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Are public and private real estate returns and risks the same?

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Views expressed are solely those of the authors and not necessarily of their respective organisations.

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Are public and private real estate returns and risks the same?

Abstract

This article aims to investigate the similarity of public and private real estate returns and risks over the relatively long horizon using data for the US and the UK. The results show evidence of a one-to-one relationship between publicly traded REIT performance and privately traded direct real estate investment performance in three out of four US real estate sectors and one out of two UK sectors included in the analysis. The return volatilities generally do not differ significantly between the REIT and direct real estate markets regardless of sector and investment horizon. The findings have important practical implications. First, they indicate that public and private real estate investments can be considered to work as good substitutes in an investment portfolio with several years investment horizon. Second, they suggest that REIT related ETFs and derivatives could be used to hedge risks caused by investors' direct real estate holdings or by lending institutions' mortgage lending inventory.

Introduction

Publicly traded securities represent indirect claims on lumpy privately traded assets such as factories and equipment or real estate.[1] Therefore, it can be expected that the returns and risks of privately traded direct investments and of securities that are based on similar direct assets are alike, at least after catering for the effects of leverage and managements costs – after all, the security cash flows are generated from the underlying direct assets. Nevertheless, due to factors such as higher liquidity and lower transaction costs of the securitised assets traded in public market places, the returns on securities may notably deviate from those on private assets.[2] In particular, a lower liquidity premium and smaller transaction costs could induce a lower required (and therefore also expected) return on securitized assets. Also the diversification benefits offered by securities vs. direct assets can differ, at least in the relatively short term, possibly affecting the required rates of return. Therefore, it is essentially an empirical question to study if the trading 'platform' influences the asset returns and return volatilities.

For investors and financial institutions, the question of whether publicly traded securitized assets provide similar overall returns and return volatilities as privately traded direct investments is of great importance due to its hedging and portfolio allocation implications. The equivalence of public and private asset returns and return volatilities would indicate that public and private assets work as substitutes in an investment portfolio. A close connection between the returns would also suggest that investors, banks and other financial institutions having a real estate exposure by either holding private real estate assets directly or through their outstanding mortgage lending inventory can use public real estate related derivatives to hedge the risk exposure arising from private real estate portfolios. Importantly, this could help banks to survive better through the periods of economic distress and drastically decreasing real estate prices.

Unfortunately, empirical examination of the question is usually not possible, since there are no reliable time series data on the typical underlying assets. However, the 'duality' of the real estate markets offers an opportunity to test whether securitized asset returns reflect the performance of underlying private assets: relatively reliable data are available both for securitized and direct real estate performance.

[1] In this article, 'public' and 'securitized' investments are used as synonyms, both referring to securities traded in public market places. 'Private' and 'direct' investments, in turn, both refer to the underlying privately traded direct assets.

[2] The influence of managers' capability on fund performance and the economies of scale provided by large Real Estate Investment Trusts (REITs) are sometimes given as potential factors inducing higher returns for real estate securities than for private real estate. The assertion that these factors could lead to greater expected security returns is at odds with the efficient market hypothesis: any expected managers' or economies of scale influence on security cash flows should be reflected in the prevailing asset prices, while the expected return-risk relationship should not be increased. Indeed, if managers' capability lessens the risks, the expected (required) return should accordingly be smaller.

Are public and private real estate returns and risks the same?

Much empirical evidence shows that the short-run comovement between securitised and direct real estate returns is quite low, whereas the returns on securitized and direct real estate investments are tightly linked in the long run (*Goetzmann and Ibbotson, 1990; Ross and Zisler, 1991; Gyourko and Keim, 1992; Barkham and Geltner, 1995; Mueller and Mueller, 2003; Brounen and Eichholtz, 2003; Hoesli and Serrano, 2007; MacKinnon and Al Zaman, 2009; Oikarinen, Hoesli and Serrano, 2011; Hoesli and Oikarinen, 2012; Yunus, Hansz and Kennedy, 2012*). Despite the vast literature on the relationship between securitised and direct real estate markets, research is still lacking on the question of whether the return and risk on securitised and direct real estate investments are of the same magnitude.

More research on the topic is needed, as it is generally not enough for an investor to know whether securitized and direct real estate provide similar diversification benefits in an investment portfolio: it is also of importance to have knowledge on whether the return magnitudes and volatilities are similar.

Pagliari, Scherer and Monopoli (2005), and *Riddiough, Moriarty and Yeatman (2005)* provide pioneering examinations on the similarity of publicly traded Real Estate Investment Trust (REIT) and direct real estate market returns. Both these studies cater for the effects of leverage, property-type mix, and management fees, and the analyses are based on comparison of the mean returns on the assets. Using US data for 1980-1998, *Riddiough, Moriarty and Yeatman (2005)* report an investment performance gap of three percentage points in favour of REITs. Based on a slightly longer sample period (1981-2001) and F-test statistics, *Pagliari, Scherer and Monopoli (2005)* find that there is no statistically significant difference between the returns and variances of the two real estate markets.

The aim of this article is to add to the scarce literature on the correspondence of the returns for publicly traded securitized real estate and direct, or 'private', real estate investments. We propose an alternative method, i.e., cointegration analysis, to test for the equivalence of the returns over the long run. This method allows us to test formally and in a straightforward manner for a one-to-one relationship between REIT and direct real estate total return indices.

Cointegration analysis has several advantages over the simple F-test on means. For one, a one-to-one cointegrating relation between two series implies that there are tight economic forces keeping the series together in the long run and therefore an observed equivalence of the mean returns is not just a coincidence that is likely to vanish in the future, but is due to a real economic phenomenon, i.e. due to an equilibrium relation between the series. The words of Nobel laureate Clive W.J. Granger (1986) describe well such a cointegrating long-term relation between two series: "*At the least sophisticated level of the economic theory lies the belief that certain pairs of economic variables should not diverge from each other by too great an extent, at least in the long run. Thus, such variables may drift apart in the short run or according to seasonal factors, but if they continue to be too far apart in the long run, then economic forces, such as the market mechanism or government intervention, will begin to bring them together again*."

Given the well documented fact that public real estate returns co-move more with the general stock market returns than with the underlying real estate performance over the relatively short horizon (e.g. *Ling and Naranjo, 1999; Mueller and Mueller, 2003; Brounen and Eichholtz, 2003 Hoesli and Serrano, 2007*) but public and private real estate appear to provide similar diversification benefits in a multi-asset portfolio in the longer horizon (*Hoesli and Oikarinen, 2012*), it is reasonable to concentrate on long-term returns in our analysis. That is, it is at the several-year investment horizon that the public and private real estate investments can be considered as substitutes if the returns and return volatilities are similar. In addition, private market data complications may distort the short-term analysis, and those investors who consider investing in direct real estate typically have an investment horizon of several years.

Our analysis is based on US data for the period 1994-2011 and UK data for the period 1991-2011. Similar to *Pagliari, Scherer and Monopoli (2005)*, and *Riddiough, Moriarty and Yeatman (2005)*, we cater for leverage, property-type mix and management fees in the analysis. After adjusting the data for the aforementioned measurement effects, we first test for pairwise cointegration between the securitised and direct real estate total return indices separately for four sectors in the US (apartments, industrial, offices, and retail) and two sectors in the UK (offices and retail). If cointegration is found, we continue by testing for a one-to-one relationship between the total return indices. In case the one-to-one restriction cannot be rejected at the conventional significance levels, it can be concluded that REITs and direct real estate returns for the given property type do not differ statistically significantly from each other. We also examine the stability of the long-term relations during the sample period. This will, for instance, make it possible to gauge whether such relationship has been altered by the recent financial crisis.

Regarding the analysis of the similarity of risks, we follow the approach used by *Pagliari, Scherer and Monopoli (2005)*. The standard deviation of returns is used as the measure of risk, and we test for the similarity of volatilities in the two markets by the F-test. Moreover, we present graphs that illustrate the influence of the planned investment horizon on the riskiness of the assets and examine, at each horizon, whether the standard deviation differences between public and private markets are of significant magnitude.

In addition to the differences in the statistical methodology used to investigate the long-run return similarity, our analysis includes some other differences compared to extant studies on the theme. First, we use more recent data that include the recent Global Financial Crisis (GFC) period. Besides being able to investigate the impacts of the GFC on the relationship between private and public real estate performance, this is deemed desirable, since the ‘new REIT era’ or ‘REIT boom’ in the early 1990s may have significantly affected the linkages between private and public real estate (*Clayton and MacKinnon, 2001, 2003; Pagliari, Scherer and Monopoli, 2005; Oikarinen, Hoesli and Serrano, 2011*). Second, while *Pagliari, Scherer and Monopoli (2005)* and *Riddiough, Moriarty and Yeatman (2005)* construct a portfolio for direct real estate that matches the NAREIT sector composition, we use the readily available direct real estate and REIT sector level indices for the US. Third, we study the UK market in addition to the US market. Furthermore, we conduct a number of robustness checks for the results, since the assumed direct real estate portfolio management costs and the planned investment horizon (i.e., the employed data frequency) may affect the conclusions (*Campbell and Viceira, 2005*).

We find evidence of cointegration between the public and private markets in all four US sectors and in the UK retail sector. Cointegration cannot be detected in the UK office sector. In three US sectors and the UK retail sector the hypothesis of a one-to-one relation between the adjusted total return indices can be clearly accepted. The results indicate that in the US retail sector private market returns are somewhat greater than the REIT returns on average. The return volatilities generally do not differ significantly between REITs and direct real estate regardless of sector and time horizon.

We further show that while the cointegrating relations, including the one-to-one relations, are generally stable over time, notable deviations from these relations emerged during the GFC. Importantly, these deviations appear to have been only temporary, although the US apartment market is still far from equilibrium as of 2011Q4. The findings also are largely robust with respect to the assumed private market management fees.

Our findings indicate that securitized and direct real estate investments can be considered to work as good substitutes in an investment portfolio with several years investment horizon since, in addition to the close co-movement of the long-term returns across the public and private markets (shown in the previous literature already), the (unlevered) total return and return volatility they provide are similar over the long horizon. This does not necessarily hold for all the real estate sectors, however. Given the equivalence of returns and volatilities, and similar diversification benefits in the long term, REITs may be a better option than private real estate – at least in most sectors – for an investor for whom the market liquidity and transaction costs are of notable importance.

Furthermore, the close linkages between REIT and direct real estate returns suggests that REIT-related ETFs and derivatives offer opportunities to hedge risks brought about by direct real estate holdings. This is particularly important for banks and other financial institutions that are not actual real estate investors, but possess significant exposure to the private real estate market through their mortgage lending.

The next section reviews previous literature. In the third section, we describe the data used in the analysis, after which we delineate the research methodology. The empirical findings are discussed in section five, and a summary of the paper and concluding remarks a provided in a final section.

Previous Studies

Geltner and Kluger (1998), Pagliari, Scherer and Monopoli (2005), and *Riddiough, Moriarty and Yeatman (2005)* are the three previous studies that are most closely related to ours. These studies are based on careful data modifications and comparisons of the mean returns for the assets.

Geltner and Kluger (1998) construct REIT-based 'pure-play' portfolios which replicate the performance of target real estate sectors using data for the US REIT and direct real estate markets (the National Council of Real Estate Investment Fiduciaries, NCREIF) performance. Catering for property type and the effects of leverage in REITs, their results indicate that REIT-based pure-play portfolio returns were greater than NCREIF returns during the 1987-1996 period, except for the industrial sector where NCREIF returns were greater. Also REIT-based volatilities were typically found to be higher.

Pagliari, Scherer and Monopoli (2005) use the National Association of Real Estate Investment Trusts (NAREIT) index for securitized real estate and the NCREIF index for private real estate to study the correspondence of public and private real estate returns in the US over the 1981-2001 period. In doing so, they control for three differences in the indices that could bias the results: property-type mix, leverage, and appraisal smoothing in the NCREIF index. Over the whole sample period, *Pagliari, Scherer and Monopoli (2005)* find a three percentage point difference between REIT (12.3%) and direct market (9.3%) returns. This difference is not statistically significant at the conventionally used significance levels, though. Moreover, the analysis shows that the annual direct market management fees would have to be as large as 250 basis points – a figure unlikely large to be true – for the return differences to be statistically significant at the five percent confidence level. Therefore, the authors conclude that the REIT and direct real estate returns do not differ from each other, in the statistical sense, over the long run.

Pagliari, Scherer and Monopoli (2005) also report evidence of a decline in the difference between the mean returns since the beginning of the 'new REIT era', i.e., after 1992. During 1993-2001, the reported mean return for REITs is 10.6%, while it is 10.0% for direct real estate. Furthermore, they report F-test statistics according to which the hypothesis of equivalent REIT and direct real estate return variances cannot be rejected.

Riddiough, Moriarty and Yeatman (2005) also use the NAREIT and NCREIF indices and account for the influence of property-type mix, leverage, and management fees in their analysis. In line with *Pagliari, Scherer and Monopoli (2005), Riddiough, Moriarty and Yeatman (2005)* report a three percentage point difference between REIT (10.4%) and direct real estate (7.4%) returns. They do not test for statistical significance of this difference, though. As stated by the authors, their finding may be due to an unrepresentative sample period (1980-1998). They mention the effects of the 1986 tax law changes and the liquidity problems in the direct commercial real estate market in the late 1980s and early 1990s as factors due to which the sample period might have been unrepresentative. Moreover, the 'new REIT era' may have substantially affected the linkages between private and public real estate. The new REIT era, or 'REIT boom', refers to the maturation process that took place in the US REIT market in the early 1990s (*Clayton and MacKinnon, 2001*). 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. *Clayton and MacKinnon (2001, 2003), Pagliari, Scherer and Monopoli (2005), and Oikarinen, Hoesli and Serrano (2011)* provide evidence of changes in the relationship between REITs and direct real estate after the early 1990s. Therefore, new examinations on the theme using more recent data are desirable.

Unlike literature on the similarity of returns for securitised and direct real estate assets, previous research on the dynamic linkages between the returns is vast. Generally, these studies indicate that publicly traded securitised real estate returns tend to lead returns in the direct real estate market (e.g. *Gyourko and Keim, 1992; Myer and Webb, 1993; Barkham and Geltner, 1995; Eichholtz and Hartzell, 1996; Geltner and Kluger, 1998; Seiler and Webb, 1999; Oikarinen, Hoesli and Serrano, 2011; Yavas* *and Yildirim, 2011; Yunus, Hansz and Kennedy, 2012*). Empirical research thus suggests that there is a price discovery mechanism between public and private real estate markets. It is a common view that this lead-lag relationship is due to the more rapid response of the securitised market to shocks in the fundamentals. Items such as the greater liquidity, larger number of market participants, lower transaction costs, and a centralised market place have been seen as factors behind the quicker adjustment of the securitized real estate assets.

Also pairwise cointegration tests have been applied in many studies to investigate the long-term dynamics between various assets and the substitutability of different assets with respect to diversification benefits and exposure to market fundamentals. Regarding cointegration analyses between securitised and underlying private assets, there appears to be previous empirical evidence concerning the real estate market only. This is likely due to the lack of reliable data on the underlying lumpy private assets returns.

In an early study, Ong (1995) does not find support for cointegration between securitised and direct real estate return indices in Singapore. More recently, *Oikarinen; Hoesli and Serrano (2011)*, *Boudry et al. (2012), Hoesli and Oikarinen (2012)*, and *Yunus, Hansz and Kennedy (2012)* report evidence of cointegration between REIT and direct real estate markets in several countries.[3] These analyses generally suggest that only direct real estate returns are predictable by deviations from the cointegrating relations. Most of these studies do not control for the leverage or property type issues, and none of them consider the influence of management costs. Moreover, while *Hoesli and Oikarinen (2012)* derive impulse responses and variance decompositions from Vector Error-Correction Models to study the dynamics – finding that the public and private market reactions to economic shocks are generally of similar magnitude over the three to four year horizon – none of the studies formally test for the equivalence of the long-run returns.

Further analysis on the long-run cointegrating relations between private and public markets is necessary to examine whether the mean returns are similar over the long term. In particular, the inability to reject a one-to-one restriction on a cointegrating vector between the two total return indices would imply that the returns are similar in the long run. The aim of our study is to contribute to filling the gap in the research on the topic. We contribute to the literature by testing for the validity of one-to-one restrictions in cointegrating relations using recent data that attempt to control for the property-type mix, leverage, and management fee complications. For the US, we also use transaction-based indices that do not exhibit appraisal-smoothing bias and thus do not need to be de-smoothed using an arbitrary de-smoothing parameter as in the previous empirical studies on the theme. Furthermore, we conduct tests on the similarity of return volatilities, and provide several robustness checks.

Data

For the US, we include four real estate sectors (apartments, offices, industrial, and retail) and for the UK two sectors (offices and retail) in the analysis. For securitised real estate, the FTSE/NAREIT Equity REIT sector level indices are used for the US In the UK case, we have constructed the REIT indices from the company level price, dividend and market cap data provided by EPRA.[4] While the sector level direct real estate indices for the US are transaction-based NCREIF (TBI) indices that do not exhibit appraisal smoothing, the IPD appraisal-based indices are used for the UK. The sample period is 1994Q1-2011Q4 for the US and 1991Q1-2011Q4 for the UK, and all real estate indices employed in the analysis are total return indices. The data frequency is constrained by the direct market data.

The use of sector level indices enables us to control for index compositional differences. This is important given that the overall direct and securitised real estate indices typically differ notably with respect to the property-type mixes and because the return dynamics and performance between various real estate sectors may substantially vary (*Wheaton, 1999; Yavas and Yildirim, 2011; Hoesli and Oikarinen, 2012*).

[3] These analyses are in line with the theoretical model developed by Carlson, Titman, and Tiu (2010) in which public and private real estate markets move together in the long run, but can diverge in the short run.
[4] The classification of companies by property type as of 2006 was used to construct the sector indices for the period from 1991 to 2005.

While the REIT returns are net of portfolio-level management fees, such fees are not deducted from TBI returns. Therefore, to make the returns comparable, we need to deduct portfolio-level management costs from the TBI and IPD data. According to *Riddiough, Moriarty and Yeatman (2005)*, these fees range between 50 and 120 basis points (bps) per year. We follow *Riddiough, Moriarty and Yeatman (2005)* and use an annual 80 bps assumption, i.e., deduct 0.2% from the quarterly TBI returns, in our baseline computations. We also conduct robustness checks using the 50 bps and 120 bps assumptions. Moreover, while REIT returns include the impact of leverage, the direct market indices consist of unleveraged properties. The magnitude of leverage naturally affects the mean and volatility of the returns. Therefore, we restate the REIT returns for the effect of leverage. Similar to *Pagliari, Scherer and Monopoli (2005)*, the unlevered returns are computed using the following formula that is based on the well-known proposition of *Modigliani and Miller (1958)*:

$$r_{uit} = r_{eit}(1\text{-}LTV_{it}) + r_{dt}LTV_{it}, \quad (1)$$

where r_{uit} = the unlevered REIT return of sector i in period t, r_{eit} = the return on equity of REIT sector i in period t, r_{dt} = the cost of debt in period t, and LTV_{it} = the loan-to-value ratio of sector i in period t. The average leverage of US. REITs during the sample period is 43% in the industrial sector, 47% in the apartment sector, 48% in the office sector, and 51% in the retail sector. The leverage is quite volatile, being at the lowest around 30% in the mid-1990s and at the highest some 70-75% in 2009. In the UK, the mean leverage ratios are similar to the US (49% for retail and 54% for office) but less volatile the minimum being 40% and maximum less than 70%. The cost of debt used in the computations is the corporate bond middle rate for the corresponding country sourced from Datastream.

After the aforementioned data adjustments, we deflate the indices by the US/UK consumer price index and take natural logs of the real indices. Figure 1 shows the real unlevered REIT indices and the real direct market indices net of 80 bps management fees. To give an idea about how the unlevering of REIT returns affects the REIT series, Figure A1 in the Appendix presents the unlevered REIT indices together with the levered (original) ones.

[Figure 1 here]

Also the geographical composition between the constituents of REIT indices and direct real estate indices may somewhat differ. This can weaken the observed long-term comovement between REIT and direct real estate markets to some extent. That is, the actual dependence between the markets could be even somewhat greater than indicated by the empirical analysis. The empirical analysis generally shows strong long-term dependence between the REIT and private real estate indices, though. Anyhow, the main aim here is to investigate whether the REIT returns and volatilities correspond to those of TBI/IPD.[5]

An additional data issue is the measurement of direct real estate market performance. Generally, different properties are transacted in different time periods. Given that properties are highly heterogeneous w.r.t. their characteristics, a price change observed from mean (or median) transaction prices may be, at least partly, due to quality differences of the properties being sold during one period relative to another rather than due to an actual price change in the market. However, the TBI indices are ‘quality-adjusted’ transaction-based indices, as they are calculated by means of the price changes between the appraised values of properties two quarters ago and the transaction prices of properties that have been sold during a given quarter. The quality control is achieved in that the characteristics of properties in the current quarter and two quarters ago should be very similar.[6]

In contrast with the transaction-based TBI indices, the IPD indices that we use for the UK exhibit appraisal smoothing. This refers to the fact that the index values and returns exhibit high levels of serial correlation as a result of appraisers largely relying on the past when estimating the value of properties (Clayton, Geltner and Hamilton, 2001). Therefore, for the purposes of the tests conducted on volatility equivalence we de-smooth the IPD returns. We use a simple reverse filter to uncover de-smoothed returns that exhibit similar levels of serial correlation as in the UK transaction-based index developed by

[5] The construction of ‘shadow portfolios’, as in Pavlov and Wachter (2011), cannot be applied here as appropriate data are not available for our time period of analysis.
[6] A similar approach is used in some countries to construct house price indices (Bourassa, Hoesli and Sun, 2006).

Devaney and Martinez Diaz (2011), i.e. approximately 0.3.[7] The de-smoothing parameter is set equal to achieve such levels of serial correlation of the de-smoothed series. To test the robustness of our results to the value selected for the de-smoothing parameter, we also consider parameters of 0.5 and 0.7.[8]

Methodology

In the words of Granger (1986): "*At the least sophisticated level of the economic theory lies the belief that certain pairs of economic variables should not diverge from each other by too great an extent, at least in the long run. Thus, such variables may drift apart in the short run or according to seasonal factors, but if they continue to be too far apart in the long run, then economic forces, such as the market mechanism or government intervention, will begin to bring them together again*." We hypothesize that public and private real estate return indices are the kind of pair of variables Granger refers to. Cointegration may or may not exist between variables that do or do not 'look cointegrated', and the only way to find out if data are actually cointegrated is through a careful statistical analysis, rather than rely on visual inspection (*Hendry and Juselius, 2000, 2001*). Hence, we test for cointegration between REIT and TBI/IPD indices by the Johansen (1996) Trace test. The cointegration tests are conducted separately for each sector. The Vector Error-Correction Model (VECM) used in the Trace test is the following:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-l} + \alpha\beta' X_{t-1} + \Omega D_t + \varepsilon_t, \qquad (2)$$

where ΔX_t is X_t - X_{t-1}, X_t is a two-dimensional vector of return index values in period t, μ is a two-dimensional vector of drift terms, Γ_i is a 2 x 2 matrix of coefficients for the lagged differences of the return indices at lag i, l is the number of lags in differences included in the model, α is a vector of the speed of adjustment parameters, β' forms the cointegrating vector, and ε is a vector of white noise error terms. β includes the public and private market return indices and no deterministic variables. The models for the US also include one point dummy variable (D) that takes the value one in 2008Q4 and is zero otherwise to cater for the outlier observations induces by the Lehman collapse and thereby to fulfil the assumption of normally distributed residuals. Similarly, the UK models include two point dummy variables, 1992Q3 and 2008Q4 for retail, and 2007Q4 and 2008Q4 for office.

The lag length is selected based on Hannan-Quin information criteria (HQ) as suggested by Johansen, Mosconi and Nielsen (2000). However, more lags are included if the assumption of no autocorrelation in residuals cannot be accepted by the Lagrange Multiplier test at lag length two. As the models include point dummies, we report Trace test p-values based on the simulated statistics computed with the program CATS2 (see Dennis, 2006). 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 throughout the cointegration analysis.

The null hypothesis in the Trace test is that of no cointegration between the variables. If this hypothesis can be rejected at the conventionally used levels of statistical significance, we conclude that the series are cointegrated, i.e., exhibit a tight long-term relationship. This is not enough to conclude that the returns are similar over the long run, however. The similarity of returns can be tested by imposing a one-to-one restriction on the cointegrating relation. We test for the hypothesis TBI or IPD = REIT in the cointegrating relations. The one-to-one hypothesis is tested by the Bartlett small-sample corrected likelihood ratio (LR) test reported in Johansen (2000). In case either of the variables can be restricted to be weakly exogenous, the test on the one-to-one hypothesis also includes the assumption of weak exogeneity.[9] If the one-to-one restriction cannot be rejected at the conventional significance levels, it can

[7] Devaney and Martinez Diaz (2011) use a hedonic model to construct their transaction-based indices for the period 2002-2010. We use their results for selection corrected indices as our benchmark for the level of serial correlation that should be inherent to 0.6 real estate indices at the quarterly frequency. They report a value of 0.33 for retail and of 0.26 for offices. Our de-smoothed series exhibit values of 0.30 and 0.31, respectively. The raw series, i.e. before de-smoothing, have values of 0.73 and 0.74, respectively.

[8] A de-smoothing parameter of 0.5 yields a serial correlation coeffcient of the de-smoothed series of 0.40 for retail and 0.42 for offices. With a 0.7 de-smoothing parameter, those values are 0.19 and 0.21, respectively.

[9] Weak exogeneity of a variable indicates that the variable does not react to deviation from the long-run relation. In other words, the speed of adjustment parameter of a weakly exogenous variable is zero.

be concluded that REITs and direct real estate for the given property type provide the same mean return over the long horizon.

Previous studies on the topic have used simple comparisons of the mean returns and corresponding F-test to investigate the similarity of REIT and direct real estate returns. Cointegration analysis has several advantages over the F-test. First, the F-test results can be highly dependent on the ending and starting dates of the sample period, especially given that the direct real estate prices (returns) appear to react notably slower to changes in the fundamentals than REIT prices do (Hoesli and Oikarinen, 2012). This can be problematic especially if the starting or ending period represents an abnormal time period, such as a financial crisis time. Although the ending date can affect the results of cointegration analysis as well, it can be argued that the cointegration analysis is less prone to the complications set by the sample period timing. This is because cointegration analysis is based on the relationship between the variables during the whole sample period, not only on the starting and ending values of return indices (as the F-test essentially is to a large extent), and because the concept of cointegration allows for even large *temporary* deviations from a long-run equilibrium relation.

Second, a one-to-one cointegrating relation between two series indicates that there are strong economic forces keeping the series together in the long run. Stated differently, it means that the equivalence of mean returns is not just a coincidence that is likely to vanish in the future, but is due to a real economic phenomenon, i.e. due to an equilibrium relation between the series.

Third, the F-test results are known to be highly dependent on outlier observations and sensitive to the violations of the normality assumption. In cointegration tests, we can add point dummy variables to cater for the outlier observations and thereby fulfill the normality of residuals assumption while still getting reliable test values. Fourth, cointegration analysis allows us to conduct some robustness checks that are not possible with the t-test, in particular the recursive estimation which makes it possible to investigate the stability of the long-term relations. Moreover, (abnormally) prominent cycles and thereby return volatility in the sample period, due to a financial crisis for instance, increases the likelihood of accepting the null of similar returns in the F-test. Nevertheless, we also report the conventional F-test p-values on the hypothesis of similar mean returns on REITs and TBI.

Regarding the analysis of the similarity of risks, we follow the approach used by *Pagliari, Scherer and Monopoli (2005)*. That is, we use return volatility, i.e., the standard deviation of returns, as the measure of risk. The similarity of volatilities in the two markets is then tested by the F-test.

Sensitivity Analyses

We conduct a number of robustness checks for the empirical findings. As the assumed direct real estate portfolio management costs can influence the results, we conduct the cointegration analysis and F-test on the mean returns assuming both 50 bps and 120 bps management fee assumption (the baseline assumption is that of 80 bps management costs).

Noticeably, also the planned investment horizon (i.e., the employed data frequency) may affect the F-test conclusions. This is particularly relevant regarding the test on the equivalence of return volatilities. Since real estate returns are known to exhibit substantial 'momentum' (positive autocorrelation) in the relatively short term and reversion (negative autocorrelation) in the long run and the momentum and reversion patterns can differ between public and private markets, the relative volatilities may be dependent on the assumed investment horizon. Additionally, the direct market volatility may be downgraded in the relatively short-term by the time-varying liquidity in the market (see *Fisher et al. 2003; Fisher, Geltner and Pollakowski, 2007; Pagliari, Scherer and Monopoli, 2005*, p. 177). Therefore, we conduct the F-tests assuming three-year and five-year investment horizons as well (instead of the baseline one-quarter horizon).

A complication with the longer-horizon F-test statistics is the loss of observations in the early sample period. This may significantly affect the results especially in those cases where there is substantial volatility in the indices during the early sample period (see e.g. the UK retail sector). This gives another reason to rely more on the cointegration statistics rather than on the F-statistics on the mean returns in the long-horizon analysis.

We also compute Variance Ratios (VR) for the returns to illustrate the impact of investment horizon on the riskiness of the markets. Given that the number of observations is relatively small, the *Wild bootstrap approach of Kim (2006)* is used to compute the VRs and their standard deviations. These VRs and standard deviations are then used to compute and graph the asset volatility and its confidence bands at each investment horizon up to 20 quarters. The standard deviation of market i at the x quarter horizon is calculated as $\sigma_i(1) * VR_i(x)$, where σ denotes standard deviation and the figure in parenthesis is the investment horizon in quarters.

As a diagnostic check regarding the cointegration analysis, we examine the stability of the long-term relations by the recursive and backwards recursive Max Test statistics (in the R-form) of constancy of the estimated long-run relation (*Juselius, 2006*). This will, for instance, make it possible to gauge whether such relationship has been altered by the recent financial crisis.

For the UK, we use the original appraisal-based IPD indices in the cointegration analysis and in the F-test for mean returns. This is because appraisal-smoothing should not affect the *long-term* relations between the public and private markets, and since compounding de-smoothed returns to get the total return indices could result in biased indices w.r.t the slope of the index (i.e. mean returns). In the volatility tests, instead, we use the de-smoothed IPD returns. The volatility comparison can depend crucially on the assumed actual first-order serial correlation and thereby on the imposed de-smoothing parameter. Therefore we conduct robustness checks using de-smoothing parameters of 0.5 and 0.7, the parameter being 0.6 in the baseline analysis.

Empirical Findings

Baseline F-Test Analysis

Tables 1 and 2 report the mean returns, return volatilities and some other descriptive statistics for the real unlevered asset returns for the US and UK, respectively. While the observed first-order autocorrelations are positive for REIT and IPD returns, they are negative (though not statistically significant) for TBI returns. The negative first-order autocorrelations of TBI returns are likely to be due to short-term measurement error in the TBI indices. The Tables also provide the F-test p-values on the hypothesis of equivalent returns and return volatilities between the public and private real estate markets.

[Table 1 here]

[Table 2 here]

The F-test clearly accepts the hypothesis of equivalent mean returns in the public and private real estate markets for all tested horizons for each sector, except for UK retail. Also the hypothesis of similar return volatilities is generally accepted. Nevertheless, the F-statistics imply that the TBI volatility is greater than that of REITs at each horizon in the US apartment sector. In the US office sector, in turn, REIT market volatility has been greater at the five-year horizon, whereas the observed quarterly TBI volatility is greater in the US retail sector. The latter observation may well be due to the measurement error induced noise in the TBI series (this is supported by the VR statistics, see Figure 3). The results further indicate that the private market volatility is greater than that of unlevered REITs in the UK office sector. Notice also that the observed greater longer-term mean return in the REIT market than in the private market in the UK retail sector is to a large extent due to the loss of observations and substantial return volatility in the early sample period, i.e., this result is unreliable. In addition, the non-normal distribution of the asset returns makes the reported p-values unreliable in many cases, especially at the quarterly frequency.

Baseline Cointegration Analysis for Long-Term Similarity

Cointegration analysis has several advantages over the conventional F-test on the equality of mean returns, as explained in the methodology section. Therefore, we conduct cointegration analysis to draw more reliable conclusions regarding the long-term similarity of public and private real estate performance. The baseline cointegration analysis results are summarized in Table 3.

[Table 3 here]

Except for the UK office sector, the Trace test statistics indicate cointegration between the public and private real estate total return indices. The US apartment sector is a borderline case with a p-value .08, though. In each US sector, REITs can be restricted to be weakly exogenous, i.e., only TBI adjusts towards the cointegrating relation. This is in line with previous empirical evidence and the assumption that the direct market reacts more sluggishly to shocks than the REIT market. In contrast, in the UK, it is the REIT market that adjusts towards the long-term relation in the retail sector, i.e., REIT returns can be predicted by deviations from the relation. This indicates that the REIT market is less mature and informationally efficient in the UK than in the US.

Most importantly, all the estimated long-term coefficients on REITs are close to one and, except for the US retail sector, the one-to-one hypothesis can be accepted. This indicates similarity of public and private market long-term returns in the US office, industrial, and apartment sectors and in the UK retail sector. The coefficient 1.10 on REITs in the US retail sector implies somewhat greater mean returns for direct real estate than for unlevered REITs. The point estimate indicates that, on average, when REIT returns are 10% the corresponding TBI returns are 11%. The corresponding ‘unconstrained’ coefficients, i.e., the coefficients estimated on REITs without imposing the one-to-one restriction, vary from .89 in the UK retail sector to 1.05 in the US industrial sector. The slight differences across sectors could of course be due to the fact that we do not control for geography in our analyses. The geographical distribution of properties across private and public markets may differ, leading to differences in returns and risks. However, such effects are likely to weaken rather than strengthen the similarity tests we conduct in this paper.

Figure 2 shows the deviations of the private market indices from the equilibrium relations.[10] Except for US retail, the graphed deviations are those for the one-to-one relations. Generally, the greater the speed of adjustment parameter, the shorter and smaller the temporary deviations from the long-term equilibrium are likely to be, thereby enhancing the substitutability between the two markets and the possibilities to hedge direct real estate portfolio risks by public market vehicles. In line with this argument, the US office sector (speed of adjustment parameter of 23%) shows much longer-lasting deviations from the equilibrium than the more rapidly adjusting US retail (42%) and industrial (31%) sectors during the late 1990s and early 2000s. The apartment sector graph suggests that the inability to get stronger evidence of cointegration in the Trace test and the small estimated alpha are due to the aftermaths of the GFC. While the other US sectors were close to the long-term relations as of 2011, the apartment TBI remained approximately 20% undervalued w.r.t. REITs. The apartment TBI followed closely the REIT index before the crisis, however. The deviation in the UK retail sector was 15% in 2011Q4.

[Figure 2 here]

Further Sensitivity Analyses

We have already discussed the impact of the investment horizon on the F-test statistics above. As the investment horizon for private real estate assets is typically several years, we further illustrate (in Figures 3-4) the influence of horizon on the return volatility by graphing the volatilities and their confidence bands in each market at each investment horizon up to 20 quarters based on Variance Ratios and their standard deviations. The UK direct market curves are based on the baseline 0.6 de-smoothing parameter.

[Figure 3 here]
[Figure 4 here]

Figures 3-4 indicate short-term momentum in each of the return series. The annualized volatility curves peak at around a two to three year horizon. Exceptions are the UK REIT returns, whose volatilities peak at the four-year (retail) and five-quarter (office) horizons. If the horizon is further extended, the curves tend back towards one indicating long-term mean reversion in the return series and thus smaller return volatility than at the five-year horizon. The reversion is particularly strong in the US apartment REIT

[10] The concept of equilibrium here is not related to the equilibrium between economic fundamentals, such as income and interest rate, and real estate values that is studied in many recent papers (see e.g. Mikhed and Zemčik, 2009; Oikarinen, 2009; Costello, Fraser and Groenewold, 2011).

market. The shape of the volatility curves for TBI is most likely affected by short-term measurement error in the indices: the initial drop in the direct market volatility curves is likely due to the short-term 'noise' in the indices rather than because of actual negative short-term autocorrelation. This 'noise' also contributes to the inability to find a statistically significant momentum effect for direct market returns.[11] While the investment horizon can affect both absolute and relative riskiness of the markets, the main message of Figure 3 is that the shapes of the private and public real estate volatility curves are generally quite similar and in each sector the hypothesis of equivalent standard deviation can be accepted regardless of the assumed investment horizon for the US and at each horizon from three quarters onwards for the UK.

Note that regarding the UK office sector, the findings based on the more reliable Variance Ratio statistics differ from the F-test results reported in Table 2. The employed de-smoothing parameter naturally affects the UK private market volatility curves. Nevertheless, the main message remains the same even if the parameter was 0.5 or 0.7 instead of the baseline 0.6. There are some slight changes, though: in the 0.5 case, there are no statistically significant volatility differences even at the short-horizon, and in the 0.7 case the IPD volatility seems to be notably greater than that of REITs, but not in a statistically significant manner.

Next, we investigate whether the estimated long-run relations, one-to-one relations in four out of five sectors, are stable over the sample period. Figure 5 graphs the recursive and backwards recursive Max Test statistics for the hypothesis of constancy of the estimated long-run relation. The statistics are scaled by the 5% critical values, so that a value exceeding one indicates rejection of the null. The stability is clearly accepted in the US retail sector throughout the sample period. In the US office sector, there is evidence of instability during the early sample period, but the relation appears to remain constant after that. The US apartment and industrial sectors as well as the U.K retail sector, in turn, show temporary instability during the GFC, which is not unexpected given a visual inspection of the deviations from the relations (Figure 2). There is no evidence of a permanent structural change and the instability around the GFC is not statistically significant, however. Therefore, it is reasonable to believe that the estimated relations hold at the end of the sample period.

[Figure 5]

We also test the robustness of our findings with respect to the assumed direct real estate portfolio management fees. These fees may range between 50 and 120 bps per year (*Riddiough, Moriarty and Yeatman, 2005*), and in the baseline analysis we follow those authors by using the 80 bps points assumption. Table 4 presents cointegration test results for the 50 bps and 120 bps assumptions.

[Table 4]

The Trace test results are generally in line with the baseline analysis.[12] There are some changes compared with the baseline 80 bps assumption, however. While the other US sectors are robust w.r.t. cointegration between the markets, the conclusion is dependent on the management fee assumption in the apartment sector: the hypothesis of no cointegration is rejected at the 4% significance level in the 50 bps case, but only at the 11% level in the 120 bps case. Assuming cointegration, the hypothesis of a one-to-one relation can be accepted in the apartment sector for all management fee assumptions, though. Regarding the one-to-one hypothesis, the management fee assumption is of significance in the retail sector, as the hypothesis is accepted assuming 120 bps fees, but not otherwise. In the industrial sector, in turn, the one-to-one relation is a borderline case if the true management fees are 50 bps per year. In the UK retail sector, the acceptance of the null of a one-to-one relation is a borderline case – the unconstrained coefficient on REITs being .84 – if the true management costs are 120bps.

[11] Some individual autocorrelations for TBI returns, third-order autocorrelations in particular, are significantly greater than zero. Moreover, the hypothesis of no significant momentum in the direct market is rejected in each sector if the baseline is a two-quarter horizon instead of a one-quarter horizon.
[12] The Max test statistics regarding the stability of the cointegrating relations are not notably affected by the variation in the management fees.

Generally, the speed of adjustment parameters are the greatest in the baseline case. This suggests that the interdependence between the REIT and TBI/IPD indices is the 'tightest' when the 80 bps level of management costs is assumed. This observation could be interpreted as indirect support for the relevance of the 80 bps assumption and is sensible given that 80 bps is considered to be a typical value for the management costs. Again, an exception is the US apartment sector, where the hypothesis of no cointegration can clearly be rejected only in the 50 bps case. Also, in the UK retail sector the REIT speed of adjustment parameter is the greatest when 50 bps management fees are assumed.
In sum, overall the empirical findings are generally robust throughout the sample period and with respect to the management fee assumption.

The Influence of the Global Financial Crisis
As shown by Figure 5, the stability of the long-run relations cannot be rejected even during the GFC. Nevertheless, Figure 3 indicates that substantial deviations from the long-term relations emerged after the Lehman collapse. Therefore, it is worthwhile to discuss briefly the influence of the GFC on the relationship between the public and private real estate market performance.

Expectedly, the outbreak of the GFC had a notable adverse influence on the asset prices both in public and private markets (Figure 1). However, since the REIT market reacted to the adverse shock much earlier than the direct market, deviations from the long-run relations of around 30% in each US sector took place in 2008Q4-2009Q1. In contrast, such overpricing of private real estate compared with REITs did not take place in the UK retail sector: also REITs reacted sluggishly in the UK market.

Given the total return indices shown in Figure 1 and the previous empirical evidence on the more sluggish adjustment of the direct market that the REIT market to shocks in the fundamentals (Hoesli and Oikarinen, 2012), the large initial deviations in the US after the Lehman collapse were most probably due to the substantial private real estate market frictions. These frictions include the low liquidity: when an investor needs cash rapidly – due to an inability to refinance short-term debt for instance – the investor will typically sell the more liquid assets (REITs) first as those can be sold relatively fast without having to accept as great a discount as concerning the less liquid assets (direct real estate).[13]

The overpricing of TBI relative to REITs disappeared towards the end of the sample period, as the direct market gradually adjusted and the financial markets calmed down. Hence, the large deviations predicted the forthcoming collapse in direct market values. There was even some overshooting in the other direction, i.e., towards undervaluation of direct real estate, in the industrial and apartment sectors since late 2009. This is partially due to the rapid 'rebound' of the REIT market. While this deviation has vanished in the industrial sector, direct apartment investments remained about 20% undervalued relative to their public counterpart as of 2011Q4. REITs rebounded faster in the UK market as well, inducing notable undervaluation of retail IPD compared with REITs. This undervaluation was at its greatest as large as 30% in 2009Q3. Relying on the above presented statistics according to which there have not been permanent structural changes in the long-term relations, the findings suggest that the US private apartment assets and UK private retail real estate assets are expected to appreciate notably faster than their REIT counterparts in the relatively close future after 2011Q4.

An interesting question is whether there could be a particular underlying fundamental variable that can explain the large temporary deviations. *Hoesli and Oikarinen (2012)* show that REITs tend to react substantially faster to risk premium and real interest rate shocks than do direct real estate values, and that a notable increase in the interest rate preceded, while an increase in the risk premium coincided with, the emergence of the substantial deviations. These findings emphasize the role of adverse interest rate and risk premium shocks behind the deviation patterns during the GFC. Figure 6 illustrates the relationship between the real risk-free interest rate, risk premium, and the deviations from the equilibrium relations for the US market.[14]

[Figure 6 here]

[13] It should also be noted that part of the initial adjustment in the direct market took place through lower liquidity, i.e., longer time-on-the-market and fewer transactions. This kind of adjustment is not visible from the total return series.
[14] The interest rate and risk premium are measured here as the three-month T-bill rate and the spread between corporate bond (Baa, Moody's) yield and the 10-year government bond yield, respectively.

Regarding portfolio allocation implications, the observations suggest that an investor should not reallocate his portfolio from REITs to direct real estate after a drastic drop in REIT prices due to shocks such as the Lehman collapse. This is because the direct market is likely to follow the REIT market fall, and the expected returns for REITs are therefore greater than those for direct real estate for some time after such adverse shock.

Finally, the experience from the GFC period suggests that hedging private real estate exposure by public real estate derivatives can work during a crisis period, i.e., just when such hedging is needed the most. Despite the slower response of private real estate values, the linkage between the private and public markets remained generally quite constant during the crisis and its aftermaths, as the notable long-run deviations vanished relatively fast (with the exception of the US apartment sector and the UK retail sector to a lesser extent). Importantly, as it is typically hard to sell the more illiquid private real estate assets rapidly without a notable discount during crisis periods, the gains on the derivatives used to hedge the downside risks can be used as a source of necessary liquidity instead of having to conduct distressed sales of private assets with discount.

Concluding remarks

This article examines empirically the similarity of returns and risks for publicly traded securitized assets and privately owned non-securitized assets using real estate market data. The relationship between publicly and privately traded asset performance is of importance to a large number of investors and financial institutions due its portfolio and hedging implications. However, empirical examination of the question is usually not possible, since there are no reliable time series data on the typical underlying privately traded assets. Since reliable data are available both for securitized real estate (REIT) and direct real estate performance, the 'duality' of the real estate markets offers an opportunity to test the hypothesis of similar returns and risks regardless of the trading 'platform', i.e., regardless of whether the asset is traded in a public market place for securities or privately as a lumpy non-securitised asset.

The theory does not give a clear indication on whether the mean returns of publicly and privately traded assets should be the same. On one hand, it can be expected that the returns and risks of privately traded direct investments and of securities that are based on similar direct assets are alike, since the security cash flows are generated by the underlying direct assets. On the other hand, the returns on securities may notably deviate from those on private assets due to factors such as higher liquidity and smaller transaction costs of the securitized publicly traded assets, and due to varying diversification benefits offered by securities vs. direct assets.

We use sector level REIT and direct real estate total return indices for the US and UK to investigate the similarity of public and private market returns and risks. The data, which cover the period 1994-2011 for the US and 1991-2011 for the UK, are adjusted to cater for the effects of leverage and management fees. We argue that cointegration analysis is more reliable than the conventional F-test in testing for the similarity of mean returns over the long horizon. Nevertheless, we report the F-test statistics in addition to the cointegration tests.

The results provide evidence of cointegration between the public and private markets in the four US sectors included in the analysis and in one of the two UK sectors. Thus, the analysis shows that while in the short run the observed REIT and direct real estate returns can substantially deviate from each other due to factors such as data complications, market frictions, and slow adjustment to changes in the fundamentals in the private market, in the long term public and private real estate returns are similar after catering for the effects of property type, leverage, and management costs. Moreover, in four of the five cointegrated sectors the hypothesis of a one-to-one relation between the adjusted total return indices can be clearly accepted.

We limit the test of risk equivalence to the standard deviation of total returns. The return volatilities generally do not differ significantly between REIT and direct real estate regardless of sector and time horizon. There may also be risks, such as liquidity risk, that differ between the markets and that are not catered for by the standard deviation of returns.

The findings are by and large robust with respect to the assumed private market management fees. While the cointegrating relations, including the one-to-one relations, are generally stable over time, notable deviations from these relations emerged during the GFC. These deviations appear to have been only temporary, although the US apartment and UK retail markets were still far from equilibrium in 2011Q4.

Our findings have important practical implications. First, the public and private real estate investments can be considered to work as good substitutes in an investment portfolio with several years investment horizon, since they provide similar total returns and return variances, and co-move tightly over the long horizon. As securitized real estate assets enable diversification with smaller amounts of capital, and the liquidity is better and transaction costs are lower in the public market than in the private market, our findings suggest that those investors who have relatively small amounts of capital and highly value liquidity and small transaction costs should tilt their real estate holdings towards publicly traded REITs. Nevertheless, this does not necessarily hold for all the real estate sectors, and liquidity and transaction costs tend to have less importance the longer is the planned investment horizon.

Second, the long-term similarity of public and private returns proposes that REIT related ETFs and derivatives can be used to hedge risks created by direct real estate holdings. As *Fabozzi, Shiller and Tunaru (2009)* note: "*A primary factor in deciding which derivative contract will provide the best hedge is the degree of correlation between the factors driving the price of the derivative instrument under consideration as the hedging vehicle and the underlying risk that investors seek to eliminate*". Due to the one-to-one cointegrating relation between REITs and direct real estate, a possibility to take short positions on ETFs, for instance, offers a good opportunity to hedge risks in lending institutions' portfolios that arise due to their outstanding mortgage lending inventory. Among other potential benefits[15], such hedging could help banks to survive better through the periods of economic distress and drastically decreasing real estate prices. From an investor's point of view, in turn, during crisis periods the gains on the derivatives used to hedge the downside risks could be used as a source of necessary liquidity instead of having to conduct distressed sales of private assets with substantial discount.

Due to the potentially lengthy deviations from the equilibrium relations between public and private real estate, hedging cannot totally remove the risks. Moreover, in many markets the current public market related vehicles are not sufficient to properly exploit the hedging opportunities. That is, new financial vehicles, especially for taking long-term short positions, and more liquid markets for them are needed in order to be able to take better advantage of the hedging potentials.[16] Anyhow, the longer the horizon and the faster the adjustment of the private market towards the equilibrium relation, the better are the hedging opportunities.

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[15] Englund, Hwang and Quigley (2002) point out that there could be large potential gains from instruments that would allow property holders to hedge their lumpy investments in housing.
[16] Fabozzi, Shiller and Tunaru (2009, 2010) provide a more detailed discussion on the potential use of real estate related derivatives.

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Figure 1 Sector level (unlevered) REIT and private real estate real total return indices

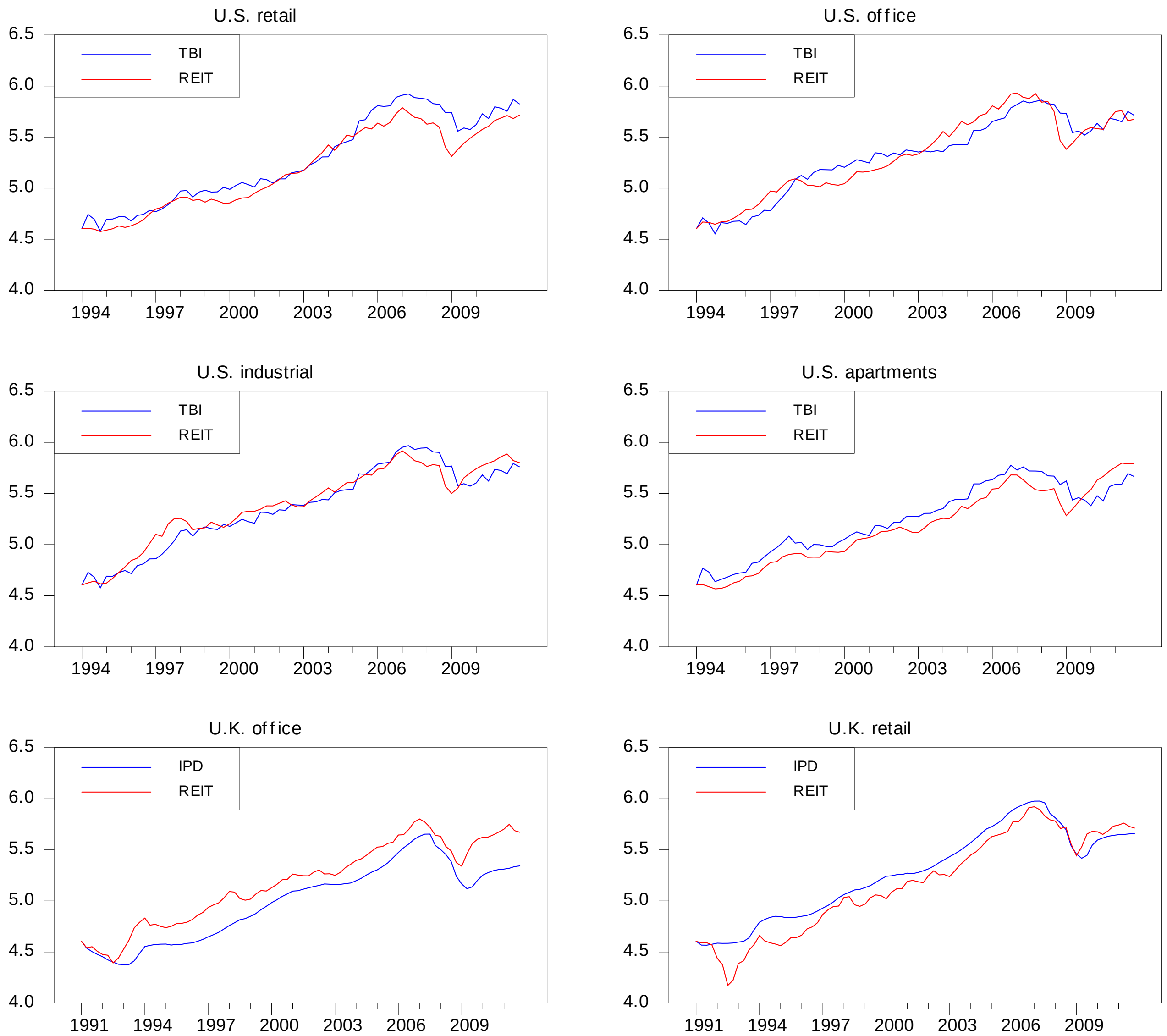

Figure 2 **Deviations of private market indices from the long-run cointegrating relations**

Figure 3 The annualised standard deviations of US TBI (blue) and REIT (red) returns and their confidence bands (± 2 s.d.) depending on the investment horizon

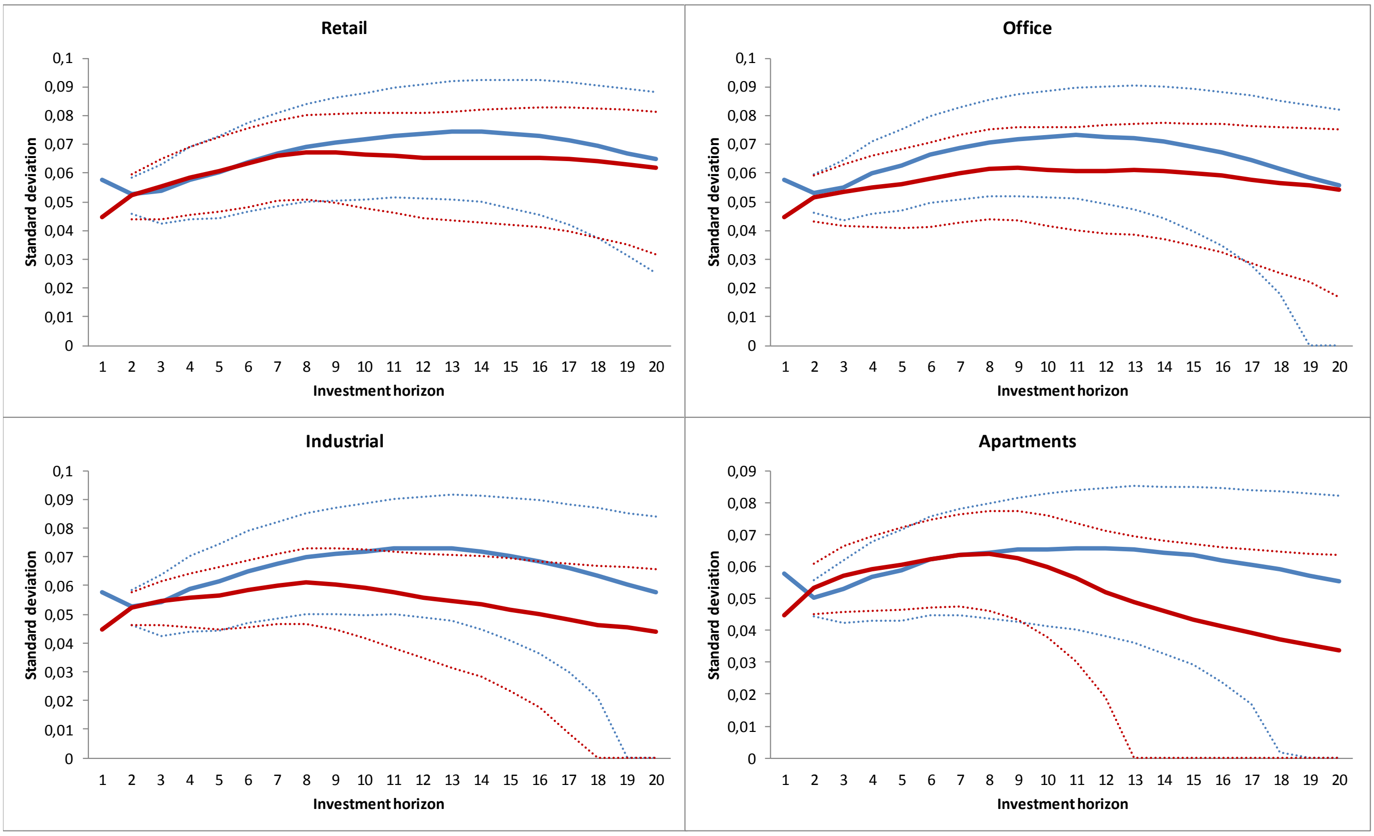

Figure 4 The annualized standard deviations of UK IPD (blue) and REIT (red) returns and their confidence bands (± 2 s.d.) depending on the investment horizon

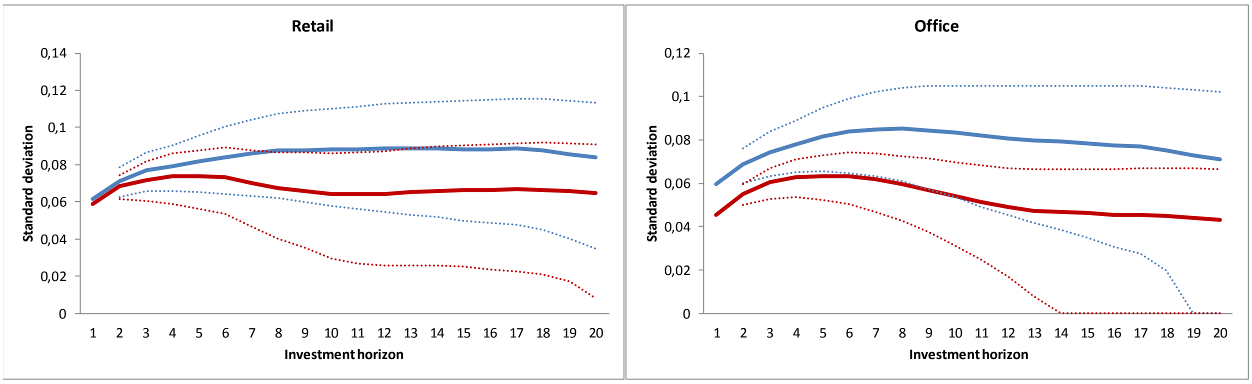

Figure 5 The forward recursive and backward recursive Max Test statistics (in the R-form) of constancy of the estimated long-run relation scaled by the 5% critical value

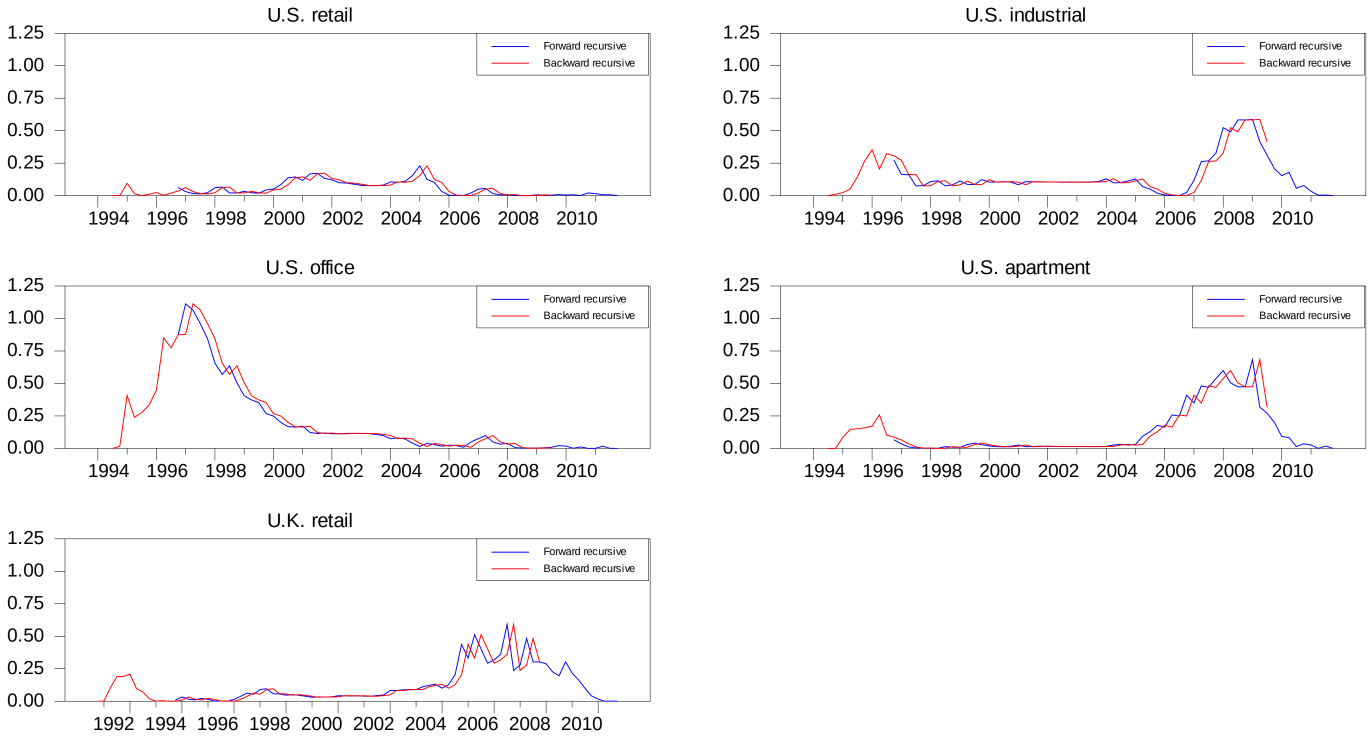

Figure 6 Deviation of retail and office TBI from the long-run relation, and the risk premium and risk-free interest rate

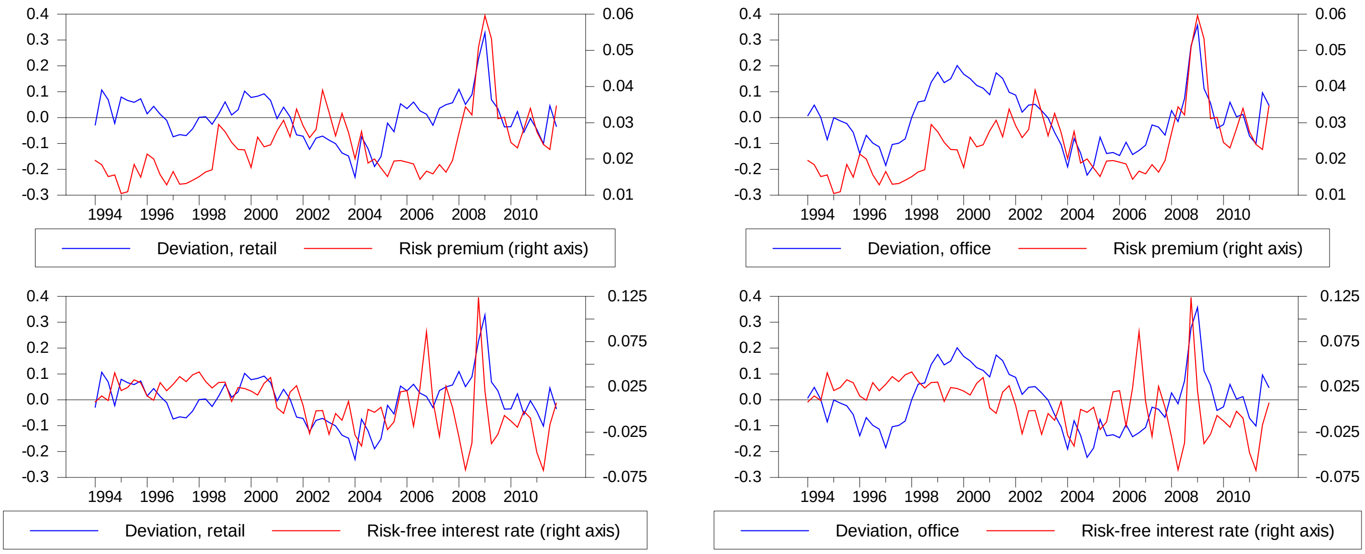

Table 1 Baseline descriptive and F-test statistics, US market returns

	Mean	Standard deviation	Jarque-Bera (p-value)	Autocorrelation
		Quarterly returns		
Retail TBI	.0172	.0576	.01	-.152
Retail REIT	.0156	.0446	.00	.335**
F-test (p-value)	*.86*	*.03*		
Office TBI	.0156	.0541	.00	-.144
Office REIT	.0150	.0571	.00	.316**
F-test (p-value)	*.95*	*.66*		
Industrial TBI	.0163	.0572	.00	-.158
Industrial REIT	.0169	.0487	.00	.343**
F-test (p-value)	*.95*	*.18*		
Apartment TBI	.0149	.0556	.00	-.204
Apartment REIT	.0167	.0413	.00	.399**
F-test (p-value)	*.83*	*.01*		
		Three-year returns		
Retail TBI	.202	.235	.73	
Retail REIT	.187	.208	.08	
F-test (p-value)	*.71*	*.35*		
Office TBI	.192	.217	.17	
Office REIT	.174	.248	.00	
F-test (p-value)	*.68*	*.32*		
Industrial TBI	.192	.231	.01	
Industrial REIT	.200	.194	.94	
F-test (p-value)	*.84*	*.19*		
Apartment TBI	.160	.200	.00	
Apartment REIT	.192	.153	.00	
F-test (p-value)	*.32*	*.04*		
		Five-year returns		
Retail TBI	.382	.246	.45	
Retail REIT	.336	.235	.29	
F-test (p-value)	*.33*	*.76*		
Office TBI	.349	.198	.21	
Office REIT	.332	.266	.07	
F-test (p-value)	*.57*	*.04*		
Industrial TBI	.356	.217	.03	
Industrial REIT	.324	.184	.20	
F-test (p-value)	*.42*	*.24*		
Apartment TBI	.292	.205	.05	
Apartment REIT	.326	.119	.26	
F-test (p-value)	*.29*	*.00*		

*** and ** denote statistical significance at 5% level and 1% level, respectively. Jarque-Bera denotes the Jarque-Bera test for normally distributed returns. Autocorrelation is not reported for the longer-run returns, since these returns are computed on an overlapping window basis. The TBI values are based on a 80 bps management cost assumption.**

Table 2 Baseline descriptive and F-test statistics, UK market returns

		Mean	Standard deviation	Jarque-Bera (p-value)	Autocorrelation
			Quarterly returns		
Retail IPD		.0127	.0617	.00	.300**
Retail REIT		.0133	.0587	.00	.320**
	F-test (p-value)	*.93*	*.66*		
Office IPD		.0089	.0594	.00	.313**
Office REIT		.0129	.0455	.24	.439**
	F-test (p-value)	*.53*	*.02*		
			Three-year returns		
Retail IPD		.138	.286	.00	
Retail REIT		.202	.203	.03	
	F-test (p-value)	*.07*	*.00*		
Office IPD		.134	.260	.00	
Office REIT		.176	.156	.00	
	F-test (p-value)	*.18*	*.00*		
			Five-year returns		
Retail IPD		.262	.328	.00	
Retail REIT		.373	.230	.11	
	F-test (p-value)	*.01*	*.00*		
Office IPD		.268	.269	.00	
Office REIT		.304	.162	.17	
	F-test (p-value)	*.29*	*.00*		

*** and ** denote statistical significance at 5% level and 1% level, respectively. Jarque-Bera denotes the Jarque-Bera test for normally distributed returns. Autocorrelation is not reported for the longer-run returns, since these returns are computed on an overlapping window basis. The IPD values are based on a 80 bps management cost assumption. The IPD volatility is based on the 0.6 de-smoothing parameter.**

Table 3 Cointegration analysis results

	Trace test (p-value on r=0)	LR test, α(REIT) = 0 (p-value)	LR test, α(TBI/IPD) = 0 (p-value)	LR test, TBI = REIT (p-value)	Uncon-strained coefficient on REIT (s.d.)	α(TBI) (s.d.)	α(REIT) (s.d.)
The US market							
Retail	.00	.77	.00	.03	1.104 (.031)	-.417 (.070)	-
Office	.00	.62	.00	.65	.941 (.057)	-.229 (.051)	-
Industrial	.00	.13	..00	.26	1.053 (.046)	-.305 (.062))	-
Apartments	.08	.43	.00	.57	.910 (.076)	-.177 (.063)	-
The UK market							
Retail	.00	.00	.15	.12	.887 (.039)	-	.155 (.047)
Office	.62						

The direct market indices are based on the 80 bps management cost assumption. The tested models for the US market include one lag in differences and a point dummy variable for 2008Q4. The UK models include two lags in differences and two point dummy variables, 1992Q3 and 2008Q4 for retail and 2007Q4 and 2008Q4 for office. The reported Trace test statistics are Bartlett small-sample corrected and simulated to cater for the influence of the dummy variable. The LR test on TBI/IPD = REIT is Bartlett small-sample corrected. The LR test on the one-to-one relation is a test on the joint hypothesis of REIT/direct weak exogeneity and the 1-1 relation in case the hypothesis of REIT/direct weak exogeneity is accepted. ‘Unconstrained’ coefficient denotes the estimated coefficient in the case of no restrictions in the cointegrating vector, but restrictions in the alpha vector if accepted. The reported speed of adjustment parameters (α) are based on a 1-1 relation if such relation is not rejected.

Table 4 Cointegration analysis results assuming 50 bps and 120 bps management fees in the private market

	Trace test (p-value on r=0)	LR test, α(REIT) = 0 (p-value)	LR test, α(TBI/IPD) = 0 (p-value)	LR test, TBI = REIT (p-value)	Uncon-strained coefficient on REIT (s.d.)	α(TBI) (s.d.)	α(REIT) (s.d.)
The US market							
				50 basis points management fees			
Retail	.00	.65	.00	.00	1.142 (.032)	-.407 (.068)	-
Office	.00	.54	.00	.73	.954 (.066)	-.212 (.047)	-
Industrial	.00	.10	.00	.09	1.092 (.044)	-.286 (.060)	-
Apartments	.04	.33	.00	.57	.951 (.072)	-.205 (.066)	-
				120 basis points management fees			
Retail	.00	.14	.00	.27	1.035 (.035)	-.390 (.064)	-
Office	.00	.45	.00	.22	.872 (.061)	-.194 (.047)	-
Industrial	.00	.18	.00	.52	1.003 (.048)	-.303 (.063)	-
Apartments	.11	.58	.01	.48	.856 (.082))	-.138 (.058)	-
The UK market							
				50 basis points management fees			
Retail	.00	.00	.17.	.19	.920 (.036)	-	.250 (.059)
Office	.57						
				120 basis points management fees			
Retail	.00	.01	.11	.09	.842 (.044)	-	.209 (.057)
Office	.65						

The tested models for the US market include one lag in differences and a point dummy variable for 2008Q4. The UK models include two lags in differences and two point dummy variables, 1992Q3 and 2008Q4 for retail and 2007Q4 and 2008Q4 for office. The reported Trace test statistics are Bartlett small-sample corrected and simulated to cater for the influence of the dummy variable. The LR test on TBI/IPD = REIT is Bartlett small-sample corrected. The LR test on the one-to-one relation is a test on the joint hypothesis of REIT/direct weak exogeneity and the 1-1 relation in case the hypothesis of REIT/direct weak exogeneity is accepted. 'Unconstrained' coefficient denotes the estimated coefficient in the case of no restrictions in the cointegrating vector, but restrictions in the alpha vector if accepted. The reported speed of adjustment parameters (α) are based on a 1-1 relation if such relation is not rejected.

APPENDIX

Figure A1 Unlevered and levered REIT total return indices in real terms