Time-varying influences on real estate returns

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IPF Research Programme 2006-2009

Real Estate's Role in the Mixed Asset Portfolio: A Re-examination

Working Paper 3
Time Varying Influences on Real Estate Returns

April 2012

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REAL ESTATE'S ROLE IN THE MIXED-ASSET PORTFOLIO: A RE-EXAMINATION WORKING WORKING PAPER 3
TIME VARYING INFLUENCES ON REAL ESTATE RETURNS

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1. EXECUTIVE SUMMARY

- This paper examines the time-varying nature of the relationship between real estate returns and other asset classes. If the relation between assets varies across time, then use of a single static correlation or covariance to inform portfolio selection may fail to provide investors with the diversification they expect;
- Five data series are employed in this study: returns from UK property companies (the FT-EPRA UK series); private real estate (the desmoothed IPD monthly index); the FT All Share index returns; returns from small-cap stocks; and a UK government bond index. Data are collected monthly from 1990 to the end of 2010;
- Overall returns statistics suggest that even after desmoothing, the IPD monthly index has a very low standard deviation, below that of the bond return index. Direct private real estate's low correlation with the other financial assets implies considerable diversification potential. Public real estate returns, however, have positive correlations with the overall equity market and small-cap stocks as well as weaker risk-return characteristics. While private real estate seems to offer good mean-variance qualities for investors, the return distribution is negatively skewed and has 'fat tails' – investors have a greater than normal probability of experiencing sharply falling returns;
- A rolling correlation technique is employed to explore the evolution of the relationship between asset class returns over the analysis period. It is evident that the correlations between public and private real estate and other financial assets are not stable over time. Use of a single correlation to represent the relationship between pairs of assets would, thus, be misleading;
- The correlation between public and private real estate has been trending upwards from the mid-1990s, peaking at nearly +0.7 in late 2008. The correlation between public real estate and the equity market has ranged between +0.2 (at the end of the technology boom) and +0.8;
- The correlation between property company and equity market returns initially fell in the financial crisis, then rose again to the end of the analysis period; Private real estate's correlation with the equity market has ranged between –0.36 and +0.51 over the analysis period but with a general upward trend. As equity markets perform poorly, so the correlation with real estate rises. This suggests that some of the presumed diversification benefits of real estate will not be delivered when most needed;
- The variation in property market returns is decomposed into elements that are explained by movements in the returns of other assets and the element that is unique to real estate. In these factor models, the equity market beta varies substantially over time, in part reflecting fluctuations in the influence of the stock market on property returns;
- The influence of the equity market on property company volatility is considerably larger than the influence of the underlying real estate market. However, during the global financial crisis, equity market influence on public real estate volatility declined – and the influence of the underlying property market increased. While equity and bond factors are significant in explaining the variability of listed property returns, from the mid-1990s, there exists a significant idiosyncratic component that suggests that property companies do provide diversification benefits;
- Far less of the variation in private real estate can be related to the equity, bond or small-cap factors, although the degree of explanation varies over the analysis period. There is evidence that the financial assets have become more significant recently, influenced by the financial crisis and continuing capital market problems;
- Overall, the results suggest that there are significant financial market influences on the volatility of real estate returns, in both public and private markets. Nonetheless, much of the variability in property returns is unexplained, suggesting diversification benefits. The apparently greater independent component to private real estate might reflect the specific nature of the direct market, but may also relate to the role of valuations in private property indices.

1. EXECUTIVE SUMMARY

- Long-run analysis suggests that property company returns lead private real estate returns, and that the equity market leads both public and private real estate. In the global financial crisis, public real estate returns continued to trail the equity market. Equity market shocks affect real estate. Public real estate responds significantly, strongly and rapidly; private real estate's response is less strong, but persists for longer. This emphasises long-run links between equities and real estate with negative stock market shocks having a significant impact on property returns.
- The evidence presented in this paper, confirms that both private and public real estate offer diversification benefits in the mixed-asset portfolio context. Both are influenced by the performance of financial assets, but retain independence. Private real estate seems to offer greater diversification potential, but this has to be set against concerns over the robustness of data and the practical issues and obstacles associated with investment in the direct market.
- It is evident that conventional portfolio allocation models do not capture the changing risk-return characteristics of property. There are periods in the market when the behaviour of the equity market is strongly linked to that of real estate and those periods tend to be when the stock market is performing badly. Shocks – negative shocks – in equity returns are transmitted to real estate returns and have a significant effect. A risk management strategy needs to account for these time-varying influences.
- The focus in this paper has been on risk-return features of the assets. There is evidence that the relationship between asset classes depends on the returns in those asset classes: in particular, that there may be stronger correlations between assets – between property and equity – when both are underperforming. That suggests that, for a more complete view of the risk-return characteristics of real estate, the relationship between assets at the extremes of their return distributions need to be considered – to seek to identify any 'tail dependence'.

2. INTRODUCTION

This is the third working paper from the Investment Property Forum funded project re-examining the 'case for property' in multi-asset portfolios. The project seeks to explore the nature of commercial real estate returns in the light of the performance of the asset class over the recent financial turmoil and the apparent failure of property to provide the diversification gains hoped for in mixed-asset portfolios. The project focuses on the dimensions of risk in property markets, the factors that drive returns, the relationship between real estate and other investment assets and the extent to which those relationships vary over time and are asymmetric in nature. This paper considers the interaction between real estate returns and other asset classes and the extent to which that interaction changes over time.

The second working paper examined valuation behaviour in different market environments and showed that both the return process and valuation smoothing were time-varying, influenced both by interest rates and by the underlying equity market. This might imply that the correlation between real estate and other asset classes changes over time – affecting the diversification benefits of real estate in the mixed-asset portfolio. In particular, does the correlation between real estate and other financial assets increase in difficult market environments? Does the influence of equity and bond markets increase when real estate markets are falling? That is the research problem addressed in this paper.

Beginning by detailing the data employed in the study, both public and private real estate returns are compared with equity market, small-cap stock and bond market returns. Data are described and basic descriptive statistics provided for the whole of the analysis period, 1990–2010. As is standard, the results for the whole period suggest that real estate and, in particular, private real estate should provide significant diversification benefits in a mixed-asset portfolio.

The following section seeks to explore whether the low correlation observed between real estate returns and the financial assets is constant over time. This is analysed by employing a rolling correlation model. Correlation coefficients are estimated for a three year (36 month) analysis period, then the earliest month is dropped and the next month added, with the analysis repeated. In this way it is possible to observe how the relationship between the different asset classes evolves over time.[1] Is there any evidence that correlation increases in particular market environments? Certainly the results suggest that the correlation between private property and the equity market increased over the second half of the 2000s, having fallen from a local peak in the early 2000s. The research shows that there appears to be a relationship between falling equity market returns and increasing correlation.

Section 5 extends this analysis by focusing on the variance of the public and private real estate series. Is the volatility of real estate returns linked to return volatility in other asset classes? If so, does the impact of the financial assets vary over time? To answer these, factor models are employed to examine the extent to which equity, small-cap stock and bond market movements explain the variation in real estate returns. As with the correlation analysis, a rolling window model is employed: here 60-month window is used, the longer window allowing for more robust results given the multi-factor models employed and linking more closely to institutional and finite-life property fund holding periods. The results here show that the influence of equity markets varies over time, but in a more complex way than implied in the correlation analysis. Moreover, the variation in direct private real estate returns is only weakly explained by return movements in equity and bond markets, even in difficult market conditions – which might imply some confirmation of the diversification benefits of property as an asset class.

[1] Here the focus is on mean return and the volatility around that mean, rather than on the higher moments, skewness and kurtosis. The mean-variance framework is the standard basis for quantitative asset allocation models.

2. INTRODUCTION

The factor model results suggest that there might be some lagging effects, with private real estate returns (even though these have been desmoothed) being led by equity market returns. Are shocks in equity and bond markets transmitted to the real estate market? If so, how rapid is the transmission and does the process vary between public and private markets? Accordingly, section 6 briefly examines some standard long-run models, Granger causality analysis and vector autoregression (VAR). These examine lead-lag relations between the different asset classes and the response of the return series to shocks in the other markets. Evidence is found that, despite the desmoothing process applied, private property returns lag the financial market series and public real estate. Shocks in equity markets induce a response in real estate markets: however, in private markets while the response is persistent, it is relatively muted in scale and masked by the impacts of income stability and valuation effects. This might also imply that information in equity and bond markets can inform private real estate asset allocation decisions (subject to issues of transaction costs and liquidity in portfolio rebalancing, of course). Finally, some conclusions and implications are deduced from the results.

2.1 Summary

This paper:

- Examines the time-varying nature of the relationship between real estate returns and other asset classes;
- If the relation between assets varies across time, then use of a single static correlation or covariance to inform portfolio selection may fail to provide investors with the diversification they expect;
- Tests whether correlation between real estate and financial assets change over the period 1990–2010 employing a rolling correlation method;
- Examines the influence that other asset classes have on the variability of real estate returns using a set of factor models that decompose property risk into elements linked to equity and bond markets and elements that are unique to real estate;
- Explores whether there are lead-lag structures and shock transmission processes between property and the other asset classes using long-run econometric models;
- Finally, the paper seeks to identify the practical implications of the research findings for portfolio selection and risk management.

3. DATA AND RETURN DISTRIBUTIONS

This section introduces the data series used in the analysis and provides basic descriptive statistics of the behaviour of returns for the period 1990–2010.

The analysis in this paper focuses on five data series:

(a) The IPD monthly returns desmoothed using the threshold autoregressive (TAR) procedure described in Working Paper 2;

(b) UK property company property returns measured by the FTSE-NAREIT-EPRA index of UK property company and REIT returns (hereinafter EPRA);

(c) UK equity market returns, measured by the FT All Share Index (hereinafter FTAS);

(d) The performance of small-cap stocks measured by FTSE small-capitalisation stocks index;

(e) Government bond returns, using the returns on ten year maturity government bonds as an appropriate proxy.

Data are analysed on a monthly basis from the start of 1990 to the end of 2010. Tables 3.1 and 3.2 show descriptive statistics for the series over the whole analysis period. The story told is familiar. Even after desmoothing, the valuation-based index seems to exhibit low volatility, as captured by the standard deviation; the apparent correlations with other asset classes also seem low. Using these *ex post* figures in an unconstrained Markowitz-style portfolio optimisation would result in a very high allocation to real estate in a mixed-asset portfolio that was higher than that held by institutional and other professional investors diversified across asset types.

By contrast, property company returns appear highly volatile – the undiversified sector index having a higher standard deviation than the FT All Share index, not compensated by higher average returns (although the disparity in returns is largely a product of the last three years). Property company correlations with FTAS and with the small-cap stock index are much higher than the correlation with IPD: indeed, the EPRA returns share many similar characteristics with the small-cap stocks.

Although desmoothed IPD returns appear very favourable judged by mean-variance characteristics, it is important to note two further features of the distribution of returns. First, the returns have negative skewness; second, the returns exhibit strong kurtosis – there are 'fat tails'. While some of the negative skewness comes from the financial crisis period, the kurtosis is clearly present before 2007. The implication for investors is that, compared to a normal distribution of returns, IPD returns are much more likely to experience extreme negative values. This result is consistent with the findings in Working Paper 2 which pointed to long periods of steady returns interspersed with short periods of sharply falling asset values. Thus, despite the apparently strong risk-return and risk diversification characteristics, risk-averse investors need to consider the possibility that they will experience periods of poor performance – a risk that is particularly pertinent for an investor with unpredictable, lumpy liabilities or for an asset manager judged on short-term performance.

3. DATA AND RETURN DISTRIBUTIONS

Table 3.1: Descriptive statistics, monthly returns 1990–2010

	IPD-Des	EPRA	FTAS	Small-Cap	Bonds
Compound return	0.56%	0.27%	0.65%	0.51%	0.69%
Mean return	0.58%	0.45%	0.74%	0.65%	0.72%
Standard deviation	1.97%	6.04%	4.29%	5.41%	2.08%
Skewness	–1.4212	–0.1262	–0.4907	–0.1637	0.0721
Kurtosis	6.0636	1.9016	0.6113	3.1085	0.9655
Autocorrelation	0.3029	0.2078	0.0970	0.2572	0.0304

Table 3.2: Correlations monthly returns, 1990–2010

	IPD-Des	EPRA	FTAS	Small-Cap	Bonds
IPD-Des	1.000				
EPRA	0.271	1.000			
FTAS	0.163	0.613	1.000		
Small-Cap	0.208	0.625	0.812	1.000	
Bonds	–0.189	0.198	0.192	0.038	1.000

3.1 Summary

- Five data series are employed in this study: returns from UK property companies (the FT-EPRA UK series); from private real estate (the IPD monthly index desmoothed using the TAR procedures described in WP Two); the FT All Share index returns; the returns from small-cap stocks; and a UK government bond index;
- Data are collected monthly from 1990 to the end of 2010;
- Descriptive statistics suggest that even after desmoothing, the IPD monthly index has a very low standard deviation, below that of the bond return index;
- Property company performance over the analysis period is weak, with low returns and high volatility;
- Correlation analysis suggests that direct private real estate offers considerable diversification potential with low correlations with the other financial assets.
- Public real estate returns exhibit high positive correlations with the overall equity market and small-cap stocks;
- While private real estate seems to offer good mean-variance qualities for investors, the return distribution is negatively skewed and has 'fat tails' – investors have a greater than normal probability of experiencing sharply falling returns.

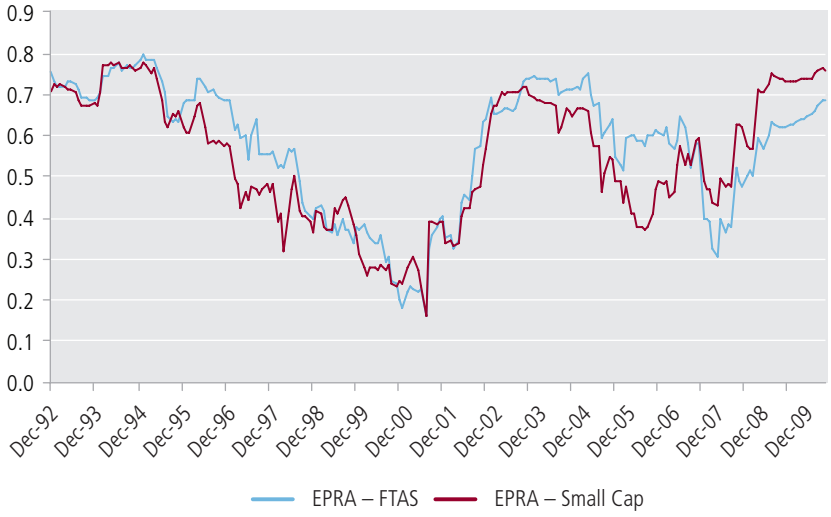
4. TIME-VARYING CORRELATION PATTERNS

In this section, a rolling correlation technique is employed to explore the changing pattern of correlation between asset classes over time. A 36-month rolling correlation technique is used that allows observation of the evolution of the relationship between the various series and relates the changes seen to the market environment.

The descriptive statistics in Tables 3.1 and 3.2 apply to the whole of the analysis period. In this section, the research investigates whether there is time variation in the relationship between the different asset classes and sub-classes. As a first analysis, rolling three-year regressions are conducted between the various return series – that is, the correlations for the first 36 months of data (January 1990 to December 1992) are calculated, then the earliest observation is dropped and one further observation (February 1990 to January 1993) added, proceeding on that basis throughout the analysis period. This allows the evolution of the relationship between assets to be observed over time and these to be related to market conditions.

The whole period correlations in Table 3.2 suggest that the property company and REIT returns (captured in the EPRA series) are strongly correlated both with FTAS (0.613) and small-cap stocks (0.625). Figure 4.1 displays rolling correlations between UK public real estate and the two equity market indices. The striking feature is the fall in correlation in the late 1990s. Prior research suggests that, during this period, equity market behaviour differed markedly between growth and value stocks. Supposed growth stocks (mainly interpreted dot.com and technology stocks) attracted substantial capital inflows, while value and cashflow-driven stocks (such as real estate) were out of favour – this era saw a number of real estate firms taken private and withdrawn from the market. Many of the small-cap stocks present in the indices were start-up technology firms. With the bursting of the tech bubble, correlations rise again but, intriguingly, fall back at the onset of the financial crisis, before rising back above 0.60 in late 2009.[2]

Figure 4.1: Rolling three year correlations: property companies with equity

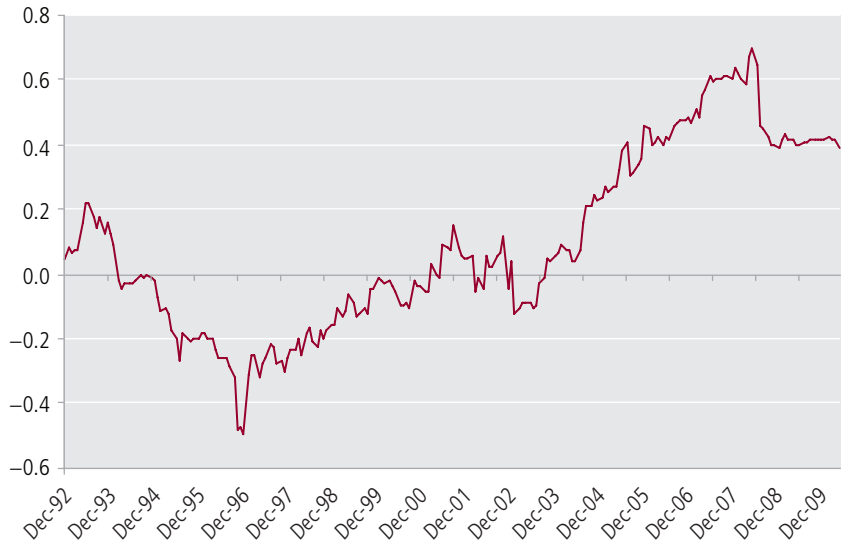


[2] Recall that these are trailing correlations: hence, a July 2009 correlation includes return observations from August 2006. However, that correlations fall from the onset of the 2007 liquidity crisis indicates that adding crisis era observations initially reveals differences of behaviour between asset classes.

4. TIME-VARYING CORRELATION PATTERNS

Figure 4.2 examines the trend in correlation between UK property company returns and the desmoothed IPD returns. The low, and sometimes negative, correlation between the two series up to the mid-2000s on the surface suggests that the series are not substitutes. Many reasons have been advanced for this pattern: that, even with desmoothing, the valuation-based private market data lag public real estate returns; that property company and REIT returns are forward looking, while valuation returns, relying on comparable evidence are backward looking; that the relationship between the two series is masked by leverage effects in the public market;[3] and that property company returns have short-run volatility that is driven by equity market factors that are not linked to the underlying real estate market fundamentals. Although explanations for the phenomenon differ, it is evident that from around 2003, the correlation begins to rise: to 0.40 at the end of 2005, 0.50 in July 2007 and peaking at 0.70 in November 2008, before falling back again. By implication, the pattern of returns in public and private markets has become more similar over time and, in particular, during the global financial crisis.

Figure 4.2: Rolling three year correlation: public versus private real estate



The research turns next to the relationship between private real estate and the equity market. Figure 4.3 shows rolling correlations between desmoothed IPD returns and the equity market (FT All-share) and small-cap stocks. Up to the turn of the century, the correlations between property and FTAS are low and often negative, which would appear to imply that real estate would be beneficial as a risk diversifier in a mixed-asset portfolio. Then the correlation rises steadily, peaking in January 2002 at 0.45, falls back across the first half of the 2000s, then rises again, to reach 0.51 in autumn 2008. The general pattern holds for the relationship between real estate and small-cap stocks, with the peak correlation of 0.60 reached in October 2008.

[3] This is not to say that private real estate capital returns were not influenced by credit availability and the growing leverage in the asset class: only that property company equity returns are **directly** affected by gearing, while the appraisal-based private market returns only consider property level cashflows and hence are only indirectly affected by credit conditions.

4. TIME-VARYING CORRELATION PATTERNS

Figure 4.3: Rolling three year correlation: private real estate with equities

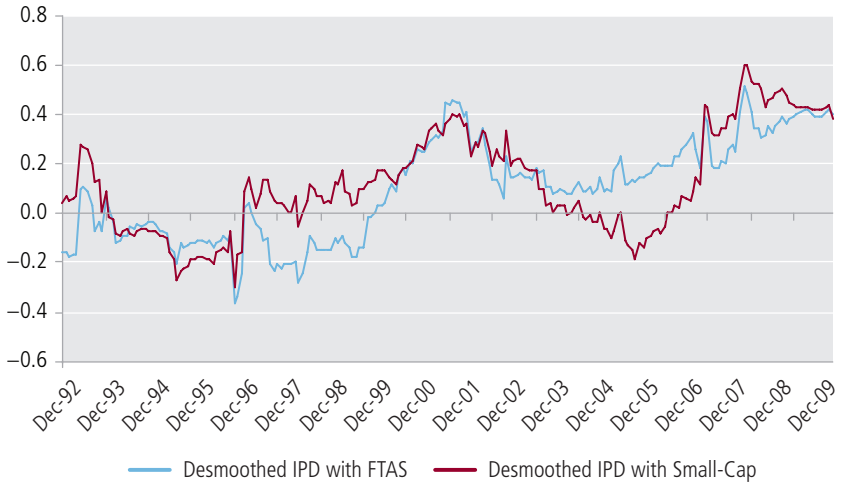
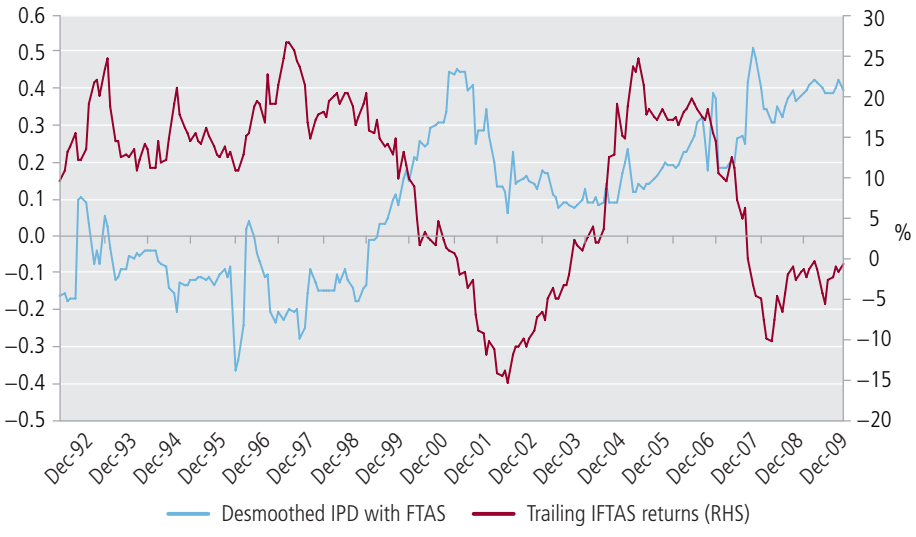


Figure 4.4 provides some insight into the nature of the relationship. It shows the rolling three-year correlation between the desmoothed IPD returns and the FT All Share index set against the trailing three-year return of FTAS. A general inverse relationship is evident – when equity market returns are poor, the correlation between property and the stock market rises. The correlation between the two series is –0.62, statistically significant at the 0.001 level. Clearly this is not the whole story (trailing FT return only explains 38% of the variation in rolling correlation) but it does suggest that the diversification properties of real estate relative to the equity market are not captured by a simple, time-invariant covariance between the two asset classes. That correlation peaks in 2002 (in the aftermath of the bursting of the dot.com bubble) and in 2008 (amidst the global financial crisis) might indicate that diversification is absent when most needed.

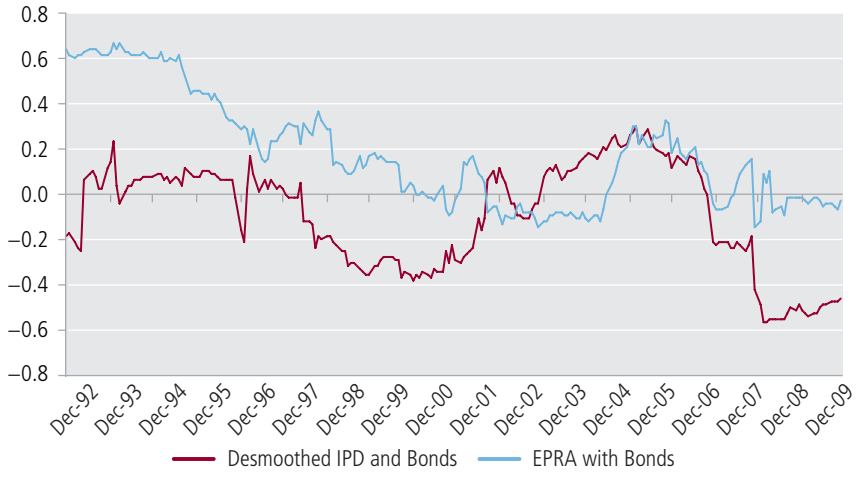
Figure 4.4: Rolling three year correlation: private real estate with equities



4. TIME-VARYING CORRELATION PATTERNS

For completeness, Figure 4.5 shows the rolling correlations between the real estate indices and the bond market series. The property company series shows a general decline in correlation from the early 1990s (where there appears to have been a strong positive correlation) down to a near-zero correlation, save for the mid-2000s (possibly driven by common prices in all asset classes driven by falling interest rates). The private real estate series also exhibits positive correlation over this period, but generally has low or negative correlations, the fall in the global financial crisis period being clearly marked. Correlation troughs at –0.57 in early 2009 and does not rise above –0.46 until the end of the analysis period. It is not easy to provide an intuitive interpretation of these results other than the consequence of the 'flight to quality' in the environment of greater uncertainty induced by the global financial crisis.

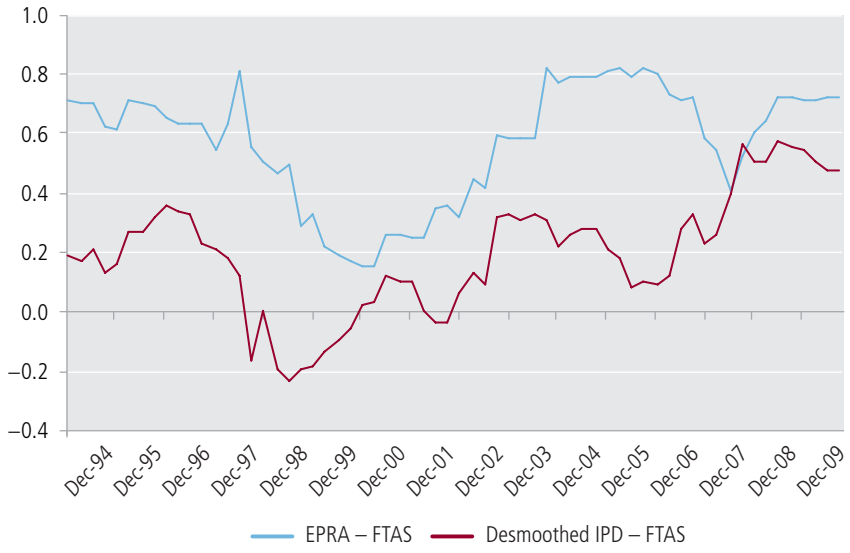
Figure 4.5: Rolling three year correlation: real estate with bonds



As a final view, Figure 4.6 shows the correlation between the two real estate indices and the equity market using quarterly rather than monthly returns and a five-year, rather than a three-year rolling window. Although each window contains fewer data points, the effect of aggregating over the quarter and taking a longer analysis period (closer to typical holding periods for professionally managed real estate funds) produces generally higher correlations. As with the monthly three-year windows, the correlation between public real estate and the equity market initially falls across the technology stock bubble period then rises strongly until the mid-2000s, when there is a downward correction and subsequent recovery. The correlation between the private real estate market and the equity market trends upwards from the late 1990s, peaking at 0.56 in late 2008 and largely maintaining that level thereafter.

4. TIME-VARYING CORRELATION PATTERNS

Figure 4.6: Five year rolling correlation: property and equities



In summary, it is evident that the single-period correlation coefficients do not tell the whole picture about the relationship between property and other asset classes. In general, private real estate's correlation with the equity market has been increasing over time. Yet that general trend has to be set in the context of considerable variation in correlation over time. Furthermore, there is some evidence that those correlations increase when equity market performance is poor – that the familiar representation of real estate as a portfolio diversifier does not hold so well precisely when that diversification is most needed. This suggests that it is important to investigate 'tail dependence' and asymmetry in the relationships between real estate and the other main financial asset classes: a task addressed in Working Paper 4.

The relationship between public real estate returns and the equity market also appears to be time-varying. Correlation levels fell across the 1990s, but began to rise again after the market correction following the technology/dot.com 'bubble' phase, falling back in the mid-2000s and fluctuating over the asset price boom and financial crisis phases. One clearer trend is the closer relationship between public and private real estate returns over time, with sharp increases in correlation observable in the period 2003–2008. This, once again, coincides with 'extreme' market conditions, with rises in asset prices across most markets followed by the rapid reversal of fortunes from 2007.

For investors, these results may imply that diversification benefits vary across market environments, with a gradual loss of diversification as markets deteriorate. A view expressed in industry is that the events of the global financial crisis were so extreme that they were unpredictable and do not undermine the long-run characteristics of real estate. The results here suggest that the situation is more complex and that investors do need to be sensitive to the possibility that their portfolios may become less diversified as market conditions worsen. As risk of a downturn or correction rises, it may prove prudent to account for that strategically.

4. TIME-VARYING CORRELATION PATTERNS

Correlation, though, is not a perfect measure of the relationship between assets. Unconditional correlation coefficients increase as volatility increases[4] – and volatility may increase in poor market environments, particularly where gearing plays a significant role, due to the Black leverage effect. The next section focuses on the time-varying volatility of the asset types analysed and examines the interactions between markets with respect to that volatility.

4.1 Summary

- The rolling correlation technique allows evolution of the relationship between asset class returns to be explored over the analysis period;
- It is evident that the correlations between public and private real estate and other financial assets are not stable over time;
- Assuming a stable, time invariant, standardised correlation between two assets would misrepresent the relationship between them, with implications for portfolio risk management;
- The rolling three year correlation between public and private real estate has been trending upwards from the mid-1990s, when there appeared to be a negative correlation, to nearly +0.7 in late 2008;
- The correlation between public real estate and the equity market has ranged between +0.2 (at the end of the technology boom) and +0.8;
- Public real estate's correlation with the equity market initially fell in the financial crisis, then rose again to the end of the analysis period;
- Private real estate's correlation with the equity market has ranged between –0.36 and +0.51 over the analysis period with a general upward trend;
- The correlation between private real estate and the equity market is negatively related to equity market returns: as equity markets perform poorly, so the correlation with real estate rises;
- Using a longer estimation window (equivalent to a longer holding period) and lower-frequency, quarterly data, real estate's correlation with the equity market seems stronger;
- The results point to a time-varying relationship between real estate and equity markets, with some evidence that private real estate's correlation increases when the stock market declines;
- By implication, this suggests that some of the presumed diversification benefits of real estate will not be delivered when most needed.

[4] One way of countering this is to calculate dynamic conditional correlations. This approach has not been here (and note issues about appropriate lag structure) but include references to DCC approaches in the bibliography.

5. MODELLING ASSET CLASS BEHAVIOUR: A FACTOR APPROACH

Developing the correlation analysis, this section of the paper seeks to decompose the variation in real estate returns to see how much of the volatility in property markets is linked to volatility in other financial markets. As with the correlation analysis, the results suggest that the relationships shift over time.

While the rolling correlation analysis allows us to examine the co-movement between pairs of asset classes to be examined, it necessarily ignores the interactions between all the different asset classes. If real estate returns are, to some extent, linked to both equities and bonds – and bonds and equities are themselves related – then the combined relationship needs to be unpicked. This section attempts to do this using a factor decomposition approach.

The broad approach here is to estimate a model of the general form:

Equation 1

$$R_{REt} = \beta_0 + \beta_E F_{Et} + \beta_{SC} F_{SCt} + \beta_B F_{Bt} + \varepsilon_t$$

where R_{REt} is the real estate return for time t, the F are independent (orthogonal) factors representing equities (subscript E), small-cap stocks (subscript SC) and bonds (subscript B) and the betas represent real estate's sensitivity to those factors. The key here is that the factors are unrelated – orthogonal – in an attempt to isolate the 'pure' effect of a particular asset class on property returns.

With such a model defined, it is then possible to analyse the influence of each of the factors on the overall variance of real estate returns, since:

Equation 2

$$\sigma^2_{RE} = \beta^2_E \sigma^2_E + \beta^2_{SC} \sigma^2_{SC} + \beta^2_B \sigma^2_B + \sigma^2_i$$

where σ^2 is the variance of the asset referenced by the subscript, the final term being the residual or idiosyncratic variance.[5] Dividing each product by the real estate variance allows the estimation of the influence the variation in the returns on one asset class has on the variation in real estate returns. Thus, the influence of equity return variance on real estate return variance would be:

Equation 3

$$\frac{\beta^2_E \sigma^2_E}{\sigma^2_{RE}} \%$$

[5] This holds since the explanatory variables are orthogonal, removing covariance terms (see Clayton and Mackinnon 2003). Thanks are due to Charlotte Bamber for drawing attention to this model.

5. MODELLING ASSET CLASS BEHAVIOUR: A FACTOR APPROACH

To model the influence of different asset classes, factors were constructed using two procedures. It is necessary to calculate factors since the raw returns are likely to be correlated (for example, the FT All Share returns include returns that reflect real estate price movements and bond market movements) which creates estimation issues and may mask the influences sought. The two procedures are, first, to 'orthogonalise' the return series by successively regressing the returns from one asset class on the others and retaining the residuals as a 'pure' asset class factor. For example, small-cap stock returns can be regressed on the FT All Share index with the returns representing a small-cap effect purged of the overall influence of the equity market. Next, bond returns can be regressed on the FTAS returns and the small-cap residuals to produce a pure bond effect; and then real estate returns can be regressed on FTAS and the small-cap and bond residuals to yield a real estate series. This is described as the residual factor approach.

The problem with such a procedure is that there are ordering effects: in the model described, any real estate influences on the overall equity market are retained in the FTAS returns.[6] The second procedure, here described as the factor approach, by contrast, uses a factor analysis/principal components approach to generate three factors that represent bond, equity and real estate performance that are uncorrelated but not affected by ordering effects. It did not prove possible to generate a small-cap stock factor using the factor approach, so the small-cap-effect variable from the residual approach was used where appropriate.

With the factors constructed, successive periods of 60 months were examined on a rolling basis. For each five-year period, the betas of the factors were calculated and used to decompose the variation in the property returns into that explained by the equity market, small-cap stocks, bonds and real estate. If the influence of, for example, the equity market, changes over time, then it will explain a greater or lesser share of the real estate returns.

As in prior research, the direct private real estate returns, even after desmoothing, have typically low correlations with the other asset class factors and exhibit lagging effects – which means that the real estate factors dominate explanation. For that reason, the research focuses solely on the influence of the other asset classes. For the EPRA returns, the influence of the (private) real estate factor can be examined additionally.

5.1 Public Real Estate: Residual Factor Model

The first model examined is the residual factor model for public real estate. The orthogonalisation equations used to derive the residual factors are shown in Appendix A. With the real estate residuals, even though the research worked with desmoothed real estate returns, there still appeared to be a lagging relationship with the equity indicators. The returns from the EPRA UK index were regressed on the FT All Share Index, the small-cap residual, the bond residual and the private real estate residual on a rolling basis, using a window of sixty months. Figure 5.1 shows the evolution of the FTAS factor beta over the analysis period. It suggests that the reaction of property company shares to equity market movements declined until the ending of the technology stock boom, then rose steadily during the period of rapidly rising asset prices, then fell back again as the impact of the global financial crisis became more evident. The fall in beta could result from real estate stocks having a greater defensive quality, or it could indicate that the impact of the equity market on property shares had lessened.

Figure 5.2 sheds further light on this. It shows the proportion of variation in property company returns that can be attributed to equity market movements and the proportion that is linked to the underlying real estate market (or, more accurately, to the real estate factor purged of equity market influences). The results are striking. Over the boom phase, it is equity market movements that are dominating property company returns – at their peak some 70% of variation results from the equity market. However, the proportional impact plummets towards the peak of the market

[6] For a more detailed discussion of issues with a regression based orthogonalisation method, see Brooks and Tsolacos (2000).

and as the global financial crisis begins to affect the return window and, at the same time, the influence of the real estate factor begins to rise. It should be stressed that the trend change predates the falls in real estate capital values, although the decline in equity market influence and the increase in the significance of the underlying market become more pronounced as the crisis proceeds.

Figure 5.1: Public real estate: evolution of equity beta

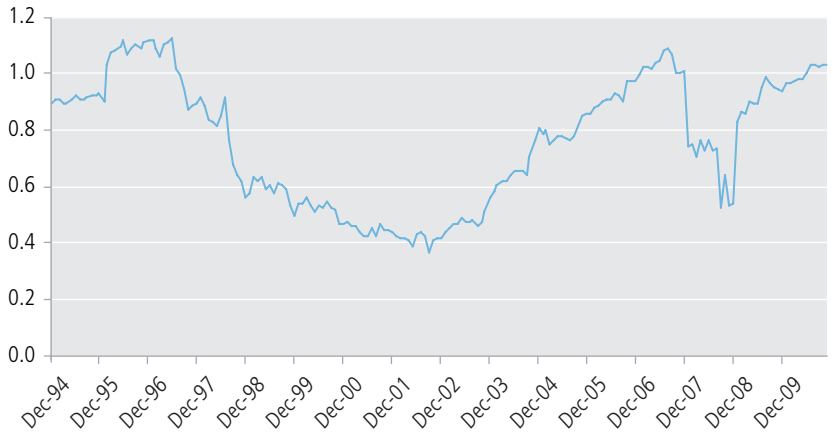


Figure 5.2: EPRA impact of equity and real estate

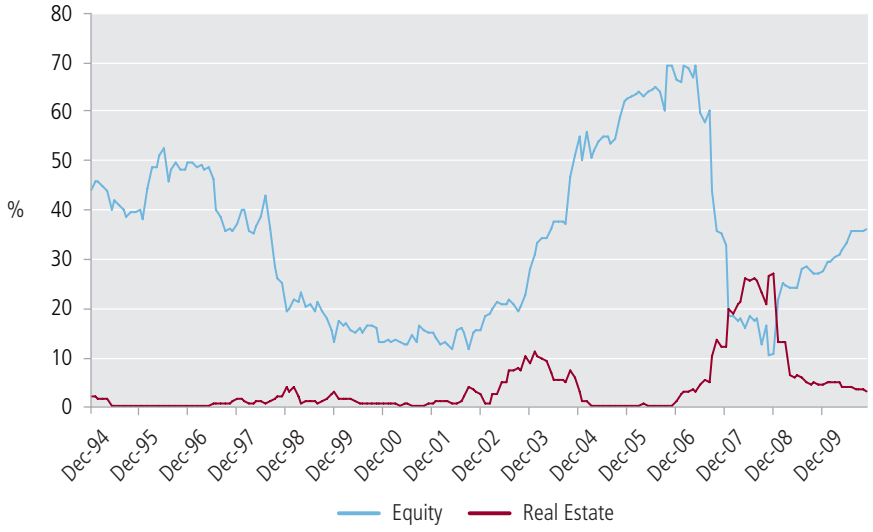
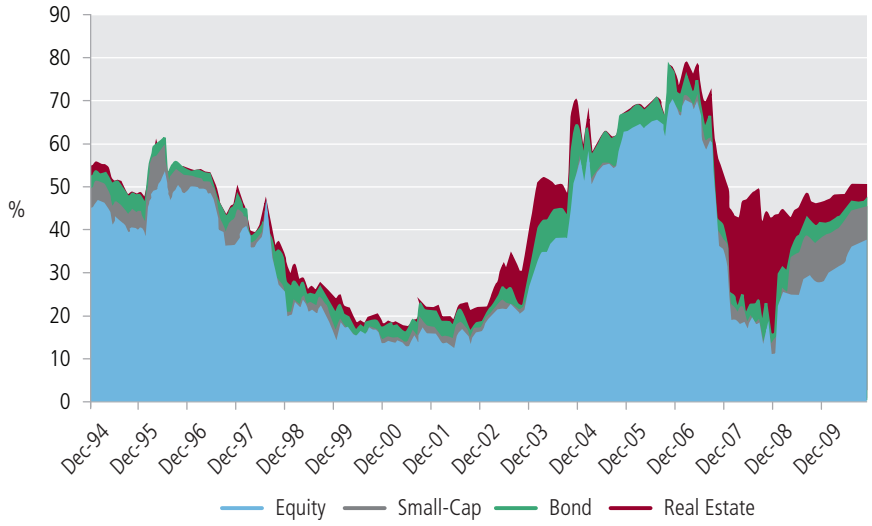


Figure 5.3 presents another view of the changing factor influences over time. For much of the period, the equity market dominates, but the influence of real estate becomes stronger in the windows ending in 2007 to 2009. The influence of the small-cap stock factor towards the end of the period is worth noting, too. Finally, the role of idiosyncratic, unexplained variation in returns shifts considerably over the period – the model's explanatory power over the turn of the century is very low; by contrast, much of the movement in property company returns over the boom that preceded the global financial crisis can be explained by other asset factors.

Figure 5.3: Influence of asset factors on EPRA variation



5.2 Public Real Estate: The Factor Component Model

The model produced using the equity, bond and real estate components from the factor analysis (detailed in Appendix B) produces the same broad results as the residual factor model, although the influence of the equity market remains stronger. The evolution of the equity beta matches the results of the residual model; as does the pattern of declining equity influence in the technology boom, the rising stock market influence approaching the financial crisis and then a reversal as the markets turn and the effects of the crisis appear. Although less pronounced, real estate's influence increases over that same period: property company returns show more real estate characteristics in that phase. Finally, it is worth noting the changes in the significance of idiosyncratic variation over the analysis period. In the dot.com boom phase, equity market influence declined, but was not replaced by real estate market influence: UK property companies seemed to behave in a distinct manner in that period.

Figure 5.4: Factor model: equity beta evolution

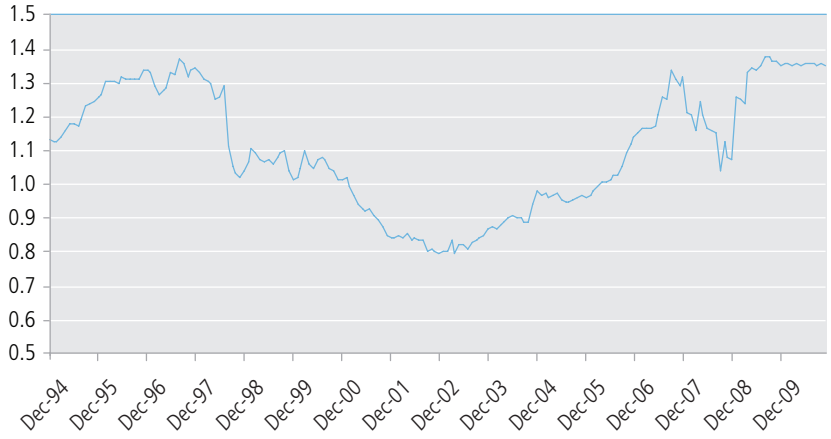


Figure 5.5: Factor influence on EPRA variance

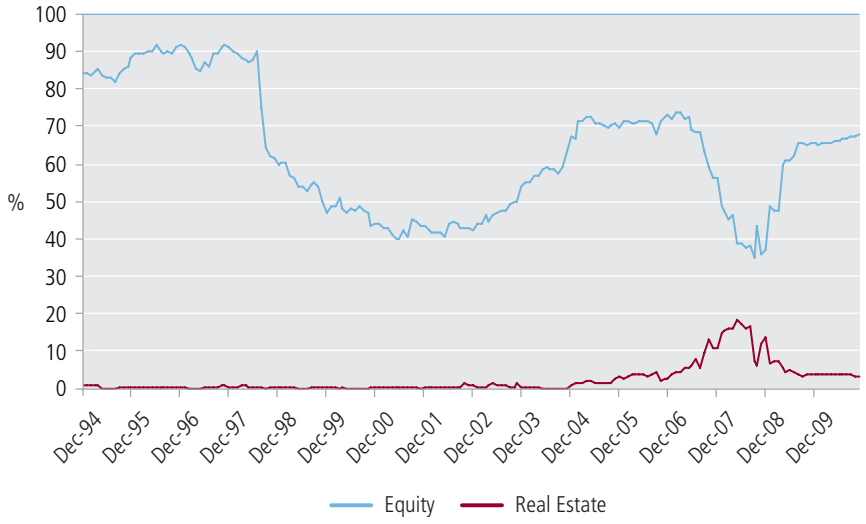
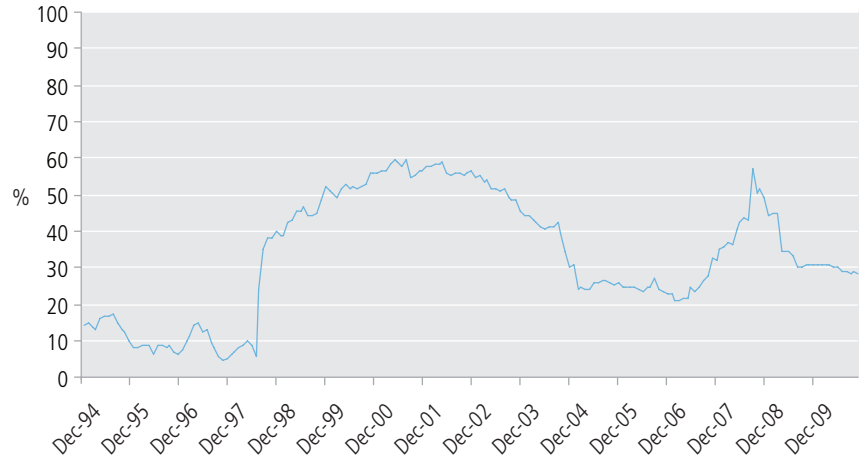


Figure 5.6: EPRA idiosyncratic variation



5.3 Private Real Estate Models

The explanatory power of the private real estate models is significantly lower than for the public real estate, property company models. Two models were estimated: a residual model using FTAS, the small-cap residuals and the bond residuals; and a factor model using the equity and bond market factors and the small-cap residual – which has a correlation of 0.38 with the equity factor, which, while not so large as to cause significant multicollinearity problems, does indicate that this is not a 'pure' uncorrelated factor model (with some implications for the decomposition of variance). Although the real estate returns series has been desmoothed there is some evidence of a lagging effect. After testing, for the factor model, the equity and bond factors are lagged one period and the small-cap factor two periods; for the residual model, the equity returns and the small-cap residual are lagged one period, but the bond residuals enter the model unlagged.

For both models, the degree of explanation over the whole analysis period remains low. The factor model explains around 10% of the desmoothed real estate series' variation; the residual model only explains around 8% of variation. More complex models with multiple time lags can be run that increase the degree of explanation, but at the expense of clarity. Including the real estate factor or the real estate residuals produces a very high level of explanation, with the real estate factor influence swamping the other asset class variables. A positive interpretation of this is that real estate exhibits behaviour that is distinct from the other asset classes, emphasising its diversification potential. Sceptics might argue that the observed effects result from the valuation-based nature of the return series and that desmoothing procedures are still not capturing the underlying market processes. Nonetheless, the influence of other asset markets does change over time using the same five-year rolling window approach used for the EPRA series.

Figure 5.7 shows the influence of the equity market, small-cap stocks and bonds on desmoothed real estate using the factor model. In the early part of the series, the three factors appear to have a stronger influence, at times explaining some 30% of return variation, with equity, bond and small-caps all playing a part. This influence declines, with adjusted R-squared figures declining to zero in the 2000s. There is a small spike upwards in the early years of the century, perhaps associated with asset price falls at the end of the technology stock boom. However, at the end of the analysis period, as the impact of the global financial crisis becomes evident, initially an increase in bond factor influence is seen, rapidly replaced by a strong equity market effect. The early bond factor effect is linked to negative betas and may thus reflect the interest rate impacts at the end of the boom/bubble phase of rising asset prices. By contrast, the equity impact is driven by positive and rising betas – with equity market prices falling during the financial crisis (and then, to an extent, recovering at the very end of the period). This suggests that the events of 2007–2009 brought more common movement and less diversification than was evident outside the crisis period. This is emphasised by noting that the series of adjusted R-squared for each of the windows has a –0.843 correlation with the annualised property return over the window: that is, the influence of other asset classes increases as real estate returns deteriorate. It should be stressed that, although the overall amount of explanation is relatively low, the equity market betas are statistically significantly positive for 43% of the five-year windows.

Figure 5.7: Direct real estate: factor influences

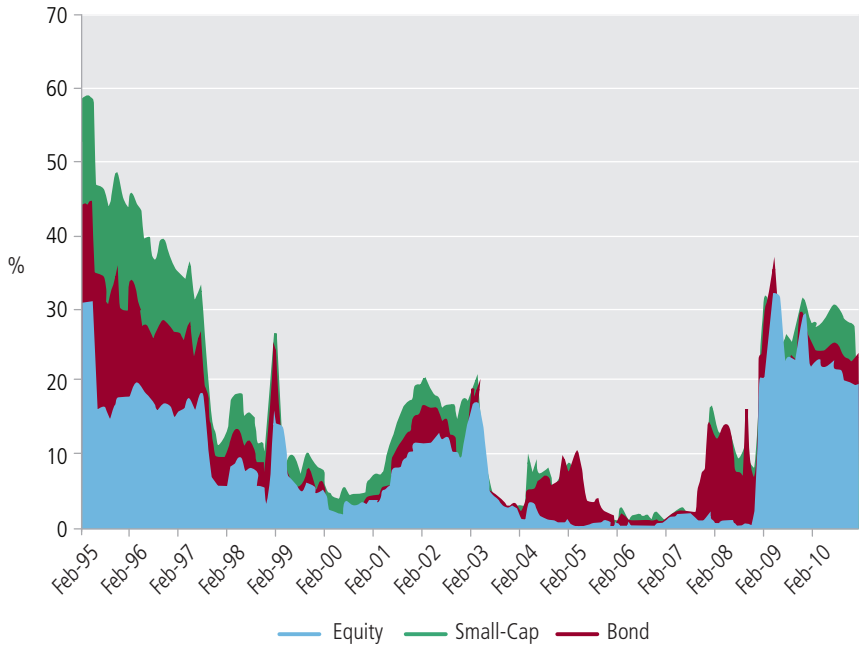
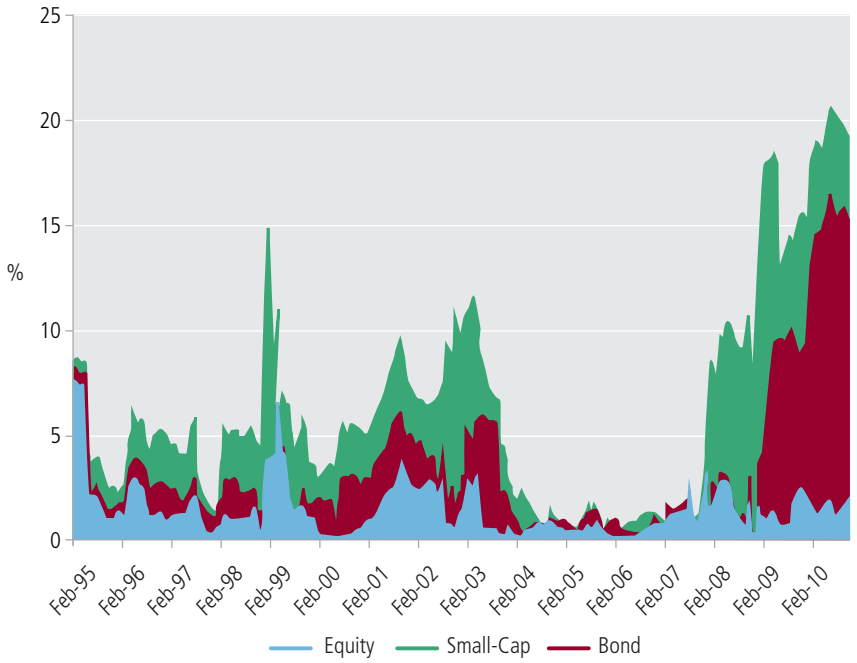


Figure 5.8: Direct real estate: residual factor influences



The model based on the three residual factors is, statistically, less robust that the pure factor model, with, in general, lower levels of explanation evident. It does suggest that the small-cap effect is more pronounced than was evident in the pure factor model. Towards the end of the period, the bond residual factor appears to have a strong influence – again, the betas in these windows are negative (and strongly significant), which could reflect some form of flight to safety (the fall in bond redemption yields pushing up bond prices and hence returns, but the fall reflecting less a reduction in the risk-free rate and more a flight away from riskier assets including real estate). In this last part of the analysis period, the residual factor model is explaining around 24% of the variation in real estate returns, with most of the work being done by the bond factor.

These results, once again, illustrate the time-varying nature of the relationship between property returns and other asset classes and, hence, that a mixed-asset portfolio strategy based on long-run mean-variance estimates would fail to account for changes in the nature of risk in different market environments. The influence of the overall equity market on public real estate returns is considerable, but there are periods where that influence wanes, notably in the second half of the 1990s and, more surprisingly, at the start of the financial crisis. Throughout the period, though, there remains a strong idiosyncratic residual variation which points to diversification potential. This, too, varies considerably over time and there are periods where much of the variation in property company performance can be explained in terms of the other asset classes. Over much of the analysis period, property company returns do not seem to be strongly influenced by the underlying property factor. However, during the financial crisis, there seems to be a stronger real estate influence, just as the wider equity market influence ebbs.

5. MODELLING ASSET CLASS BEHAVIOUR: A FACTOR APPROACH

Variation in private real estate returns is less well explained by the factor models and there is evidence of a lagging effect despite the use of a desmoothing model. There are spikes of equity market influence in the early 2000s and at the end of the analysis period, which seem to relate to bad stock market conditions but, even here, the influence is low relative to the equity market influence on public real estate. The residual factor model suggests an inverse bond market link at the end of the period. The results, at face value, suggest that private real estate has greater diversification potential. However, there remains a possibility that this might reflect measurement issues. Given the lagging effects observed, the next section explores long-run models of asset class interactions.

5.4 Summary

- The variation in property market returns is decomposed into elements that are explained by movements in the returns of other assets and the element that is unique to real estate;
- To do this, two models are used: one based on principal components that identify uncorrelated factors representing equity, real estate and bonds; the other based on a residual regression approach;
- The models are estimated for rolling 60-month periods to see how the factor contributions change over time. Once again, the results show major shifts in the influence of financial assets over time;
- In the factor models, the equity market beta varies substantially over time, in part reflecting changing equity market risk, in part fluctuations in the influence of the stock market on property returns;
- The influence of the equity market on public real estate volatility is considerably larger than the influence of the underlying property market;
- In the midst of the global financial crisis, equity market influence on public real estate volatility declined – and the influence of the underlying real estate market increased;
- While equity and real estate factors are significant in explaining the variability of returns in public equity, from the mid-1990s there exists a significant idiosyncratic component that suggests that property companies do provide diversification benefits;
- Far less of the variation in private real estate can be related to the equity, bond or small-cap factors, although the degree of explanation varies over the analysis period;
- There is some evidence that the financial assets have become more significant in the latter years of the analysis period, influenced by the financial crisis and continuing capital market problems;
- The factor model identifies a spike in equity market influence, while the residual component model suggests that bond returns have become more significant in explaining variation in property returns;
- Overall, the results suggest that there are significant financial market influences on the volatility of real estate returns, in both public and private markets;
- Nonetheless, much of the variability in property returns is unexplained, suggesting diversification benefits, albeit time-varying in nature;
- The apparently greater independent component to private real estate might reflect the specific nature of the direct market, but may be an artefact of the construction of property indices.

6. LONG-RUN MODELS OF RETURN BEHAVIOUR

With some evidence of lagged relationships between real estate and the financial assets, this final empirical section examines the long-run behaviour of the asset series, exploring the inter-relationships between the variables and the transmission of shocks from one market to another.

Given some evidence of lead-lag relationships between the financial asset returns and property returns, this section examines long-run relationships in the data set. Two approaches are employed. First, the extent to which one asset leads another asset is examined, using Granger causality tests. The Granger model examines whether inclusion of lagged values of a second variable helps explain variation in a first, subject, variable. For example whether equity market returns influence property returns might be tested. A model is first run where property returns are explained by lagged values of the real estate variable. The model is then re-run, including lagged values of both the real estate variable and the equity market variable. If the second offers statistically significantly more explanation of the real estate variable than the first model, then it can be said that equity 'Granger causes' real estate. In effect, it suggests that return movements for the equity variable precede movements in the real estate variable and, hence, have some predictive power.

The second type of model examined is a vector autoregressive (VAR) model. VAR models assume that there is a long-run relationship between a set of variables. Shocks to one variable in the system are transmitted through to the other variables and the system adjusts to new external conditions. The adjustment phase may be rapid or stretched out over a number of periods, but the long-run stable relationship is restored. A number of different VAR and vector error correction model formulations were tried, which gave similar results. The model reported here is of a simple unrestricted VAR: the focus is on the influence that a shock to one of the variables has on the property variable using impulse-response analysis.

Turning first to the Granger causality tests, Figure 6.1 shows the analysis for the whole sample period, 1990–2010 using a lag length of four months in the tests reported. The first pair of results suggests that EPRA returns lead desmoothed IPD returns. That valuation-based returns lag property company returns is a well known result, explained in part by the smoothing process and in part by the different nature of the valuation process, one forward looking, one backward looking. However, the private property market series has been desmoothed (and desmoothed using an equity-market-based regime model) so this result is a strong one. Next, it appears that EPRA results trail the overall equity market, measured by the FT All Share index. Small-cap stocks weakly lead EPRA (the result significant only at the 10% level) while there appears to be a feedback mechanism between bond returns and property company returns.

The fifth and sixth pairs of tests provide a strong indication that the desmoothed IPD returns lag returns in the equity market – as might be expected, given the earlier results that property companies lead IPD, and that FTAS leads EPRA. The two-way lead-lag relationship between IPD returns and UK bonds is unexpected. This result is not robust to a change of lag length – for example, with a six-month lag, bond returns weakly lead property returns. Other results remain broadly unchanged using six-monthly lags. FTAS and small-cap stocks Granger-cause EPRA returns (albeit less strongly than with the four-month lag structure). The relationship between the desmoothed IPD returns and the two equity market indices is more complex, with some evidence of two-way causality that might indicate some form of switching between real estate and equity markets. UK bonds now seem to lead both property company and private real estate returns. Results vary by lag length employed but the broad story remains the same: evidence of the equity market (both FTAS and small-cap stocks) leading the two property indices, with property company returns leading private market returns despite the desmoothing approach utilised.

6. LONG-RUN MODELS OF RETURN BEHAVIOUR

To test whether these relationships changed over the global financial crisis, the tests from mid-2007 to the end of 2010 were re-run. The results are shown in Table 6.2. They are somewhat unexpected, in that while EPRA returns trail the equity market (with some evidence of common movement with small-cap stocks and bonds), the private market, IPD returns seem not to exhibit lead-lag relationships with the other return series, including EPRA. While this seems at odds with the rising correlations seen over the financial crisis (shown in section 4), the evidence from the factor models in section 5 does hint that equity market factors did not play as significant role in explaining variation in returns over that period as might be expected given the common trend of falling asset prices in the aftermath of the credit crunch and liquidity crises.

Table 6.1: Granger causality test results 1990–2010

Null hypothesis	F-statistic	Probability
1a Desmoothed IPD does not Granger cause EPRA	1.85920	0.1183
1b EPRA does not Granger cause desmoothed IPD	4.43179	0.0018
2a FTAS does not Granger cause EPRA	2.43390	0.0481
2b EPRA does not Granger cause FTAS	0.77749	0.5408
3a Small-cap stocks do not Granger cause EPRA	2.12140	0.0788
3b EPRA does not Granger cause small-cap stocks	1.00751	0.4042
4a UK bonds does not Granger cause EPRA	3.24123	0.0130
4b EPRA does not Granger cause UK bonds	3.00161	0.0192
5a FTAS does not Granger cause desmoothed IPD	3.07774	0.0170
5b Desmoothed IPD does not Granger cause FTAS	1.33572	0.2573
6a Small-cap stocks do not Granger cause desmoothed IPD	3.95334	0.0040
6b Desmoothed IPD does not Granger cause small-cap stocks	1.17414	0.3228
7a UK bonds does not Granger cause desmoothed IPD	0.92353	0.4509
7b Desmoothed IPD does not Granger cause UK bonds	3.09763	0.0164

Sample period 1990–2010, four lags used in analysis.

6. LONG-RUN MODELS OF RETURN BEHAVIOUR

Table 6.2: Granger causality test results 2007–2010

Null hypothesis	F-statistic	Probability
1a Desmoothed IPD does not Granger cause EPRA	1.17386	0.3402
1b EPRA does not Granger cause desmoothed IPD	1.11839	0.3645
2a FTAS does not Granger cause EPRA	4.32996	0.0063
2b EPRA does not Granger cause FTAS	0.33657	0.8513
3a Small-cap stocks do not Granger cause EPRA	6.32645	0.0007
3b EPRA does not Granger cause small-cap stocks	2.38244	0.0714
4a UK bonds does not Granger cause EPRA	3.39292	0.0197
4b EPRA does not Granger cause UK bonds	2.27551	0.0821
5a FTAS does not Granger cause desmoothed IPD	1.07874	0.3828
5b Desmoothed IPD does not Granger cause FTAS	0.53149	0.7134
6a Small-cap stocks do not Granger cause desmoothed IPD	1.42732	0.2468
6b Desmoothed IPD does not Granger cause small-cap stocks	0.41241	0.7984
7a UK bonds does not Granger cause desmoothed IPD	0.67501	0.6141
7b Desmoothed IPD does not Granger cause UK bonds	0.91081	0.4691

Sample period June 2007 to end 2010, four lags used in analysis.

The research turns now to the VAR analysis. As noted above, a variety of models were run, having tested the variables for stationarity and distributional qualities.[7] Full technical details of the unrestricted VAR are available from the authors. The focus is on impulse-response analysis. The analysis examines the impact of a one standard deviation shock on the returns of one of the variables in the VAR system on the returns of the other variables. Are there spillover impacts and, if so, how large and persistent are they? The research focuses just on the impacts on the property company returns proxied by the EPRA series and on the direct real estate market proxied by the desmoothed IPD returns.

Examining, first, the responses of the EPRA series to shocks in the system, Figures 6.1 and 6.2 show the response to standardised one standard deviation shocks in, respectively, the EPRA series itself and the FTAS all-equity return series. Return shocks to EPRA do not persist beyond a month; however, there is some evidence that the response to shocks in the wider equity market are more persistent, remaining significantly above zero for two months with an echo occurring at month five (the echo is present in FTAS's response to FTAS shocks, but it is less pronounced).

[7] Stationarity tests using both Phillips-Perron and Augmented Dickey-Fuller tests reject a unit root in the differenced (returns) series for all variables; all the index number series however, fail to reject the null hypothesis of a unit root. It can be assumed that the index number series are I(1) and the return series are I(0).

6. LONG-RUN MODELS OF RETURN BEHAVIOUR

Figure 6.1: EPRA response to 1SD EPRA shock

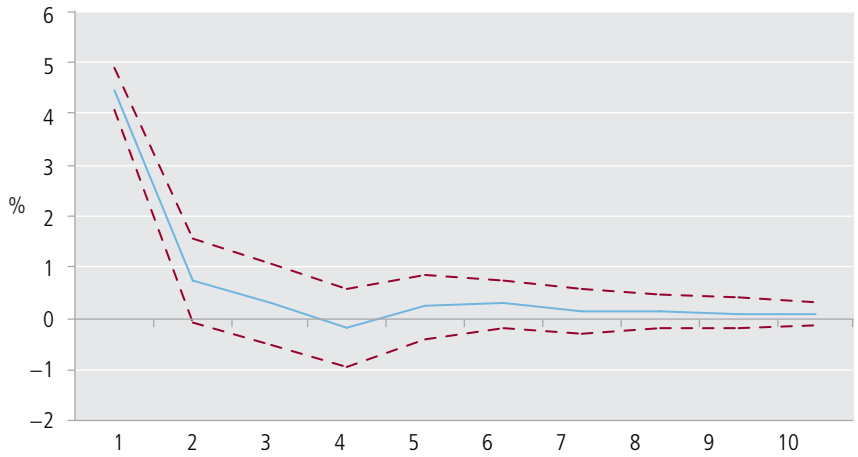
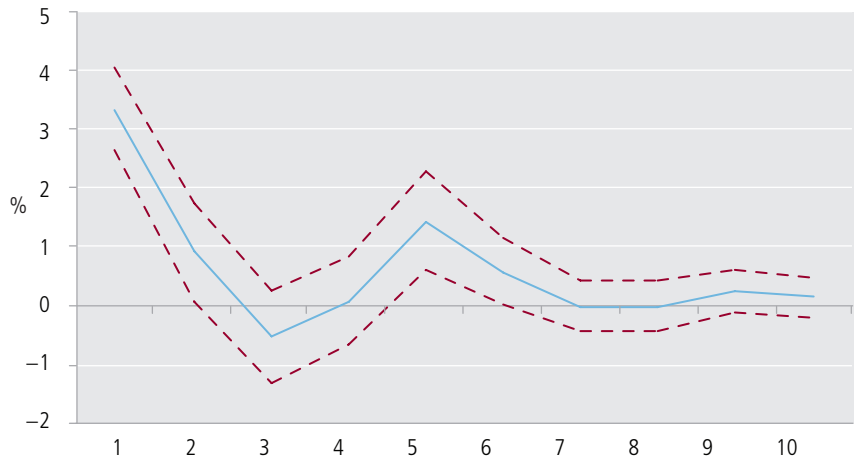


Figure 6.2: EPRA response to 1SD FTAS shock



The response of desmoothed IPD returns to property market shocks appears to be persistent. This is not unexpected: the desmoothing process has not completely removed the serial correlation in the series. As noted in Working Paper 2, the contractual nature of lease contracts means that income returns will not vary greatly from period to period. The same effect is present in the income (coupon) returns from bonds. This stickiness may well contribute to the pattern of response to shocks observed in the EPRA, property company series, although it is important to note the vertical scale of the graph and the muted nature of the response.

Figure 6.3: Desmoothed IPD response to 1SD IPD shock

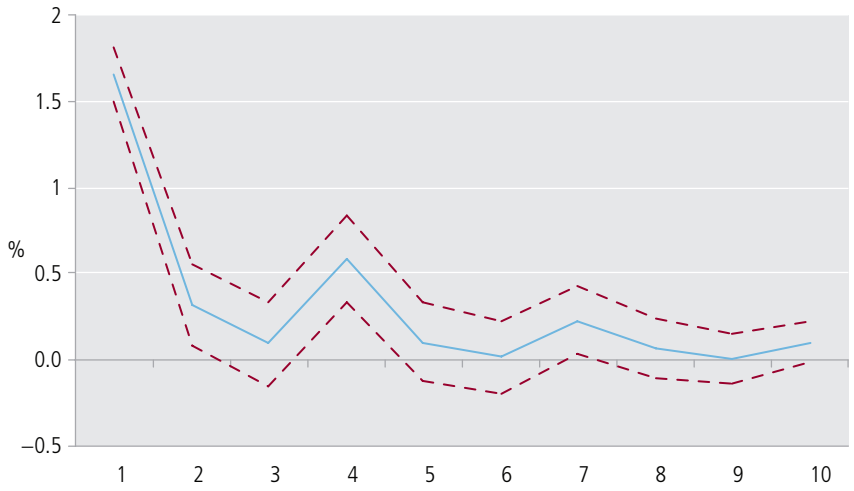
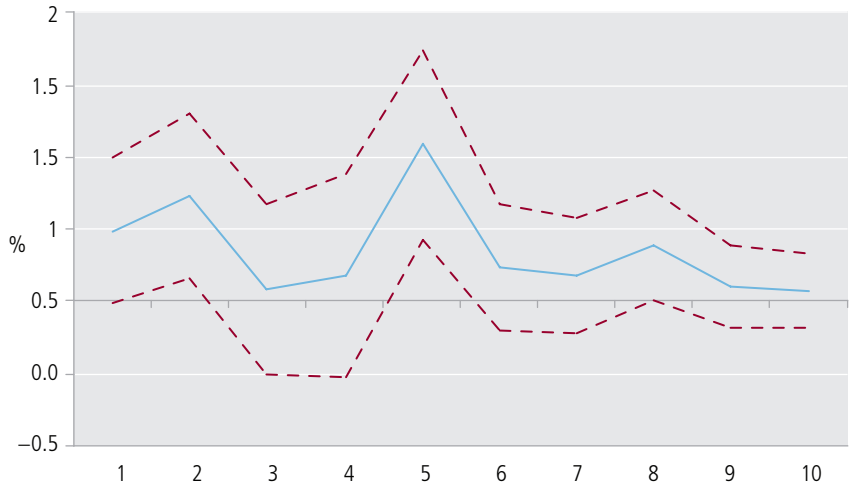
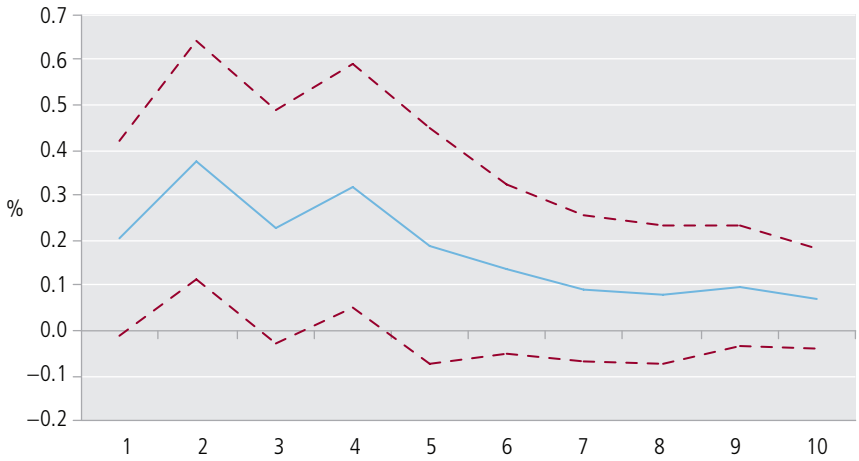


Figure 6.4: Desmoothed IPD response to 1SD EPRA shock



Finally, Figure 6.5 shows the private real estate market's response to equity market shocks. Once again, there is evidence of stickiness in the response, although the extent of the movement is relatively small. Even with an exacting two standard error confidence band, the response remains statistically significant four months out, with the response still positive and at the margin of significance after ten periods. It must be emphasised that the response is not large – consistent with the factor models described above and other analyses, it seems that private real estate has a (somewhat lagged) response to equity market movements, but a response that is masked by valuation effects and the stickiness that results from the bond-like income returns of the asset class.

Figure 6.5: Desmoothed IPD response to 1SD FTAS shock



To summarise, the long-run models extend understanding of the relationship between real estate returns and other asset classes, and between public and private real estate. The Granger models suggest that the returns in the overall equity market lead property company returns which, in turn, lead private real estate returns, despite correction of valuation effects via desmoothing. There appear to be more complex two-way relationships between bond and property returns, perhaps mediated by interest rate effects. With a longer, six month, lag structure, there is some evidence of switching behaviour between the equity market and private real estate (with no comparable switching behaviour manifest between general equities and property companies. The VAR impulse-response analyses point to a persistent real estate impact of shocks in the equity market – an impact that is much more pronounced for public real estate than for private real estate. In combination, these results point to long-run influences that run from equity returns to property returns, the magnitude varying sharply between public and private markets. Stock market shocks (which, given the skewness shown in Table 3.1, are more likely to be negative than positive) are transmitted into the real estate market, with a sharp and rapid effect on property company returns and a smaller but more protracted and persistent impact on private real estate.

6.1 Summary

- The long-run models shed light on the relationship between real estate and the other financial assets and provide evidence of lead-lag relationships;
- Public real estate returns lead private real estate returns, despite desmoothing;
- The equity market returns lead both public and private real estate returns, with weaker evidence of a lagging relationship with small-cap stocks;
- There is some evidence of a feedback mechanism between bonds and real estate returns, perhaps as a result of interest rate sensitivity;
- In the global financial crisis, public real estate returns continue to trail the equity market (with weaker evidence of a feedback mechanism). However, consistent with the volatility decompositions, private real estate does not seem to lag the stock market;

6. LONG-RUN MODELS OF RETURN BEHAVIOUR

- Shocks in public and private real estate markets have persistent impacts on their returns over a number of time periods – it seems as if returns are 'sticky';
- A shock in the equity market is transmitted into the real estate markets. Public real estate responds significantly, strongly and rapidly; private real estate response is less strong, but persists for longer;
- The results emphasise the long-run links between equity markets and real estate, with negative stock market shocks having a significant impact on property returns.

7. CONCLUSIONS AND IMPLICATIONS

Building on the evidence outlined in Working Paper 2, this paper's aim has been to explore the extent to which the relationship between real estate returns and other asset classes varied over time. Specifically, the paper has addressed three broad questions:

(a) Do the correlations between real estate returns (both public and private) and those of other asset classes vary over time?

(b) How significant is the influence of the other financial asset classes on the volatility of real estate returns and does that influence vary over time?

(c) Are there long-run linkages between property and other asset classes that lead to shocks in one market being transmitted to another?

To an extent, all three questions address the same issue: to what extent do the apparent diversification benefits of holding real estate in a mixed-asset portfolio persist over the market cycle and over different economic environments? Do investors get diversification when they need it and do investors need to adjust their risk management strategies to account for any time variation in those diversification benefits?

The results clearly show that property's correlations with other asset classes vary markedly over the analysis period, for both public and private real estate. Public real estate is more closely correlated with the equity market than is private real estate, although the correlation between the EPRA returns and the desmoothed IPD returns has been trending upwards over the analysis period. Nonetheless, there appear to be periods where the overall equity market and property company returns appear to be less closely related, and periods when the equity and bond markets appear to have a stronger influence on the direct, private real estate market. In particular, there seems to be an association between poor performance in the stock market and an increase in correlation between equities and real estate. This might indicate that diversification diminishes when it would be most beneficial.

Examining the decomposition of real estate variance using factor models, the most striking result is the high proportion of variation in private real estate markets that cannot be explained in terms of variation in the equity, small-cap and bond factors – which could suggest that, at least in terms of mean-variance, private real estate does offer substantial diversification benefits, as suggested in the conventional risk-return models. There are, once again, periods in the market where the financial assets seem to be more closely influencing private property returns, periods generally linked to equity market poor performance: the early 2000s, the global financial crisis era.

The influences on public real estate returns are much stronger (particularly from the overall equity market, as might be expected) but also complex in terms of variation. Intriguingly, for the periods that include the earlier phases of the global financial crisis, the influence of the equity market seems to fall (and the influence of the underlying private real estate market appears to strengthen). While the diversification potential of public property companies does seem less than for private real estate (at least as captured in the index), there remains sufficient unexplained variation to suggest that there would be risk-reduction benefits. The beta for public real estate is time-varying and falls at the onset of the financial crisis.

The long-run analyses point to lags in the relationship between direct real estate returns and the public market indices: it is not possible distinguish between data construction effects and more structural lead-lag results. Stock market shocks (which, given the distribution of equity returns are more likely to be negative shocks) are clearly

transmitted into both public and private real estate markets. The impact on public property is sharp and comparatively rapid; the impact on private real estate is less marked and more extended. Again, it is hard to say whether this reflects fundamental features in the private market such as illiquidity and thin trading or is a function of lags in valuations processing relevant market information.

Combining these insights, the evidence presented here confirms that both private and public real estate offer diversification benefits in the mixed-asset portfolio context. Both are influenced by the performance of financial assets, but retain independence. Private real estate seems to offer greater diversification potential, but this has to be set against concerns over the robustness of data and the practical issues and obstacles associated with investment in the direct market. What is clear, however, is that adopting a single time period, mean-variance optimisation approach does not capture the changing risk-return characteristics of property. Betas are time-varying; correlations are time-varying; the influence of other assets on real estate volatility is time-varying. There are periods in the market when the behaviour of the equity market is strongly linked to that of real estate, and those periods tend to be when the stock market is performing badly. Shocks – negative shocks – in equity returns are transmitted to real estate returns and have a significant effect. A risk management strategy needs to account for these time-varying influences.

There is one further implication of the results. The focus here has largely been on risk-return features of the assets, on mean, standard deviation and covariance. Within that, however, there is evidence that the relationship between asset classes depends on the returns in those asset classes: in particular, that there may be stronger correlations between assets, between property and equity, when both are underperforming. This has further significance given the distribution of returns in property markets and, to a lesser extent, in equity markets: negative skewness and positive kurtosis indicating a higher probability than normal of there being poor returns (with the serial correlation evident in private real estate suggesting that those poor returns may persist). This suggests that, for a more complete view of the risk-return characteristics of real estate, the relationship between assets at the extremes of their return distributions need to be considered – to seek to identify any 'tail dependence'. Working Paper 4 is focused on that task.

APPENDIX A: ORTHOGONALISATION REGRESSIONS

Figures in parentheses are t-statistics. All coefficients estimated with White's adjustment for heteroskedasticity.

(a) The small-cap residual factor:

Small-Cap = –0.001 + 1.023 FTAS + e

(–0.515) (15.815)

Adj R^2 = 0.658, F = 482.275***

(b) The bond residual factor:

Bond = 0.006 + 0.093 FTAS – 0.133 Small-Cap + e

(5.074) (2.706) (–3.191)

Adj R^2 = 0.070, F = 10.384**

(c) The desmoothed IPD residual:

RE = 0.004 + 0.076 FTAS + 0.082 FTAS(–1) + 0.057 FTAS(–2) + 0.076 FTAS(–3)

(2.637) (1.820) (2.328) (1.768) (2.210)

+ 0.061 Small-Cap Resid(–2) – 0.163 Bond Resid.

(1.582) (–2.282)

Adj R^2 = 0.0144, F = 7.920**

(d) Public real estate residual factor:

EPRA = –0.002 + 0.857 FTAS + 0.414 Small-Cap Resid + 0.379 Bond Resid + 0.565 RE Resid

(–0.568) (10.832) (3.600) (2.232) (2.557)

Adj R^2 = 0.457, F = 52.953**

APPENDIX B: THE FACTOR MODEL

To estimate the factor model, the return series for equities, small-cap stocks, EPRA UK property company returns, private real estate (both smoothed and desmoothed) and an interest rate variable were subject to a principal components analysis. Three factors were retained, which were then rotated using a varimax procedure (to maximise loadings on individual variables). The analysis clearly identified three variables: an equity factor, a bond/interest rate factor and a real estate factor (where the private real estate loadings were much higher than for EPRA which appeared to have properties more akin to the equity indices. The factor scores for the extracted and rotated factors were retained as the asset class factors in subsequent analysis.

The first three factors explained 74% of the total variation of the eight variables included in the analysis. Factor one explained 38% of variation and, after rotation, had strong positive loadings on FTAS(0.903), Small-Caps (0.890) and EPRA (0.817): it thus captures equity market behaviour. Factor two explained 24% of the variation and had strong positive loadings on the two desmoothed series, the threshold desmoothing (0.910) and conventional desmoothing (0.904), and the unsmoothed IPD returns (0.783); EPRA returns have a weak positive loading (0.178). This thus seems to be a direct real estate market factor. Finally, factor three explains 12% of variation; the Bond series (0.549) and LIBOR (0.866) load positively implying this is a bond/interest rate factor. By construction, all three factors are orthogonal and uncorrelated in risk-return space.

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