The Long-Run Dynamics between Direct and Securitized Real Estate

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Abstract

This study presents evidence of cointegration between securitized (NAREIT) and direct (NCREIF) real estate total return indices. Since the two real estate indices are cointegrated with one another but not with the stock market, REITs and direct real estate are likely to have similar long-term diversification benefits in a stock portfolio. Only direct real estate is found to currently adjust towards the cointegrating relation, with NAREIT returns leading NCREIF returns. However, the results show evidence of the predictability of NAREIT returns during the 1980s. Additionally, a large and long-lasting deviation from the long-run relation between NAREIT and NCREIF is identified at the beginning of the “new REIT era”.

Keywords: Cointegration, Vector Error-Correction Models, Direct Real Estate, Securitized Real Estate, REITs, Diversification

JEL Classifications: G11, G14, C32

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1 Introduction

The contemporaneous correlation between the returns on direct and indirect real estate investments is typically found to be weak. In contrast, indirect real estate returns have generally been found to closely resemble general stock market returns. Several factors may explain the lack of significant contemporaneous correlation between securitized and unsecuritized real estate returns. For instance, in several studies the use of appraisal-based real estate indices is likely to bias the contemporaneous correlations downwards. Furthermore, securitized real estate prices may embed stock market noise that is not related to the fundamentals driving real estate returns.

Much of the low correlations observed can probably be attributed to the sluggish adjustment of direct real estate prices to shocks in the fundamentals. Due to the higher liquidity, greater number of market participants, smaller transaction costs and the existence of a public market place in the securitized market, the indirect real estate market is generally more informationally efficient than the direct market. Therefore, the prices of indirect real estate investments should react faster to shocks in the fundamentals than those of direct real estate. Indeed, empirical evidence shows that the securitized market leads the direct real estate market (Gyourko and Keim, 1992; Myer and Webb, 1993; Barkham and Geltner, 1995; Li, Mooradian and Yang, 2009).

A positive lead-lag relation between securitized and direct real estate returns diminishes the short-horizon correlations relative to the longer-horizon correlation figures. As in the long run both markets should adjust to shocks in the fundamentals and the impact of noise in securitized real estate prices should vanish, the return correlation is likely to increase as the investment horizon increases. That is, the long-horizon returns on securitized real estate should strongly co-vary with the returns on a portfolio composed of equivalent direct real estate investments (in terms of type, size, location, etc.), since the fundamental asset is
essentially the same in both markets. In fact, since securitized real estate returns are derived from direct real estate assets, one would theoretically expect the return indices of similar indirect and direct real estate portfolios to be cointegrated. However, considerable alterations in the leverage over time may lead to an absence of cointegration between the indices. Consequently, the existence of a cointegrating relationship requires that the leverage used in the securitized portfolio does not exhibit notable permanent alterations over time.

Even in the absence of leverage, returns on securitized real estate might differ somewhat from those on direct real estate. For instance, the required return on indirect real estate may be smaller than on direct property due to the generally better liquidity of securitized real estate. Hardin and Wolverton (1999) suggest that REIT investors are willing to accept lower returns than investors making direct investments in real estate. On the other hand, the better diversification properties (at least in the short run) of direct real estate may cause just the opposite. Moreover, the returns on securitized real estate are affected by factors such as management quality (Sirmans, Friday and Price, 2006) and cost of debt, which may also influence the relationship between the return indices. The results by Hardin, Hill and Hopper (2009), for instance, indicate that REIT-owned properties generate higher effective rents than non-REIT-owned properties. Nevertheless, Pagliari, Scherer and Monopoli (2005) do not reject the hypothesis that direct real estate returns (NCREIF) are equal to the returns of de-leveraged securitized real estate returns (NAREIT) over the 1981-2001 period.

The relative inefficiency of the direct real estate market suggests that direct real estate returns can be predicted by historical returns on equivalent real estate securities. This predictability can materialize through the short-run dynamics or via the long-run cointegrating relation, or both. Nevertheless, given the potential existence of speculative, non-fundamental related noise in securitized real estate prices in the short run, a cointegrating relationship between direct and indirect return indices might also be used to predict returns in the
securitized market. It is essentially an empirical question to find out whether the potential long-run relation can be used to predict returns on securitized real estate. Previous research suggests that there is no such predictability (Ong, 1995; Wang, 2001). However, studies exploring the long-term dynamics between direct and indirect real estate are limited, and existing studies use relatively short sample periods.

In a recent study, Li, Mooradian and Yang (2009) examine the linkages between the appraisal-based NCREIF returns and the NAREIT returns. They find a unidirectional Granger causality from NAREIT to NCREIF even when using a reconstructed NAREIT series that is free of leverage and matches the property mix of the NCREIF index. However, they do not include any long-run dynamics in their model nor do they examine whether such long-term dynamics exist. Since long-run dynamics might be of major importance regarding the linkages between direct and indirect real estate returns and since it is doubtful that previously observed empirical relationships between the markets hold due, for instance, to the maturation of the REIT market, further research on the dynamics using recent data is desirable. The aim of this paper is to extend the analysis conducted by Li, Mooradian and Yang by catering for the long-term dynamics and by discussing the implications of such dynamics. In addition, we examine the impact of the “new REIT era” on the dynamics. Moreover, to avoid the appraisal smoothing problem that is present in the Li, Mooradian and Yang analysis, we also use the transaction-based NCREIF returns. The analysis is carried out using a longer sample period (1977Q4-2008Q4) than in previous related studies.

The main findings of the paper are as follows. First, the results show evidence of a tight long-run relationship between NCREIF and NAREIT total return indices. Based on the previous empirical literature, it is still not clear whether the diversification properties of direct and securitized real estate are the same over the long run. Our finding supports the hypothesis that over the very long horizon their diversification properties are similar. Second, only the
direct market is found to currently adjust towards the long-run relation. This finding is in line with the assumption of greater efficiency of the securitized real estate market and indicates that the direct market returns can be predicted by the deviation from the long-run cointegrating relation. Third, it appears that the NAREIT returns can be used to predict returns on NCREIF through the short-term dynamics as well. Since this lead-lag relation applies also to the transaction-based NCREIF, it cannot only be attributed to appraisal smoothing effects. Fourth, the results suggest that the divergence between NAREIT and NCREIF that emerged in the early 1990s vanished due to the better performance of NCREIF in the late 1990s. That is, the divergence from the long-run relation appears to have been only temporary. Fifth, consistent with the often stated argument regarding weaker informational efficiency of the REIT market prior to the “new REIT era”, the results show evidence that NAREIT returns are predictable during the 1980s but not after that. Finally, our findings confirm the results of Pagliari, Scherer and Monopoli (2005) according to which the deleveraged returns on NAREIT do not differ significantly from the returns on NCREIF.

The findings should be of importance to long-term portfolio investors such as pension funds or other institutional investors. In particular, since cointegration between two return indices implies that the correlation between their returns approaches one as the investment horizon is extended (Cochrane, 2001), cointegration between NAREIT and NCREIF indicates that REITs and direct real estate are substitutable in the mixed-asset portfolio of a long-horizon buy-and-hold investor. That is, the long-horizon diversification gains of adding real estate to a mixed-asset portfolio are expected to be similar with both types of real estate. Since the two real estate indices are cointegrated with one another but not with the stock market, REITs are likely to bring equivalent long-term diversification benefits to a stock portfolio as direct real estate. In the short-run, the diversification benefits of REITs and direct real estate may differ substantially, however. The current notable deviation from the
estimated long-run relationship between the direct and securitized real estate return indices, caused by the global financial crisis, has significant implications for today’s investment strategy as securitized real estate is likely to perform better than direct real estate in the forthcoming years. The predictability implications may also be of importance to various financial institutions and to economic policy makers.

The structure of the paper is as follows. The next section provides a review of the literature on the dynamics between direct and indirect real estate markets. Then, the data used in the empirical analysis are described. The following sections present the econometric methodology employed in the analysis and the empirical results, respectively. Finally, the findings and implications of the study are summarized.

2 Review of the Literature

2.1 Dynamics between Direct and Securitized Real Estate

It is well known that the contemporaneous correlation between indirect and direct real estate returns is low. However, it has also been established that over long horizons, the linkages between indirect and direct real estate are substantially stronger than suggested by the simple contemporaneous correlation figures (Giliberto, 1990; Geltner and Kluger, 1998).

Goetzmann and Ibbotson (1990) and Ross and Zisler (1991) were among the first to note that returns on REITs are only weakly correlated with returns on direct real estate investments. Since then, the low correlation between the two sets of returns has been confirmed in a number of studies and in several countries even when appraisal-based direct real estate indices have been unsmoothed (Gyourko and Keim, 1992; Barkham and Geltner, 1995; Geltner and Kluger, 1998; Hoesli, Lekander and Witkiewicz, 2004; Newell et al., 2005).
Instead of co-moving with direct real estate returns, early empirical evidence, mainly concerning the U.S. market, identified a similar return behavior between securitized real estate and the general stock market (Goetzmann and Ibbotson, 1990; Ross and Zisler, 1991). Ling and Naranjo (1999) find that REITs are integrated with stocks (i.e., that the risk premia for the macroeconomic factors are the same in both markets), but segmented from direct real estate. Giliberto (1990), on the other hand, finds that the residuals from regressions of direct and indirect real estate returns on financial asset returns are significantly correlated. This implies that there is a common factor (or factors) associated with real estate that influences both direct and indirect real estate returns. Also, Mei and Lee (1994) present some evidence of a common real estate factor driving both equity REITs and direct real estate.

According to Clayton and MacKinnon (2001 and 2003) and Pagliari, Scherer and Monopoli (2005), the difference between indirect and direct real estate returns has diminished in the U.S. It has been stated that this is because the REIT market has matured informationally and, therefore, REITs have begun to better reflect their “true” nature (Clayton and MacKinnon, 2001). Hoesli and Serrano (2007) find evidence of decreasing correlation between the securitized real estate and equity markets in a panel of sixteen countries over the 1990-2004 period. Nevertheless, several studies also show that the co-movement between REIT returns and general stock market returns has increased recently. While Ambrose, Lee and Peek (2007) explain the increased correlation by the inclusion of several REITs in the S&P 500 index after October 2001, Simon and Ng (2009) argue that the growth in the co-movement since February 2007 appears to originate from the global financial crisis.

Since the direct real estate market is generally considered less informationally efficient than the securitized market, direct real estate returns may well lag those of the indirect market. Therefore, it is reasonable to assume that the actual linkages between direct and indirect real estate are stronger than implied by the relatively short-horizon contemporaneous correlations.
only. Furthermore, because of their similarity with stock returns over the short horizon, securitized real estate returns may include non-fundamental related noise that vanishes in the long run. If this holds, the correlations between direct and indirect returns over longer investment horizons are expected to be larger than the conventionally reported short-term correlations. Indeed, Giliberto (1990) and Geltner and Kluger (1998) show that the relationship between REIT and direct real estate returns is notably stronger when a lead in the REIT returns is considered. The findings by Morawski, Rehkugler and Füss (2008), in turn, support the argument about the increasing correlation between direct and indirect returns as the investment horizon is extended.¹

Other evidence supporting the leading role of securitized real estate with respect to direct property is presented by Gyourko and Keim (1992), Myer and Webb (1993), and Barkham and Geltner (1995) concerning the U.S. and U.K. markets. Newell and Chau (1996) and Ong (1995) report a short-term leading relationship for real estate companies over commercial real estate in Hong Kong and in Singapore, respectively. On the other hand, Myer and Webb (1994) and Newell et al. (2005) do not find significant Granger causality between securitized and direct commercial real estate. However, both of these examinations are based on short sample periods, 1983-1991 in the former study and 1995-2002 in the latter.

In a more recent paper, Li, Mooradian and Yang (2009) study the linkages between the appraisal-based NCREIF returns and the NAREIT returns. Consistent with the above mentioned results, they find a unidirectional Granger causality from NAREIT to NCREIF. However, their analysis, just like all of the above mentioned studies, lacks one factor that might be of major importance regarding the dynamics between direct and indirect real estate returns. That is, they do not include any long-run dynamics in their model neither do they examine whether such long-term dynamics exist.
Note that, generally, Granger causality from securitized to direct real estate is implied even when the influence of appraisal smoothing has been extracted from the direct return series. Moreover, Geltner and Kluger (1998) and Pagliari, Scherer and Monopoli (2005) find that REIT returns lead the direct returns even after making adjustments for leverage and appraisal smoothing. Pagliari, Scherer and Monopoli (2005) also control for the potential effect of property-type mix. Also, Li, Mooradian and Yang (2009) reconstruct a NAREIT series that is free of leverage and matches the property mix of the NCREIF index, but that exhibits appraisal smoothing. The results based on the reconstructed NAREIT index closely resemble the ones based on the original index.

2.2 Long-Run Dynamics

Despite the appealing intuition and practical importance of cointegration between direct and securitized real estate return indices, only a few studies have examined the existence of long-run dynamics between the two markets. In an early study, Ong (1995) does not find support for cointegration between indirect and direct real estate return indices in Singapore. However, Wang (2001) reports a cointegrating relation between direct and securitized real estate return indices in the U.K. Using quarterly total return indices over 1977-1993, Wang’s results suggest that only direct real estate prices adjust towards the long-run relation. As expected, Granger causality tests imply that securitized real estate returns Granger-cause direct real estate returns also through the short-run dynamics. Wang does not find any feedback from the direct market to the securitized market.

More recently, Morawski, Rehkugler and Füss (2008) find a cointegrating relation between NAREIT, NCREIF and the S&P 500 stock index over the 1978-2006 period. Their results suggest that the stock index cannot be excluded from the long-run relation. That is, the results imply that there is no pairwise cointegrating relation between NAREIT and NCREIF.
Overall, the empirical literature on the long-term dynamics between direct and securitized real estate is limited. The recent study by Li, Mooradian and Yang (2009) is closely related to our analysis. However, this paper extends the Li, Mooradian and Yang analysis and contributes to the literature by examining both the short- and long-run co-movement and the lead-lag relations between direct and securitized real estate. Recent data are used, and the paper also investigates the impact of the “new REIT era” on the dynamics between direct real estate and REITs.

3 Data
The data used in this study were sourced from Thomson Datastream and cover the period 1977Q4-2008Q4. For securitized real estate, the FTSE/NAREIT Equity REITs index (NAREIT) is used and for direct real estate two versions of the NCREIF Property Index are employed. One is the conventional appraisal-based NCREIF index (NCREIF), and the other is the transactions-based NCREIF index (TBI) that is available since 1984Q1.² The shorter TBI index is included in the analysis, since the conventional NCREIF index is likely to exhibit appraisal smoothing (Geltner, 1993). Stock market performance is calculated with Datastream’s U.S. total market index. The stock data are included in the dataset in order to check whether REIT returns resemble stock returns also in the long run or whether REITs are more tightly related to direct real estate in the long term. In addition, the stock data enable the examination of the potential long-run diversification benefits of adding securitized or direct real estate to a broad U.S. stock portfolio. All the indices employed in the analysis are total return indices and natural logarithms of the indices are used throughout the analysis.

While NAREIT includes the impact of leverage, the NCREIF indices consist of unleveraged properties. The magnitude of leverage naturally affects the mean and volatility of securitized real estate returns. The greater the leverage, the higher are the mean and
standard deviation of returns (assuming that the return on assets is greater than the cost of
debt, on average). Therefore, an indirect return index is expected to grow faster than a
corresponding direct real estate index over the long run. Moreover, together with time
variation in the inflation rate, leverage can cause instability of the ratio between NAREIT and
NCREIF returns when real returns are considered. This could hinder the examination of long-
run dynamics between the indices. For instance, if the average leverage of REITs was 50%,
we would expect the average nominal return on REITs to be twice that on a corresponding
unleveraged (direct) portfolio, abstracting from the other potential sources of divergence
between the returns. As the ratio between real returns would be dependent on the inflation
rate, we use nominal indices in the analysis.

In addition to leverage, there are also other reasons why the two indices are not
perfectly equivalent to each other. First, the property mix of the NAREIT index somewhat
differs from that of the NCREIF (Pagliari and Webb, 1995; Pagliari, Scherer and Monopoli,
2005). Second, management may affect the performance of REITs to some extent. The
above mentioned complications should be of minor relevance in the empirical analysis as our
aim is to investigate if the NAREIT and NCREIF returns reflect the same “real estate factor”
in the long run and to examine the predictability of the overall NAREIT and overall NCREIF
returns.

The appraisal-based NCREIF is used in the empirical analysis to estimate a long-run
relation between NCREIF and NAREIT. The complications with the appraisal-based index
are well known. However, appraisal smoothing should not notably influence the
cointegration test results or the long-run parameter estimates, since in the long run the
appraiser’s views cannot diverge from the actual price level in a systematic manner, i.e., the
appraisal-based return index and the actual (unobservable) returns should be cointegrated.
Nevertheless, since appraisal smoothing is likely to bias the estimation of the short-run dynamics, the transactions-based NCREIF index is also included in the analysis.

The four total return indices used are depicted in Exhibit 1, while the descriptive statistics of the returns (i.e., the differenced indices) are reported in Exhibit 2. As can be seen, the total returns and return volatilities of REITs (including the effect of leverage) and stocks have been practically the same over 1977Q4-2008Q4. As expected, the NCREIF returns have been somewhat lower. According to Pagliari, Scherer and Monopoli (2005), however, there is no statistically significant difference between the unleveraged NAREIT and NCREIF returns. Exhibit 1 also shows that during 1984Q1-2008Q4 the growth rate of the appraisal-based NCREIF has equaled that of the TBI on average, as anticipated. The volatility of the transaction-based index has been twice the volatility of the appraisal-based index. None of the return series appear to be normally distributed and there is evidence for seasonal variation in the returns on the TBI.

Exhibit 1 here

Exhibit 2 here

The correlation coefficients between the quarterly returns are reported in Exhibit 3. The contemporaneous correlation of NCREIF returns with REIT returns is surprisingly similar to the correlation between TBI returns and REIT returns. When the sample from 1984Q1 onwards is employed for NCREIF as well, the figures are even closer. That is, appraisal smoothing does not seem to diminish the contemporaneous quarterly correlation all that much. The greatest observed correlation is that between REITs and stocks (0.58). It should be noted that the correlations exhibit substantial time-variation. In particular, the time-variation in the correlation between NAREIT and stock market returns shown in Figure A1 in the Appendix is in line with both the findings regarding increasing co-movement between REITs and the general stock market recently (Ambrose, Lee and Peek, 2007; Simon and Ng,
2009) and concerning the decline in the co-movement since the early 1990s (Hoesli and Serrano, 2007). The jump in the correlation from the 2003Q4-2008Q3 period to the 2004Q1-2008Q4 period is likely to be due to the financial crisis. The increased co-movement between the markets during the crisis is not surprising, since it is well known that during crisis periods returns on many assets tend to co-move more strongly than during “normal” periods.

[Exhibit 3 here]

4 Econometric Methodology
In the empirical section, the dynamic interdependences between securitized real estate, direct real estate and stocks are examined econometrically. First, the existence of cointegrating relationships between the total return indices is tested employing pairwise Johansen tests. As explained in the introduction, there are sound a priori theoretical reasons to expect that the real estate indices might be cointegrated, and cointegration between the markets would have important implications regarding portfolio diversification and return predictability. In particular, cointegration between two indices would indicate that tight long-run interrelations exist between the series. In this article, the cointegration tests are based on the following conventionally used Vector Error-Correction Model (VECM):

\[ \Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_k \Delta X_{t-k+1} + \alpha \beta' X_{t-1} + \epsilon_t \]  

(1)

where \( \Delta X_t \) is \( X_t - X_{t-1} \), \( X_t \) is a two-dimensional vector of total return index values in period \( t \), \( \mu \) is a two-dimensional vector of drift terms, \( \Gamma_i \) is a 2 x 2 matrix of coefficients for the lagged differences of the return indices at lag \( i \), \( k \) is the maximum lag, i.e. the number of lags included in the corresponding vector autoregressive (VAR) model, \( \alpha \) is a vector of the speed of adjustment parameters, \( \beta' \) forms the cointegrating vector and \( \epsilon \) is a vector of white noise
error terms. The long-run relationship ($\beta'X_{t-1}$) in (1) includes only the two indices included in the test and no deterministic variables.

The maximum lag (ML) is selected based on the Hannan-Quinn information criteria (HQ) as suggested by Johansen, Mosconi and Nielsen (2000). Furthermore, since some of the series seem to exhibit seasonal variation, the need for seasonal dummies is detected based on HQ. Finally, the selection of the number of cointegrating vectors ($r$) is done by comparing the estimated Trace statistics with the quantiles approximated by the $\Gamma$-distribution (see Doornik, 1998). Because asymptotic distributions can be rather bad approximations of the finite sample distributions, the Bartlett small sample corrected values suggested by Johansen (2002) are employed. Weak exogeneity of the variables is tested by the Likelihood Ratio (LR) test (Johansen, 1996) and exclusion of the variables from the cointegrating vector is tested by the Bartlett small-sample corrected LR test reported in Johansen (2000).\footnote{3}

Furthermore, because of the possible structural break in the long-run dynamics due to the “new REIT era”, the stability of the estimated long-run relations is examined employing a recursive estimation analysis explained in Juselius (2006).

Based on the estimated long-run relations, VECMs are estimated to study the dynamics more carefully. The direction of the possible Granger causality is tested by a standard F-test to examine the existence of lead-lag relations between the assets.

**5 Empirical Results**

In this section, the short- and long-run dynamics between direct real estate (NCREIF and TBI) returns, REIT (NAREIT) returns and the overall stock market returns are examined by testing for the existence of cointegrating relations and by estimating Vector Error-Correction Models (VECM). The order of integration of the variables is checked first. Then
cointegration tests are conducted. Finally, Granger causalities are examined based on the estimated VECMs.

The ADF unit root test indicates that all the indices are I(1). This finding is in line with the majority of previous related empirical work. The unit root test results are reported in Exhibit 4.

[Exhibit 4 here]

5.1 Long-Run Relationship

Since the NCREIF series is longer than the TBI series, NCREIF is first used to study the existence of long-run dynamics between direct real estate and REITs. Due to the leverage, NAREIT is expected to grow faster than NCREIF over the long run. Consequently, the long-run coefficient on NAREIT is expected to be less than one in absolute value when the long-run relation is normalized on NCREIF. Furthermore, if the leverage varies substantially and permanently over time, a stable cointegrating relation will probably not be observed since the coefficient on NAREIT is expected to be time-varying.

The Johansen Trace test results, reported in Exhibit 5, reject the hypothesis of no cointegration between NCREIF and NAREIT. That is, despite the potential complications caused by the property mix and leverage, the two indices appear to be tightly related in the long-run. Clearly, this gives strong support to the hypothesis that the direct and securitized real estate markets are integrated, i.e., that there is a common real estate factor driving the returns on direct and securitized real estate investments.

[Exhibit 5 here]

The estimated long-run coefficient of -0.65 on NAREIT implies that REITs have had an average leverage of 35%. This estimate is similar to the 40% average loan-to-value ratio reported by Pagliari, Scherer and Monopoli (2005) over the 1981-2001 period. According to
the LR test, NAREIT can be restricted to be weakly exogenous. This suggests that only NCREIF adjusts towards the long-run relation. The weak exogeneity restriction does not alter the long-run coefficient on NAREIT.

The finding of cointegration based on the conventionally employed VECM that does not include a trend in the long-run dynamics suggests that NAREIT does not outperform NCREIF in the long run if the impact of leverage is controlled for. If the de-leveraged NAREIT had outperformed NCREIF, there would be a trend in the long-run dynamics that would require the inclusion of a trend term in the long-run model in order to find a cointegrating relation between the indices. Hence, our results support the finding by Pagliari, Scherer and Monopoli (2005) according to which the returns on NCREIF and on the de-leveraged NAREIT are the same in the long term.

A plot of the deviation of NCREIF from the estimated long-run relation, presented in Exhibit 6, shows that there was a large and long-lasting deviation from the long-run relationship during the 1990s. The aim of this article is not to examine the reasons behind the deviation. Nevertheless, we suggest a potential explanation behind the finding. The emergence of this deviation coincides with the beginning of the “REIT boom” (Clayton and MacKinnon, 2003) or the “new REIT era” (Pagliari, Scherer and Monopoli, 2005). It has been often stated that in the early 1990s the REIT market went through a maturation process. This process was enhanced by the Revenue Reconciliation Act of 1993 (Crain, Cudd and Brown, 2000). The maturation included an increase in the institutions’ and analysts’ interest towards the REIT market, thereby leading to more widely distributed and reliable information about REITs being available. The increased and more sophisticated investor base, together with the growth in REIT market capitalization, may well have improved the informational efficiency of the market, thereby inducing REIT prices to better reflect current and expected
market fundamentals. In line with this argument, the forthcoming analysis supports an increase in the REIT market efficiency.

[Exhibit 6 here]

The notable deviation from the long-run relation may have been caused by the adjustment of REIT prices to better reflect future expectations. According to Pagliari, Scherer and Monopoli (2005) it seems plausible to argue that the large premiums to net asset values observed in the REIT marketplace in the mid 1990s coincided with the real estate market’s recovery from the real estate recession of the late 1980s and early 1990s. The recovery of the direct market started later, which can be seen from Exhibit 1. That is, positive future expectations could have led to an upwards correction in NAREIT relative to NCREIF due to the typically very sluggish adjustment of the direct real estate market. Hence, the remarkable deviation from the long-run relation is not unexpected given the notable frictions in the market for direct real estate. The fact that it appears to have been NCREIF that adjusted towards the long-run relation supports the claim that the REIT market is more informationally efficient than the direct market, rather than the idea of a transitory over-valuation of REITs in the 1990s.

Morawski, Rehkugler and Füss (2008) argue that there was a structural break in the long-run relation between NCREIF and NAREIT due to a change in investor perception of REITs in the beginning of the 1990s. The results reported in this paper, however, imply that there was no permanent structural break in the long-run relationship between direct and securitized real estate. Instead, there was a temporary large deviation from the relation that ended around 1999. This argument is supported by the recursive estimation according to which the stability of the relation throughout the sample period cannot be rejected (see Exhibit A2 in the Appendix).
It is important to understand that the existence of cointegration does not mean that there cannot be notable transitory deviations from the long-run relation. Instead, cointegration suggests that the deviations disappear in the long run and can be used to predict future returns on direct real estate to some extent. Interestingly, a substantial deviation from the estimated long-run relation has emerged again since 2007. This time the deviation of NCREIF from the relation is positive. The deviation is due to an almost 50% drop in the NAREIT index since its peak in 2007Q1. While prices in the securitized market have responded rapidly to the global financial crisis, the direct real estate market appears to have been slow in its adjustment to the economic downturn. That is, similarly to the deviation in the 1990s, this recent sharp increase in the deviation from the long-term relationship is likely to be temporary and can be probably attributed to informational factors and market frictions. After severe shocks such as a major financial crisis, it is typical that in the direct market sales volumes decrease and average selling times increase rapidly, whereas the price level adjusts only sluggishly. In the longer-term, the impact of the crisis is expected to be fully reflected in market prices on the direct market as well. Therefore, it is exactly the large shocks like that of the global financial crisis that are likely to induce large temporary deviations from the long-term relationship between the direct and securitized markets.

Similarly to the appraisal-based NCREIF case, the hypothesis of no cointegration between the transactions-based TBI index and the NAREIT index can be rejected based on a sample period from 1984 to 2008. However, the estimated coefficient on NAREIT appears to be overly large (0.90). More so, the deviation from the relationship seems to be trending during the early sample period. It is likely that the relative shortness of the sample period together with the observed deviation from the long-run relation between NCREIF and NAREIT during the early and mid 1990s bias the parameter estimate. Knowing the importance of the length of the sample period in cointegration tests, it is reasonable to rely on
the longer time series (NCREIF) in the cointegration analysis. As NCREIF and TBI must be
cointegrated by construction (since they are based on the same properties)\(^8\), the cointegration
between NCREIF and NAREIT implies that TBI and NAREIT are cointegrated with the same
parameters. If we assumed that TBI is not cointegrated with NAREIT or is cointegrated but
with some other long-run parameters than 1 and -0.65, we would propose that this is the case
regarding NCREIF as well. Since the results obtained with a longer sample period are more
trustworthy than those obtained with a shorter one, we assume in the forthcoming analysis
that TBI is also cointegrated with NAREIT, with the coefficient on NAREIT being -0.65. In
line with this assumption, the TBI appears to adjust towards the relation. NAREIT, instead, is
restricted to be weakly exogenous, since its speed of adjustment parameter would have the
wrong sign. As expected, the deviation of the TBI from this long-run relation closely
resembles that of the appraisal-based NCREIF, as shown in Exhibit 7.

[Exhibit 7 here]

Exhibit 8 reports the Trace cointegration test results between the overall stock market
index and the real estate indices. The test statistics clearly accept the hypothesis of no
cointegration between stocks and NAREIT or NCREIF. This implies that there are notable
diversification benefits obtainable by including REITs or direct real estate in a broad stock
portfolio even when a very long horizon is considered. The perceived cointegration between
NAREIT and NCREIF indices, on the contrary, suggests that REITs and direct real estate are
substitutable assets in a portfolio of a long-horizon buy-and-hold investor. In other words, the
correlation between NAREIT and NCREIF returns approaches one as the investment horizon
lengthens. The horizon has to be very long, though, since the adjustment of REITs towards
the long-run relation is negligible and the speed of adjustment of the direct market is low,
around 3% to 4% per quarter. Moreover, even though cointegration indicates that the markets
are moving together in the long run and diversifying between them over the long horizon is
not likely to lead to large benefits in risk reduction, cointegration does not prevent the possibility of long-horizon diversification benefits totally. Diversification gains are made obtainable by the possibility of temporary deviations from the long-run relation. The longer the holding period, the smaller the relative significance of the temporary deviations is and the smaller the diversification benefits are likely to be.

[Exhibit 8 here]

The reported results are in contrast with those of Ling and Naranjo (1999), according to which REITs are integrated with the stock market but segmented from direct real estate. There are several possible explanations for the difference between the results. First, Ling and Naranjo use different securitized real estate data. Their data include also other publicly traded real estate companies than EREITs. Second, Ling and Naranjo employ a substantially shorter sample period (1978–1994). Maybe the securitized real estate market was integrated with the stock market during that period, but the integration has vanished as the securitized real estate market has matured.\(^9\) Finally, maybe the analysis of Ling and Naranjo excludes one or more relevant risk factors.\(^10\) As they state, “we do not claim that these factors capture all relevant economic risks”.

2.2 Granger Causalities

The dynamics between NAREIT, NCREIF and the stock market are further investigated by Granger causality tests. The tests are based on VECMs that employ the above estimated long-run relations as the long-run dynamics. Lag length in the models is decided based on Sim’s small-sample corrected LR test.\(^11\) The Granger causality tests results, which are based on basic F-tests, are reported in Exhibits 9-11. In Exhibits 9-11, \((we)\) stands for weak exogeneity of the variable and \(ege\) denotes the equilibrium error, i.e., the deviation from the long-run relation.
As expected and in line with the recent findings by Li, Mooradian and Yang (2009), changes in NAREIT appear to lead movements in NCREIF without feedback from NCREIF to NAREIT. The same applies to the dynamics between NAREIT and TBI. However, before the “new REIT era” there is some evidence of the predictability of NAREIT as well. In particular, based on a sub-period from 1984Q1 to 1990Q4 the results suggest that both TBI and NAREIT performance as well as the deviation from the long-run relation could be used to predict NAREIT performance. Concerning the predictive power of the TBI, this predictability is only hypothetical since the index was not available during that period. Nevertheless, this finding suggests that the direct market led the REIT market prior to 1991. After 1990, instead, NAREIT has clearly led both NCREIF indices, and REIT returns have not been predictable using past information on real estate market performance. NAREIT has clearly not adjusted towards the long-run relation during 1991-2008, since, in addition to the relatively large p-value (0.28), the speed of adjustment parameter would have the wrong sign.

The reported findings are in line with the argument that the REIT market has become more informationally efficient since the early 1990s. However, even though the reported statistics generally apply to other lag lengths as well, the results regarding the first sub-period should be taken cautiously due to the small number of observations. Note also that at longer lags there is some evidence of feedback from NAREIT to TBI. Although a similar inefficiency of REITs cannot be observed during 1977Q4-1990Q4 based on the model including NCREIF, these results apply also to the NCREIF model when focusing on sub-period 1984Q1-1990Q4 (which corresponds to the TBI analysis).

What then might explain the perceived adjustment of NAREIT towards the unobservable (at that time) long-run relation with the direct market? As widely stated in the literature, prior to the 1990s the REIT market was immature and appeared to co-move with
the stock market rather than to reflect real estate market fundamentals. Therefore, due to a potentially substantial short-term speculative (i.e., non-fundamental related) component in REIT prices, the direct market prices might have reflected the real estate market fundamentals (even the expectations) better than REIT prices. If the direct market, indeed, reflected better the fundamentals, it would have been expected that it was the REIT market that adjusted towards the long-run relation.

As noted above, the adjustment speeds of the NCREIF indices are slow: for the appraisal-based index 4.6% and 3.7% in the first and second sub-periods, respectively, and for the transaction-based index 3.1% in the latter period. Concerning the post 1980 period, it is the fourth lag of NAREIT returns that is relatively large and significant in the equation for the appraisal-based NCREIF returns. This suggests that movements in NCREIF lag NAREIT performance by as long as one year. The lag of the transaction-based returns, in turn, is two quarters based on the estimated VECM.

In theory, the reported lead-lag relation between NAREIT and NCREIF may be caused by different property mixes. However, Li, Mooradian and Yang (2009) argue that the lead-lag relation between NAREIT and NCREIF indices is caused by something other than the property mix, and Pagliari, Scherer and Monopoli (1999) find NAREIT to lead NCREIF even when the property mixes are modified to be similar. A likely reason for the observed lead-lag relation would be better informational efficiency of the REIT market. This is suggested already by Barkham and Geltner (1995). They also argue that, since the fundamental asset is essentially the same in both the direct and indirect markets, the type of lead-lag relation found here is not likely to be caused by changes over time in investor perceptions and preferences. In any case, regardless of the possible influence of the property mix, this analysis shows that the NCREIF indices cannot be used to predict the evolution of
the NAREIT index even through the long-run relationship, whereas NAREIT performance can be employed to predict future movements in the NCREIF indices.

Exhibit 11 reports Granger causality test results when the overall stock market is included in the estimated models. As it is especially the relationship between the stock market, REIT market and the actual (non appraisal-based) direct real estate market that is of interest here, only the test results including the TBI as a proxy for the direct real estate market are reported. Based on the whole sample period from 1984Q1 to 2008Q4, the inclusion of stock market returns in the model does not alter the findings presented in Exhibit 10. Moreover, the stock market does not appear to have significant predictive power with respect to either of the real estate indices. As would be expected, the model also implies that stock market performance is not predictable.

The result according to which the REIT market appears to have been less informationally efficient prior to 1991 applies also when stock returns are in the model. In particular, the results imply that NAREIT adjusted towards the long-run relation with direct real estate. However, this model suggests that both NAREIT and stock market performance could be used to predict the direct market returns during the first sub-period. Moreover, after the inclusion of stocks, there is also evidence for a significant adjustment of the TBI towards the long-run relation. The estimated adjustment speed is rather fast, 17% per quarter, and its p-value is relatively low. Hence, this model shows that in the 1980s there appears to have been a two-way Granger causality between the direct and securitized real estate markets.

The results also indicate that since the early 1990s NAREIT returns have predicted future direct real estate returns, supporting the hypothesis of a more informationally efficient securitized market. The speed of adjustment parameter on TBI is small (2.2%) and statistically insignificant during the latter sub-period. However, if two more lags are added to the equation for TBI returns (there is some evidence for higher order autocorrelation), the
adjustment parameter (3.3%) and its statistical significance (0.13) increase, and there is some support for the TBI return series to Granger cause itself. Surprisingly, the latter sub-period model shows some predictability in the stock market performance. Note also that the inclusion of stock returns slightly improves the fit of the models for NAREIT returns.

All in all, the Granger causality results show that both previous returns on REITs and the deviation from the long-run relation between NAREIT and direct real estate can be used to predict future NCREIF and TBI returns. Whether this predictability can be employed to gain abnormal returns in the direct real estate market depends crucially on the transaction costs and liquidity of the market.

6 Summary and Conclusions

This study examines the short-run and long-run dynamic relations between securitized real estate (NAREIT) and direct real estate (both appraisal-based and transaction-based NCREIF) returns in the U.S. employing a sample period from 1977Q4 to 2008Q4. The study contributes to the literature by scrutinizing the existence of cointegration between NAREIT and NCREIF total return indices and by discussing the portfolio and predictability implications of such long-term dynamics. Moreover, since it is doubtful that previously found empirical relationships between the markets hold, due to the maturation of the REIT market for instance, there is a need to study the dynamics using the latest data. The recent paper by Li, Mooradian and Yang (2009) examines the linkages between NCREIF and NAREIT returns, but these authors use only appraisal-based returns for direct real estate and their analysis lacks the examination of long-run dynamics. We extend their study by catering for the long-term dynamics and by including the transaction-based NCREIF returns in the analysis.
Our results support the existence of a cointegrating relationship between NCREIF and NAREIT total return indices. The fact that the indices appear to be cointegrated despite the leverage of REITs and in spite of the differences between the property mixes of NAREIT and NCREIF gives strong support to the hypothesis that the same “real estate factor” is driving both REIT and direct real estate returns in the long term. Currently only direct real estate appears to adjust towards the long-run cointegrating relation and NAREIT returns lead NCREIF returns. Since REIT returns lead also the transaction-based NCREIF returns, the perceived lead-lag relation cannot only be attributed to appraisal smoothing effects. That is, even the true prices of direct real estate appear to lag changes in the securitized market. Moreover, it is also argued that the property-mix is not a likely reason for the lead-lag relation found. The lead-lag relation and the adjustment of only the direct market towards the long-run relation is consistent with the notion that the securitized real estate market is more efficient than the direct market, i.e., that news about real estate fundamentals are reflected more rapidly in securitized real estate prices. The results show that the NCREIF returns can be predicted by NAREIT returns as well as by the deviation from the cointegrating relation. This is not surprising, since due to the lower liquidity, the smaller number of market participants, greater transaction costs and the lack of a public market place in the direct market, the prices of direct real estate investments are expected to adjust more sluggishly to shocks in the fundamentals than securitized real estate prices.

Supporting the often stated argument regarding weaker informational efficiency of the REIT market prior to the “new REIT era”, the results show evidence of the predictability of NAREIT returns during the 1980s, but not after that. It is also found that at the beginning of the “new REIT era” a large and long-lasting deviation from the long-run relation between NAREIT and NCREIF emerged. There is no evidence of a permanent structural break in the long-run relation, though, since the deviation appears to have been only temporary. A
potential reason for the sudden emergence of a notable deviation during the 1990s is the increased informational efficiency of the REIT market.

Our findings provide new evidence on the substitutability of direct and securitized real estate in a mixed-asset portfolio. The findings are of particular importance to long-horizon buy-and-hold portfolio investors. Due to the tight long-run interdependence, the longer the investment horizon is, the greater the degree of substitutability between REITs and direct real estate in a mixed-asset portfolio. In other words, the correlation between NAREIT and NCREIF returns approaches one as the investment horizon lengthens. This long-term similarity is due to the adjustment of the direct market. Although cointegration indicates that the markets are moving together in the long run and diversifying between them over the long horizon is not likely to lead to large benefits in risk reduction, cointegration does not prevent the possibility of long-horizon diversification benefits totally. Diversification gains are made possible by the existence of temporary deviations from the long-run relation. Nevertheless, since the two real estate indices are cointegrated with one another and not with the stock market, REITs are likely to bring similar long-term diversification benefits to a stock portfolio as direct real estate. In the short run, the diversification benefits of REITs and direct real estate may differ substantially, however. The long-horizon diversification benefits are of particular interest regarding real estate, since direct real estate is typically a long-horizon investment due to its high transaction costs and relatively low liquidity.

The cointegrating relation found supports the argument of Pagliari, Scherer and Monopoli (2005) according to which NCREIF and de-leveraged NAREIT returns do not differ notably in the long horizon. The predictability implications regarding direct real estate returns, in turn, may be of importance not only to investors but also to various financial institutions and to economic policy makers. REIT performance, in contrast, does not appear
to be predictable, at least not at the quarterly level using lagged NAREIT, NCREIF or stock market performance.

Finally, the notable deviation from the long-run relation that emerged since 2007 due to the global financial crisis has significant implications for today’s investment strategy as securitized real estate is likely to perform better than direct real estate in the forthcoming years. If the REIT market does not recover from the almost 50% drop from 2007Q1 to 2008Q4 during the following years, the estimated long-run relation and the current deviation from it suggest that direct real estate prices should decrease by a third from the 2008Q4 level during the forthcoming years to reach the long-term relationship. Based on the estimated speed of adjustment of NCREIF, this downwards correction would be highly sluggish, though. According to the preliminary figures regarding the transaction-based NCREIF index, direct real estate prices dropped by 23% during 2009, while REIT prices rose by 21%. Therefore, the deviation from the long-run relation between NCREIF and NAREIT has already decreased.

References


Real Capital Analytics, Global Capital Trends, February 2010.


**Acknowledgements**

We wish to thank Ko Wang (the editor), three anonymous referees, the participants at the European Real Estate Society 2009 Conference and at the first ReCapNet Conference for numerous valuable comments. The first author is grateful for financial support received from the OP-Pohjola Group Research Foundation and from the Yrjö Jahnsson Foundation.
Exhibit 1  Total Return Indices
### Exhibit 2  Descriptive Statistics of Returns, 1978Q1-2008Q4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (annualized %)</th>
<th>Standard deviation (annualized %)</th>
<th>Jarque-Bera test (p-value)</th>
<th>Ljung-box test for autocorrelation (p-value, 4 lags)</th>
<th>Seasonal variation (p-value, F-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCREIF</td>
<td>9.3</td>
<td>3.9</td>
<td>0.00</td>
<td>0.00</td>
<td>0.99</td>
</tr>
<tr>
<td>NAREIT</td>
<td>11.3</td>
<td>16.6</td>
<td>0.00</td>
<td>0.59</td>
<td>0.39</td>
</tr>
<tr>
<td>Stocks</td>
<td>10.7</td>
<td>16.2</td>
<td>0.00</td>
<td>0.83</td>
<td>0.32</td>
</tr>
<tr>
<td>TBI (1984Q2-2008Q4)</td>
<td>7.9</td>
<td>7.8</td>
<td>0.00</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>NCREIF (1984Q2-2008Q4)</td>
<td>8.0</td>
<td>3.9</td>
<td>0.00</td>
<td>0.00</td>
<td>0.76</td>
</tr>
</tbody>
</table>
**Exhibit 3**  Contemporaneous Quarterly Correlations between the Returns, 1978Q1-2008Q4

<table>
<thead>
<tr>
<th></th>
<th>NCREIF</th>
<th>NAREIT</th>
<th>Stocks</th>
<th>NCREIF (1984Q2-2008Q4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCREIF</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAREIT</td>
<td>0.30**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stocks</td>
<td>0.15</td>
<td>0.58**</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>NCREIF (1984Q2-2008Q4)</td>
<td>0.33**</td>
<td>0.19*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>TBI (1984Q2-2008Q4)</td>
<td>0.35**</td>
<td>0.29**</td>
<td>0.48**</td>
<td></td>
</tr>
</tbody>
</table>

* and ** denote statistical significance at the 5% and 1% level, respectively.
**Exhibit 4**  Augmented Dickey-Fuller Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level (lags)</th>
<th>Difference (lags)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCREIF</td>
<td>-1.79 (6)^c</td>
<td>-1.96* (5)</td>
</tr>
<tr>
<td>TBI</td>
<td>-0.00 (4)^cs</td>
<td>-3.49** (3)^c</td>
</tr>
<tr>
<td>NAREIT</td>
<td>-1.98 (0)^c</td>
<td>-8.20** (0)</td>
</tr>
<tr>
<td>Stocks</td>
<td>-1.91 (0)^c</td>
<td>-8.96** (0)</td>
</tr>
</tbody>
</table>

* and ** denote the statistical significance at the 5% and 1% level, respectively. Critical values at the 5% and 1% significance levels are -1.95 and -2.58 if a constant is not included and -2.89 and -3.51 in the case where a constant is present. The number of lags included in the ADF tests is decided based on the general-to-specific method. A constant term (^c) is included in the test for level variables, since all the indices are trending upwards. In addition, three seasonal dummies (^s) are added to the test if recommended by the F-test.
**Exhibit 5**  Test Statistics for the Cointegration between the real estate indices

<table>
<thead>
<tr>
<th>Variables: NCREIF, NAREIT; Sample Period: 1977Q4-2008Q4; ML = 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_0 ) (rank)</td>
</tr>
<tr>
<td>( r = 0 )</td>
</tr>
<tr>
<td>( r \leq 1 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>NCREIF</th>
<th>NAREIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value in the test for exclusion</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>P-value in the test for weak exogeneity</td>
<td>0.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Estimated long-run relation</td>
<td>1.00</td>
<td>-0.654</td>
</tr>
<tr>
<td>(standard error)</td>
<td>(0.022)</td>
<td></td>
</tr>
<tr>
<td>Speed of adjustment parameter</td>
<td>-0.038</td>
<td>0.018</td>
</tr>
<tr>
<td>(standard error)</td>
<td>(0.009)</td>
<td>(0.064)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables: TBI, NAREIT; Sample Period: 1984Q1-2008Q4; ML = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_0 ) (rank)</td>
</tr>
<tr>
<td>( R = 0 )</td>
</tr>
<tr>
<td>( R \leq 1 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>TBI</th>
<th>NAREIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value in the test for exclusion</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>P-value in the test for weak exogeneity</td>
<td>0.00</td>
<td>0.61</td>
</tr>
<tr>
<td>Estimated long-run relation</td>
<td>1.00</td>
<td>-0.899</td>
</tr>
<tr>
<td>(standard error)</td>
<td>(0.056)</td>
<td></td>
</tr>
<tr>
<td>Speed of adjustment parameter</td>
<td>-0.068</td>
<td>0.025</td>
</tr>
<tr>
<td>(standard error)</td>
<td>(0.020)</td>
<td>(0.046)</td>
</tr>
</tbody>
</table>

The table presents the Johansen Trace test statistics for pairwise cointegration between the real estate indices. In the test including TBI and NAREIT, the Trace test values are small-sample corrected, whereas the test values on the model including NCREIF and NAREIT are not small-sample corrected due to the long lag length. Seasonal dummies are not included in any of the tested models.
Exhibit 6  Deviation of NCREIF from its Estimated Long-Run Relation with NAREIT
Exhibit 7  Deviation of TBI (Continuous Line) and of NCREIF (Dashed Line) from their Estimated Long-Run Relationship with NAREIT
## Exhibit 8  Test Statistics for the Cointegration between Stock and Real Estate Markets

<table>
<thead>
<tr>
<th>Variables: NAREIT, stocks; Sample Period: 1977Q4-2008Q4; ML = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$ (rank)</td>
</tr>
<tr>
<td>$R = 0$</td>
</tr>
<tr>
<td>$R \leq 1$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables: NCREIF, stocks; Sample Period: 1977Q4-2008Q4; ML = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$ (rank)</td>
</tr>
<tr>
<td>$R = 0$</td>
</tr>
<tr>
<td>$R \leq 1$</td>
</tr>
</tbody>
</table>

The table presents the Johansen Trace test statistics for pairwise cointegration between the real estate indices and stocks. The Trace test values are small-sample corrected. Seasonal dummies are not included in any of the tested models.
### Exhibit 9  Granger Causality Test Results including NCREIF and NAREIT

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta$NCREIF</td>
<td>$\Delta$NAREIT</td>
<td>eqe</td>
</tr>
<tr>
<td>$\Delta$ NCREIF</td>
<td>0.00</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>$\Delta$ NAREIT</td>
<td>0.91</td>
<td>0.78</td>
<td>0.83</td>
</tr>
<tr>
<td>$\Delta$ NAREIT (we)</td>
<td>0.92</td>
<td>0.78</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

The table shows the p-values of the Granger causality tests. The null hypothesis is that of no Granger causality. *(we)* denotes that the variable is restricted to be weakly exogenous and *eqe* stands for the equilibrium error, i.e., deviation from the long-run relation. The models include four lags in differences.
## Exhibit 10  Granger Causality Test Results including TBI and NAREIT

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta TBI$</td>
<td>$\Delta NAREIT$</td>
<td>eqe</td>
<td>Adj. $R^2$</td>
</tr>
<tr>
<td>$\Delta TBI$</td>
<td>0.02</td>
<td>0.01</td>
<td>0.16</td>
<td>0.24</td>
</tr>
<tr>
<td>$\Delta NAREIT$</td>
<td>0.78</td>
<td>0.59</td>
<td>-0.04</td>
<td>0.23</td>
</tr>
<tr>
<td>$\Delta TBI$ (we)</td>
<td>0.17</td>
<td>0.12</td>
<td>0.07</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The table shows the p-values of the Granger causality tests. The null hypothesis is that of no Granger causality. *(we)* denotes that the variable is restricted to be weakly exogenous and *eqe* stands for the equilibrium error, i.e., deviation from the long-run relation. The models, except for the early sample-period model (one lag), include four lags in differences.
### Exhibit 11  Granger Causality Test Results including TBI, NAREIT and Stocks

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>∆TBI</td>
<td>∆NAREIT (we)</td>
<td>∆Stocks</td>
<td>eqe</td>
</tr>
<tr>
<td>∆ TBI</td>
<td>0.01</td>
<td>0.03</td>
<td>0.58</td>
<td>0.07</td>
</tr>
<tr>
<td>∆ NAREIT (we)</td>
<td>0.67</td>
<td>0.22</td>
<td>0.33</td>
<td>-0.02</td>
</tr>
<tr>
<td>∆ Stocks</td>
<td>0.77</td>
<td>0.85</td>
<td>0.81</td>
<td>-0.07</td>
</tr>
<tr>
<td>∆ TBI</td>
<td>0.70</td>
<td>0.01</td>
<td>0.01</td>
<td>0.14</td>
</tr>
<tr>
<td>∆ NAREIT</td>
<td>0.12</td>
<td>0.03</td>
<td>0.20</td>
<td>0.01</td>
</tr>
<tr>
<td>∆ Stocks</td>
<td>0.93</td>
<td>0.24</td>
<td>0.20</td>
<td>-0.05</td>
</tr>
<tr>
<td>∆ TBI</td>
<td>0.30</td>
<td>0.01</td>
<td>0.86</td>
<td>0.36</td>
</tr>
<tr>
<td>∆ NAREIT</td>
<td>0.95</td>
<td>0.16</td>
<td>0.15</td>
<td>0.49</td>
</tr>
<tr>
<td>∆ Stocks</td>
<td>0.42</td>
<td>0.21</td>
<td>0.18</td>
<td>0.03</td>
</tr>
<tr>
<td>∆ NAREIT (we)</td>
<td>0.97</td>
<td>0.13</td>
<td>0.10</td>
<td>0.01</td>
</tr>
</tbody>
</table>

The table shows the p-values of the Granger causality tests. The null hypothesis is that of no Granger causality. (we) denotes that the variable is restricted to be weakly exogenous and eqe stands for the equilibrium error, i.e., deviation from the long-run relation. The full-sample model includes four lags in differences, while early sample-period model includes one lag and the latter sub-period model two lags. Due to apparent residual heteroscedasticity at the fourth lag, test values for ∆TBI model in the early sub-period are based on a covariance matrix that is computed allowing for heteroscedasticity as in White (1980).
Appendix

Exhibit A1  Time-variation of the quarterly contemporaneous correlation between NAREIT and stock market returns based on a rolling twenty-quarter window
Exhibit A2  Plot of the recursive and backwards recursive Max Test statistics (in the R-form) of constancy of the estimated long-run relation, with the value of one being the 5% critical value
Morawski, Rehkugler and Füss employ unadjusted appraisal-based return indices of direct real estate, which is likely to diminish the reliability of their analysis.

For details on the latter index, see Fisher, Geltner and Pollakowski (2007).

Weak exogeneity of a variable indicates that the variable does not react to a deviation from the long-run relation (i.e., to disequilibrium). In other words, the speed of adjustment parameter of a weakly exogenous variable is zero.

The Trace test statistics would actually imply that $r = 2$. This would mean that both indices are stationary. This is obviously not the case. Neither of the indices can be excluded from the long-run relation, i.e., the long-term relation needs to include both indices in order to be stationary. Furthermore, the ADF statistics suggest that all the indices are non-stationary. Hence, it is concluded that $r = 1$.

We do not claim that the adjustments for property mix and leverage that some scholars have conducted are useless. Rather, we state that finding a cointegrating relationship despite the property-mix and leverage complication gives strong support to the existence of a common real estate factor.

Global commercial property transactions fell from $1,241 billion in 2007, to $546 billion in 2008, and to $381 billion in 2009 (Real Capital Analytics, 2010).

This points out the fact that econometric tests, such as the Johansen Trace test, do not always yield reliable results. In the case of cointegration tests, the possibility of faulty results increases as the sample period shortens.

In the short run, the appraisal smoothing of the NCREIF, together with the facts that the TBI is likely to exhibit some short-run noise and that its quarterly changes are based on transactions of only a small sample of all the properties of the NCREIF database, may cause deviation from a one-to-one relation. In the long term, however, this deviation must vanish and the indices should not diverge. Indeed, Exhibits 1 and 2 show that the growth rates of the appraisal-based and transaction-based indices have been the same over 1984-2008.

There does not appear to be cointegration between NAREIT and stocks during 1978-1994. Given the shortness of the sample period this is not surprising and we might observe this result even if the markets had actually been cointegrated during that period.

According to Ling and Naranjo, if the commercial real estate market (both exchange-traded and nonexchange-traded) and the stock market are integrated, the risk premia for the macroeconomic factors must be the same in both markets.
Based on HQ, seasonal dummies are not included in any of the VECMs. The results would not change notably even if seasonal dummies were included.

The sample period is divided into two sub-periods based on the Akaike Information Criteria in the model including the TBI.

We also tested whether the adjustment of the direct market (TBI) towards the long-run relation is asymmetric. A priori, the downwards adjustment might be slower than the upwards adjustment due to loss aversion. Nevertheless, we found some evidence of the downwards adjustment of TBI being faster than the upwards adjustment. During the latter sample period this is not surprising given the long-lasting negative deviation of the direct market from the long-run relation, but the same difference between the speed of adjustment parameters applies to the early sub-period as well. However, the difference between the two adjustment parameters is not statistically significant during either of the sub-periods or the whole period. Moreover, the Schwarz information criteria suggest the existence of only one adjustment parameter in the models. Therefore, there does not appear to be significant asymmetry in the speed of adjustment.