Comovement in UK Real Estate Sector Returns

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Abstract

Engle et al. (1990) distinguish between 'heat waves' and 'meteor showers' in an analogy which tries to differentiate between particular effects, not transmitted among markets, and general effects, which tend to affect all the markets, although different markets can be affected to different degrees. This paper applies this approach to the study of the monthly returns of four real estate market sectors: Office, Retail, Industrial and Retail Warehouses in the UK over the period 1979:2 to 1997:12. A VAR methodology used with the aim of detecting the causal relations and dynamic interactions among sector returns, as well as the transmission mechanisms of their information flows. The results obtained permit us to conclude that there is a good deal of integration between the monthly return time series for all the sectors. Therefore, diversification across real estate market sectors does not allow for the reduction of risk without sacrificing expected returns.

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Introduction

The aim of this paper is to analyse both the interdependence of price formation in different property types and the weight of this interdependence in each sector. That is we investigate how much the monthly returns in one real estate sector can be explained by the changes in returns in other property types, and how rapidly these movements in one sector are transferred between property types. This is accomplished by testing for the existence of two types of comovement processes, i.e. 'heat waves' and 'meteor showers'. The heat wave analogy indicates a hot day in London is likely to be followed by another hot day, but not typically by a hot day in New York, which implies that shocks or innovations in one market are independent of events in another. In contrast the meteor shower analogy suggests that celestial debris falling to earth hits various cities in sequence across the globe as the earth turns, which implies that innovations in one market have influence on events in another market. The heat wave hypothesis therefore posits that the movements in property types as only sector specific impacts, while the meteor shower hypothesis indicates that the changes in returns in one market sector has implications for the other property types (see Engle *et al* 1990).

In order to study these effects the vector auto regressive (VAR) methodology (Sims, 1980) appears to be the most appropriate in that it provides a dynamic system of simultaneous equations without, a priori, restrictions on the structure of relationships among variables. As a consequence the VAR approach can be considered as a flexible approximation to the reduced form of a correctly specified unknown model of the present economic structure. Empirical structural regularities among property types are then analysed by a variance decomposition approach, i.e. investigating the extent to which a sector responds to shocks in other property types in the UK real estate market. In addition the impulse-response function is utilised, addressing the question of how rapidly events in a one sector are transmitted to other sectors.

The structure of this paper is as follows. First the methodology to be applied is discussed. Second the sample data used is described. This is followed by an analysis of the interactions and influences among real estate market sectors. Then conclusions are drawn.

Methodology

The relationship between property types has been analysed in a number of studies. Previous studies, however, have tended to rely on the inspection of correlation matrices, all of which indicate that there are significant positive correlations between market sectors (see Lee and Byrne 1998 for a review). However, it is not easy to tell whether strong positive correlations in the rates of return between sectors implies that property types are integrated or rather that sectors are segmented and responding to common real estate shocks. Furthermore, correlation coefficients do not provide information on causal relationships between variables in a model.

Therefore to analyse the transmission of returns across sectors a four-variable VAR system, that includes the series of returns for each property type, is set up (see Sims, 1980). This approach is a useful alternative to the conventional structural modelling procedure. VAR analysis works with unrestricted reduced forms, treating all variables as potentially endogenous. Each variable is thus treated as endogenous and is regressed on lagged values of all variables in the system. As a consequence the results of tests within a multivariate VAR system are considerably more general and reliable as compared to simple bivariate correlations, which may be suspect because of the omission of variables, (see Sims, 1980 and Lutkepohl, 1982).

VAR models have been used in the financial and real estate by several authors. The main focus is on causal relations among macroeconomic variables and asset returns. In the financial markets Hamilton (1983), for example, examines the influence of oil price changes on stock returns and real activity changes in the US. Burbidge and Harrison (1984) test for the effects of oil price rises on the price level and industrial output in five countries. James et al. (1985) analyse the causal links between stock returns, real activity, money supply, and inflation in the US. The VAR technique has also been used to investigate the degree of international linkages stock markets (Eun and Shim, 1989 and Von Furstenberg and Jeon, 1989) In the context of the real estate markets the VAR methodology has been used by Kling and McCue, (1987,1991) to examine Office and Industrial construction behaviour in the US, the diffusion of price information across housing markets, (Pollakowski. and Ray, 1997) and Office rent forecasting in the UK, (Tsolcacos and McGough, 1994).

Only a brief presentation of the VAR analysis is presented in this section. For a more rigorous discussion, see Sims (1980). Let

$$\Phi(B)Z_t = e_t \qquad (1)$$

where $Z_t^{'} = (Z_{1t}, Z_{2t}, \ldots\ldots\ldots Z_{kt})$ represents a stationary (k x 1) vector of the k time series containing n observations and where $e_t^{'} = (e_{1t}, e_{2t}, \ldots\ldots e_{kt})$ is a (k x 1) vector of random shocks, which are independently, identically, and normally distributed with mean zero. The covariance matrix $\sum \Phi(B)$ is a (k x k) matrix of full rank, containing the auto regressive parameters. The Z_t in Equation 1 may then be interpreted as the response in each time series to a shock in e_t, while the matrix $\Phi(B)$ represents the adjustment pattern to these shocks. This approach is designed to minimise theoretical demands and also to let the data determine aspects of the specification such as the lag structure. The development of the VAR system only requires the determination of the variables to be included and the number of lags to adequately captures the effect of the variables on each other. Therefore, assuming equal information lags in all property types the following VAR system obtains:

$$O_t = \alpha^O + \sum_{i=1}^{n} \beta_i^O O_{t-i} + \sum_{i=1}^{n} \delta_i^O R_{t-i} + \sum_{i=1}^{n} \gamma_i^O I_{t-i} + \sum_{i=1}^{n} \phi_i^O RW_{t-i} + e_t^O, \qquad (2a)$$

$$R_t = \alpha^R + \sum_{i=1}^{n} \beta_i^R O_{t-i} + \sum_{i=1}^{n} \delta_i^R R_{t-i} + \sum_{i=1}^{n} \gamma_i^R I_{t-i} + \sum_{i=1}^{n} \phi_i^R RW_{t-i} + e_t^R, \qquad (2b)$$

$$I_t = \alpha^I + \sum_{i=1}^{n} \beta_i^I O_{t-i} + \sum_{i=1}^{n} \delta_i^I R_{t-i} + \sum_{i=1}^{n} \gamma_i^I I_{t-i} + \sum_{i=1}^{n} \phi_i^I RW_{t-i} + e_t^I, \qquad (2c)$$

$$RW_t = \alpha^{RW} + \sum_{i=1}^{n} \beta_i^{RW} O_{t-i} + \sum_{i=1}^{n} \delta_i^{Rw} R_{t-i} + \sum_{i=1}^{n} \gamma_i^{RW} I_{t-i} + \sum_{i=1}^{n} \phi_i^{RW} RW_{t-i} + e_t^{RW}, \qquad (2d)$$

where O_t, R_t, I_t and RW_t represent the returns at time t of the Office, Retail, Industrial and Retail Warehouses property market sectors, respectively.

The VAR system is then used to examine the comovement processes of the four sectors in the framework of the heat waves and meteor showers hypotheses developed by Engle et al. (1990). In this context, the heat wave and meteor shower hypotheses are mutually exclusive. The heat wave hypothesis holds for the Office sector if β_i^O is significant, but δ_i^O, γ_i^O and ϕ_i^O are zero. Similarly, the heat wave hypothesis is supported for the Retail sector δ_i^R is significant, but, β_i^R, γ_i^R and ϕ_i^R are not. In the Industrial sector, heat waves occur if γ_i^I is not zero, but β_i^I, δ_i^I and ϕ_i^I are. Finally in the case of the Retail Warehouse sector the heat wave hypothesis is supported if ϕ_i^{RW} is significant and β_i^{RW}, δ_i^{RW} and γ_i^{RW} are not. In other words, the heat wave hypothesis for a particular property type is equivalent to restricting the coefficients of the other markets sectors in its equation to equal zero. If the null hypothesis that there is no difference between the explanatory powers of the unrestricted and restricted VAR models is rejected, the heat wave hypothesis is rejected, indicating the presence of comovements between property types and the acceptance of the meteor shower hypothesis. The equality of explanatory power between the unrestricted and restricted models is investigated using a Wald test.

In addition the estimation of the model is well suited to studying the dynamic response of a system to innovations within market sectors and to show the structural interdependence of the property types. Analysis of the pattern of innovations and responses in different markets can be precisely performed by the impulse response function and variance decomposition available in the VAR model (see Leamer 1985). From this point of view, instead of estimating simple correlations, impulse-response analysis will be more appropriate to investigate what effect a shock or innovation in one property type will have on others and what the strength and persistence of those effects will be.

Data

Monthly returns for the four property types, Office, Retail, Industrial and Retail Warehouses were obtained from the Richard Ellis Monthly Index (REMI) (Richard Ellis, 1998). The indices based on a sample of 430 properties with a market value of £2.2 billion at the end of October 1997. This data used, in preference to the much larger Investment Property Databank Monthly Index (IPDMI), as it is the longest monthly data series currently available (Barber, 1990), while the REMI and the IPDMI show similar performance characteristics (Nanthakumaran and Newell, 1995). Further details of the REMI series are given in Gordon (1991), Morrell (1991) and the Society of Property Researchers (1993). The data covering the period 1979:2 to 1997:12, providing a time series of 227 returns for each real estate market sector, the most recent Bull and Bear markets in the UK[1].

Monthly returns were calculated as the change in the logarithm of successive index values, that is:

$$R_t = \ln(I_t) - \ln(I_{t-1}) \qquad (3)$$

where:

[1] The data has also been used in a different context by Newell and Stevenson (1997) and Barkham and Ward (1997).

R_t is the return at time t;
I_t is the price index at time t and
I_{t-1} is the price index at time t-1.

Table 1 contains summary statistics for the monthly returns, of the four property types. An examination of Table 1 indicates that the highest monthly volatility is reported for the Retail Warehouse sector, the Retail sector showing the lowest volatility, Retail Warehouses also had the highest mean returns. Moreover, as anticipated from the work of Ward (1979), and Lee and Byrne (1998) in the UK, and Young and Graff (1995), Miles and McCue (1984), Hartzell, Hekman and Miles (1986) in the US, all four series exhibit thick tails (positive kurtosis) and all but the Office sector positive skewness. Table 1 also shows that there is a high level of contemporaneous correlation among all the markets under study. They are all significant at a 1% level. The highest contemporaneous correlation is shown by the Office and Retail sectors, while the lowest is shown by the Retail Warehouse sector with Industrial properties. These correlations indicating a high level of integration of the property sectors in the UK.

Table 1 Summary Statistics

	Office	**Retail**	**Industrial**	**Retail Warehouse**
Mean	0.003	0.005	0.005	0.008
Std. Dev.	0.013	0.011	0.013	0.020
Skewness	-0.071	0.873	0.826	3.619
Kurtosis	3.568	5.896	4.908	23.187
	Contemporaneous Correlations			
Office	1.00			
Retail	0.66	1.00		
Industrial	0.60	0.53	1.00	
Retail Warehouse	0.33	0.40	0.30	1.00
Period of Lag	**Auto Correlations**			
1	0.698	0.628	0.686	0.205
2	0.659	0.523	0.639	0.234
3	0.590	0.371	0.552	0.168
4	0.622	0.386	0.473	0.287
5	0.571	0.396	0.383	0.172
6	0.536	0.387	0.356	0.086
12	0.292	0.113	0.164	-0.063
18	0.011	0.068	-0.101	-0.011
24	-0.138	0.089	-0.089	-0.080
30	-0.243	0.052	-0.124	-0.075
36	-0.263	0.010	-0.164	-0.003

However, there are a number of differences between the auto correlations of the sector returns. Although for all sectors the magnitudes of the auto correlation coefficients decay at higher orders, more than half of the reported coefficients are statistically significant, at the 5% level. In addition all of the sectors have significant first and second order auto correlations. In particular the auto correlation coefficients for the Office sector are greater than those for the other three property types up to the 12th month. While the autocorrelations of the Retail Warehouse sector are much lower than the autocorrelations in the other three property types and become insignificantly different from zero by the 6th month. The presence of substantial autocorrelation in all four markets suggests that the volatility behaviour of each may be explained by the heat wave hypothesis, although Retail Warehouse sector may be also be influenced by the other sectors.

However, the results presented in Table 2 for leading and lagging autocorrelations indicate that there are strong links in returns between the Office, Retail and Industrial sectors, but that the link is less between Retails and Industrials. While the Retail Warehouse sector is strongly linked to the Retail sector. Which suggests that the meteor shower hypothsesis can not be ruled out on the basis of substantial autocorrelations between sector returns.

Table 2: Leading and Lagging Cross Auto Correlations

Period			**TO**			
Correlation From	**Retail**		**Industrial**		**Retail-Warehouse**	
Office	**lag**	**lead**	**lag**	**lead**	**lag**	**lead**
0	0.66	0.66	0.60	0.60	0.33	0.33
1	0.54	0.56	0.60	0.55	0.35	0.29
2	0.51	0.50	0.54	0.47	0.37	0.28
3	0.44	0.38	0.53	0.45	0.29	0.21
4	0.47	0.38	0.45	0.42	0.24	0.17
5	0.42	0.40	0.44	0.40	0.32	0.19
6	0.45	0.34	0.41	0.40	0.32	0.16
Correlation From	**Office**		**Industrial**		**Retail-Warehouse**	
Retail	**lag**	**lead**	**lag**	**lead**	**lag**	**lead**
0	0.66	0.66	0.53	0.53	0.40	0.40
1	0.56	0.54	0.55	0.42	0.29	0.36
2	0.50	0.51	0.45	0.35	0.32	0.32
3	0.38	0.44	0.39	0.35	0.23	0.19
4	0.38	0.47	0.28	0.34	0.22	0.25
5	0.40	0.42	0.31	0.35	0.19	0.22
6	0.34	0.45	0.16	0.32	0.21	0.23
Correlation From	**Office**		**Retail**		**Retail-Warehouse**	
Industrial	**lag**	**lead**	**lag**	**lead**	**lag**	**lead**
0	0.60	0.60	0.53	0.53	0.30	0.30
1	0.55	0.60	0.42	0.55	0.28	0.35
2	0.47	0.54	0.35	0.45	0.28	0.22
3	0.45	0.53	0.35	0.39	0.18	0.26
4	0.42	0.45	0.34	0.28	0.21	0.11
5	0.40	0.44	0.35	0.31	0.19	0.20
6	0.40	0.41	0.32	0.16	0.14	0.10
Correlation From	**Office**		**Retail**		**Industrial**	
Retail Warehouse	**lag**	**lead**	**lag**	**lead**	**lag**	**lead**
0	0.33	0.33	0.40	0.40	0.30	0.30
1	0.29	0.35	0.36	0.29	0.35	0.28
2	0.28	0.37	0.32	0.32	0.22	0.28
3	0.21	0.29	0.19	0.23	0.26	0.18
4	0.17	0.24	0.25	0.22	0.11	0.21
5	0.19	0.32	0.22	0.19	0.20	0.19
6	0.16	0.32	0.23	0.21	0.10	0.14

Finally before developing the VAR system the data was tested for stationarity using the Phillips-Perron (PP) test developed by Phillips (1987) and Phillips and Perron (1988). The PP tests are based on the following Augmented Dickey-Fuller (ADF) regression,

$$\Delta X_t = \lambda_0 + \lambda_1 X_{t-1} + \lambda_2 T + \sum_{i=1}^{n} \Psi_i \Delta X_{t-i} + \varepsilon \qquad (4)$$

where Δ is the difference operator, X is the natural logarithm of the series, T is a trend variable, λ and Ψ are the parameters to be estimated and ε is the error term. The PP unit root test is utilised for the following reasons. First the PP tests do not require an assumption of homoscedasticity of the error term (Phillips, 1987). Secondly, since lagged terms for the variable of interest are set to zero there is no loss of effective observations from the series (Perron, 1988). Lastly, the PP unit root test corrects the serial correlation and autoregressive heteroscedasticity of the error terms by a technique called the Bartlett window. This aims at providing unit root tests results that are robust to serial correlation and time-dependent heteroscedasticity of errors.

In the PP unit root tests the null hypothesis is that the series is non-stationary and this is either accepted or rejected by examination of the t-ratio of the lagged term X_{t-1} compared with the tabulated values. If the t-ratio is less that the critical value the null hypothesis of a unit root (i.e. the series is non-stationary) is accepted. If so the first difference of the series is evaluated by Equation (4) and if the null hypothesis is rejected the series is considered stationary and the assumption is that the series is integrated of order one I(1). Critical values for this t-statistic are given in Mackinnon (1991). The results presented in Table 3.

Table 3: Results of the Unit Root Tests

Sector	Level	1st Difference
Office	-2.217	-6.704
Retail	-1.830	-8.013
Industrial	-1.287	-6.440
Retail Warehouse	-3.641	-12.884
Critical Value 1%	-4.002	

As can be seen the results presented in Table 2 show that all series were non-stationary in levels but stationary in first differences. The 1% significance level deemed to be more appropriate in testing for a unit root as the critical values of the t-statistics simulated by Fuller (1976), Gulkey and Schmidt (1989)and Mackinnon (1991) can vary markedly. Having established the stationarity of the data series the following section presents the results of the VAR system for the four property type: Office, Retail, Industrial and Retail Warehouses.

Empirical Results

The ordering of real estate market sectors implicitly assume a causal chain. The arbitrariness of this causal ordering has been subject to much criticism, but a natural ordering of sectors based on capital[2] values seems reasonable. In addition the amount of information on the Office and Retail sectors in the UK is much greater than for Industrials and especially Retail Warehouses, (Thompson and Tsolacos, 1997). As a consequence the following ordering of sectors was chosen: Office, Retail, Industrial and Retail Warehouses.

Another consideration in a VAR model is the number of lags to be used in the system.. In a market that adjusts quickly to all relevant information, that is one that is efficient, at most should show one lag in the VAR estimation. However, the cost of obtaining information and difficulties in terms of negotiation the purchasing and selling of property, in real estate markets, would suggest that lags of more than one month are possible, without implying any inefficiency in the pricing. In deciding on the lag length the log-likelihood ratio tests is employed (as outlined in Henry and Pesaran, 1993). The log likelihood ratio statistic given by:

$$LR = -2(LnLR - lnLU) \qquad (5)$$

where LR is the maximum log likelihood of the restricted estimate of Equation 2 and LU is the maximum log likelihood of the unrestricted estimation of Equation 2. The likelihood ratio statistic distributed asymptotically as $\chi^2(k)$ where k is the degrees of freedom, dependent on the number of lags. The results in Table 4 for the choice of the lag length confirmed the conjecture that a lag length greater than one month was required, while there was no indication of statistical significance for a three period lag. The following results therefore are based on a two period lag structure.

Table 4 shows that the Office sector is significantly positively influenced by its own returns, lagged one and two periods (at the 1% level), the Industrial sector lagged one period (at the 1% level), and the Retail warehouse sector (at the 10% level). The Retail sector is significantly positively influenced by its own returns lagged one period (at the 1% level) and two periods (at the 5% level) and the Industrial sector lagged one period (at the 1% level). While the Industrial sector, the significant influences are from the Office sector lagged one period (at the 5% level) and its own return lagged one and two periods (at the 1% level). In contrast the Retail Warehouse sector presents a very particular pattern of influence. It depends significantly positively upon the Retail sector (at the 5% level) and Industrial sector lagged one period and significantly negatively upon the Industrial sector lagged two periods (both at the 1% level), but does not depend significantly upon its own lagged returns. This may be due to hybrid nature of the Retail Warehouse sector, (Gibbs, 1986). All this would suggest that the sectors may present evidence of the ‘meteor shower’ hypothesis. In order to test this proposition a Wald test was employed.

The results of the individual Wald tests shows that the null hypothesis of no difference between the restricted and unrestricted models can be rejected, at less than the 1% significance level, for the Office, Retail and Retail Warehouse sectors, and that the ‘heat wave’ analogy is rejected. This indicates acceptance of the ‘meteor shower’

[2] The capital values of the four property types as a percentage of the total portfolio at the end of October 1997 were 37.5% Offices, 37.5% Retail, 15% Industrial and 10% Retail Warehouses.

analogy, implying that these sectors react significantly to changes in prices in other sectors. In contrast the 'heat wave' hypothesis can only be rejected for the Industrial sector at the 25% level, indicating that Industrial properties appear to have only sector specific autocorrelation, with any new information originating from the other sectors having only a minor effect.

Table 4: Vector Auto-Regression Estimates

	Office	**Retail**	**Industrial**	**Retail Warehouse**
Office (-1)	0.346	0.094	0.148	-0.013
	4.831***	1.413	2.038**	-0.094
Office (-2)	0.251	0.014	0.007	0.026
	3.540***	0.208	0.101	0.187
Retail (-1)	-0.003	0.340	-0.063	0.377
	-0.039	4.588***	-0.779	2.370**
Retail (-2)	0.035	0.146	-0.077	0.226
	0.433	1.959**	-0.953	1.419
Industrial (-1)	0.222	0.250	0.426	0.407
	3.316***	4.021***	6.271***	3.046***
Industrial (-2)	-0.025	-0.091	0.285	-0.290
	-0.365	-1.411	4.044***	-2.089**
Retail Warehouse (-1)	0.045	-0.002	0.027	0.009
	1.358	-0.048	0.810	0.140
Retail Warehouse (-2)	0.059	0.036	0.032	0.098
	1.809*	1.197	0.959	1.514
Constant	-0.001	0.001	0.001	0.003
	-0.980	2.038	1.555	2.081
Individual Wald Tests				
Chi-square	21.66	30.44	7.79	35.74
Probability	0.001	0.000	0.254	0.000

Log Likelihood Lag 1	2888.04	Log Likelihood ratio test	
Log Likelihood Lag 2	2908.15	Lag 1 against 2	40.224***
Log Likelihood Lag 3	2909.03	Lag 2 against 3	1.758

Notes: * significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.

The residuals for all equations in the VAR model were then tested for any significant auto correlation by an F-test. In none of the equations was there any apparent auto correlation, at the 5% significance level. It can be concluded therefore that the two period lag system of equations is a reasonable representation of the data series. However, although the error terms may be serially uncorrelated, they may be contemporaneously correlated. Then, the simulation of a shock from a particular sector, holding all other components at zero, may not be what occurred historically as the variables have a common component which cannot be associated with a specific variable. As a consequence inferences cannot be drawn in a straight forward manner. Significant contemporaneous correlations between the residual returns among the four sectors are presented in Table 5. Therefore, before undertaking variance decomposition, and impulse response function analysis, the contemporaneous correlation in residuals was eliminated by carrying out an orthogonalising transformation as suggested by Hamilton (1994).

Table 5: Residual Correlation matrix

Sector	Office	Retail	Industrial	Retail Warehouse
Office	1.00			
Retail	0.39	1.00		
Industrial	0.27	0.23	1.00	
Retail Warehouse	0.07*	0.16	0.08*	1.00

Note: All correlations are significantly different from zero at the 1% level, except *.

To provide a more detailed analysis on the speed of adjustment in returns in a particular property type to innovations in the other sectors, VAR innovation accounting is used. Innovation accounting, or decomposition, makes it possible to study the percentage of forecast error variance of a particular property sector explained by innovations in itself and the other three sectors. The accounting innovations presented in Table 6.

These results indicate that the extent of adjustments to innovations or shocks in the system take a considerable time to be completed. The Retail sector in particular is significantly influenced by the Office and Industrial sectors. In contrast the Office sector is *not* influenced by the Retail sector but by Industrials. Results which are in line with the those presented in the residual correlation matrix in Table 4. Innovations in the Industrial sector meanwhile show it is almost as equally influenced by the Office sector as it has influence on Office property. In contrast the Retail Warehouse sector appears to be influenced almost equally by all the other three sectors.

The general impression from Table 6 is that all sectors, including Industrial properties, are influenced to a considerable extent by the other property types. No one real estate market sector dominating the others. This is especially so for the Retail sector where almost half the innovations in Retail sector return can be explained by shocks from other sectors, principally the Office sector. The Retail sector is therefore the most endogenous of the property types and seems to act as a conduit for transmitting information across the sectors. In contrast the Retail Warehouse sector appears to be a recipient of information which is then retained rather than passed on to other sectors.

Table 6: Accounting Innovations

Sector Explained	Horizon in Months	Office	Retail	Industrial	Retail Warehouse
Office	1	100.00	0.00	0.00	0.00
	6	84.44	1.29	10.94	3.33
	12	79.24	1.54	15.40	3.82
	18	78.13	1.55	16.43	3.89
	24	77.90	1.55	16.65	3.91
Retail	1	15.17	84.83	0.00	0.00
	6	25.48	62.69	10.41	1.42
	12	27.39	57.19	13.54	1.88
	18	27.71	56.08	14.25	1.96
	24	27.77	55.85	14.40	1.98
Industrial	1	7.12	2.01	90.86	0.00
	6	14.83	1.10	82.50	1.57
	12	17.10	1.00	79.91	2.00
	18	17.59	0.99	79.34	2.08
	24	17.70	1.00	79.21	2.09
Retail Warehouse	1	0.52	1.95	0.15	97.38
	6	5.02	8.11	5.04	81.83
	12	6.29	8.06	6.08	79.57
	18	6.54	8.02	6.35	79.09
	24	6.59	8.01	6.41	78.99

Finally the VAR approach makes it possible to analysis the dynamic pattern of innovations by impulse response functions. These functions show the current and subsequent effect of innovations in a given sector on all sectors in the system and how quickly the other sectors react to shocks from a particular property type. In other words this process consists of looking at reaction of all the property types to an shock produced by one of them. The analysis is carried out for all the property types. The normalised individual and cumulative impulse response to a unit (1 standard deviation forecast error) shock was used in each of the four sectors, on all the other sectors, are presented in Table 7.

As can be seen from an examination of Table 7, the response of Industrials to a unit shock in the Office sector is 0.185 in the second month, followed 0.139 in the third month, while the effect in the first month is zero. So, although the results of the Wald test in Table 4 suggest that the Industrial sector follows a heat wave process the results of the variance decomposition and impulse response function analysis indicate that Industrial properties are in fact subject to innovations in other real estate market sectors. In contrast the Retail and Retail Warehouse sectors are very slow to react to shocks from the Office sector. No real estate sector, therefore, reacts instantaneously to shocks from the Office sector and the main influence is on Industrial properties, with the least impact occurring in the Retail sector. Retail shocks in contrast have an immediate effect on the Office market, which is followed by impacts on the Industrial sector, with little or no impact on Retail Warehouse properties. In the case of Industrial sector shocks both the Office and Retail sectors react in the first month, with the influence on the Office market, for some considerable time. However, beyond the first month, shocks to the Retail sector from Industrials are almost negligible, with the impact on Retail Warehouses limited. While shocks from the Retail Warehouse sector having an influence on all the other sectors, especially Retails, in the first month and continue to have an effect for months to come. But the effect of a shock in the Retail Warehouse sector on itself is essentially limited to the first month.

Table 7: Individual Impulse Response to a Unit Shock in the Other Sectors

Origin of Shock	ith Month	Office	Retail	Industrial	Retail Warehouse
Office	1	0.845	0.000	0.000	0.000
	2	0.348	0.036	0.185	0.076
	3	0.399	0.065	0.139	0.135
	4	0.289	0.068	0.202	0.092
	5	0.262	0.068	0.169	0.095
	6 Cum	2.360	0.295	0.873	0.473
	12 Cum	3.181	0.496	1.638	0.776
	24 Cum	3.713	0.595	2.204	0.977
Retail	1	0.306	0.725	0.000	0.000
	2	0.241	0.277	0.205	-0.003
	3	0.206	0.203	0.102	0.078
	4	0.181	0.123	0.163	0.057
	5	0.160	0.087	0.125	0.058
	6 Cum	1.233	1.475	0.724	0.240
	12 Cum	1.771	1.626	1.254	0.440
	24 Cum	2.126	1.691	1.634	0.574
Industrial	1	0.229	0.122	0.819	0.000
	2	0.207	0.013	0.351	0.046
	3	0.182	-0.012	0.409	0.084
	4	0.179	-0.008	0.284	0.070
	5	0.158	-0.007	0.255	0.066
	6 Cum	1.099	0.107	2.322	0.324
	12 Cum	1.687	0.146	3.057	0.554
	24 Cum	2.091	0.207	3.507	0.709
Retail Warehouse	1	0.121	0.236	0.066	1.666
	2	0.199	0.325	0.334	0.016
	3	0.210	0.264	-0.010	0.180
	4	0.172	0.165	0.185	0.053
	5	0.164	0.121	0.084	0.064
	6 Cum	1.001	1.189	0.786	2.027
	12 Cum	1.537	1.374	1.284	2.224
	24 Cum	1.889	1.441	1.657	2.357

Conclusions

Engle et al. (1990) distinguish between ‘heat waves’ and ‘meteor showers’ in an analogy which tries to differentiate between particular effects, not transmitted among markets, and general effects, which tend to affect all the markets, although different markets can be affected to different extents. This paper has applied this approach to the study of the monthly returns series which have been estimated from the indexes of four real estate market sectors: Office, Retail, Industrial and Retail Warehouses. A VAR methodology used with the aim of detecting the significant interrelations among the property market sectors, as well as the transmission mechanisms of their information flows.

The results set out in Tables 4 through 7 indicates that although no one sector dominates movements in other sectors, not all of the variability in a particular sectors returns can be explained by changes in their own returns. That is each property type presents characteristics which are derived from its own economic effects and are sensitive to the innovations which are generated in other sectors, even in the Industrial sector, although the effect here is less pronounced that that between the other sectors. The results indicate in particular that the Office, Retail and Retail Warehouse sectors follow a meteor shower rather than a heat wave process. In other words, new information in one property type seems to influence the behaviour in other sectors as well. However, the meteor shower effect is not as strong for Industrial properties, meaning that the returns in this sector are more influenced by its own innovations than shocks or new information from other sectors. In contrast Retail properties seem to react to almost all other sector shocks and seems to act as a conduit through which most of the innovations flow to different sectors. On the whole the results obtained leads to the conclusion that property types do not behave in an autonomous way in discounting of their own innovations, even in the case of Industrial properties, indicating a notable integration between the sectors. Therefore, diversification across the real estate market does not allow for the reduction of risk without sacrificing expected returns, unless diversification was implemented by choosing properties whose differential characteristics give them a specific behaviour with respect to the particular sector.

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