\text{-}4}$	0.255	0.447	0.298	0.421
	(0.954)	(0.280)	(0.908)	(0.341)
$TBIRET_{t\text{-}1\ to\ t\text{-}4}$	−0.044	−0.767***	−0.005	−0.731***
	(0.685)	(0.000)	(0.592)	(0.000)

Notes: This table presents results obtained from estimating our unrestricted bivariate VAR models using REIT and TBI returns for All- and Core-Properties as endogenous variables with exogenous asset pricing control variables. The lag-length of the VAR is chosen by using the AIC criterion for various choices of *p*. We find that four lags provide the best fit. With four lags and a TBI return series starting date of 1994Q1, the estimated sample period spans 1995:Q1–2012:Q4. The set of exogenous asset pricing control variables included in the VAR estimation are the yield on three-month U.S. Treasury securities (*TBILL3M*), the slope of the Treasury term structure of interest rates (*TERMSPREAD*), the spread between yields on BAA rated and AAA rated corporate bonds (*DEFSPREAD*) and inflation (*INFL*). We also include the three Fama–French risk factors *MKT*, *SMB* and *HML* augmented by a return momentum factor, *MOM*, and a liquidity factor, *LIQ_PS*. *MKT* is the total return on the value-weighted stock market portfolio, as measured by the Center for Research in Securities Pricing (CRSP), minus the corresponding quarterly return on U.S. Treasury securities from CRSP. *SMB* is defined as the total return on a portfolio of small cap stocks in excess of the return on a portfolio of large cap stocks. *HML* is the total return on stocks with high ratios of book-to-market value in excess of the returns on a portfolio of stocks with low book-to-market ratios. *MOM* is the total return on a portfolio of stocks with high prior returns in excess of stocks with low prior returns. *LIQ_PS* is Pastor and Stambaugh's liquidity innovation factor. We also include dividend yields (*DIVYLD*) on equity REITs from NAREIT and weighted average capitalization rates (*CAPRATE*) derived from Real Estate Research Corporation property type data. Panel A contains the individual coefficient estimates. In Panel B, we report the sum of the four lagged coefficients of the endogenous variables and tests of their joint significance. *P*-values are reported in parentheses. *** represents 1% significance level.

REITRET is no longer significant in the *TBIRET* equation. Similarly, the Core-Properties specification shows that lagged REIT returns do not predict TBI returns, and the sum of the four lagged coefficients on *REITRET* is also no longer significant in the *TBIRET* equation. Overall, our results strongly suggest that asset pricing control variables are an important fundamental channel through which REIT returns influence TBI returns. However, it does not appear that equity REIT returns contain additional real estate specific information useful in predicting private market returns, once standard asset pricing controls have been added to the specification.

While our focus is on the relation between public and private returns and not on the asset pricing controls, the significance of the asset pricing controls is still of interest. In each specification, the asset pricing controls are jointly significantly different from zero at least at the 10% level.[22] Although not separately tabulated, we also performed numerous robustness checks. These checks include adding control variables such as real non-durable consumption expenditures, the percentage of properties sold from the NCREIF NPI Index as a measure of private market liquidity, REIT turnover measures and the use of levered REIT returns. In each case, our results between public and private real estate returns are robust to alternative specifications, with no inferential or economic significance changes.[23]

The results reported in Table 9, based on separate estimates for each property type, further demonstrate the importance of including asset pricing controls. In each specification, the asset pricing controls are again jointly significantly different from zero at least at the 10% level (they are jointly significantly different from zero at the 5% level and lower in half of the specifications). For apartment properties, lagged REIT returns predict TBI returns, although the impact is again significantly muted relative to specifications that do not include the exogenous controls. However, for industrial, office and retail properties, the sum of the lagged coefficients on *REITRET* in the *TBIRET* equation cannot be distinguished from zero.

Although not tabulated, $INFL_{t-1}$ has a positive and significant effect on REIT returns in the apartment sector (1.45 with p-value $= 0.026$). However, the estimated coefficient on lagged realized inflation is not significant in the industrial, office and retail regressions over the full period estimates. Apartment leases generally have lease terms of one year or less. In contrast, lease terms on industrial and retail properties can range to 25 years (or more with renewal options),

[22]The adjusted R^2s across specifications also improve relative to the baseline specifications without controls, suggesting again that the models are better specified when exogenous control variables are included.

[23]While *MKT* is not statistically significant in any of our complete model specification results, it is significant if we exclude all of the other exogenous controls. This result suggests that the *MKT* effect is being absorbed by the inclusion of the other asset pricing control variables. Moreover, while the significance level of specific exogenous controls varies some with varying model specifications and subsample time periods, our documented relations between public and private market real estate returns are robust to alternative exogenous variable specifications. For instance, in subsample tests, we find that lagged inflation (*INFL*) has a significantly positive effect on REIT returns, which can be viewed as an inflation hedge. This finding is consistent with Hoesli, Lizieri and MacGregor (2008) who document that real estate returns are linked to inflation. Similarly, we find that REIT returns are influenced by *MOM* in other subsample time periods. However, our documented relations between public and private market real estate returns are robust in these alternative tests.

Table 9 ■ VAR results with asset pricing control variables: Unlevered equity REIT and TBI returns by property type.

	Apartments		Industrial		Office		Retail	
Variables	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*	*REITRET*	*TBIRET*
$REITRET_{t\text{-}1\ to\ t\text{-}4}$	−0.008	0.619***	0.088	0.373	0.442	0.095	−0.576	0.785
	(0.996)	(0.002)	(0.613)	(0.433)	(0.691)	(0.503)	(0.802)	(0.507)
$TBIRET_{t\text{-}1\ to\ t\text{-}4}$	−0.066	−0.663***	0.320	−0.792***	−0.298	−0.624***	0.458	−0.456***
	(0.701)	(0.000)	(0.370)	(0.000)	(0.431)	(0.000)	(0.369)	(0.000)
Adjusted R^2	0.013	0.375	−0.049	0.303	0.020	0.339	0.016	0.220

Notes: This table presents joint coefficient results obtained from estimating our unrestricted bivariate VAR models using REIT and TBI returns for apartment, industrial, office and retail property types as endogenous variables with exogenous asset pricing control variables. The lag-length of the VAR is chosen by using the AIC criterion for various choices of *p*. We find that four lags provide the best fit. With four lags and a TBI return series starting date of 1994Q1, the estimated sample period spans 1995:Q1–2012:Q4. The set of exogenous asset pricing control variables included in the VAR estimation are the yield on three-month U.S. Treasury securities (*TBILL3M*), the slope of the Treasury term structure of interest rates (*TERMSPREAD*), the spread between yields on BAA rated and AAA rated corporate bonds (*DEFSPREAD*) and inflation (*INFL*). We also include the three Fama–French risk factors *MKT*, *SMB* and *HML* augmented by a return momentum factor, *MOM*, and a liquidity factor, *LIQ_PS*. *MKT* is the total return on the value-weighted stock market portfolio, as measured by the Center for Research in Securities Pricing (CRSP), minus the corresponding quarterly return on U.S. Treasury securities from CRSP. *SMB* is defined as the total return on a portfolio of small cap stocks in excess of the return on a portfolio of large cap stocks. *HML* is the total return on stocks with high ratios of book-to-market value in excess of the returns on a portfolio of stocks with low book-to-market ratios. *MOM* is the total return on a portfolio of stocks with high prior returns in excess of stocks with low prior returns. *LIQ_PS* is Pastor and Stambaugh's liquidity innovation factor. We also include dividend yields (*DIVYLD*) on equity REITs from NAREIT and weighted average capitalization rates (*CAPRATE*) derived from Real Estate Research Corporation property type data. We report the sum of the four lagged coefficients of the endogenous variables and tests of their joint significance. *P*-values are reported in parentheses. *** represents 1% joint significance level.

typically with prespecified lease rates (including escalations). The fixed-rate nature of these long-term leases makes their present values highly sensitive to unexpected inflation. This risk exposure leads to higher negotiated lease rates, all else equal, that respond slowly to realized inflation. In sharp contrast, relatively short-term apartment leases require negligible inflation premiums at origination. However, market participants understand that nominal apartment rental rates can be quickly marked-to-market in response to inflation. Thus, higher realized inflation is expected to be reflected in rental rates, and therefore property values, relatively quickly. In addition to inflation effects, REIT returns by property type are also significantly influenced by *SMB*, *MOM* and *LIQ_PS* over our sample period.

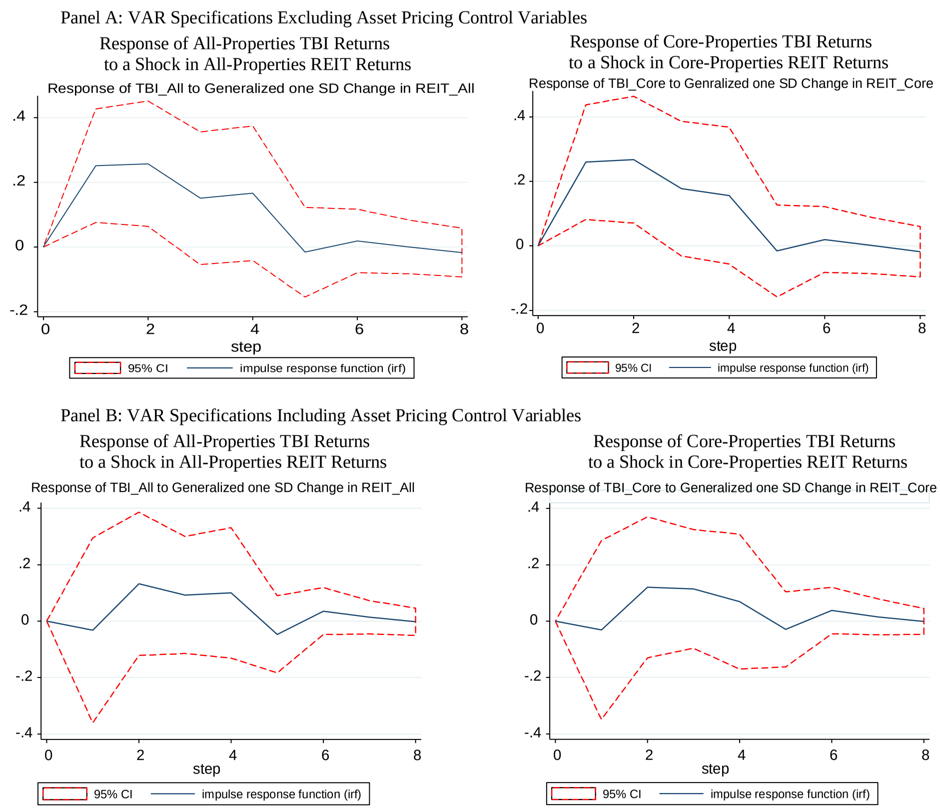
Impulse Response Functions: REIT and TBI Return Dynamics

We employ generalized impulse response functions to further quantify the economic significance of relations between the REIT and TBI returns. Impulse response functions trace the effect of a one-standard-deviation residual shock to current and future values of the endogenous variables within the dynamic structure of the VAR. We express responses in standard deviation units similar to Griffin, Nardari and Stulz (2007). In particular, we standardize each variable in our VAR prior to estimation and then generate the associated impulse response functions. Similar to Statman, Thorley and Vorkink (2006), we also aggregate responses across periods to illustrate the cumulative effect of REIT returns on TBI returns over time.

The VAR generalized impulse response functions displayed in Figure 12 provide additional evidence regarding the impact of REIT returns on TBI returns. In Panel A, we provide the impulse response functions for our All-Properties and Core-Properties indices using the baseline VAR specifications that exclude exogenous control variables. Panel B presents the corresponding impulse response functions from the VAR specifications that include exogenous control variables. The vertical axis in each panel measures the standard deviation change in TBI returns in response to a one-standard-deviation shock in REIT returns. The solid line in each figure represents the estimated diffusion of quarterly TBI returns to a shock in REIT returns; the remaining two curves depict the 95% confidence interval of these estimates.

Panel A of Figure 12 reveals an economically significant increase in TBI returns in response to a shock to REIT returns for both the All-Properties and Core-Properties REIT indices. In particular, a one-standard-deviation shock to the All-Properties REIT Return Index results in a 0.825 SD change in All-Properties TBI returns over the subsequent four quarters. In percentage terms, this is a 4.29% change in TBI returns. Similarly, a one-standard-deviation shock to the

Figure 12 ■ Impulse response functions.



Core-Properties REIT returns results in a 0.861 SD change in Core-Properties TBI returns over the subsequent four quarters; this is a 4.48% change in TBI returns. In sharp contrast, Panel B shows that when the exogenous asset pricing control variables are included in the VAR specifications, the TBI return response to a shock in REIT returns is substantially muted and not statistically different from zero, as displayed by the 95% confidence bounds.

Conclusion

Both the direct private market and the public securities market can provide investors with exposure to CRE markets. However, public and private CRE returns, as commonly measured, have exhibited significantly different risk-return characteristics. Comparing public and private CRE returns, both unconditionally and conditionally, requires several adjustments. We employ a two-stage approach. First, we use an unconditional approach that consists of adjusting the composition and risk characteristics of publicly traded REIT portfolios to match as closely as possible the composition and characteristics of our benchmark private market portfolios. More specifically, we unlever equity REIT returns at the firm level before aggregating into portfolios. In addition, when aggregating quarterly returns across property types to create representative portfolios and return series, each major property type is assigned the same weight each quarter in both the public market and private market portfolios.

Our sample period runs from 1994 to 2012, thereby capturing the recent boom and bust in CRE markets. However, in addition to extending the time period under analysis relative to prior studies, our procedure for unlevering REIT returns at the firm level, our careful classification of each REIT's property type focus and our construction of an aggregate index that includes only those REITs that invest primarily in core property types collectively provide a contribution to the existing literature on the relative return performance of private and public CRE markets.

We provide evidence in our first-stage unconditional analysis that passive portfolios of U.S. office and retail REITs outperformed their private market benchmarks over the 1994–2012 sample period; in contrast, in the multifamily market we provide evidence of modestly higher average returns in the private market. In the aggregate, unlevered core REITs outperformed their private market benchmark by 49 basis points (annualized) over the sample period.

Although we carefully unlever REIT returns and construct REIT portfolios with similar property types and weights as our private market benchmark portfolios, there are likely other factors that differentially influence the relative risk and return characteristics of public and private real estate investments. These other factors include liquidity, inflation, dividend yields, the term structure of interest rates, defaults spreads as well as standard CAPM and Fama–French risk factors. Therefore, in our second-stage analysis, we use VAR models and a comprehensive set of asset pricing control variables to examine the short-run dynamics between public and private CRE returns. This dynamic analysis allows us to answer several important questions, including the extent to which each market is influenced by fundamental risk factors and the degree to which public market returns predict private market returns.

Our baseline bivariate VAR results that exclude asset pricing controls strongly suggest that lagged private market returns have no predictive power in our REIT return regressions. In contrast, lagged REIT returns are highly predictive of private market returns. However, when standard asset pricing control variables are included in the VARs, the significance of lagged REIT returns in the private market return equations is eliminated. That is, REIT returns do not appear to contain additional CRE specific information useful in predicting private market returns. These results strongly suggest that equity REIT returns simply react to fundamental (latent) asset pricing information more quickly than private market returns given their greater liquidity and transparency. Said differently, REITs serve as a fundamental information transmission channel to private market returns when asset pricing variables are omitted.

Of particular interest is that the estimated coefficient on the one quarter lag of realized inflation in the apartment REIT regressions is positive and significant; however, the estimated coefficient on lagged inflation is not significant in the industrial, office and retail regressions. We hypothesize that these results reflect the short-term (one year or less) leases standard in the apartment market and the longer-term nature of leases in the industrial, office and retail sector. The fixed-rate nature of long-term leases makes their present values highly sensitive to unexpected inflation. In the apartment market, higher realized inflation can be quickly incorporated into nominal rental rates and property values.

Although we carefully control for leverage, property type and management fees in our comparison of public and private market returns and in our analysis of the ability of REITs to predict private market returns, we do not adjust for differences in the geographic composition of underlying properties. Future research should attempt to address the extent to which performance differences are attributable to differences in the geographic distribution of REIT properties relative to NCREIF properties.

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Appendix

Calculating Levered Returns

Let $bval^{d}_{i,t}$ represent the total book value of short- and long-term debt and $lval^{p}_{i,t}$ the estimated liquidation value of outstanding preferred shares for REIT$_i$ at the end of quarter t.[24] The returns on debt obligations and preferred shares,

[24]Using quarterly Compustat data, the book value of debt is set equal to Debt in Current Liabilities (DLCQ) plus Long Term Debt (DLTTQ); the estimated liquidation value of preferred shares is set equal to Preferred Stock-Liquidating Value (PSTKL). In the quarterly Compustat file, Debt in Current Liabilities, *i.e*., the book value of short-term debt is often missing for one or more quarters. In these cases, we obtain the book value of short-term debt at the end of each year from the annual Compustat file. We then assume that the change in the book value of short-term debt from the end of one year to the next occurs in equal amounts over the four quarters. This assumption obviously smooths quarterly changes in short-term debt but is preferable to dropping the firm in that quarter or assuming the book value of short-term debt is zero. It is also important to note that the quarterly book value of preferred shares reported in Compustat is not usable because the field (PSTKQ) is not well populated; moreover, when a figure is reported it generally appears to be implausible. Thus, we use the estimated liquidation value of preferred shares. As discussed by Riddiough, Moriarty and Yeatman (2005), preferred

respectively, are calculated as:

$$r_{i,t}^{d} = \frac{int_{i,t}^{d}}{bval_{i,t-1}^{d}}, \tag{A1}$$

$$r_{i,t}^{p} = \frac{pdiv_{i,t}^{p}}{lval_{i,t-1}^{p}}, \tag{A2}$$

where $int_{i,t}^{d}$ is total interest paid to debt holders in quarter t and $pdiv_{i,t}^{p}$ is total preferred dividends.[25] $r_{i,t}^{e}$ is constructed by chain-linking monthly returns obtained from CRSP-Ziman.

Total asset value for REIT i at the end of quarter $t, TA_{i,t}$, is set equal to

$$TA_{i,t} = mcap_{i,t}^{e} + bval_{i,t}^{d} + lval_{i,t}^{p}, \tag{A3}$$

where $mcap_{i,t}^{e}$ is the market capitalization of the firm's common shares at the end of quarter t. The capital structure weights in the return on total assets equation for each REIT in each quarter are based on the claims of equity, debt and preferred shares outstanding at the end of quarter t – 1, relative to total assets outstanding, or

$$\theta_{i,t}^{e} = \frac{\left(mcap_{i,t-1}^{e}\right)}{TA_{i,t-1}} \tag{A4}$$

$$\theta_{i,t}^{d} = \frac{\left(bval_{i,t-1}^{d}\right)}{TA_{i,t-1}} \tag{A5}$$

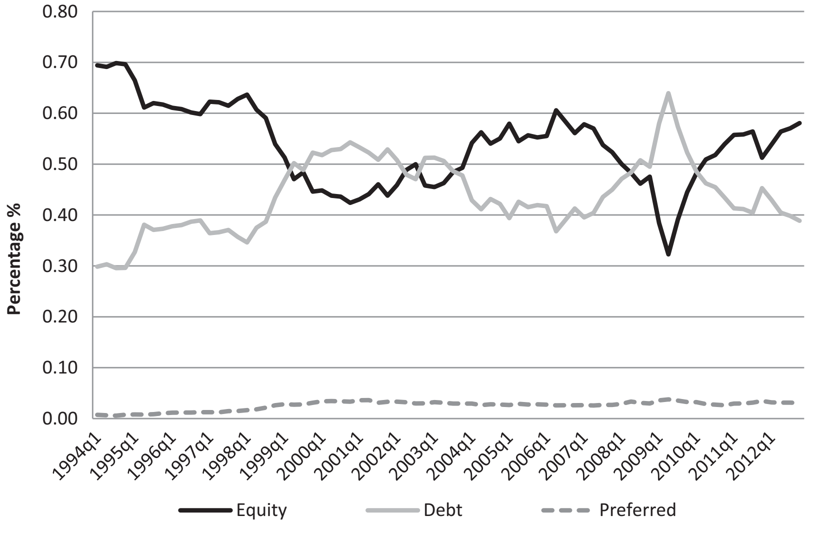
$$\theta_{i,t}^{p} = \frac{\left(lval_{i,t-1}^{p}\right)}{TA_{i,t-1}}. \tag{A6}$$

Figure A1 displays how the weights of equity, debt and preferred share obligations in the typical REIT's capital structure vary by quarter over the sample

shares are often convertible to common shares and/or are callable by the REIT. This optionality makes the estimation of liquidation value difficult because it is set equal to the capitalized dividend stream of the preferred shares or the converted value to common shares, whichever is greater. As a result of this complexity, reported liquidation values are likely noisy estimates of true market value.

[25]Using Compustat data, total interest paid is set equal to Interest Expense on Short-Term Borrowing plus Interest Expense on Long-Term Debt (XINTQ); total preferred dividends paid is set equal to Dividends Preferred (DVPQ). In the quarterly Compustat file, Interest Expense on Short-Term Borrowing plus interest Expense on Long-Term Debt (XINTQ) and Dividends Preferred (DVPQ) are sometimes missing. In these cases, we obtain the total amount of dividends paid and Interest Expense on Short-Term Borrowing and Long-Term Debt (XINTQ) in the year from the annual Compustat file and then assume the annual total was paid in equal amounts over the four quarters. Although preferred dividends on REITs are often constant for long periods of time, this assumption may smooth quarterly dividends on preferred shares but is again preferable to dropping the firm in that quarter or assuming no preferred dividends were paid.

Figure A1 ■ Components of REIT capital structures.



period. These aggregate weights (shares) are constructed by equally weighting REIT-level shares each quarter. On average, equity market capitalizations approached 70% of estimated total asset value in 1994. Use of preferred stock was negligible until 1997 and has since averaged a little more than 2% of the typical equity REITs capital structure. The significant stock price declines experienced by equity REITs in 1998 and 1999 pushed the average equity weight down to nearly 43% by the beginning of 2000, with a corresponding increase in the importance of debt (at book value) in REIT capital structures. During the early 2000s, the role of equity in REIT capital structures gradually increased, maintaining an average weight of 56% from 2004 to 2007Q2. Beginning in late 2007, equity weights again decreased sharply as REIT stock prices plummeted, reaching an average of just 32% in 2009Q2. The average debt share increased to 64% over this period, forcing many REITs to pay down debt obligations and to pursue other strategies to improve their balance sheets. This delevering strategy, coupled with sharply rising stock prices, pushed the average debt share down to 39% by 2012Q4. The average quarterly weights of equity, debt and preferred shares over the full sample period are 54.2%, 43.3% and 2.5%, respectively.