Elias Oikarinen, Martin Hoesli and Camilo Serrano

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ABSTRACT

This paper contributes to the literature by identifying the response patterns of direct and indirect real estate returns to shocks in the market fundamentals. The response speeds are estimated with vector autoregressive models using TBI and NAREIT returns for the period 1994-2009 in the United States. To avoid the potential influence of different property mixes and of leverage on the dynamics, we use sector level data and deleveraged NAREIT returns. The findings indicate that REIT returns lead direct real estate returns even when catering for the property type and for leverage. Our estimations suggest that this lead-lag relationship is due to the sluggish reaction of direct real estate prices to unexpected changes both in the fundamentals and in REIT prices. The findings further suggest that the perceived lead-lag relations are not only due to the slow adjustment of sellers' reservation prices, but also due to the sluggish reaction of demand in the direct real estate market.

JEL Classification: G14; C32

Keywords: Vector Autoregressive Models, Generalized Impulse Response Functions, Direct Real Estate, Securitized Real Estate, Dynamics

Contact information

Elias Oikarinen: Email: elias.oikarinen@tse.fi
Martin Hoesli: Email: martin.hoesli@unige.ch
Camilo Serrano: Email: camilo.serrano@iazi.ch

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1 Introduction

The securitized real estate market is generally assumed to be more informationally efficient than the direct real estate market. This is due to the better liquidity, greater number of market participants, smaller transaction costs and the existence of a public market place for real estate securities. Therefore, the price of securitized real estate investments are expected to react faster to shocks in the fundamentals than direct real estate prices. In line with this hypothesis, empirical evidence suggests that the public market leads the direct real estate market even when transaction-based data, i.e. data that do not exhibit appraisal smoothing, are used (Barkham and Geltner, 1995; Oikarinen et al., 2010).

However, since the reported lead-lag relations are generally based on data that do not correct for the different property-type mixes of the securitized and direct real estate indices, the empirical evidence is not conclusive. As the price reaction speeds may substantially differ between real estate sectors (Wheaton, 1999), it has been claimed that the perceived lead-lag relations may be caused by the property-mix differences in the data used in the analyses. Geltner and Kluger (1998), Seiler et al. (1999), and Li et al. (2009) find that REIT returns lead NCREIF returns even when catering for the property-type mix. However, while Geltner and Kluger limit their analysis to simple correlation analysis and do not study the phenomenon in detail, Seiler et al. and Li et al. use the NCREIF data that exhibit appraisal smoothing to proxy for the direct market performance. To date, no study has concentrated on examining the reaction speeds of and the lead-lag relationships between the securitized and direct real estate markets using sector level data and non-appraisal based direct real estate returns.

We use sector level REIT (NAREIT) and direct real estate (TBI) total return data from 1994Q1 to 2009Q4 to study the reaction patterns of securitized and direct real estate returns to economic shocks and to examine the lead-lag relations between the securitized and direct real estate markets. To avoid the potential influence of leverage in the REIT data on the dynamics, we restate the REIT return index to exclude the impact of leverage. Based on the estimated vector autoregressive models, the results show that REIT returns lead direct real estate returns regardless of the property sector. Hence, the property-type mix is not the reason behind the observed lead-lag relationship between the markets as claimed in the extant literature. Moreover, our findings suggest that the perceived lead-lag relations are not only due to the slow adjustment of sellers' reservation prices, but also due to the sluggish reaction of demand in the direct real estate market.

The findings have several practical implications. In particular, REIT returns can be used to predict direct real estate returns. The results also show that REIT returns have predictable components. Furthermore, the positive lead-lag relations indicate that over the longer horizon the co-movement between securitized and direct real estate markets is stronger than the contemporaneous quarterly correlation coefficients suggest. That is, the securitized real estate performance more closely tracts the direct real estate market performance in the long run than indicated by the relatively short-term contemporaneous co-movement only. Therefore, the benefits of including securitized real estate in a long-horizon multiple asset portfolio containing already direct real estate are more limited than what typically reported quarterly correlations would suggest.

Although the main findings are similar concerning all four sectors, the results also show that there are some differences between the sectors regarding the return dynamics. Therefore, it is reasonable to use sector level data when evaluating the return and price dynamics in the REIT and direct property markets and when making forecasts concerning future price development in the markets.

A review of the literature on the lead-lag relations between direct and securitized real estate markets is presented in the next section. The third section describes the data used in the empirical analysis, while the fourth section delineates the econometric methodology employed in the analysis. Empirical results are reported in the fifth section, while some further analysis using demand indices is contained in the following section. A final section summarizes the findings and the implications of the study.

2 Review of the Literature

A great number of studies have shown that securitized real estate returns tend to lead returns in the direct real estate market. In other words, empirical research suggests that there is a price discovery mechanism between securitized and direct real estate markets.[1] It is a common view that this lead-lag relationship is due to the more rapid response of the securitized market to shocks in the fundamentals. The better liquidity, greater number of market participants, smaller transaction costs and the existence of a public market place in the securitized market have been seen as the factors behind the quicker adjustment of the securitized real estate market.

Among the several studies that have contained empirical evidence supporting the leading role of securitized real estate with respect to direct real estate in the U.S. or British markets are Gyourko and Keim (1992), Myer and Webb (1993), Barkham and Geltner (1995), Eichholtz and Hartzell (1996), Li et al. (2009), and Oikarinen et al. (2010). Newell and Chau (1996), in turn, report a short-term leading relationship for real estate companies over commercial real estate in Hong Kong, and Ong (1994, 1995) and Liow (2001) in Singapore. 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 and 1995-2002 in the latter.

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. The results by Geltner and Kluger (1998), Seiler et al. (1999), Pagliari et al. (2005), Li et al. (2009), and Yavas and Yildirim (2011) imply that REIT returns lead direct returns even after making adjustments for the property-type mix. Geltner and Kluger base their analysis simply on contemporaneous and lagged correlation coefficients. Pagliari et al., in turn, mention their finding in a footnote without reporting the analysis in more detail, while Seiler et al., Yavas and Yildirim, and Li et al. use data that exhibit appraisal smoothing as a proxy for direct real estate returns. Also Chau et al. (2001) include sector level direct real estate data in their analysis. However, the securitized real estate data are at the aggregate level and Chau et al. do not study the lead-lag relations or dynamics between the securitized and direct markets. Moreover, none of the above mentioned studies attempts to derive impulse responses to study the response speeds of real estate returns to shocks in the fundamentals. To our knowledge, this is the first study that compares the reaction patterns of securitized and direct real estate returns to shocks based on impulse responses derived from an econometric model.

The recent findings of Yavas and Yildirim (2011) imply that there are differences between property types and between firms within a property sector. We acknowledge the possibility of different reaction speeds among REITs. However, this study concentrates on examining the price discovery at the market (sector) level, since our aim is to investigate whether the REIT market generally reacts faster to shocks than the direct market or whether the previous findings can be attributed to the property-type complications.

3 Data Description

We include four real estate sectors in the analysis: apartments, offices, industrial property, and retail property.[2] For securitized real estate, the FTSE/NAREIT Equity REIT sector level indices are used and for direct real estate we use the sector level transaction-based NCREIF

(TBI) indices. More sectors are not included in the TBI. The sector level data cover a period from 1994Q1 to 2009Q4. All the real estate indices employed in the analysis are total return indices.

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. Therefore, we restate the NAREIT returns for the effect of leverage. Similar to Pagliari et al. (2005), the unlevered returns are computed using the following formula that is based on the well-known proposition of Modigliani and Miller (1958):

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

where r_{uit} = the unlevered REIT return of sector i in period t, r_{eit} = the return on equity of 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 cost of debt is proxied by the U.S. home mortgages contract interest rate. The average leverage of REITs during the sample period is 48% in the apartment and office sectors, 43% in the industrial property sector, and 51% in the retail property sector.

In addition to the real estate data, the analysis includes several variables that may affect significantly real estate returns according to the theory and previous empirical evidence. These variables concern economic growth (Ling and Naranjo, 1997; Payne, 2003; Ewing and Payne, 2005), general price level (Chan et al., 1990; Ling and Naranjo, 1997; Payne, 2003; Ewing and Payne, 2005), short-term interest rates and the term structure of interest rates (Chan et al., 1990; Ling and Naranjo, 1997), the default risk premium (Chan et al., 1990; Karolyi and Sanders, 1998) and the economic sentiment (Berkovec and Goodman, 1996). We measure economic growth with the change in U.S. *GDP*. The economic sentiment, that gives a more forward looking measure of growth in economic activity, is captured by the University of Michigan consumer sentiment index regarding the five year economic outlook. Changes in the consumer price index (CPI) are used to track movements in the general price level, while the three month T-bill rate and the spread between the 10-year government treasury bond yield and the three month T-bill rate measure the short-term interest rates and the term structure of interest rates, respectively. Finally, the spread between low-grade corporate bond (Baa, Moody's) and the 10-year government treasury bond yield is used as the measure of default risk premium as suggested by Chen et al. (1986), Bernanke and Blinder (1992), and Ewing (2001).

In the econometric analysis, we use only real indices regarding real estate returns and *GDP*. The (unlevered) real estate indices and *GDP* are deflated using CPI to get the real indices. Furthermore, the real estate and *GDP* indices are used in the natural log form. For the short-term interest rate, we test both nominal and real (deflated by CPI) rates in the estimated models. The interest rate choice of the final model is done with the Akaike Information Criteria.

Table 1 presents some descriptive statistics regarding the unlevered apartment (*apt_tbi, apt_reit*), industrial property (*ind_tbi, ind_reit*), office (*of_tbi, of_reit*) and retail property (*re_tbi, re_reit*) total returns. The volatilities between the unlevered REIT returns and TBI returns do not notably differ from each other at the quarterly level. However, the table shows that the TBI returns were substantially greater during the period than the unlevered REIT returns regardless of the property sector. Also, Figure 1 illustrates that direct real estate has substantially outperformed REITs during the sample period. This does not necessarily imply that, once the leverage is taken into account, TBI returns are expected to outperform REIT returns. Rather, the notable difference between the reported TBI and REIT returns is most likely explained by the unusual sample period. According to Oikarinen et al.

(2010), the overall TBI total return index was substantially below the long-run relation between the TBI and NAREIT indices in 1994, while the TBI index was clearly above the relationship in 2008; thus the observed outperformance of TBI returns over the period. Oikarinen et al. relate the relatively high REIT prices in the mid 1990s to the "REIT boom" and the relatively low REIT price level in 2008 to the substantially faster reaction of the REIT market to the financial crisis. Moreover, some of our results suggest flight-to-safety from more risky assets to direct real estate during times of growing risk aversion and uncertainty. This indicates that any financial crisis is likely to hit REIT prices harder that direct prices. In consequence, we concentrate on the short-run dynamics and we do not deal with the potential long-run relationships between the securitized and direct markets in this study.

[Table 1 here]

[Fig. 1 here]

Contemporaneous quarterly correlations between the returns are reported in Table 2. Interestingly, the correlations between the TBI and REIT returns within the same property type are relatively weak – the correlation figures are notably greater between different TBI sectors and, in the case of *apt_tbi* and *ind_tbi*, even between TBI returns and REIT returns for other sectors. This may be due to the potential lead-lag relations of the TBI and REIT returns within the same sector, since a lead-lag relationship may notably diminish the observed short-run correlations between asset returns. Table 2 also reveals that co-movement between various REIT indices is greater than that between the sector level TBI indices at the quarterly frequency.

[Table 2 here]

All the return indices, as expected, appear to be non-stationary in levels and stationary in differences, and also the fundamental variables seem to be I(1) with the exception of the inflation rate (see Table A1 in the Appendix). Therefore, the inflation rate is the only variable that is included in the vector autoregressive models in levels. All the other variables are differenced in the forthcoming analysis.

4 Econometric Methodology

We use vector autoregressive (VAR) models to study the dynamic interdependences between securitized and direct real estate markets and the reactions of the real estate returns to shocks in the fundamentals. For each of the four sectors, two separate VAR models are estimated: a pairwise model that includes the securitized and direct real estate returns as the only stochastic variables and a multiple variable model that includes the fundamentals as well. The estimated models are specified as follows:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Upsilon_t + \varepsilon_t \qquad (2)$$

where ΔX_t is $X_t - X_{t-1}$, X_t is a 2+F-dimensional vector (where F is the number of fundamentals included in the model) of the stochastic variable values in period t, μ is a 2+F-dimensional vector of drift terms, Γ_i is a (2+F) x (2+F) matrix of coefficients for the lagged differences of the stochastic variables at lag *i*, *k* is the number of lags included in the model and ε is a vector of white noise error terms. Finally, Υ_t incorporates dummy variables that take the value of one at time t and of zero otherwise. Dummy variables are incorporated in the models to cater for some extreme movements in the real estate returns and thereby to fulfil the assumption of normally distributed residuals. Relying on the Schwarz Bayesian Information Criteria (SBC), seasonal dummies are not included in any of the models.

The fundamental variables that are included in the models are selected by the block exogeneity test using Sim's small-sample corrected LR test values. The multiple variable models for offices and industrial property incorporate nominal interest rate (*IRN*), interest rate spread (*S*), economic sentiment (*SE*) and the default risk premium (*D*) as the fundamental variables, whereas the models for apartments and retail property also include *GDP*, the inflation rate (*INF*) and the real interest rate (*IR*) instead of the nominal one.[3] The economic sentiment, *GDP* and inflation cater for the expectations concerning real cash flow growth, whereas the other fundamentals in the model (and the inflation rate, to some extent) represent the current and expected future movements in the discount factor.

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. The multiple variable models are also used to derive the impulse responses of real estate returns to unanticipated changes in the fundamentals and in the real estate returns themselves. This paper employs the 'generalized' impulse response function developed by Pesaran and Shin (1998). The generalized impulse responses (GIRFs) do not require orthogonalization of shocks and is invariant to the ordering of the variables in the VAR. This is desirable, since the theory does not give clear guidance as to which of many possible parameterizations one should use in the traditional impulse response analysis. Furthermore, we estimate and graph 90% confidence bands for the impulse responses by performing 100 bootstrap replications for the residuals. Bootstrapping is conducted to diminish the problem of relatively small number of observations on the results. Finally, the lag length in the models is decided by SBC. SBC tends to select relatively parsimonious models. This is desirable in this analysis due to the relatively small number of observations.

5 Empirical Results

The Granger causality test results are reported in Tables 3 through 6. In general, the Granger causality test results are similar regardless of the property sector. Most importantly, in all the cases the Granger causality tests show evidence of REIT returns leading TBI returns. That is, REIT returns lead direct real estate returns even when controlling for the property type and for leverage. Nevertheless, also the REIT prices seem to contain predictable elements. In particular, REIT returns seem to be predictable either by changes in the risk premium (apartments and retail property) or in the economic sentiment (industrial and office sectors).[4] The fact that only the forward-looking variable regarding economic growth (i.e., the sentiment) belongs in the office and industrial models indicates that both of these markets embody notable forward-looking components concerning economic growth. With the exception of the apartment sector, the inclusion of fundamentals in the models only slightly increases the adjusted coefficient of determination for TBI returns.[5] This, together with the fact that in all the sectors REIT returns remain significant in the equation for TBI returns even after including fundamentals in the models, emphasizes the predictive power of REIT returns with respect to TBI returns.

[Tables 3-6 here]

The Granger causality tests examine the short-run predictability of and the lead-lag relations between real estate returns. They do not give details about the reaction patterns and speeds of the real estate prices to various shocks, however. Therefore, we derive impulse responses of the real estate returns to shocks in the fundamentals and in the returns themselves employing the same multiple variable VARs as in the Granger causality tests.

The generalized impulse responses up to 12 quarters from the shock are exhibited in Figures 2-5. In all the figures, the impulse responses correspond to reactions to shocks that are one standard error in magnitude. Therefore, the estimated responses show the economic significance of the shocks, while the confidence intervals are included in the graphs to examine the statistical significance of the responses. That is, the impulse responses essentially summarize the dynamics of the models. Note that the Hansen stability test accepts the stability of the estimated parameters and the CUSUM test does not detect any structural breaks in the models.

[Fig. 2-5 here]

The estimated reactions generally look sensible and have the expected signs. The responses that have an unexpected sign – mainly some positive responses to interest rate and inflation rate shocks – are statistically insignificant with the exception of the *ind_tbi* and *re_tbi* reactions to a shock in *IR* and of the *apt_tbi* reaction to an inflation shock. *A priori*, we would expect an inflation shock to have a negative short-term influence on current real property prices since rental prices typically adjust only sluggishly to changes in the general price level while the impact of inflation on the discount factor is typically somewhat faster and positive. While the empirical literature presents mixed results regarding the inflation hedging qualities of direct real estate, empirical evidence has generally suggested that securitized real estate does not provide a hedge against inflation (see Hoesli et al., 2008, for a review of the inflation hedging literature). Based on our estimations, however, the hypothesis that both direct and securitized real estate investments work as a hedge against unexpected changes in the inflation rate cannot be rejected. In fact, it appears that an inflation shock may induce higher real returns in the direct apartment market. That is, unexpectedly high inflation rates possibly induce investment flows to the apartment market where the rental price level generally can be adjusted relatively rapidly to cater for changes in the general price level.

After an unexpected increase in the T-bill rate, in turn, we would expect a decline in real estate prices due to an increase in the discount factor. A potential explanation for the observed positive reactions to a T-bill shock is given by the expectations theory of the term structure together with the Fisher hypothesis. Generally, higher short-term interest rates are expected to diminish economic activity thereby reducing inflation pressures. Lower inflation expectations, in turn, induce lower long-term interest rates (Howells and Bain, 2008). Given that real estate is a long-horizon investment vehicle, the long-term expectations (regarding interest rates and inflation) may well dominate the short-term effects in some markets. The generally negative impact of greater term spread on real estate prices is expected and relates to the greater expected increases in the level of interest rate and therefore in the discount factor.

Expectedly, the reactions (at least all the statistically significant ones) to shocks in economic growth and growth expectations are positive. Both these shocks anticipate larger cash flows for real estate investments. The initial positive reaction and generally negative lagged (though statistically insignificant) impact of sentiment and GDP shocks to REIT returns implies that REIT prices may overreact to sentiment and income shocks at first. Growth in the risk premium increases the discount factor for risky investments and thereby decreases REITs prices, as expected. However, the impact of a risk premium shock on *of_tbi* appears to be positive and also *apt_tbi* seems to respond positively to a risk shock after an initial negative reaction. This may appear somewhat surprising at first. Nevertheless, there is probably a logical explanation for this finding: direct real estate is often conceived as a relatively safe investment vehicle. Therefore, greater risk aversion can induce flight-to-safety from more risky assets to direct apartment and office markets thereby increasing demand in these markets. The impulse responses also suggest that in many cases it takes a while before the real estate prices wholly absorb new information regarding unexpected changes in the fundamentals. This may generate predictability in real estate returns both in the REIT market and in the direct market.

The estimated reactions of REIT returns to shocks in the risk premium differ from those reported by Ewing and Payne (2005), according to which the reaction is positive. While the results by Ewing and Payne suggest flight-to-safety (from risky bonds to REITs; it is, of course, highly questionable whether REITs are safe), our results suggest that an increase in the risk perceived by investors lowers REIT prices via an increase in the discount factor.

Of particular interest in the impulse response analysis are whether the reaction to shocks is notably slower in the direct market than in the securitized market, and whether and how quickly the REIT and direct markets react to shocks in each other. The findings are in line with the prior expectations and with the results of the Granger causality analysis. In particular, TBI returns appear to react to innovations in REIT returns with a lag. In other words, the information that is revealed by unexpected movements in REIT prices are sluggishly absorbed by the direct market prices. This is particularly pronounced regarding industrial real estate. Nevertheless, there is also evidence of a sluggish REIT price reaction to a direct market shock in the apartment and industrial property markets. Furthermore, the impulse responses suggest that in many cases direct market prices react more sluggishly to shocks in the fundamentals than REIT prices. Regarding a sentiment shock this seems to be the case in all four sectors, and there is some indication that direct apartment returns react slowly compared with REIT returns to shocks in all the fundamentals. In contrast, REIT prices do not appear to adjust more slowly to any of the shocks. Hence, the sluggish response of direct real estate prices to shocks both in the fundamentals and in the REIT market causes the perceived lead-lag relationship between REIT and direct market returns.

6 Further Analysis Using Demand Indices

In theory, the perceived sluggish adjustment of direct real estate prices may be caused by asymmetries in buyers' and sellers' responses to shocks in the fundamentals. In particular, in search theoretic models where buyers are assumed to respond prior to sellers, sales volume is expected to respond prior to prices to changes in the fundamentals (Berkovec and Goodman, 1996; Hort, 2000; Fisher et al., 2003). That is, if buyers react more rapidly than sellers, changes in the demand for an asset are expected to lead returns on the asset. Clearly, given the notable informational asymmetries in the direct real estate market, asymmetries in buyers' and sellers' responses are more likely in the direct real estate market than in the REIT market where liquid assets are traded in a centralized market place. Therefore, the observed lead-lag relationship between REIT returns and TBI returns might be due to the slow adjustment of the supply side in the direct real estate market.

To gain further insight to the perceived lead-lag relations, we investigate the dynamics of the sector level demand indices by Fisher et al. (2003 and 2007). The demand indices are based on the same properties as the TBI indices and track the movements in buyers' reservation prices. In other words, the demand indices show the development of the "constant-liquidity value" of direct market real estate. Table 7 present descriptive statistics regarding the demand indices. In line with the vast empirical evidence showing time-varying liquidity in the direct real estate market, the volatility of demand changes is notably greater than that of the TBI returns during the sample period. Expectedly, the constant-liquidity indices appear to be stationary in differences just like the TBI returns – after all there should not be any differences in the order of integration between the constant-liquidity indices and the total return indices.

[Table 7 here]

If movements in the demand indices led TBI returns and did not lag REIT returns, the lead-lag relationship between REIT and TBI returns would be due to the slow reaction of the seller reservation prices in the direct market rather than a sluggish response of direct real estate demand to shocks. However, the dynamics of the demand indices appear to be highly similar to the TBI dynamics. REIT returns lead changes in the demand indices in all the sectors and only in the office market there is some evidence of demand leading TBI returns. Furthermore, the impulse responses do not generally show evidence of a more rapid reaction of demand than of prices in the direct market. An exception is the retail market, where the GIRFs present some support for a more rapid response of demand to interest rate, inflation and sentiment shocks. Figures 6-7 shows the reaction patterns of TBI returns and of demand index movements to shocks in the fundamentals in the apartment and retail sectors. In the office and industrial sectors, the differences between the estimated GIRFs for the demand changes and returns are only trivial.

[Fig. 6-7 here]

The finding according to which the demand and return dynamics are alike and do not generally exhibit lead-lag relations is somewhat surprising and does not support the hypothesis that it is due to the slow response of sellers that the TBI returns lag REIT returns. Instead, also the demand for direct real estate (and the constant-liquidity value of real estate) adjusts sluggishly. Nevertheless, the estimated impulse responses are generally in line with the claim that demand is more volatile than prices in the direct real estate market and that thereby the direct market liquidity is time-varying. This is particularly prominent in the apartment market and can be seen to a somewhat lesser extent in the other markets as well.

7 Summary and Conclusions

Due to the better liquidity, greater number of market participants, smaller transaction costs and the existence of a public market place in the securitized market, it is expected that the prices of securitized real estate investments react faster than the price of direct real estate to shocks in the fundamentals. Previous empirical evidence supports this hypothesis. However, the previous studies are generally based on data in which the property-type mixes differ between the securitized and direct real estate portfolios, and the studies that cater for the property mix include notable complications. Since the reaction speeds and magnitudes to shocks may vary between real estate sectors, the empirical evidence regarding the lead-lag relations is not conclusive.

To avoid the property-type complication, we employ sector level REIT (NAREIT) and direct real estate (TBI) data over the period 1994-2009 to examine the dynamics and reaction speeds between and of the securitized and direct real estate markets in the U.S. Furthermore, we restate the NAREIT returns for the effect of leverage. Four sectors (apartments, industrial property, offices and retail property) are included in the analysis. To the best of our knowledge, this article is the first one to concentrate on studying rigorously the dynamics between the securitized and direct real estate returns using sector level data that do not exhibit appraisal smoothing. Moreover, this appears to be the first study that compares the reaction speed of securitized and direct real estate returns to shocks in the fundamentals based on impulse responses derived from an econometric model. In addition to examining the lead-lag relations between the securitized and direct real estate markets, our analysis helps to understand the behavior of securitized and direct real estate and sheds light on issues such as price discovery and inflation hedging.

Based on the estimated vector autoregressive models, the REIT returns lead direct real estate returns even when catering for the property type and regardless of the property sector. This indicates that the previously found lead-lag relations are not due to factors such as appraisal smoothing or the differing property-type mixes between securitized and direct real estate indices. Therefore, the direct market appears to be less informationally efficient than the REIT market (Barkham and Geltner, 1995, pp. 39-42, provide a detailed discussion on why these kinds of findings can be assumed to give implications regarding informational efficiency). Interestingly, the inclusion of fundamentals in the models only slightly increases the adjusted coefficient of determination for TBI returns and in all the sectors REIT returns remain significant in the equation for TBI returns even after the inclusion of fundamentals in the models. This emphasizes the predictive power of REIT returns with respect to TBI returns.

In line with prior expectations, the estimated impulse responses suggest that direct real estate prices adjust more slowly than REIT prices to shocks in the fundamentals. Moreover, TBI returns appear to react to unexpected changes in REIT returns with a lag, i.e., the information that is revealed by movements in REIT prices is only sluggishly absorbed by the direct market prices. Nevertheless, the analysis reveals that there are predictable components in REIT returns as well. In particular, it appears that changes either in the economic sentiment or in the default risk premium contain some predictive power with respect to REIT returns.

We also investigate whether the demand for direct real estate reacts more rapidly to shocks than prices do. It can be argued that if demand changes were to lead TBI returns and did not lag REIT returns, the observed lead-lag relationship between REIT and TBI returns would be due to the sluggish adjustment of sellers' reservation prices. However, we do not find notable differences between the reaction speeds of demand and prices in the direct market and REIT returns appear to lead changes in the direct market demand. Therefore, the results suggest that the perceived lead-lag relations between the securitized and direct real estate returns are not only due to the slow reaction of sellers, but also due to the sluggish adjustment of the demand side in the direct real estate market.

Although the main findings are similar concerning all four sectors, the results also show that there are some differences between the sectors regarding the return dynamics. Therefore, it is reasonable to use sector level data when evaluating the return and price dynamics in the REIT and direct property markets and when making forecasts concerning future price developments in the markets. The aggregated data may mask valuable sector specific information.

In addition to the predictability of real estate returns, the findings have portfolio implications. The found positive lead-lag relations indicate that over the longer horizon the co-movement between REIT returns and direct real estate returns is notably stronger than the contemporaneous quarterly correlation coefficients suggest. Indeed, the average annual correlation between the sector level (unlevered) real NAREIT and TBI returns is 0.67, while the corresponding quarterly figure is as low as 0.23. Moreover, based on the model dynamics, the hypothesis that both direct and securitized real estate investments work as a hedge against unexpected changes in the inflation rate cannot be rejected.

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Figure 1 Sector level (unlevered) NAREIT and TBI total return indices over 1994Q1-2009Q4

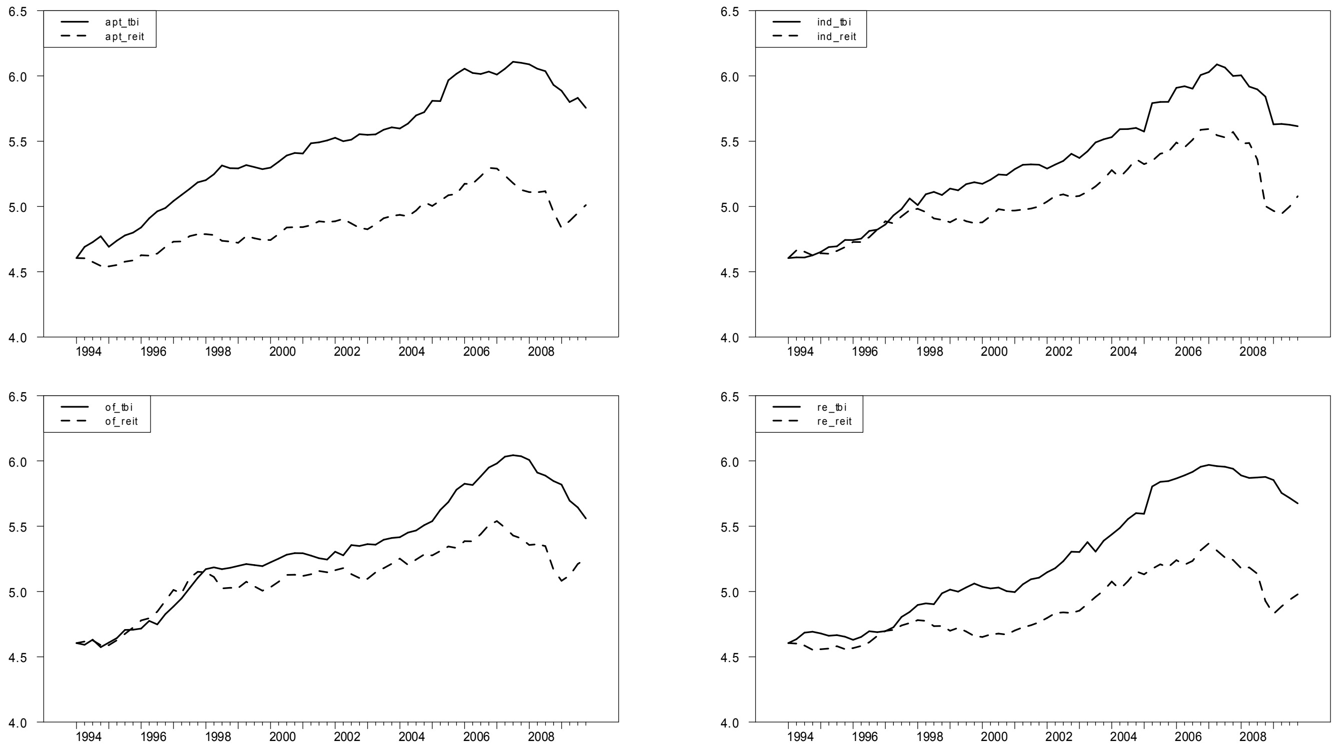

Figure 2 The reactions of the securitized and direct apartment returns to shocks in the fundamentals

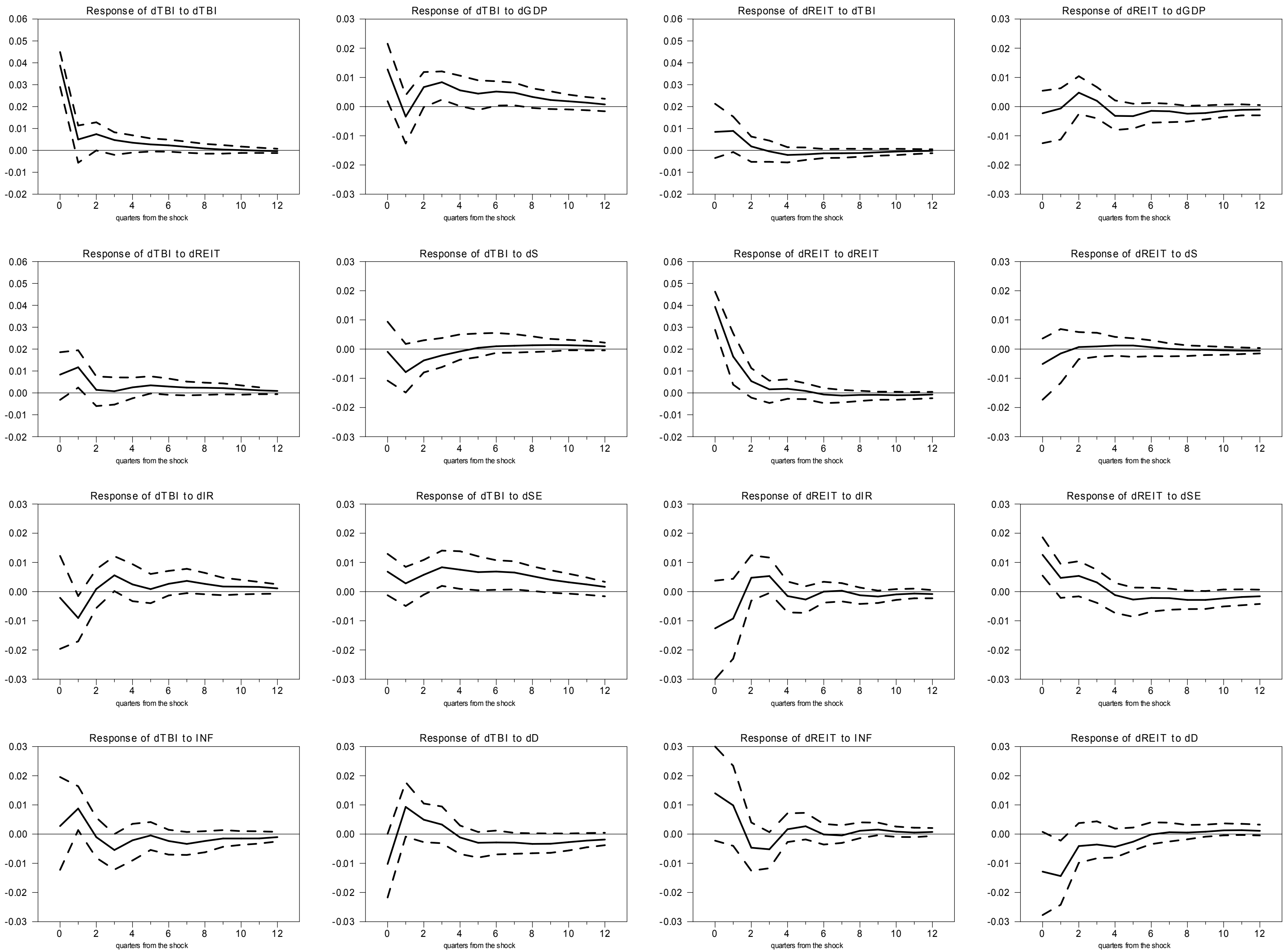

Figure 3 The reactions of the securitized and direct industrial property returns to shocks in the fundamentals

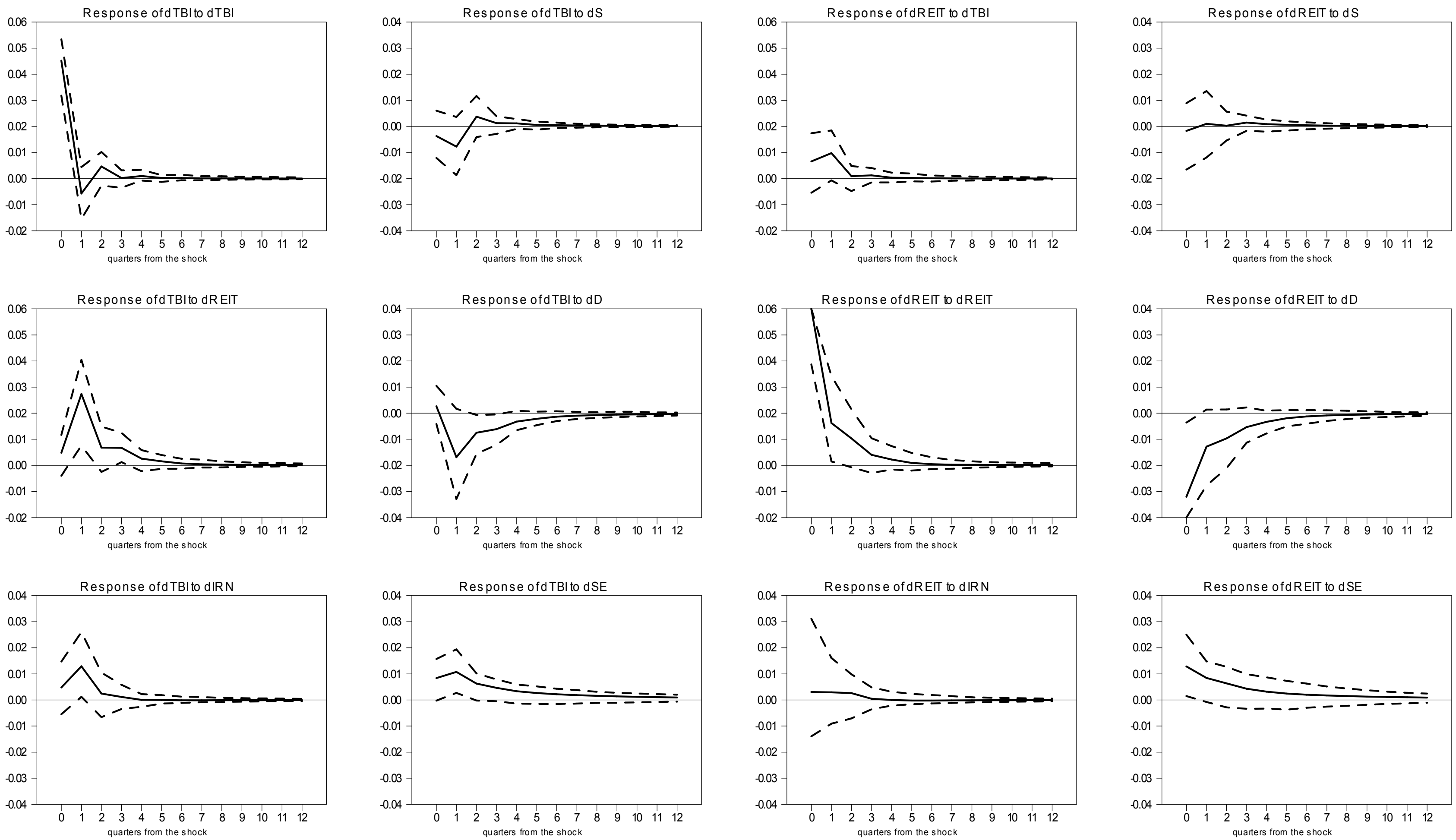

Figure 4 The reactions of the securitized and direct office returns to shocks in the fundamentals

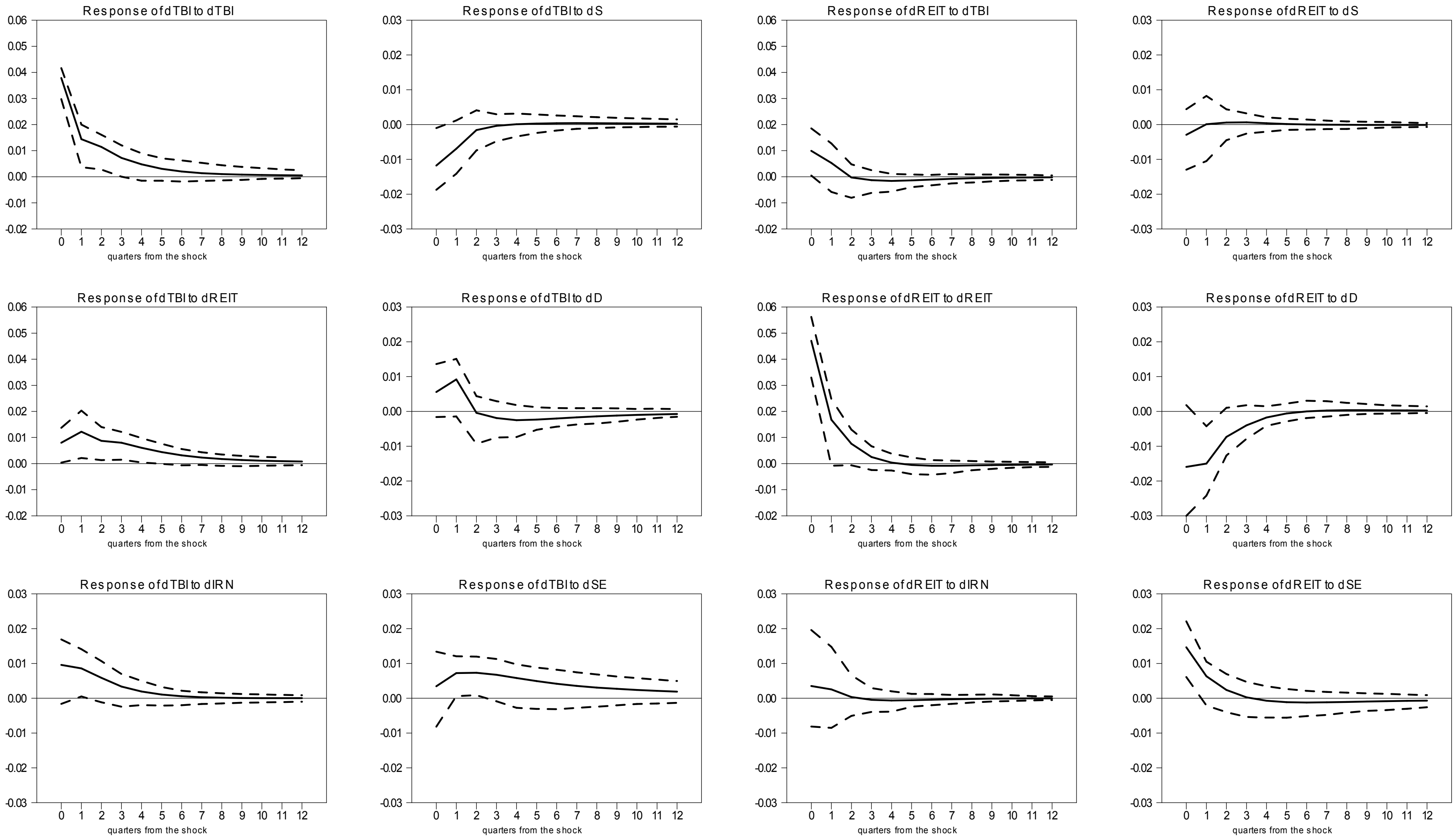

Figure 5 The reactions of the securitized and direct retail property returns to shocks in the fundamentals

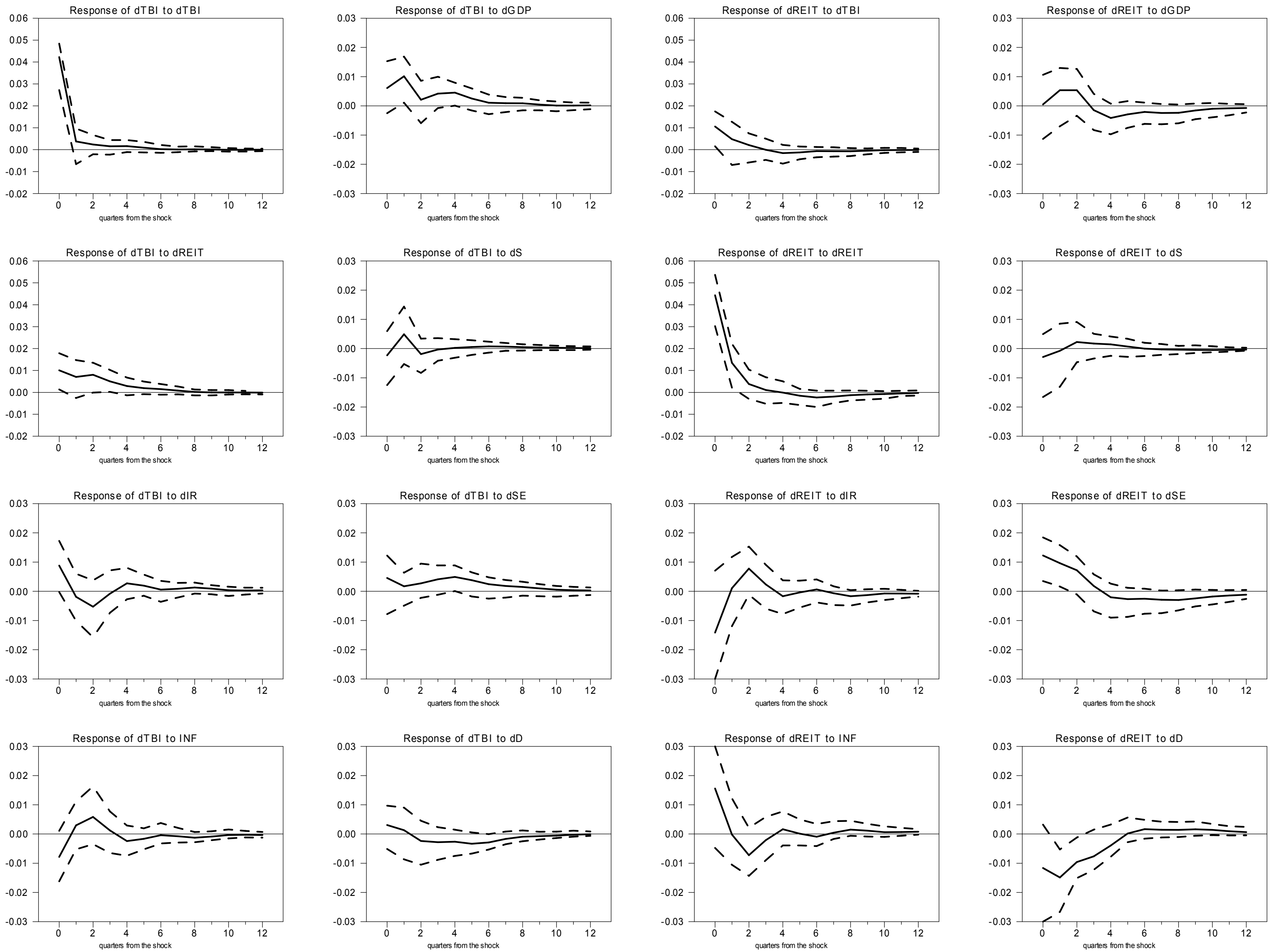

Figure 6 The reactions of apartment TBI and demand index returns to shocks in the fundamentals

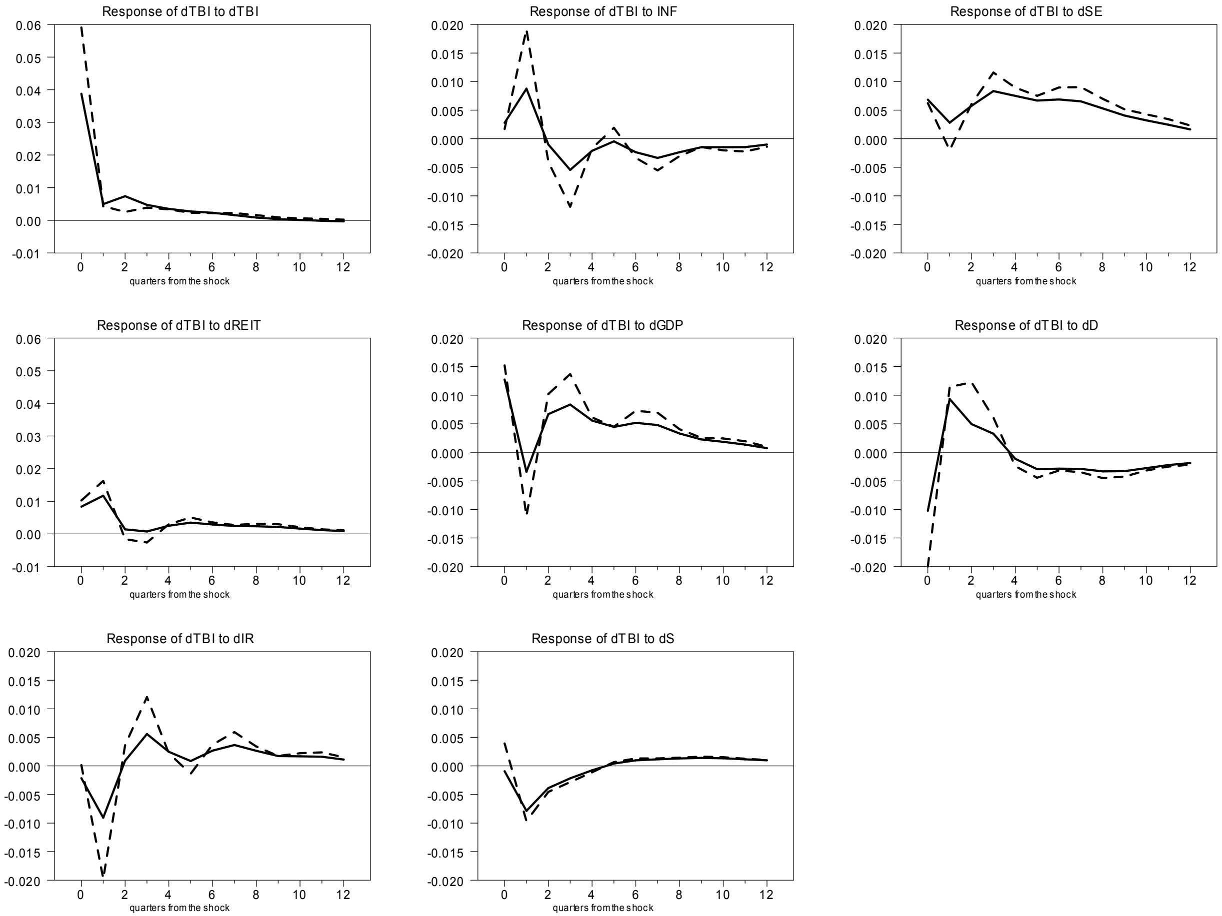

Figure 7 The reactions of retail property TBI and demand index returns to shocks in the fundamentals

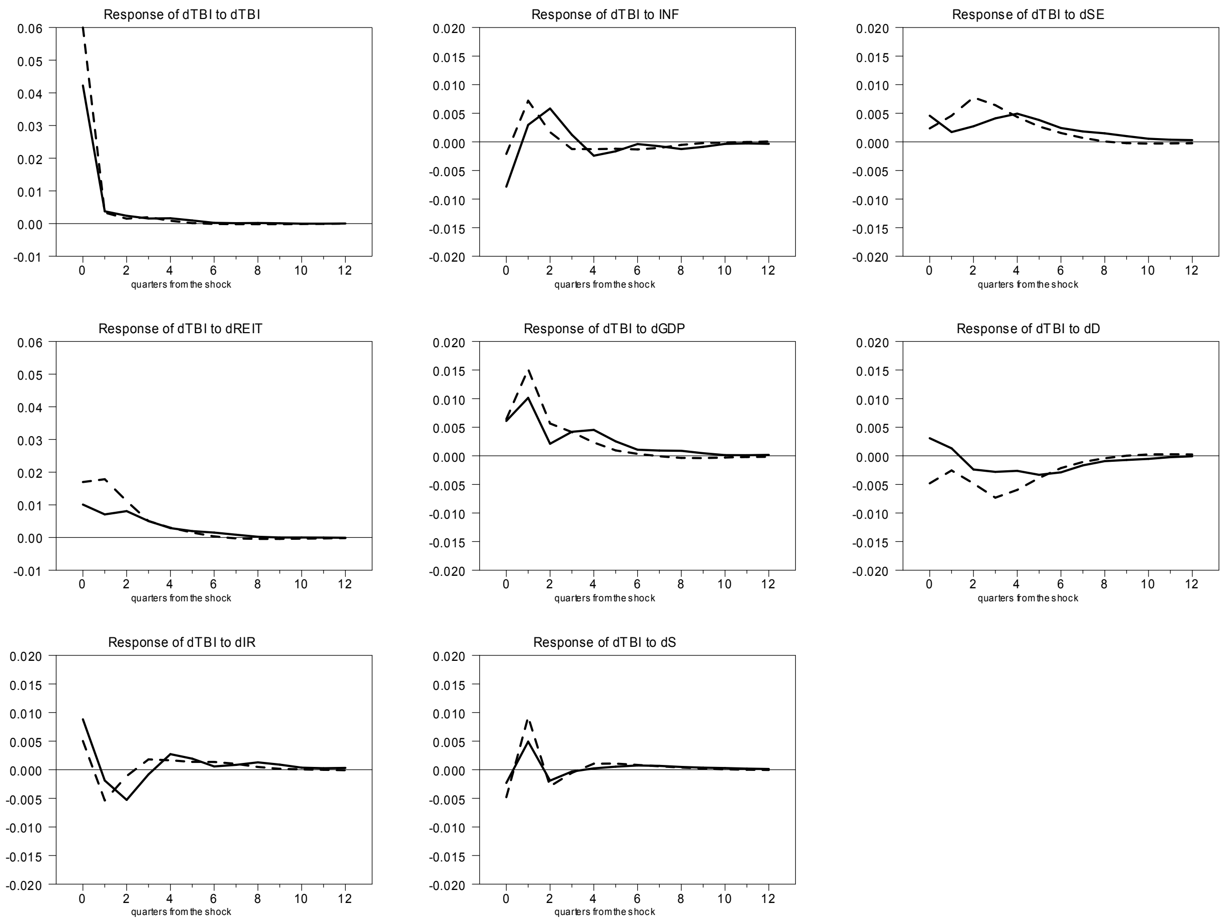

Table 1 Descriptive statistics of sector level real estate returns over 1994Q1-2009Q4

Variable	**Mean (annualised %)**	**Standard deviation (annualised %)**	**Jarque-Bera test for normality (p-value)**	**Ljung-box test for auto-correlation (p-value, 4 lags)**
apt_tbi	7.5	8.9	.02	.00
apt_reit	2.6	8.4	.00	.05
ind_tbi	6.6	10.9	.00	.03
ind_reit	3.0	12.5	.00	.07
of_tbi	6.2	9.0	.07	.00
of_reit	4.1	9.2	.00	.07
re_tbi	7.0	8.9	.00	.01
re_reit	2.4	9.3	.00	.07

Table 2 Contemporaneous quarterly correlations between the returns over 1994Q1-2009Q4

	apt_tbi	*apt_reit*	*ind_tbi*	*ind_reit*	*of_tbi*	*of_reit*	*re_tbi*	*re_reit*
apt_tbi	1.00							
apt_reit	.23	1.00						
ind_tbi	.27*	.45**	1.00					
ind_reit	.36**	.74**	.24	1.00				
of_tbi	.46**	.19	.37**	.29*	1.00			
of_reit	.26*	.88**	.32**	.80**	.25*	1.00		
re_tbi	.20	.07	.43**	.14	.42**	.10	1.00	
re_reit	.23	.84**	.37**	.85**	.22	.83**	.19	1.00

* and ** denote statistical significance at the 5% and 1% level, respectively.

Table 3 Granger causality test results for apartments

		Explanatory variable								
		Δtbi	$\Delta reit$	INF	ΔIR	ΔS	ΔSE	ΔD	ΔGDP	Adj. R^2
Dependent Variable	Pairwise model									
	Δ *apt_tbi*	.52	**.02**							.19
	Δ *apt_reit*	.98	**.03**							.36
	Multiple variable model									
	Δ *apt_tbi*	.64	**.04**	.11	.58	**.09**	.68	**.05**	.74	.30
	Δ *apt_reit*	.80	.20	.97	.98	.43	.38	**.03**	.29	.42

The table shows the p-values in the tests. The null hypothesis is that of no Granger causality between the variables. The models include one lag and one dummy variable that take the value one in a single period (2008Q4) and is zero otherwise.

Table 4 Granger causality test results for industrial property

Dependent Variable	Explanatory variable: Δtbi	$\Delta reit$	ΔIRN	ΔS	ΔSE	ΔD	Adj. R^2
Pairwise model							
Δ *ind_tbi*	.52	**.00**					.54
Δ *ind_reit*	**.07**	.45					.56
Multiple variable model							
Δ *ind_tbi*	.20	**.00**	.26	.99	.97	.91	.54
Δ *ind_reit*	.19	.34	.80	.53	**.07**	.11	.61

The table shows the p-values in the tests. The null hypothesis is that of no Granger causality between the variables. The models include one lag and two dummy variables that take the value one in a single period (1995Q2, 2008Q4) and are zero otherwise.

Table 5 Granger causality test results for offices

Dependent Variable	Explanatory variable: Δtbi	$\Delta reit$	ΔIRN	ΔS	ΔSE	ΔD	Adj. R^2
Pairwise model							
Δ *of_tbi*	**.00**	**.03**					.22
Δ *of_reit*	.92	**.00**					.32
Multiple variable model							
Δ *of_tbi*	.14	**.00**	**.02**	.22	.58	**.03**	.28
Δ *of_reit*	.70	.40	.70	.50	**.07**	.12	36

The table shows the p-values in the tests. The null hypothesis is that of no Granger causality between the variables. The models include one lag and one dummy variable that takes the value one in a single period (2008Q4) and is zero otherwise.

Table 6 Granger causality test results for retail property

Dependent Variable	Explanatory variable: Δtbi	$\Delta reit$	INF	ΔIR	ΔS	ΔSE	ΔD	ΔGDP	Adj. R^2
Pairwise model									
Δ *re_tbi*	.15	**.07**							.41
Δ *re_reit*	.96	**.00**							.34
Multiple variable model									
Δ *re_tbi*	.28	**.04**	.08	.64	.21	**.04**	.31	**.01**	.47
Δ *re_reit*	.39	.50	.14	.58	.19	.51	**.01**	**.09**	.46

The table shows the p-values in the tests. The null hypothesis is that of no Granger causality between the variables. The models include one lag and two dummy variables that take the value one in a single period (1995Q2, 2008Q4) and are zero otherwise. Due to heteroscedasticity of the residuals in the model for Δ*re_reit*, the p-values for Δ*re_reit* in the multiple variable model are based on a covariance matrix that is computed allowing for heteroscedasticity as in White (1980).

Table 7 Descriptive statistics of sector level demand index movements over 1994Q1-2009Q4

Sector	**Mean (annualised %)**	**Standard deviation (annualised %)**	**Jarque-Bera test for normality (p-value)**	**Ljung-box test for auto-correlation (p-value, 4 lags)**
Apartments	4.6	13.2	.01	.13
Industrial	2.8	15.0	.00	.03
Office	3.7	11.2	.57	.00
Retail	2.5	12.9	.06	.05

APPENDIX

Table A1 Augmented Dickey-Fuller test results 1994Q1-2009Q4

Variable	Level (lags)	Difference (lags)
apt_tbi	-1.70 (2)^{c,s}	-3.38** (1)^{s}
apt_reit	-1.49 (1)^{c}	-5.09** (0)
ind_tbi	-1.87 (3)^{c,s}	-2.22* (2)^{s}
ind_reit	-1.59 (1)^{c}	-5.62** (0)
of_tbi	-1.87 (2)^{c}	-1.99* (1)
of_reit	-2.11 (1)^{c}	-5.18** (0)
re_tbi	-1.17 (3)^{c}	-2.25* (2)
re_reit	-1.32 (1)^{c}	-5.37** (0)
Nominal interest rate	-1.53 (4)	-3.61** (3)
Real interest rate	-1.55 (6)	-5.31** (6)
Inflation rate	-2.52 (6)^{s}	
GDP	-1.88 (1)^{c,s}	-2.35* (2)
Sentiment	-0.32 (0)	-9.35** (0)
Risk premium	-.070 (1)	-6.13** (0)

* and ** denote for statistical significance at the 5% and 1% level, respectively. Critical values at the 5% and 1% significance levels are -1.95 and -2.60 if constant is not included and -2.89 and -3.51 in the case where 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 tested model if the series clearly seem to be trending or if the ADF test without the constant term suggests that the series are exploding. In addition, three seasonal dummies (^{s}) are added to the test if recommended by the F-test.

Endnotes

[1] For a general discussion concerning the price discovery mechanism between the markets, see Geltner et al. (2003).

[2] The data used in this study were sourced from *Thomson Datastream* and from NAREIT.

[3] It is often assumed that it is the real interest rate that affects real returns. However, the real interest rate is typically observed only with considerable lag while changes in the nominal interest rate are perceived immediately. The selection between the real and nominal rates is done using the Akaike Information Criteria. In any case, the results do not change notably when the real interest rate is used in all the models.

[4] *SE* and *D* capture, to some extent, the same economic fundamentals. In a DCF valuation, *SE* affects the numerator and *D* the denominator. Therefore, the correlation between the levels and differences of *SE* and *D* is negative, large and highly statistically significant.

[5] This contrasts with the results by Chau et al. (2001) according to which securitized real estate returns contain no independent information about the returns on direct real estate in the Hong Kong market.

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Contact information: Aboa Centre for Economics, Taloustieteen laitos, Assistentinkatu 7, FI-20014 Turun yliopisto, Finland.

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