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Permanent and Transitory Drivers of Securitised Real Estate

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Abstract

This paper re-examines the sensitivity and importance of interest rates and stock market price behavior on securitised property by decomposing their long-run impact between transient and permanent effects. This is achieved within a framework that accounts for endogenously determined structural breaks within the data. The results provide a different perspective on the relationship securitised property has with these markets and sheds new light on their long-run interaction. Once structural breaks are accounted for the results show that securitised property is sensitive to both interest rate and stock market changes, regardless of the type of securitised property being examined. Evidence also points to companies with increased debt-to-asset ratios and companies that are REITs tax-exempt are still all influenced by both the equity and fixed income markets.

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Abstract

This paper re-examines the sensitivity and importance of interest rates and stock market price behavior on securitised property by decomposing their long-run impact between transient and permanent effects. This is achieved within a framework that accounts for endogenously determined structural breaks within the data. The results provide a different perspective on the relationship securitised property has with these markets and sheds new light on their long-run interaction. Once structural breaks are accounted for, the results show that securitised property is sensitive to both interest rate and stock market changes, regardless of the type of securitised property being examined. Evidence also points to companies with increased debt-to-asset ratios and companies that are REITs tax-exempt are still all influenced by both the equity and fixed income markets.

1. Introduction

Current academic literature has produced a wealth of information on the inter-relationships that securitised property has with the fixed income and general equity markets. Due to the underlying physical asset, arguments have regularly been put forward that securitised property will be more affected by interest rate changes than other types of equity holdings. Mortgage and loan rates set in the fixed income market, for example, can have a large effect on demand for both residential and commercial property, and thereby prices. This will invariably lead to changes in securitised property value, which may otherwise behave very much like general stocks. Therefore, for securitised property, one might ask the question whether it more closely follows the fixed income or equity markets?

This paper analyses the above issue from a different contextual setting than has previously been attmepted. By decomposing securitised property price behaviour into components that are driven by interest rate and stock market price changes, an exact picture can be developed as to the importance that both of the explanatory factors have in driving the long-run trend of securitised property. Essentially, it will be possible to determine the relative importance of stock and interest rate movements in driving property price behaviour. This will provide a unique outlook on the long-run determination of prices for securitised property. In order to achieve this, cointegration tests that account for structural breaks by Inoue (1999) are combined with the methods proposed by Gonzalo and Granger (1995) to test for permanent and transitory components among error-corrected vector autoregressive systems. This is performed on several categories of securitised real estate, including equity Real Estate Investment Trusts (REITs) and mortgage REITs in the US, as well as property management companies in the US and UK. Consideration is also made for the debt-to-asset ratio of companies plus whether the company is REIT tax-exempt as these factors may all have a bearing on the relative significance the interest rate and stock markets have on the series.

The rest of the paper is structured to first provide the reader, in the following section, with the background literature on previous research that examines the relationship the property market has with interest rate and stock market behaviour. After this, sections 3 and 4 review the data and preliminary statistics, and contains details of the econometric methods applied in this study. Section 5 discusses the empirical results and this is followed by section 6 which draws out some implications of the results for portfolio fund managers, investors and policy managers within securitised property companies.

2. Literature Review on the Sensitivity of Interest Rates and Stock Market Movements to the Securitised Real Estate Market

The question on whether securitised real estate follows the bond or stock market has led to a wealth of research work exploring the varying sensitivities securitised property display to changes in various economic and financial factors. As a start, it is generally assumed that securitised real estate does have an obvious link with non-securitised real estate. McMahan (1994) defends this point by highlighting the fact that income flows from securitised property are derived from the physical property asset. This relationship will invariably tie the performance of property listed company stock to factors affecting the physical assets, such as general demand / supply changes due to such items as rents and demographic changes. This may also have an effect on the relationship between securitised real estate shares and the overall stock market. A number of papers have highlighted that there are seemingly other factors that determine securitised real estate stock price movements other than general stock market trends. In particular, there exists a mounting body of evidence that suggests some categories of securitised real estate act as yield-bearing instruments. REITs in the US are required to payout 95% of their taxable income as a form of dividend. Even though they may not be passively managed as a fixed income instrument, the payout features of these REITs may lend itself to follow the bond market more closely than the actual stock market.

On top of this, there has been a growing amount of literature which examines the impact of interest rates on securitised property prices. Swanson, Theis and Casey (2002) find that real estate returns are sensitive to the spread between short and long-term treasuries. Glascock, Liu and So (2000) find that REITs are now less sensitive to interest rate movements than prior to 1993, as the securitised real estate market matured and REITs took on more general stock market features. Allen, Madura and Springer (2000), who also consider various REIT structural characteristics, such as asset structure and financial leverage, show both equity and mortgage REITs are sensitive to short or long-term interest rate changes. They also show evidence that REITs with lower financial leverage can also minimize their impact from interest-rate changes, thereby suggesting that the financial makeup of the company can impact sensitivity to these determinants.

The methodology employed in the above papers and in other related literature does vary considerably and this may partially explain results the differing results that emerg. For example, Liang et al. (1995) utilized a two-factor model that focused on applying a two-factor model to determine the relative sensitivity of stock market risk and interest rate risk. They find the sensitivity to the two risk factors differs between equity and mortgage REITs, with interest-rate movements being insignificant in determining equity REIT price changes. Similarly, Mueller and Pauley (1995) find equity REITs are not significantly related to interest rate changes. Swanson, Theis and Casey (2002) ran regressions over individual years to measure the time-varying sensitivity of the stock market and interest rate factors. The majority of their results support evidence that interest rate changes have become less important over time. Allen, Madura and Springer (2000), however, applied a two-step procedure to analyse this same topic and show interest rates still to be important.

The application of cointegration analysis applied to this research is also prevalent. Glascock, Lu and So (2001) examined the relationship REITs have with inflation. If REITs are a good inflation-hedge, then it also would support evidence that REITs follow less the physical real estate market and more so the fixed income market, which can also act as an inflation-hedge. Using Granger-causality tests within an error-correction framework they show inflation does not Granger cause REITs returns. However, they still find a long-run negative relationship between inflation and REITs, which they argue is due to more fundamental economic relationships that bind the two series together. Glascock, Lu and So (2000) also use cointegration analysis to explicitly examine the long-run relationship property has with the bond and stock markets, showing evidence of REITs increasingly behaving more like stocks than bonds.

The cointegration analysis that has up to now been conducted on securitised property does not, however, provide sufficient evidence on which of the markets drive real estate stock price movements. This paper decomposes the long-run relationship that may exist between real estate, interest rates and stock market prices into permanent and transitory components in an attempt to determine the primary driving force behind securitised real estate returns. In particular, the decomposition will be able to distinguish the contribution of the bond and stocks markets to both long-run behaviour and short-term cycles within the securitised property market. This will allow for an explicit consideration of the relative impacts that the bond and stock markets have upon securitised property market behavior.

Moreover, there is evidence from a number of papers (see Glascock et al, 2000) that there has been a shift in the sensitivity, of REITs in particular, to interest-rate changes. This may be due to structural shifts in the relationship securitised property has with other economic variables. This, unfortunately, is not accounted for in standard cointegration analysis. This study therefore proposes an extension of the standard cointegration procedure. We will adopt the methodology developed by Inoue (1999) for determining a potential structural break endogenously within a multivariate cointegrated system. The Inoue (1999) procedure allows for a test of cointegrating rank within the presence of a mean- and/or trend-break. A significant advantage from an analyst's viewpoint here is the fact that this is a Johansen (1988, 1991) type test and does not require prior specification of the structure of a cointegrating system. That is, a whole portfolio can be analysed in one pass to examine the number of common linkages that may exist among assets given the presence of an unknown structural break. This is then combined with a decomposition of the components of the cointegrating model following the methods of Gonzalo and Granger (1995). These are more formally detailed in the following section.

3. Data and Methodology

Data and Preliminary Statistics

In order to observe the long-run driving forces of REIT returns, a long span dataset is desirable. For this study, monthly data is extracted from both DataStream International and the National Association of Real Estate Investment Trusts (NAREIT) from January 1990 to September 2005. Specifically, equity and mortgage REIT data was extracted from NARIET. The proxies for the market index in the US and UK (NYSE and FTSE-100) plus ten-year government bond yields over the time horizon were taken from Datastream. Also, two additional real estate indices were constructed from Datastream data for real estate management and development[1] (REMD) companies in the US and UK.

Each real estate index comprises roughly of 200 companies over the sample period. The ten-year government bond yield is chosen as a proxy for long-term interest rates. The primary reason for focusing on long-term yields is that most real estate companies tend to borrow significant amounts of long-term debts. Short-term debt only represents a small percentage of REIT total liabilities. As shown in table 1, real estate companies are heavily geared and use approximately 40-50 percent long-term debt to finance their business operations.

It is important at this stage to highlight why it might be necessary to examine the various sub-categories of securitised real estate. Between mortgage and equity REITS, for example, there is an important fundamental difference in the assets they hold which may lead to explaining the differences to their sensitivity to various financial variables.

Equity REITs will predominately take an equity interest in property, primarily for rental purposes whereas mortgage REITs create or own established loans and other obligations secured by real estate collateral. Intuitively, one could postulate that mortgage REITs would be more influenced by changing interest rates than perhaps equity REITs. The literature would seem to support this opinion as well.

The third category that this paper examines, real estate management and development companies (REMD), are actually not classified as REITS and therefore do not enjoy the tax-exempt status given to the other two categories. Raising capital through debt therefore can provide tax deductions and therefore REMD are more likely to have higher debt-equity ratios than REITs. REITs, in general, are considered to be highly capitalized ventures with, according to the European Public Real Estate Association, ten companies being included in the world's top 20 ranked by free-float capitalization. These differences, again, may show in the sensitivities that REITs and REMD have to interest rate and stock market changes. On a simple basis, it can be hypothesized that differing capital structures will lead to differences in how sensitive the company will be to interest rate changes. Table 1 further illustrates these differences in capital structure between the different realty categories.

Table 1: The Liabilities Structure of Real Estate Companies in the US and UK

United States Equity REIT (USD in millions)

	Aggregate		Mean		Median	
	Level	Percentage	Level	Percentage	Level	Percentage
Total Current Liabilities	$502.36	0.13%	$125.59	5.00%	$127.10	9.61%
Total Long Term Debt	$190,443.21	50.24%	$1,252.92	49.91%	$594.80	44.96%
Other LT Liabilities	$16,151.15	4.26%	$106.26	4.23%	$39.59	2.99%
Total Liabilities	$228,331.27	60.24%	$1,502.18	59.84%	$742.65	56.14%
Total Assets	$379,041.79	100.00%	$2,510.21	100.00%	$1,322.84	100.00%

United States Mortgage REIT (USD in millions)

	Aggregate		Mean		Median	
	Level	Percentage	Level	Percentage	Level	Percentage
Total Current Liabilities	$0.00	0.00%	$0.00	0.00%	$0.00	0.00%
Total Long Term Debt	$82,602.60	38.59%	$2,232.50	38.59%	$452.14	14.45%
Other LT Liabilities	$4,491.11	2.10%	$121.38	2.10%	$43.28	1.38%
Total Liabilities	$192,639.59	89.99%	$5,206.48	89.99%	$2,615.26	83.60%
Total Assets	$214,059.86	100.00%	$5,785.40	100.00%	$3,128.42	100.00%

United States REMD (USD in millions)

	Aggregate		Mean		Median	
	Level	Percentage	Level	Percentage	Level	Percentage
Total Current Liabilities	$1,092.99	5.02%	$121.44	26.80%	$3.47	3.95%
Total Long Term Debt	$9,676.95	44.48%	$201.60	44.48%	$10.42	11.86%
Other LT Liabilities	$1,961.76	9.02%	$40.87	9.02%	$5.27	6.00%
Total Liabilities	$14,835.97	68.20%	$309.08	68.20%	$42.71	48.63%
Total Assets	$21,754.87	100.00%	$453.23	100.00%	$87.84	100.00%

United Kingdom REMD (USD in millions)

	Aggregate		Mean		Median	
	Level	Percentage	Level	Percentage	Level	Percentage
Total Current Liabilities	$588.19	0.50%	$39.21	2.04%	$16.34	4.64%
Total Long Term Debt	$47,985.43	40.99%	$786.65	40.99%	$113.13	32.13%
Other LT Liabilities	$6,041.29	5.16%	$99.04	5.16%	$20.55	5.84%
Total Liabilities	$60,502.18	51.68%	$991.84	51.68%	$150.74	42.81%
Total Assets	$117,074.87	100.00%	$1,919.26	100.00%	$352.08	100.00%

Source: Thomson ONE Financial Database

- Total Current Liabilities represents liabilities due within one year, including the current portion of long-term debt.
- Total Long Term Debt represents debt obligations due more than one year from the company's Balance Sheet date or due after the current operating cycle.
- Other LT Liabilities represents all noncurrent liabilities not considered debt, deferred taxes, investment tax credits, minority interest, or shareholders' equity.
- Total Liabilities represents the sum of Total Current Liabilities, Deferred Taxes and Investment Tax Credit (Balance Sheet), Other LT Liabilities, Total Long Term Debt and minority interest.
- Total Assets represents current assets plus net property, plant, and equipment plus other noncurrent assets (including intangible assets, deferred items, and investments and advances).

Table 2: Descriptive Statistics

		United States					*United Kingdom*		
		Equity REITs	*Mortgage REITs*	*REMD*	*Market Index*	*Interest Rate*	*REMD*	*Market Index*	*Interest rate*
Mean		0.0046	-0.0016	0.0022	0.0073	-0.0036	0.0049	0.0049	-0.0047
Std. Dev.		0.0384	0.0596	0.0588	0.0406	0.0510	0.0502	0.0429	0.0418
Skewness		-0.4370	-1.2696	-0.8316	-0.4260	0.6736	-0.4921	-0.5155	0.2774
Kurtosis		4.3988	6.5242	7.6434	3.6424	6.3471	3.2575	4.0525	3.5379
Jarque-Bera Test		21.197 (0.0000)	147.01 (0.0000)	190.56 (0.0000)	8.9187 (0.0116)	101.97 (0.0000)	8.1058 (0.0174)	17.005 (0.0002)	4.6779 (0.0964)
ADF test	*Level*	0.0693 (0.9626)	-1.7830 (0.3881)	-0.7510 (0.8298)	-1.2599 (0.6479)	-1.2917 (0.6333)	0.1504 (0.9687)	-1.2350 (0.6591)	-0.8637 (0.7979)
	1st diff	-13.2977 (0.0000)	-12.9131 (0.0000)	-9.7750 (0.0000)	-13.3188 (0.0000)	-11.9097 (0.0000)	-11.8769 (0.0000)	-13.0889 (0.0000)	-13.8155 (0.0000)

All statistics are from logarithmic returns. The Jarque-Bera test is a test for normality and is χ^2 distributed with 2 degrees of freedom. Augmented Dickey-Fuller (ADF) tests with intercept were performed on logarithmic values (levels) and their first differences (returns). Parentheses represent the p-value (significant level). The NSYE and FTSE-100 are used as market indices for the US and UK, respectively. Interest rates are from ten-year government bond yields in the US and UK.

Table 2 shows the descriptive statistics for all main series that are utilized within the paper. With the exception of the long-term debt rates and US mortgage REITs, positive values are reported for average monthly returns for the 1990 – 2005 period. With the exception of the long-term bond rates, all the distributions are also negatively skewed, and all series show excess kurtosis, both implying that none of the series are normally distributed. Augmented Dicky Fuller (ADF) tests also show that all series are stationary in first differences (returns) which allows for the implementation of cointegration analysis.

4. Methodology

In order to formally test for the permanent and transitory components of securitised property arriving from the fixed income and equity markets, the econometric process developed in this paper incorporates work from a variety of sources. Cointegration tests that account for structural breaks by Inoue (1999) are combined with the methods proposed by Gonzalo and Granger (1995) and Johansen (1991) to test for permanent and transitory components among co-integrated error-corrected vector autoregressive (VAR) systems. In each set of results that are presented in the empirical section, the results are generated from incorporating three time series in each system. The first being a real estate index, the second being an orthogonalised market index and the third being the unanticipated interest rate.

The use of the unanticipated interest rate is to ensure that our model captures unexpected rate changes that would otherwise not be accounted for. It effectively filters out responses that may come from expected rate movements that may also be potentially reflected in general stock market trends. Autoregressive Integrated Moving Average (ARIMA) processes are used to identify the best-forecast model for the interest rate series. The Schwarz criterion (SC) is used to determine the best model. We settled for an ARIMA (1,1,1) model for the US and ARIMA (3,1,3) for the UK. From these models, forecast interest rate changes were generated and unanticipated interest rate changes were calculated based on the difference between the actual interest rate changes and the forecasted interest rate changes.

Also, and because of the inter-relationship that the fixed income and equity markets share with each other, it is important to carefully consider exogeneity issues of being able to categorically ensure that the time series used represents separate features from each of the other time series. For example, property stock values may change due to stock market changes, which indirectly may be a result of changes in the interest rate. However, property returns would also likely directly react to changes in the ten-year government bond yield. To avoid this problem, and consistent with previous studies (see Fraser, Madura and Weigand, 2002), we orthogonalise to eliminate potential multicolinearity problems. Specifically, market returns are orthogonalised against interest rate changes. The residuals from the regression of the market return on unanticipated interest rate changes are used as orthogonalised market returns. With the orthogonalisation process, the coefficient of the orthogonalised market returns will be an unbiased estimate of the sensitivity between REIT returns and market returns.

For the cointegrative procedure used, consider the case where a system denoted by *X*, contains *p* series that are all non-stationary I(1) processes. We assume a finite error-correction model (ECM) representation for this system, allowing for structural breaks in the models' deterministic components, as in Inoue (1999). Inoue considers 3 models, each allowing for slightly different structural breaks, as follows:

Model A, B

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{q-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad t = q+1, \ldots, T-1$$

Model A $Y_t = X_t - \mu - \lambda(du)_t$

Model B $Y_t = X_t - \mu - \lambda(du)_t - \delta t - \tau(dt)_t$

Model C $\Delta X_t = \mu + \lambda(du)_t + \Pi X_{t-1} + \sum_{i=1}^{q-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t \qquad t = 1,\dots,T$

,

where each error term is independently and identically distributed as $\varepsilon_t \sim N_p(0, \Omega)$. The model here includes dummy variables to represent structural breaks in the intercept (A, B and C) and trend (B only) components of the VAR, defined so that:

$$(du)_t = \begin{cases} 0, & t < t_k \\ 1, & t \geq t_k \end{cases}; \qquad (dt)_t = \begin{cases} 0, & t < t_k \\ (t - t_k + 1), & t \geq t_k \end{cases}$$

The parameters λ and τ represent the magnitude of the structural breaks in the intercept and trend terms respectively. If *X* (or *Y* for model A and B) has *r* co-integrating vectors then we can write

$$\Pi = \gamma\alpha'$$

where α is a ($p \times r$) matrix of co-integrating vectors and γ is a ($p \times r$) matrix of adjustment coefficients. As shown in Johansen (1988), we can isolate the parameters in Π by regressing ΔX_t and X_{t-1} jointly on (ΔX_{t-1}, …, ΔX_{t-q+1}). We then can regress the residuals corresponding to ΔX_t on the residuals corresponding to X_{t-1}, and use reduced rank regression to estimate the parameter matrices α and γ. Johansen (1988) did not consider structural breaks in the model and so we have a slightly refined technique to use for each of models A, B and C above to account for the breaks.

(i) For model A, firstly regress ΔX_t on $\Delta(du)_t$ and denote the residuals as $Z1_t$. Next regress X_t on 1 and $(du)_t$ and denote the residuals as $Z0_t$.

(ii) For model B, regress ΔX_t on $\Delta(du)_t$, $(du)_t$ and $\Delta(dt)_t$ and denote the residuals as $Z1_t$. Then regress X_t on 1 and $(du)_t$, t and $\Delta(dt)_t$ and denote the residuals as $Z0_t$

(iii) For model C, regress ΔX_t on 1 and $(du)_t$ and denote the residuals as $Z1_t$. Then denote X_t as $Z0_t$.

The procedure now is to regress $Z1_t$ and $Z0_{t-1}$ jointly on $(Z1_{t-1}, \ldots, Z1_{t-q+1})$. The test statistic is then based upon the eigenvalues from the generalised eigenvalue problem

$$\left|\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}\right|,$$

where S is the scaled residual sums of squares matrix from the latter regression above,

$$S = \begin{pmatrix} S_{00} & S_{10} \\ S_{01} & S_{11} \end{pmatrix} = \tfrac{1}{T} \eta \, \eta'$$

and η are the residuals. The subscripts 0 and 1 refer to the matrix components corresponding to $Z1_t$ and $Z0_{t-1}$ respectively. The r largest eigenvalues from this problem are placed in descending order and denoted λ^u. The eigenvectors, M_u, corresponding to λ^u can be used to estimate both parameter matrices α and γ. Rather than focus on these parameter estimates, we will employ methods utilizing the resulting eigenvalues λ^u, in order to identify permanent and transitory components of the system X.

Gonzalo and Grainger (1995) illustrated that any co-integrated system consisting of I(1) components, can be uniquely represented as the sum of permanent and transitory drivers. In fact, if *X* (or Z0) has *r* co-integrating vectors, then the components of *X* consist of ($p - r$) common permanent factors that are I(1), and *r* transitory factors that are I(0), or stationary. Thus, the model can be written as

$$X_t = A_1 \gamma'_{\perp} X_t + A_2 \alpha' X_t ,$$

where $A_1 = \alpha_{\perp}(\gamma'_{\perp}\alpha_{\perp})^{-1}$, $A_2 = \gamma(\alpha'\gamma)^{-1}$ are called the factor loadings and $\alpha'_{\perp}\alpha = 0$. The first term in the sum above represents the effect of the common I(1) factors on *X* and the second term represents the transitory effects on *X*. As illustrated in Darrat and Zhong (2000), we can test whether single component series in *X* are the major drivers of the common permanent component, or just a transitory short run driver, of the system.

Test for transitory factors

Johansen (1991) showed how to test that certain linear combinations of *X* were transitory factors. The test is described by the null hypothesis

$$H_0 : \alpha = HM_H$$

It determines whether the co-integrating vectors α are significantly different from a specific linear combination, described by the (p x s) matrix *H*, of the set of eigenvectors

M_H. These eigenvectors are associated with the *r* largest eigenvalues from the generalized eigenvalue problem

$$\left| H'(\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}) H \right| = 0$$

where S is as defined above from the regression of $Z1_t$ and $Z0_{t-1}$ jointly on ($Z1_{t-1}$, …, $Z1_{t-q+1}$). Again the *r* largest eigenvalues are placed in descending order and denoted λ^H. The test employs a likelihood statistic as follows:

$$T \sum_{i=1}^{r} \ln \left(\frac{1 - \hat{\lambda}_i^H}{1 - \hat{\lambda}_i^u} \right)$$

This statistic asymptotically follows a χ^2 distribution with (r x (p-s)) degrees of freedom. The matrix *H* is typically chosen to isolate and ignore one of the eigenvectors corresponding to a single component series of *X*, as in Darrat and Zhong (2000). Rejecting the null hypothesis above thus determines that this single series is a significant *transitory* driver of the system *X*.

Test for permanent factors

Gonzalo and Grainger (1995) extended the work in Johansen (1991) and showed how to test that certain linear combinations of *X* were permanent factors or drivers of the system. The test is described by the null hypothesis

$$H_0 : \gamma_{\perp} = GM_G$$

It determines whether the matrix of vectors orthogonal to the adjustment matrix γ are significantly different from a specific linear combination, described by the *(p-r)* x *m* matrix *G*, of the set of eigenvectors M_G. These eigenvectors are associated with the *(p - r)* largest eigenvalues from the generalized eigenvalue problem

$$\left|G'(\lambda S_{00} - S_{01}S_{11}^{-1}S_{10})G\right| = 0$$

Again the *(p – r)* largest eigenvalues are placed in descending order and denoted λ^G. Again a likelihood ratio test is employed, with test statistic:

$$-T\sum_{i=r+1}^{p}\ln\left(\frac{1-\hat{\lambda}_{i+m-p}^{G}}{1-\hat{\lambda}_{i}^{u}}\right)$$

This statistic asymptotically follows a χ^2 distribution with *(p–r)* x *(p-m)* degrees of freedom. The matrix *G* can be chosen to isolate and ignore one of the eigenvectors corresponding to a single component series of *X*, see Darrat and Zhong (2000). Rejecting the null hypothesis thus determines that this single series is a significant *permanent* driver of the system *X*.

Tests for structural breaks

Darrat and Zhong (2000) test whether the US or Japan is the driving force behind a group of Asia-Pacific stock markets, in the presence of structural breaks in the model. They used a model similar to model C above, with two breaks, one corresponding to the Gulf War in 1990 and the other the Asian crisis in 1997-1999. However, the specific dates or time points for these structural breaks were guessed by the authors without the use of any statistical tests. Such an adhoc choice of break times can lead to bias and errors in results and conclusions, if these points are mis-specified, for example see Gregory and Hansen (1996). We take a more complete approach and test for the presence and most likely position or timing of structural breaks in the model endogenously, using multivariate co-integration techniques from Inoue (1999). These techniques allow us to identify the most probable position and nature of structural breaks, while simultaneously testing hypotheses about the co-integrating rank of the system. The procedure can then be confirmed by the use of the modified procedure in Johansen, Mosconi, Neilsen (2000) for choosing a specific co-integrating rank, in the presence of a known structural break. The Inoue (1999) test procedure, a Johansen type test providing a maximum eigenvalue statistic and a trace statistic, follows:

The null hypothesis concerns the cointegrating rank of the system;

$$H_0 : rank(\gamma) = rank(\alpha) \leq r; \mu = \lambda = 0$$

As pointed out by Inoue, under this null hypothesis, models A and C are cointegrated as in Engle and Granger (1987), when r $\in [1,2,..., p-1]$. Model B under this null is cointegrated as in Campbell and Perron (1991), also when r $\in [1,2,..., p-1]$. The hypothesis implies no structural break for all three models.

There are two alternative hypotheses considered, one for the maximum eigenvalue test and one for the trace test. These are, respectively:

$$H_1 : rank(\gamma) = rank(\alpha) = r + 1 \quad \text{and} \quad H_2 : rank(\gamma) = rank(\alpha) > r$$

We note a few things here before proceeding. Firstly, rejecting the null hypothesis does not imply that a structural break has occurred, it simply suggests the most likely time point that a break might have occurred, through that point corresponding to the maximum of the test statistics below. Neither does not rejecting the null hypothesis imply that a break has not occurred. However, rejecting the null hypothesis does imply that the rank is greater than *r*, including the case *r*=0, which will be a test of no co-integration against co-integration.

We again proceed by regressing $Z1_t$ and $Z0_{t-1}$ jointly on ($Z1_{t-1}$, …, $Z1_{t-q+1}$), where Z1 and Z0 are defined as above for models A, B and C. We then solve the generalised eigenvalue problem

$$\left|\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}\right|,$$

where S is as defined above. The *p* eigenvalues from this problem are placed in ascending order and denoted λ. The maximum eigenvalue test statistic for testing the null hypothesis about the rank *r* vs the first alternative, H_1, is

$$\max_{\xi \in [0.15T, 0.85T]} \left\{-(T-q-1)\ln\left(1-\hat{\lambda}_{r+1}\right)\right\}.$$

The corresponding trace statistic for this test is

$$\max_{\xi \in [0.15T, 0.85T]} \left\{-(T-q-1)\sum_{j=r+1}^{p} \ln\left(1-\hat{\lambda}_j\right)\right\}$$

The tests in general are not likelihood ratio tests, however critical values have been tabulated using simulation and response surface analysis and are reported in table 1 of Inoue (1999).

These hypothesis tests are repeated based on each time point in the region [0.15T,0.85T] being a potential break, with break fraction $\xi_t = t / T$, with the final test statistics being the maximum values of the statistic over all possible break factions.

5. Empirical Results

Table 3 reports the results for both the standard Johansen eigenvalue and trace tests for determining cointegrating rank, as well as the Inoue test results for the trivariate system of long-term interest rates, property market index and stock market index. Comparing the Johansen results to the Inoue statistics it is evident that ignoring structural breaks leads to the erroneous conclusion that there is no long-run relationship between any of the series, regardless of which property index is used. A conclusion of this nature would suggest that portfolio managers can treat property as a unique financial asset that in the long-run shows diversification benefits for equity and bond portfolio managers as it does not share a common stochastic component with either equity or fixed income. However, given the length of the time series stretches over more than a decade which saw significant changes in the global financial environment, it is perhaps unrealistic to expect that no structural breaks exist in the data, which the standard Johansen tests would simply not pick up. When the possibility of a structural break is taken into consideration, Inoue (1999) test results indicate there is at least one cointegrating equation in each system of equations, with breaks occurring around 1996/97. Interestingly, around this time period, there were a few changes occurring within the various property markets. For all the property indices being examined, there was a turnaround from there being a bull to bear market for securitised real estate assets.

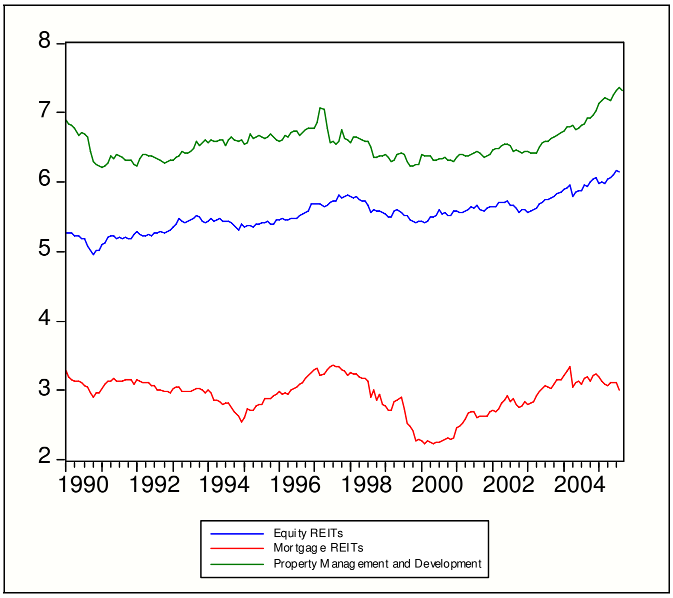
5.1 Inoue Test Results

Table 3: Inoue and Johansen Rank Tests from 1990 to 2006

		H_0:	Inoue tests		Johansen tests	
			λ_{Max}	λ_{Trace}	λ_{Max}	λ_{Trace}
US	EREIT	r = 0	46.3437 [a] *(03/97)*	73.7118 [a]	19.6683	29.0694
		r = 1	24.8767	32.5909	7.7238	9.4011
		r = 2	11.3549	11.3549	1.6773	1.6773
	MREIT	r = 0	46.9021 [a] *(03/96)*	73.3751 [a]	20.6352	33.7580
		r = 1	26.7508	39.7010	9.6616	13.1228
		r = 2	19.3500	19.3500	3.4612	3.4612
	REMD	r = 0	55.2389 [a] *(03/97)*	69.5764 [b]	16.5794	24.7031
		r = 1	17.3602	25.9269	6.3779	8.1237
		r = 2	12.2744	12.2744	1.7458	1.7458
UK	REMD	r = 0	41.4898 [b] *(11/97)*	66.7538 [b]	12.2884	19.0592
		r = 1	20.6627	29.8134	5.2486	6.7708
		r = 2	12.7957	12.7957	1.5222	1.5222

Critical values for the Inoue's model allowing for slope change, trace and maximum eigenvalue statistics are taken from Inoue (1999). The lag order was determined by sequential LR tests on the lags as followed by Inoue (1999). Break point dates (MM/YY) for Inoue Test are presented in brackets under the last significant test statistic. [a]Indicates rejection of the null at the 1% level, and [b] indicates rejection of the null at the 5% level.

Figure 1. US Property Sector Indices from 1990 to 2005.



The figure above tracks the three property sector indices over time. For illustrative purposes all series have been standardized and logarithmic values taken.

Figure 1 shows the price series for the three US property indices. It is noticeable that for all three series the indices do turn down from approximately the latter part of 1996 onwards. Although not illustrated, the same pattern exists for the UK property REMD index. This downturn, however, does not explain the cause for the relationship between the bond, stock and real estate markets to shift, as that would be dependent on various potential economic and financial factors. In particular, and given the previous literature has focused on this particular aspect before, figure 2 shows credit spread movements over the course of the same sample period, and the noticeable increase in the drift rate around 1997. This would partially be due to the ramifications of the 1997 Asian financial crisis, which would have dampened the demand for US debt as a lot of Asian investors repatriated monies to pay-off bad loans. This increase in credit risk would also very likely be felt within the property sector, particularly as a result of credit risk increasing.

Figure 2. US Credit Spread from 1990 to 2006.

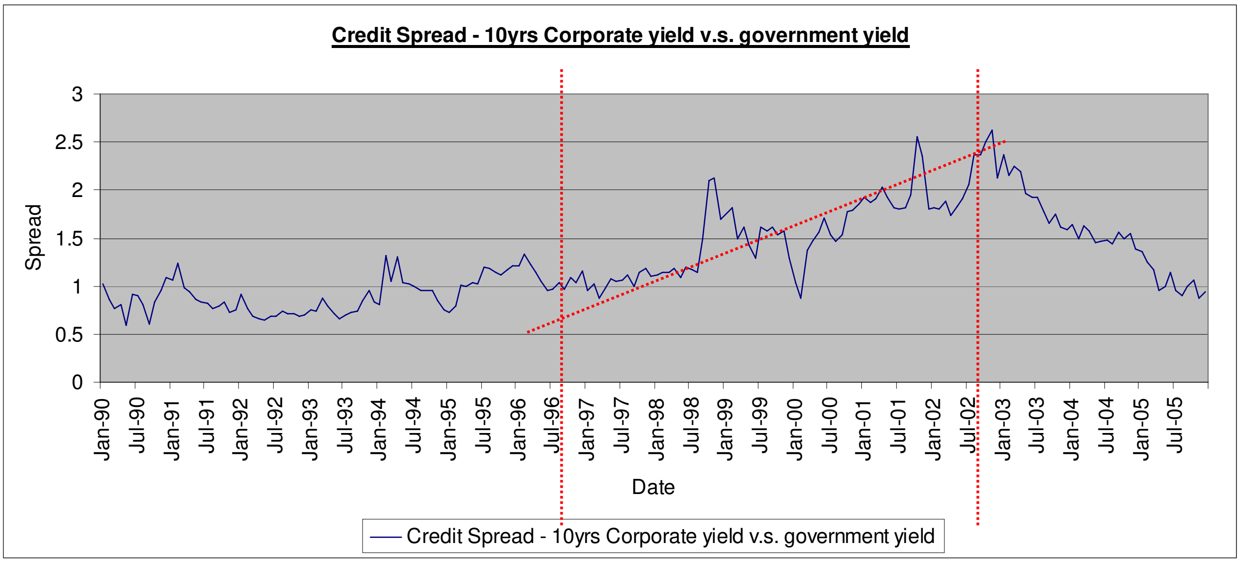


Figure 2 also shows that by the 2nd half of 2002, credit spreads had reached a high a downward trend ensued thereafter until the end of the sample period in 2005. If credit spreads are responsible for the structural break in 1997, it may also be necessary to consider whether due consideration needs to be placed on any further breaks after this date. As the basic Inoue process only reports the most likely date of a break for a sample, it would be appropriate to re-run the test again for a sub-sample period starting at the end of the break in 1997, and finishing at the end of 2005 to detect any further potential structural time series breaks. The results are tabulated in table 4, showing that for equity REITS and the REMD index a further potential break exists around the second half of 2002 and beginning of 2003, respectively. This further supports the premise that the relationship shared between the securitised property sector, the general stock market and interest rates are partially governed by credit spreads and potentially the financial risks that stem from this. Although it is not possible to directly account for credit spread changes within the cointegrative procedures as it is an I(0) process, whereas all the rest of the series are I(1), it is important to take note of the structural breakpoints that are a result of the changing trends in credit spreads within the permanent-transitory decompositions presented next.

Table 4: Inoue and Johansen Rank Test for US Property Series from 1997-2005

		H_0:	Inoue B		Johansen tests	
			λ_{Max}	λ_{Trace}	λ_{Max}	λ_{Trace}
US	EREIT	r = 0	42.6257[c] (05/02)	65.6976[c] (05/02)	19.7808	28.5276
		r = 1	24.8877	32.6756	8.7112	8.7468
		r = 2	11.3666	11.3666	0.0356	0.0356
	MREIT	r = 0	34.0957	47.7671	22.1421	32.7988
		r = 1	15.1653	16.9843	7.4481	10.6566
		r = 2	4.2573	4.2573	3.2085	3.2085
	REMD	r = 0	51.8635[c] (03/03)	63.7348	25.8430	35.4568
		r = 1	20.9658	27.8737	9.5639	9.6137
		r = 2	8.4227	8.4227	0.0498	0.0498

Critical values for the Inoue's model allowing for slope change, trace and maximum eigenvalue statistics are taken from Inoue (1999). The lag order was determined by sequential LR tests on the lags as followed by Inoue (1999). Break point dates (MM/YY) for Inoue Test are presented in brackets under the last significant test statistic. [a]Indicates rejection of the null at the 1% level, and [b] indicates rejection of the null at the 5% level.

5.2 Permanent-Transitory Decompositions

Focusing on the actual Gonzalo-Granger (1995) permanent-transitory decomposition, we set the cointegrating rank at one, plus allow for two structural break points for the US equity REITs and REMD, and one for mortgage REITs and UK REMD. An interesting feature emerges from the results tabulated in table 5. For all three US property series, both long-term interest rates and stock market performance can be considered as permanent drivers, to at least the 5% critical level, of property market prices. For mortgage REITs, interest rates also seem to influence transitory price behavior. Previous research has shown mixed and sometimes contrary results as to whether interest rates and general stock market trends influence property. Based on the tabulated results, both are long-term drivers of property prices, although this is not to say that perhaps there are periods when one driver may be more dominant than another. For transitory effects, however, it would seem that both the stock market and interest rates have limited influence. The only significant transitory driver is interest rates for mortgage REITs. Possibly because of the underlying product, mortgage REITs will be sensitive in the short-run to interest movements as it would not only affect the immediate value of mortgage loans, but also the demand for the product.

For the UK, the results are very similar to that of the US, with the additional extra influence of interest rates on transitory price changes within UK REMD.

Table 5: Gonzalo-Granger Permanent-Transitory Test

		Interest Rate		Market	
		Permanent	Transitory	Permanent	Transitory
US	EREIT	10.6935 [a]	0.1199	9.9966[b]	1.2889
	MREIT	5.9642[b]	4.9323[b]	6.8332[b]	0.0029
	REMD	6.5064 [b]	0.9087	7.3489 [b]	0.2226
UK	REMD	5.1843[b]	7.9795 [a]	9.2647 [a]	0.0578

The results presented are χ^2 distributed with 2 degrees of freedom for permanent component and 1 degree of freedom for transitory component. [a]indicates rejection of the null at the 1% level, and [b] indicates rejection of the null at the 5% level.

One limitation of table 5 is that although the property indices are categorized into various product offerings, consideration is still not made for the impact that debt-equity ratios may have on individual company sensitivity to either the stock and/or bond markets. To deal with this, table 6 reports the results from breaking down the composition of each property portfolio into high and low leverage companies. The figures, surprisingly, show for the most part identical results for the sensitivity of high and low leveraged firms to the stock and bond markets. In each case, both the fixed income and equity markets are significant permanent driving factors. It would seem, that in the long run, company leverage factors cannot remove either the fixed income nor equity markets as long-run driving factors to property. These results, however, should not be seen in opposition to some of the previous literature, such as by Allen, Madura and Springer who find debt-equity ratios do impact the sensitivity some types of REITs have towards interest rates. This study focuses on long-run driving forces within the property market, as opposed to short-run explanatory variables, that may change in significance over time. In fact, there is little evidence to suggest in the results of table 6 that fixed income and the equity market behavior have transitory influences over the property market. The exception is for low leveraged equity REITs, where transitory changes within the stock market does influence the property index. This is to be expected, as equity REITs with low debt structure would be in effect as close as a property stock could be to a normal equity offering.

Table 6: Gonzalo-Granger Permanent-Transitory Test for High and Low Leveraged Property Portfolios

		Interest Rate		Market	
		Permanent	Transitory	Permanent	Transitory
US	Low D/A EREIT	15.2117[a]	0.0101	10.0332[a]	3.9746[c]
	High D/A EREIT	10.6624[a]	0.1362	9.0952[b]	0.9568
	Low D/A MREIT	Insufficient information		Insufficient information	
	High D/A MREIT	15.3351[a]	1.0233	14.7302[a]	1.1532
	Low D/A REMD	12.8455[a]	0.5118	14.7021[a]	3.6942
	High D/A REMD	8.2249[b]	0.2369	7.4304[b]	1.2379
UK	Low D/A REMD	4.9203	5.0777[b]	8.4964[b]	0.4816
	High D/A REMD	6.7457[c]	5.8169[b]	8.8037[b]	0.5899

Companies within each series are sorted into quartiles from low to high average debt to total asset ratio (D/A). The first quartile represents the low D/A and the last quartile represent the high D/A categories.

The results presented are χ^2 distributed with 2 degrees of freedom for permanent component and 1 degree of freedom for transitory component. [a]Indicates rejection of the null at the 1% level, and [b]indicates rejection of the null at the 5% level.

6. Conclusion

This paper re-examined the relationship that securitised property shares with the general stock and bond markets. Previous literature has shown mixed results to the influence that equity and fixed income have over property, although a majority of studies have suggested the influence of interest rate movements have waned over the previous decade. However, we postulate that the influence of the fixed income market, and for that matter the stock market as well, is entrenched in driving long-run property prices, regardless of product category and debt/equity ratio. Once structural breaks are accounted for, property prices are shown to have a long-run cointegrative relationship with both the equity market and long-run interest rates. However, the structural dynamics of this relationship may change over time, which we show might be due to changes in credit spreads. Conceivably, as credit spread risk increases, interest rate movements become more important. Due to the fact that until 1997 credit spreads were relatively low, some of the published literature noted a declining importance in interest rates determining property movements. This, however, does not infer the long-run importance of the fixed income market has declined in setting property prices, but rather for varying periods of time the relative importance of various driving forces underpinning property value does change. Further research in this area is still needed and would be able to shed valuable information on this and further contribute to explaining the relationship property has with the fixed income and equity markets.

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ENDNOTES

[1] Global Industry Classification Standard code 40401020