Securitised Real Estate Regime-Switching Behaviour and the Relationship with Market Interest Rates

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Abstract

This paper examines the regime-switching behaviour of the six major international securitised real estate markets by utilizing the Dynamic Markov-Switching methodology. Using crises-rich sample period of 1993-2010, we find that the securitised real estate returns can be sufficiently characterised by two distinct regimes of high return-low volatility and low-return high-volatility that are substantially different from the underlying stock markets in terms of the duration and risk-return characteristics of the regimes in each market. The presence of two distinct regimes provides new international evidence on the sector's relationship with interest rates and the fact that securitised real estate reaction to unexpected market interest rate changes is of the asymmetric nature

Introduction

A number of research papers have considered the sensitivity of real estate securities to interest rates. A common finding in this literature has been the evidence of the time-varying influence of market interest rates on securitised real estate markets. A number of papers have documented shifts in the relationship between REITs and the fixed-income market (e.g. Glascock et al., 2000; Swanson et al., 2002; and Cheong et al., 2009) whilst Liang et al. (1995) suggest the regime-shifting behaviour of the real estate prices as a possible reason for the unstable statistical links although no formal evidence is provided. In financial literature, studies like Kodres and Pritsker (2002) have shown that financial market returns can be affected by the episodic economic and political shocks. Prime examples include the Asian financial crisis of 1997, currency crises in Russia and Brazil in late 90's and the 9/11 attacks in the U.S. This list may include the recent financial crisis of 2007-2009 that has affected almost every corner of the global economy. One of the main policy responses in many countries was the significant reduction of the base (target) interest rates by the Central Banks. Those measures although helped businesses to focus on issues like liquidity and asset quality. At the same time it left the companies exposed to the event of the potential interest rate rise in the future (Clair et al. 2009).

Our goal in this paper is to examine regime shifts in the behaviour of securitised real estate relative to the stock markets. Secondly, by assuming formal regime changes, we attempt to examine the exposure of securitised real estate to interest rate risk. We examine this issue by allowing the effects of interest rate changes to vary in accordance with the state of the underlying securitised market. In particular, we question whether the interest rate sensitivity of real estate companies varies during persistent periods of market turbulence (bear state) in comparison with periods of market tranquillity and high returns (bull state). For that we employ short-term as well as long-term interest rate measures: the changes in 1-month, 3-month, 12-month and 10-year government bonds yields. The understanding of the interest rate impact during bull and bear markets is important for publicly traded real estate businesses and their stockholders as well as portfolio fund managers. For the former, evidence of the regime-dependent effects is intended to help managing interest rate risk more efficiently. For the latter, it will aid their decision making in terms of the investment's risk-return profile of the sector and/or an individual company.

With the data time span between 1993 to 2010, our choice of the markets to be included in the sample is motivated by the growth of the listed real estate industry, the expansion of tax-

transparent REIT regimes internationally and the increase in cross-border real estate investment over the last decade. Therefore, the paper aims to provide a number of contributions to the literature. Firstly, we model regime-switching behaviour in six largest international securitised real estate markets. Our sample comprises of four Asian-Pacific markets (Australia, Hong Kong, Japan and Singapore) and two large Western markets (U.S. and the U.K). European Public Real Estate Association (EPRA) and National Association of Real Estate Investment Trusts (NAREIT) estimate market capitalization of these countries to be over $800bn, which also represents approximately 80% of the global listed real estate market. These countries are also the largest real estate equity markets in terms of market capitalization and trading volume (Psaltis & Chubb, 2008). The sample is also of interest as it contains a mixture of regulatory structures. Two of the securitised real estate markets, Australia and the U.S., operated under a REIT regime throughout the entire sample period. The remaining markets have introduced a REIT structure during the time considered in the study. Furthermore, in Hong Kong the majority of real estate companies, including the largest, remain corporates. In addition, in the U.K., the majority of firms have also retained a corporate structure, although in this case the majority of the large cap stocks did convert to REIT status. The question of whether interest rates exposure differs with regard to the two alternative structures remains largely open, with only a few works available. For instance, Stevenson et al. (2007) find significant exposure in the context of U.K. property companies. Their study covers a period of low and stable interest rates and shows that the significance of the interest rate factor for listed real estate returns is not dependent on a REIT status being in place.

In addition to considering a broader range of markets, particularly within an Asia-Pacific context, this paper also differs from the previous literature in differentiating between the anticipated and unexpected components of interest rate movements. We find that every market from our sample exhibit a high degree of sensitivity to unexpected interest rate movements. Previous work has largely relied on the actual market interest rates. The importance of taking into account market expectations is highlighted in a small number of papers and is dominated by the literature on financial institutions.[1] Following Flannery & James (1984) and Bae (1990) we estimate unanticipated interest rate changes through appropriate Autoregressive Moving Average (ARMA) specifications. We transform the autocorrelated changes into white noise, which can be viewed as the unexpected component of the interest rate proxy. Consistently with a critic by Tufte & Wohar (1999), our sample is large enough to account for potential

[1] In real estate literature, Devaney (2001), Stevenson et al. (2007) among others consider the actual changes in interest rates, while financial literature such as Flannery & James (1984), Bae (1990), Madura & Zarruk (1995), Faff & Howard (1999) utilises the unexpected changes.

inefficiency in OLS estimates of the ARMA models. In the second stage, when the effects of interest rates on securitised real estate are considered, we also abandon OLS regression in favour of dynamic Markov-Switching models and a variation of the Generalised Autoregressive Conditional Heteroscedasticity (GARCH) type of model.

Our Markov-Switching regression analysis augments the recent work by Chen et al. (2012) who model U.S. market regimes non-parametrically and assume that the reaction of U.S. REITs to macroeconomic variables is governed by the regime shifts in the S&P500. As a further contribution, we show that the impact of the macroeconomic variable such as interest rates can be modelled within the Dynamic Markov-Switching framework. This framework allows securitised real estate returns to shift between low and high volatility states of the sector and offers each exogenous variable separate coefficient estimates for each state of the market. One of the key findings that we observe is that asymmetries are presented in the reaction to interest rate changes between the two variance regimes. These findings are especially evident in the bear state of the market.

Finally, we analyse each countries securitised real estate volatility reaction to the state-dependent measures of the interest rates uncertainty using GARCH models. GARCH models are augmented with conditional volatilities of the interest rate variables and are estimated with the maximum likelihood functions suggested in Bollerslev & Wooldridge (1992). We find that the volatility of securitised real estate markets is affected by the interest rates uncertainty across our sample. Moreover, we find consistently that higher variance in securitised real estate is associated with either the absolute change or increased conditional volatility of domestic interest rates. The asymmetry in the variance sensitivity to interest rates is dominated during regimes shifts within the listed real estate sector and not the overall stock market. In the latter case, the evidence of asymmetries in variance is much weaker. A potentially mistaken assumption that securitised real estate markets are driven by the underlying stock markets explains a lack of significant findings in Chen et al. (2012). One the last two findings reveal a counter-cyclical behaviour of the securitised real estate sector when compared to the stock market. Therefore, the real estate sector yet again can be viewed as a separate market from the general equities. This can be potentially useful from the portfolio management point of view since we find that the impact of the potential risk proxies is weaker during the periods of the general market instability.

Literature review

The linear relation between listed real estate price changes and interest rate fluctuations is examined by a number of studies. The majority of them considers U.S. REIT market and yet fails to assert the significance of the interest rate risk exposure. For instance, early work of Chen & Tzang (1988) finds a weak interest rate sensitivity of Equity REITs over the period 1973 to 1985. Park et al. (1990) claim no relationship between Equity REITs and short-term interest rates. Liang et al. (1995) estimate a two factor model that includes interest rate variable and the overall stock market. They find no significant impact of interest rates on Equity REITs. All three studies conclude that Mortgage REITs experience a far more pronounced exposure to interest rate variables than Equity REITs. Mueller & Pauley (1995) consider separately the periods of rising and falling interest rates. Their correlation analysis suggests a weak association between REITs and interest rates.

In contrast, studies by Allen et al. (2000), Devaney (2001), Swanson et al. (2002), He et al. (2003) find statistically significant impact of the changes in long-term interest rates on U.S. REITs.[2] Allen et al. (2000) report significant sensitivity of REITs to both short and long-term government bonds, as well as the stock market. They further argue that the companies can adjust their exposure to the market by changing financial leverage, but not the exposure to interest rates. Devaney (2001) is among the first in the area to adopt GARCH model, but the author uses the variance equation solely for the purposes of the risk-return trade-off testing. Swanson et al. (2002) uses the sample of 300 individual REITs and find very consistent exposure of daily REIT prices to the spread between 30-year and 1-month Treasury bills rates during the 1990s. He et al. (2003) find the time-varying nature of the relationship between REITs and interest rates and suggest that the analysis can be influenced by the choice of interest rate proxy. Finally, Cheong et al. (2009) note a growing impact of fixed income markets on Equity REITs and a declining influence on Mortgage REITs.

The time-variation of the exposure of real estate stocks returns is tested in the international studies such as Liow et al. (2006) who assess the markets in Hong Kong, Japan and Singapore. Stevenson et al. (2007) examine U.K. public property companies. The former study adopts the exact Devaney's GARCH-M model, while the latter paper augments both mean and variance equations with the interest rate factor and its conditional volatility respectively as well as

[2] In addition to the above cited papers, three recent papers examine consider the impact of changes Federal Reserve rates, specifically the Fed Funds rate. Bredin et al. (2007, 2011) considers the impact on the domestic U.S. market, whilst Xu & Yang (2011) examine the international impact of changes in Federal Reserve Policy rates.

control for the Central Bank rate change decisions. Stevenson et al. (2007) use interest rate proxies of three maturities, the 1-month interbank rate together with 10 and 15-year government bond yields. They conduct their analysis for a period of historically low and stable interest rates, yet report significant results for all of the interest rates used on both returns and volatility, although the coefficient on the short-term rate is of the unexpected positive sign.[3] The findings of Stevenson et al. (2007) are consistent with the earlier study of Lizieri & Satchel (1997) who estimated the response of UK property stocks during two distinct interest rates regimes finding that firms were particularly sensitive during the period of low interest rates. In contrast, during the high interest rate regime real estate stocks may experience sharp falls in value, felt to reflect increased uncertainty. Finally, Liow et al. (2003) examine the Singaporean market prior to the introduction of SREITs. The authors identify a systematic relationship with interest rate risk but note that the pricing of that risk is subject to market conditions.

Overall, the estimation procedures, time periods under examination and the country of interest vary greatly. However, the majority of the studies adopt a generally common proxy for the interest rates represented by the government bond yield changes.[4] In particular, Devaney (2001) and He et al. (2003) employ 10-year government bond yields, while Swanson et al. (2002) uses 20-year government bond yields as the longer-term rates. Chen & Tzang (1988) and Akimov & Stevenson (2012) sample a range of maturities on both short-term and long-term interest rates. Multiple interest rates proxy becomes relevant since Akimov & Stevenson (2012) concede that the interest rate risk exposure often shifts from the long-term to the short-term rates depending on the macroeconomic situation or the type of listed real estate company.[5]

Data

Securitised Real Estate and Stock Markets Data

[3] Similar results are found in the banking sector, where Kane & Unal (1988) and Yourougou (1990) report varying interest rate sensitivities during periods of high and low volatility

[4] The exception is the study by Akimov et al. (2012) who attempt to model the changes of the whole term structure of interest rates. The authors summarize the information on 12 interest rates of the various maturities in three yield curve factors: level, slope and curvature. This approach allows them to model those factors jointly in a single model.

[5] Publicly traded property companies in the markets like the UK and Hong Kong involve in a lot of development activity and often employ larger amounts of the short-term debt than traditional REIT structures in the U.S. and Australia. In addition, REITs do not have the direct incentives for borrowing. REITs are tax-exempt vehicles in comparison to the public property companies who have the advantages of using their tax-shield

Our sample is comprised of daily data for Australia, Hong Kong, Japan, Singapore, U.K. and U.S. for the period January 1993 to December 2010. The choice of 1993 as the earliest date is due to two key reasons. The first is concerned with the U.S. market where the use of 1993 date constrains the analysis to the modern REIT era. Secondly, as Stevenson et al. (2007) note, the use of U.K. data prior to September 1992 is complicated by the membership of Sterling in the European Exchange Rate Mechanism (ERM). Furthermore, the large scale movements in U.K. rates in late 1992 following departure of Sterling from the ERM was an added element in deciding to start the analysis in January 1993.[6] The real estate security indices used are those calculated by Thomson Reuters Datastream with the exception of the U.S. where the SNL Equity REIT Index was used.[7] SNL Equity REIT index is highly regarded as one of the most reliable with the very close coverage of REIT industry in the U.S. Unfortunately, there are no such dedicated services for other markets. However, Thompson Reuters Datastream holds a substantial database for many listed real estate markets with some of them go back as far as to 1971. In order to provide crucial reliability to their indexes, Datastream imposes a number of criteria when listed real estate indexes are constructed. Firstly, a representative list of real estate investment firms is included. Secondly, any number of firms should cover a minimum of 75-80% of total market capitalisation; hence the number of firms is not particularly important as long as they represent a dominant part of the market. Therefore, a representative sample of firms is provided for each listed real estate sector index from Australia, Hong Kong, Japan, Singapore and the U.K. The constituents of the listed real estate indexes are reviewed each quarter. The limitation for the current analysis is that Datastream does not provide the list of constituents for each particular trading day. It restricts the possibility to differentiate a sample of REIT firms in markets like the U.K. since REIT-regime introduction in 2007.

Overall, listed real estate indexes in the sample have a number of similarities by the way they are constructed. Particularly, the sample in this paper includes six value-weighted listed real estate indexes with a common business theme of their constituents. Particularly, all listed real estate firms (REITs and public property companies) have their core business in investing, holding, managing and developing real properties. The indexes exclude homebuilding and construction firms.

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[6] During the period when Sterling was a member of the ERM interest rates were being frequently determined with reference to exchange rate policy. This is also an issue with respect to Hong Kong due to the fixing of the Hong Kong Dollar to the U.S. Dollar at a rate of HK$ 7.80 since October 1983.

[7] We exclude both U.S. Mortgage and Hybrid REITs from our analysis for two main reasons. Firstly, both public real estate companies and REITs in the countries outside the U.S. predominately invest in real estate directly and structurally are closer to U.S. Equity REITs. Secondly, Equity REITs occupy more than 90% market share of the REIT market in the U.S., which gives us a representative sample for this country

Finally, one may suggest using the alternative benchmarks such indexes constructed by European Public Real Estate Association (EPRA). However, similar to Datastream, the historic variation in the list of constituents of the FTSE/EPRA NAREIT indexes is equally hard to obtain. In addition, the benefits of shifting the indexes from one benchmark (i.e. provided by Datastream) to another (i.e. provided by EPRA) can be negligible, since Serrano & Hoesli (2009) find an average correlation of 0.95 over the period from 1990 to 2007 between main listed real estate index providers including Datastream, FTSE/EPRA NAREIT, GRP and S&P/Citigroup. Therefore, it is anticipated that the empirical results of this paper are robust and should not be dependent on choice of the listed real estate index.

For each market the broad equity market is used as a control variable, consistent with previous studies (e.g. McCue & Kling, 1994; Stevenson et al., 2007). The market indices used were the ASX200 (Australia), Hang Seng Index (Hong Kong), Nikkei 225 (Japan), Straits Times Index (Singapore), FTSE 100 (U.K.) and the S&P500 (U.S.). Each of the stock market benchmarks are the largest stock exchanges in their respective countries. The main goal of the inclusion of these indexes in the analysis is to control for the broad market sentiment. It is done to separate the news about stock markets from the news that indicate changes in interest rate risk of the real estate sector. Also this makes the conclusions about listed real estate exposure to interest rate risk being sector real estate specific. Otherwise, if the following tests find no significant influence of interest rates on real estate prices, it will imply that listed real estate exhibits the same level of interest rate sensitivity as the equity market portfolio. The formulation does not necessarily imply that the immunity of real estate to interest risk is tested. Rather it is interesting to identify whether listed real estate exposure differs from the general stock market. Thus, the largest equity indices had to be chosen for each country. Alternative equity indices of smaller capitalisation stocks would not be as appropriate for the analysis since they capture the specific segment of equities with less trading and liquidity involved that is essential to capture the broad market sentiment.

Additional reason for inclusion of the general stock market portfolio in the analysis as a control variable is dictated by the exposure of the regression estimates to an omitted-variable bias. This problem is potentially causing the instability of findings in the previous literature as seen in Devaney (2001), Liow & Huang (2006) and Najand et al. (2006). Moreover, the stock market is often found to be the main determinant of REIT returns in the U.S. (Gyourko & Keim, 1992; Oppenheimer & Grissom, 1998; Okunev et al., 2000). This may be even more so in the markets like Hong Kong, Singapore and the U.K. where public property companies represent a far larger

proportion of the stock market and far more integrated in the underlying equity sector than REITs in the U.S. If interest rates are correlated with the stock market as shown in Fogler et al. (1981), Chen et al. (1986) and Sweeney & Warga (1986), the regression model will result in a biased interest rate beta estimate, where the sign and magnitude of the bias may remain unknown (Greene, 2003).

Interest Rates Data

Changes in daily interest rates are defined as the simple difference between the appropriate domestic government bonds yield: $ir_{i,t} = y_{i,t} - y_{i,t-1}$. For each market we use four maturities, namely 1, 3 and 12 months together with the 10 year yield. Whilst the full sample extends from 1993 to 2010, for two markets the unavailability of 10 year Government Bond Yields results in a curtailed sample. For Hong Kong the 10 year yield is only available from January 1995, whilst for Singapore the starting point is June 1998. We also estimate the "yield curve spread" between the 10 year and 3 month bonds yields $\left(ir_{i,t}^{spread}\right)$. Although the Central Banks may have little control over the $ir_{i,t}^{spread}$ variable, the latter is felt to provide a good indication of future economic activity and inflation (Estrella & Mishkin, 1997). The source of the interest rates data is Thomson Reuters Datastream.

A key component of the paper is the examination of unanticipated interest rate movements. We adopt the two-step approach used in papers such as Flannery & James (1984), Madura & Zarruk (1995) and Faff & Howard (1999) who illustrate that expectations about future interest rate movements can be extracted using an appropriate ARMA specification. Following, Tufte & Wohar (1999), in order to account for any potential inefficiency of the two-step OLS we obtain a large sample size of daily interest rate changes that adds more consistency into OLS estimate performance in the ARMA stage. In our second step, we estimate Markov-switching and GARCH models using maximum likelihood functions that provide more flexibility into estimation.

Methodology

Markov-Switching Autoregression

We employ the methodology that is based on two types of Markov-switching models originally introduced by Hamilton (1989). Firstly, the presence of regimes in securitised real estate and general stock market series is considered. Therefore, Markov-switching autoregression (MS-AR model) is applied with the objective to obtain characteristics of regimes of two assets of interest. MS-AR allows us to assess regimes persistence and assets' mean-variance performance. The smoothed probabilities identify regimes of the assets as high-return stable and low-return volatile.

A simple Markov-switching model specification that is referred as MS-AR(k) model can be described as follows:

$$\psi(L)r_t = \mu_{i,t} + \eta_t; \qquad \eta \sim N(0, \sigma_{i,t}^2) \tag{1}$$

where $\psi(L)r_t = 1 - L - L^2 - \ldots - L^k$ is the lag operator, $\mu_{i,t}$ and $\sigma_{i,t}^2$ are state-dependent mean and variance of asset index returns respectively. The market states i are represented by unobserved latent dummy variable s_t that is assumed to follow a two-state Markov process with fixed transitional probability matrix shown as:

$$P = \begin{pmatrix} p^{00} & 1 - p^{11} \\ 1 - p^{00} & p^{11} \end{pmatrix} \tag{2}$$

where $p^{00} = P(s_t = 0 \mid s_{t-1} = 0)$ and $p^{11} = P(s_t = 1 \mid s_{t-1} = 1)$.

The model is estimated using maximum likelihood procedure that uses non-linear programming approach of Lawrence and Tits (2001) where transition probabilities $p^{s_{i,t}, s_{i,t-1}}$ are subject to 0-1 range constraint and sum to unity. The model uses filtering algorithm of Kim (1994). The model lag selection process is based on minimizing Akaike Information Criterion (AIC) as suggested Chen (2007) and applies exclusively to the MS-AR(k) model specified above.

Therefore, we compare Markov-Switching model with the linear autoregression of the same lag structure for each market and asset. Our linear AR(p) model is of the form:

$$r_t = \phi_1 \cdot r_{t-1} + \phi_2 \cdot r_{t-2} + ... + \phi_p \cdot r_{t-p} + \nu_t; \quad (3)$$

where ν are i.i.d. errors with zero mean and variance σ^2.

The results of MS-AR(k) models for each country's listed real estate and general stock markets are reported in Table 1. Among the main findings is the presence of two distinctive regimes in each asset returns distribution. It is evident by the substantial increase in Log-likelihood figures for MS-AR models in comparison with the linear AR(p) specifications. Linearity Likelihood Ratio (LR) tests are rejected for every single market and each asset implying a superior performance of the non-linear Markov-Switching model against a simple autoregression.[8] The regimes for both listed real estate and stock market can be described by periods of low return-high variance and high return-low variance respectively. The existence of two regimes in listed real estate returns is consistent with the general finance studies such as Maheu and McCurdy (2000) and Chen (2007). However, the evidence indicates that in terms of performance and regimes durations, listed real estate markets have quite distinct behaviour that varies from the underlying stock market.

TABLE 1 HERE

The durations of the regimes that can be estimated using the following ratios, $(1-p^{00})^{-1}$ and $(1-p^{11})^{-1}$ vary for each market. I estimate that listed real estate bear market regime in Australia persists for 32 days, while the bull market regime lasts for 181 days. The regimes duration for the stock market in Australia differs from real estate and is found to persist for the shorter time periods of 24 days (bear market) and 84 days (bull market) respectively. Another

[8] The Likelihood ratio test is important for comparison of the proposed Markov-Switching model against its constant parameter or linear counterpart. However, the significance of the test suffers from a problem of parameters being not identified under the null hypothesis. Therefore, the significance of LR-test can be assessed using approximate upperbound suggested in Davies (1987) or using critical values tabulated in Garcia (1998). The significance of our LR-test results are robust to both methods.

REIT market in the sample, US REITs, is found to experience also shorter high volatility periods than US general stock market (25 days against 48 days respectively). The figures for the period of high return-low volatility are 81 day for US REITs and 93 days for S&P500. This particular finding questions the recent work by Chen et al. (2010) who do not differentiate the REIT regime from the overall stock market. We will return to their findings in the empirical results section. Further, the discrepancies found between listed real estate and stock market regimes are consistent across the markets. For Hong Kong, I document the bear (bull) market durations of 36 (66) days and 55 (119) days for real estate and stock markets respectively. Similar picture is evident for the UK public companies sector, where real estate and stock market respectively are expected the bear (bull) market to persist for 17 (56) days and 57 (124) days. Finally, in Japan and Singapore, listed real estate (general equities) bear-market regime lasts for 27 (24) days and 16 (27) days respectively, while figures for the bull-market regime are 49 (80) days and 56 (59) days.

Overall, I find every listed real estate market to experience distinguishable two-regime mean-variance performance and regime persistence that is different from the underlying stock market. These findings provide an alternative surface for the assessment of systematic risks in listed real estate. It includes the consideration of the market beta and the sensitivity to interest rate changes that are often assumed to be constant over time.

Dynamic Markov-Switching Model

Next, we employ a variation of Regime-Switching models known as Markov-switching dynamic regression model (MS-DR). The main advantage of this type of models as it allows the specification of the dynamics to enter the equation as well as to include a set of explanatory variables ($\mathbf{X}_t$). There is a distinctive difference between two specifications in terms of how the variables adjust to the regimes. In MS-AR(k) model, a regime shift occurs in the mean $\left(\mu_{i,t}\right)$ which result in a gradual adjustment of the model. In MS-DR model, the adjustment occurs in the intercept $\left(c_{s_t}\right)$ and become immediate (See Krolzig, 1997 for details). The full model specification can be written as follows:

$$r_t = c_{s_t} + b_{1i} \cdot r_t^m + b_{2i} \cdot ir_{t-1} + e_t;\ e \sim N(0, \sigma_{i,t}^2) \qquad (4)$$

where c_{s_t} is the regime-switching intercept:

$$c_{s_t} = \begin{cases} c_0 & if \quad s_t = 0 \ (low\ return - high\ \ volatility) \\ c_1 & if \quad s_t = 1 \ (high\ return - low\ \ volatility) \end{cases} \tag{5}$$

The model tests for asymmetric reactions of international listed real estate markets to changes in interest rates. It provides the framework that allows us to estimate the impact of the variables such as interest rates to vary during the times of listed real estate tranquillity and turbulence respectively. In a two-state model of listed real estate returns, the coefficient b_{21} will indicate the interest rate sensitivity of listed real estate prices during the bear market state of the real estate market, while b_{22} captures the interest rate impact during bear-state of the market.

To our knowledge, the state-dependent effects of interest rate changes on prices of securitised real estate have not been yet examined in the real estate finance literature.

Empirical Results

Dynamic Regime-Switching Approach

Table 2 reports the estimates of the dynamic regime-switching model over the period of 1993-2010. Consistently with MS-AR results in the previous section, MS-DR model recognizes the distinct differences between the variances σ^2_{i,s_t} for each country. In particular, the model picks up the high stress regime with notably higher volatility on the market. However, the high stress regime in listed real estate sector in relation to the underlying stock market is reflected in betas (b_{11}) not far of the unity. This would imply that in the real estate markets like Australia $(b_{11} = 1.02)$, Hong Kong $(b_{11} = 1.02)$, Japan $(b_{11} = 0.95)$, the U.K. $(b_{11} = 0.90)$, despite being in bear state carry the same levels of risk as the overall stock market. The two exceptions are the U.S. REITs $(b_{11} = 1.56)$ and listed real estate in Singapore $(b_{11} = 1.20)$.

TABLE 2 HERE

In the low volatility or stable regime market betas (b_{12}) are significantly lower than unity. This indicates that when the real estate market is in the bull state, it maintains lower risk levels than the stock market. The findings are consistent across countries with Hong Kong as an outlier. This is not surprising given the integration of the pubic real estate companies into Hong Kong's stock exchange. In addition, the estimates reflect the limited space private real estate sector in Hong Kong where the publicly traded non-real estate businesses are also the major tenants. The issue of a single-city real estate market is also partly captured by results for Singapore. However, their bull state "market beta" is also close to unity $(b_{12} = 0.91)$.

With respect to interest rate results, the evidence is consistent with the previous literature in regard to the long-term interest rate representing the most significant factor as shown in He et al. (2003). We find the significance of 10-year domestic government bond yield changes during the bull state of the listed real estate in Australia and Hong Kong (-0.33 and -0.44 respectively). A stronger (in absolute value) sensitivity to the long-term interest rates is documented for the US REITs (-2.01) and the market in Japan (1.97). The higher value of the coefficient estimates is no surprise since they are found in relation to the bear state of the market when the risk can be transmitted at higher magnitude. Two markets, namely Singapore and the UK are found to be sensitive to the shorter-end of the yield curve. In Singapore, all three measures of the short-term interest rates influence the returns of the public real estate companies during the periods of sector's instability. The evidence for the UK is weaker in terms of confidence level with 3- and 12-months rates impact during the bull state of the market.

One of the advantages of using Markov-Switching models is the ability to test the presence of the asymmetries in the effects from the explanatory variables. In particular, we are interested in interest rate impact and whether it is different during the bull and bear states of the market. The Wald test results for the general restrictions $(\mathrm{H}_0 : b_{21} - b_{22} = 0)$ highlights strong asymmetric reaction of listed real estate returns to interest rate changes only for the US and Singapore. To recall, these are two markets with the sector's interest rate sensitivity predominately during the market stress regime.

Modified GARCH

In the last part of our analysis, we look at whether the reaction of listed real estate volatility differs during the times of turbulence in comparison with the periods of stability. Specifically,

we estimate the following modified GARCH regression of the daily listed real estate index returns:

$$r_{i,t} = a_0 + a_1 \cdot r_{i,t}^{m} \cdot D_t^{bear} + a_2 \cdot r_{i,t}^{m} \cdot D_t^{bull} + a_3 \cdot ir_{i,t-1} \cdot D_{t-1}^{bear} + a_4 \cdot ir_{i,t-1} \cdot D_{t-1}^{bull} + e_{i,t} \quad (6)$$

$$e_{i,t} \left| \Omega_{t-1} \right. \sim N(0, h_{i,t}) \quad (7)$$

$$h_{i,t} = b_0 + b_1 \cdot e_{i,t-1}^2 + b_2 \cdot I_{t-1} \cdot e_{i,t-1}^2 + b_3 \cdot h_{i,t-1} + b_4 \cdot \left| ir_{i,t-1} \right| \cdot D_{t-1}^{bear} + b_5 \cdot \left| ir_{i,t-1} \right| \cdot D_{t-1}^{bull} \quad (8a)$$

$$h_{i,t} = b_0 + b_1 \cdot e_{i,t-1}^2 + b_2 \cdot I_{t-1} \cdot e_{i,t-1}^2 + b_3 \cdot h_{i,t-1} + b_4 \cdot h_{i,t-1}^{ir} \cdot D_{t-1}^{bear} + b_5 \cdot h_{i,t-1}^{ir} \cdot D_{t-1}^{bull} \quad (8b)$$

$$I_{t-1} = \begin{matrix} 1 & \text{if} & e_{i,t-1} < 0 & (\text{bad news}) \\ 0 & \text{if} & e_{i,t-1} > 0 & (\text{good news}) \end{matrix} \quad (9)$$

The model represents an augmented version of GARCH suggested in Glosten et al. (1993). The so-called GJR-GARCH model allows us simultaneously model mean and conditional volatility of listed real estate as well as GJR-term (I_{t-1}) controls for the asymmetric volatility reaction between positive and negative news about the market. The returns of the listed real estate sector in country *i* ($r_{i,t}$) are specified to be a function of the appropriate domestic stock market ($r^m_{i,t}$), changes in the relevant market interest rate ($ir_{i,t}$). Both explanatory variables are made to be state-dependent by using the dummy variables of the listed real estate sector or the general stock market being in the bear ($D_{i,t}^{bear}$) and bull ($D_{i,t}^{bull}$) market regimes respectively. Dummy variables are constructed using the smoothed probabilities extracted from Markov-Switching Autoregression (Figure 1 for the listed real estate probabilities). We define $D_{i,t}^{bear}$ as equal to 1 when $p^{00} \geq 0.5$ and 0 otherwise. Hence, the dummy that captures the bull state of the market is simply $D_t^{bull} = 1 - D_t^{bear}$. Therefore, the coefficients a_1, a_2 and a_3, a_4 measure the average response of listed real estate sector to both main stock market and interest rate news in bear and bull markets respectively.

FIGURE 1 HERE

The conditional variance of real estate securities is modelled assuming it follows a univariate asymmetric GJR-GARCH process and is a function of past squared shocks ($e_{i,t}^2$), the past

conditional variance ($h_{i,t}$) and the bear/bull market state-dependent conditional volatilities of both the domestic stock market ($h_{i,t}^{m}$) and interest rates ($h_{i,t}^{ir}$). We estimate the specification using the five interest rates variables described in Data Section. Finally, the model is estimated using two alternative conditional volatility specifications with respect to interest rate variables. One uses absolute interest rate changes as in Baillie & DeGennaro (1990). The second specification uses conditional variance of the interest rate series similar to Elyasiani & Mansur (1998) and Stevenson et al. (2007).

Equations (6)-(9) are estimated using the quasi-maximum likelihood procedure with the normal likelihood function and robust standard errors as suggested by Bollerslev & Wooldridge (1992). The results are reported in Table 3 and 4. Our GJR-GARCH specification allows us to test a number of important empirical questions. Firstly, we allow the dummy variables to proxy for the '*bull*' and '*bear*' states on the listed real estate as well as general stock market. Hence, we are able to compare whether interest rate sensitivity of listed real estate differ during the good and bad times on the stock market and the sector. Simple R-square figures can be used to identify the performance of the return generating process specification between two models. It is evident that on average the performance in terms of goodness-of-fit is does not vary much for all Asia-Pacific markets. This implies a stronger integration of the listed real estate sectors of those countries into their domestic general stock markets. However, we document substantial increase in R-square figures for the U.S. REITs (from 23% to 53%) and U.K. public companies (from 30% to 39%). The results for R-square figures are supported by the traditional "betas" (coefficients a_1 and a_2 using our notation). Particularly, listed real estate in Asia-Pacific move closer to the overall stock markets which is reflected in betas close to unity irrespective of the choice of market states dummies.

TABLE 3 HERE

Secondly, the coefficients $a_1 < 1$ and $a_2 < 1$ reported in Tables 3 and 4 indicate that in the majority of cases listed real estate is less risky than the overall stock market. This is especially important finding for the periods of high volatility regime of the latter. In Asia-Pacific markets, the coefficients for listed real estate of Australia and Japan during the times of the general stock market downturn are between 0.71 and 0.95 respectively. The figures are most staggering for the U.S. REITs and UK public companies. In the U.S. we find beta of 0.31, while for the U.K.

beta is around 0.45 on average. These results support the notion that real estate stocks represent the defensive and counter-cyclical asset relative to the underlying stock market during the stock market falls.

Thirdly, the interest rate coefficients in the mean equation of our Modified GARCH serve as the robustness checks for the previously estimated Dynamic Markov-Switching model. The estimation methods and likelihood functions are substantially different. Due to the use of dummy variables in our GARCH estimations we do not expect the coefficients a_3 and a_4 to be of the same magnitude as b_{21} and b_{22} in MS-DR model. However, we find very consistent evidence of listed real estate returns' sensitivity to interest rate variables when we compare two models. Identical to MS-DR model results, we find consistent exposure of the Australian LPTs to 10-year interest rate and Term structure spread fluctuations. The same consistency is revealed with respect to every market that was previously found sensitive to 10-year interest rate change. The examples are Hong Kong (both volatile and stable regimes), Japan in high volatility state and the U.S. in bear state of the REIT market. The results with regard to long-term interest rate are consistent with He et al. (2003) who also report the long-term interest rate to have the strongest impact on REITs. Finally, we find consistency among the markets with the sensitivity to the short-term interest rates, namely Singapore (12-month rate/bear state) and the U.K. (3-month rate/bull state).

Finally, our Modified GARCH models report coefficient estimates of interest rate variables that we include in the variance equations (8a,b).[9] Coefficients b_4 and b_5 in Table 3 refer to the estimates of the impact of the absolute interest rate changes on listed real estate market total risk. Among the findings, we detect that in every country in our sample, during the bear state of the market, the absolute changes in interest rates increase real estate market volatility. In contrast, during the bull state of the market, absolute changes in interest rates lead to the subsequently reduced volatility clustering in listed real estate sector. Both findings are consistent to multiple sources of interest rates across the markets in our sample. They are also consistent to interest rate variable introduced in the variance equation. Table 4 reports the estimates of b_4 and b_5 that refer to the coefficients attached to conditional volatility of interest rates, the variables included in Equation (8b). As a measure of uncertainty that surround interest rates, conditional volatilities of interest rates have significantly positive impact on listed real estate risk during the bear state of the market in the majority of cases. The negative effect is

[9] We report the estimates of the interest rate variables only for the brevity reasons. The full specifications that include ARCH, GARCH, GJR terms estimates are available from the authors upon request.

evident during the stable periods on the real estate market, although the evidence is somehow weaker.

TABLE 4 HERE

There are two additional important results that can be extracted from the GARCH models. Firstly, we find almost no evidence of asymmetry in the response of listed real estate returns to interest rate changes in mean equation. This is indicated by the Wald-test results (column $a_3 - a_4$). The test is conducted under the null hypothesis of equal listed real estate sensitivity to interest rates during the bull and bear states: $a_3 = a_4$. The contrasting evidence is found with respect to asymmetries in variance equation (column $b_3 - b_4$). We find asymmetric reaction in almost every case where interest rate variable enters the variance equation, which is supported by the Wald test of no asymmetry in listed real estate variance reaction to absolute changes (conditional volatility changes) in interest rates during the bear and bull market regimes: $b_4 = b_5$.

Conclusion

This study examines the regime-switching behaviour of six international listed real estate markets selected among the ten largest real estate equity markets in terms of market capitalization and volume traded, namely Australia, Hong Kong, Japan and Singapore, the U.S. and the U.K. The sample spans from 1993 to 2010 and offers a mixture of regional and regulatory structures. The findings reveal the presence of two quite distinct regimes in country's real estate sector. In general, one regime can be characterized as high return-stable market, while the other regime is found to be low return-volatile. Further, the regimes between listed real estate and the underlying stock market differ substantially in terms of persistence and the overall mean-variance profile.

We also model the impact of the macroeconomic variable such as interest rates within the Dynamic Markov-Switching framework. This framework allows listed real estate returns to shift between low and high volatility states of the sector and offers the separate coefficient estimates for each exogenous variable in respect to the state of the market. Among the findings

we find the asymmetries in both listed real estate market returns and volatility reaction to interest rate changes between two variance regimes. In particular, the results are the strongest when real estate markets are in the bear state of the market. When we allow the variables to be state-dependent on the general stock market, it reduces the information content of the model measured by R-square with the asymmetries in variance are found to be much weaker. Finally, we confirm an important characteristic of the securitised real estate sector such as the defensive, counter-cyclical nature of securitised real estate stocks. The sector can also be viewed as a separate disintegrated market from the general equities. This can be potentially useful from the portfolio management point of view since we find that the impact of the potential risk proxies is weaker during the periods of the general market instability.

The presented results provide important implications for the investors' assessment of the securitised real estate interest rate risk. In order to formulate the effective international real estate investment and risk strategies, an investor needs to control for the asymmetries in market responses during the good and bad times. The importance of interest rate risk may be especially critical today when the investors may be less protected against rising interest rates given the current monetary policy environment in vast number of global markets.

References

Akimov, A. and Stevenson, S. (2012) Time-Varying Sensitivity of Listed Real Estate to Central Bank and Market Interest Rate Changes, Working paper, University of Reading

Akimov, A., Stevenson S. and Zagonov, M. (2012) Listed Real Estate and the Term Structure of Interest Rate: A Cross-Country Study, Working paper, University of Reading

Allen, M., Madura, J. & Springer, T. (2000). REIT Characteristics and the Sensitivity of REIT Returns, *Journal of Real Estate Finance and Economics*, **21**, 141-152.

Bae, S.C., 1990. Interest rate changes and common stock returns of financial institutions: Revisited. Journal of Financial Research. 13, 71-79.

Baillie, R.T. & DeGennaro, R.P. (1990) Stock Returns and Volatility, Journal of Financial and Quantitative Analysis, 25(2), pp. 203-214

Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics*, **31**, 307-327.

Bollerslev, T. & Wooldridge, J. (1992). Quasi-Maximum Likelihood Estimation and Inference in Dynamic Models with Time-Varying Covariances, *Econometric Reviews*, **11**, 143-172.

Bredin, D., O'Reilly, G. & Stevenson, S. (2007). Monetary Shocks and REIT Returns, *Journal of Real Estate Finance and Economics*, **35**, 315-331.

Bredin, D., O'Reilly, G. & Stevenson, S. (2011). Monetary Policy Transmission and Real Estate Investment Trusts, *International Journal of Finance & Economics*, **16**, 92-102.

Chen, S.-S., 2007. Does monetary policy have asymmetric effects on stock returns? Journal of Money, Credit and Banking, 39(2-3), pp.667–688.

Chen, N. F., Roll, R. & Ross, S. A. (1986). Economic forces and the stock market. Journal of Business, 383-403.

Chen, K. & Tzang, D. (1988). Interest-Rate Sensitivity of Real Estate Investment Trusts, *Journal of Real Estate Research*, **3**, 13-22.

Chen, M.C., Peng, C.L., Shyu, S.D. & Zeng, J.H. (2012) Market States and the Effect on Equity REIT Returns due to Changes in Monetary Policy Stance, *Journal of Real Estate Finance & Economics*, **45**, 364-382

Cheong, C., Gerlach, R., Stevenson, S., Wilson, P. & Zurbruegg, R. (2009). Equity and Fixed Income Markets as Drivers of Securitised Real Estate, *Review of Financial Economics*, **18**, 103-111.

Clair, S.L., Touhey, A.T. & Turbeville, L.J. (2009). Nowhere to Go but Up: Managing Interest Rate Risk in a Low-Rate Environment, *FDIC Supervisory Insights*, **6**, 3-15.

Davies, R. B. (1987). Hypothesis testing when a nuisance parameter is present only under the alternative. *Biometrika,* **74,** 33-43.

Devaney, M. (2001). Time Varying Risk-Premia for Real Estate Investment Trusts: A GARCH-M Model. *The Quarterly Review of Economics and Finance*, **41**, 335-346.

Elyasiani, E. & Mansur, I. (1998). Sensitivity of the bank stock returns distribution to changes in the level and volatility of interest rates: A GARCH-M model, *Journal of Banking & Finance*, **22**: 535-563

Estrella, A. & Mishkin, F. (1997). The Predictive Power of the Term Structure of Interest Rates in Europe and the United States: Implications for the European Central Bank, *European Economic Review*, **41**, 1375-1401.

Faff, R.W., Howard, P.F., 1999. Interest rate risk of Australian financial sector companies in a period of regulatory change. Pacific-Basin Finance Journal. 7, 83-101.

Flannery, M.J., James, C.M., 1984. The effect of interest rate changes on the common stock returns of financial institutions. Journal of Finance. 39, 1141-1153.

Fogler, H. R., John, K. & Tipton, J. (1981). Three factors, interest rate differentials and stock groups. Journal of Finance, 36, 323-335

Garcia, R. (1998) Asymptotic Null Distribution of the Likelihood Ratio Test in Markov Switching Models, *International Economic Review*, **39**(3), pp. 763-788

Glascock, J., Lu, C. & So, R. (2000). Further Evidence on the Integration of REIT, Bond, and Stock Returns, *Journal of Real Estate Finance and Economics*, **20**, 177-194.

Glosten, L.R., Jagannathan, R. & Runkle, D.E. (1993). On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks, *Journal of Finance*, **48**, 1779-1801.

Greene, W. H. (2003). Econometric analysis, 5th. ed. Upper Saddle River, NJ: Prentice Hall.

Gurkaynak, R.S., Sack, B. & Swanson, E. (2007). Market Based Measures of Monetary Policy Expectations, *Journal of Business and Economic Statistics*, **25**, 201-212.

Gyourko, J. & Keim, D. B. (1992). What does the stock market tell us about real estate returns? Real Estate Economics, 20, 457-485

Hamilton JD (1989) A new approach to the economic analysis of nonstationary time series and the business cycle, *Econometrica* 57 pp.357–384

He, L., Webb, J.R. & Myer, F. (2003). Interest Rate Sensitivities of REIT Returns, *International Real Estate Review*, **6**, 1-21.

Kane, E. & Unal, H. (1988). Change in Market Assessments of Deposit-Institution Riskiness, *Journal of Financial Services Research*, **1**, 207-229.

Kim, C.-J., (1994). Dynamic linear models with markov-switching. Journal of Econometrics, **60**(1-2), 1-22.

Kodres, L. E. & Pritsker, M. (2002). A rational expectations model of financial contagion. *The Journal of Finance,* **57,** 769-799.

Krolzig, H. M. (1997). *Markov-switching vector autoregressions:(modelling, statistical interference, and application to business cycle analysis)*, Springer.

Lawrence, C. T. & Tits, A. (2001). A computationally efficient feasible sequential quadratic programming algorithm. *SIAM Journal on Optimization,* **11,** 1092-1118.

Liang, Y., McIntosh, W. & Webb, J. (1995). Intertemporal Changes in the Riskiness of REITs, *Journal of Real Estate Research*, **10**, 427-443.

Liow, K.H., Ooi, J.T.L. & Wang, L.K. (2003). Interest Rate Sensitivity and Risk Premium of Property Stocks. *Journal of Property Research*, **20**, 117-132.

Liow, K. H. & Huang, Q. (2006). Interest rate risk and time-varying excess returns for Asian property stocks. *Journal of Property Investment & Finance,* **24,** 188-210.

Lizieri, C. & Satchell, S. (1997). Property Company Performance and Real Interest Rates: A Regime-Switching Approach, *Journal of Property Research*, **14**, 85-97.

Madura, J., Zarruk, E.R., 1995. Bank exposure to interest rate risk: A global perspective. Journal of Financial Research. 18, 1-13.

Maheu, J. M. & McCurdy, T. H. (2000). Identifying bull and bear markets in stock returns. *Journal of Business & Economic Statistics***,** 100-112.

Mueller, G. & Pauley, K. (1995). The Effect of Interest-Rate Movements on Real Estate Investment Trusts, *Journal of Real Estate Research,* **10**, 319-325.

Okunev, J., Wilson, P. & Zurbruegg, R. (2000). The causal relationship between real estate and stock markets. Journal of Real Estate Finance and Economics, 21, 251-261.

Oppenheimer, P. & Grissom, T. V. (1998). Frequency space correlation between REITs and capital market indices. Journal of Real Estate Research, 16, 291-310.

Park, J. Y., Mullineaux, D. J. & Chew, I. K. (1990). Are REITs inflation hedges? *The Journal of Real Estate Finance and Economics,* **3,** 91-103.

Psaltis, E. & Chubb, S. (2008). *Riding out the Storm*, Ernst & Young: Global Real Estate Investment Trusts Report.

Serrano, C. & Hoesli, M. (2009). Global securitized real estate benchmarks and performance. Journal of Real Estate Portfolio Management, 15, 1-19.

Stevenson, S., Wilson, P.J. & Zurbruegg, R. (2007). Assessing the Time-Varying Interest Rate Sensitivity of Real Estate Securities. *European Journal of Finance*, **13**, 705-715.

Swanson, Z., Theis, J. & Casey, K. (2002). REIT Risk Premium Sensitivity and Interest Rates, *Journal of Real Estate Finance and Economics,* **24**, 319-330.

Sweeney, R. J. & Warga, A. D. (1986). The pricing of interest-rate risk: Evidence from the stock market. Journal of Finance, 41, 393-410.

Tufte, D., Wohar, M.E., 1999. Models with Unexpected Components: The Case for Efficient Estimation, Review of Quantitative Finance and Accounting. 13, 295-313.

Xu, P. & Yang, J. (2011). U.S. Monetary Policy Surprises and International Securitised Real Estate Markets, *Journal of Real Estate Finance and Economics*, **43**, 459-490

Yourougou, P. (1990). Interest-Rate Risk and the Pricing of Depository Financial Intermediary Common Stock: Empirical Evidence, *Journal of Banking & Finance,* **14**, 803-820.

Table 1. Markov-Switching Autoregression (MS-AR) results over 1993-2010, by country.

	Real Estate		Stock Market		Real Estate		Stock Market		Real Estate		Stock Market	
	Linear	MS	Linear	MS	Linear	MS	Linear	MS	Linear	MS	Linear	MS
	Australia				Hong Kong				Japan			
μ_0	0.009	-0.139	0.024*	-0.120**	0.028	-0.058	0.032	-0.050	0.001	-0.004	-0.011	-0.123
	(0.017)	(0.100)	(0.014)	(0.058)	(0.033)	(0.083)	(0.027)	(0.076)	(0.030)	(0.082)	(0.022)	(0.081)
μ_1		0.035***		0.066***		0.074**		0.071***		0.005		0.022
		(0.012)		(0.012)		(0.030)		(0.023)		(0.034)		(0.021)
ψ_{11}					0.122***	0.097***	0.007	-0.020	0.112***	0.109***	-0.046***	-0.071*
					(0.015)	(0.036)	(0.015)	(0.045)	(0.015)	(0.034)	(0.015)	(0.043)
ψ_{12}						0.159***		0.055***		0.115***		-0.019
						(0.021)		(0.018)		(0.027)		(0.019)
ψ_{21}					-0.023	-0.037			-0.088***	-0.115***		
					(0.015)	(0.031)			(0.015)	(0.031)		
ψ_{22}						0.005				-0.017		
						(0.020)				(0.025)		
σ_1	1.437***	2.563***	0.871***	1.571***	4.037***	2.913***	3.107***	2.703***	3.844***	2.775***	2.363***	2.438***
	(0.030)	(0.132)	(0.018)	(0.109)	(0.083)	(0.144)	(0.064)	(0.134)	(0.079)	(0.210)	(0.049)	(0.188)
σ_2		0.729***		0.637***		1.224***		1.082***		1.270***		1.135***
		(0.014)		(0.020)		(0.040)		(0.029)		(0.078)		(0.037)
p^{11}		0.9685		0.9576		0.9724		0.9817		0.9628		0.9575
Regime 1		32		24		36		55		27		24
p^{22}		0.9945		0.9880		0.9849		0.9916		0.9797		0.9874
Regime 2		181		84		66		119		49		80
Log L.	-7514.0	-6201.0	-6339.2	-5678.34	-9413.6	-8790.5	-8861.9	-8107.5	-9222.8	-8764.0	-8181.7	-7773.6
Linearity test		2626***		1321.7***		1238***		1505.3***		911.11***		813.4***
	Singapore				UK				US			
μ_0	0.020	-0.004	0.017	-0.057	0.015	-0.084	0.016	-0.072*	0.018	-0.062	0.024	-0.071*
	(0.030)	(0.133)	(0.022)	(0.066)	(0.020)	(0.077)	(0.015)	(0.043)	(0.020)	(0.080)	(0.016)	(0.042)
μ_1		0.027		0.049***		0.045***		0.059***		0.053***		0.076***
		(0.025)		(0.017)		(0.015)		(0.015)		(0.013)		(0.014)
ψ_{11}	0.109***	0.095**	0.090***	0.093***	0.047***	-0.002	-0.033**	-0.063*	-0.183***	-0.235***	-0.069***	-0.090***
	(0.015)	(0.039)	(0.015)	(0.034)	(0.015)	(0.034)	(0.015)	(0.034)	(0.015)	(0.050)	(0.015)	(0.032)
ψ_{12}		0.097***		0.067***		0.192***		0.028		0.168***		-0.001
		(0.021)		(0.023)		(0.022)		(0.021)		(0.025)		(0.020)
ψ_{21}			0.007	-0.002	0.037**	0.036	-0.052***	-0.075**	-0.042***	-0.066	-0.064***	-0.074*
			(0.015)	(0.036)	(0.015)	(0.031)	(0.015)	(0.037)	(0.015)	(0.052)	(0.015)	(0.040)
ψ_{22}				-0.007		0.034		-0.001		0.016		-0.029
				(0.021)		(0.023)		(0.022)		(0.026)		(0.023)
ψ_{31}							-0.073***	-0.094**				
							(0.015)	(0.038)				
ψ_{32}								-0.015				
								(0.022)				
σ_1	3.354***	3.277***	1.840***	2.107***	1.596***	2.320***	1.397***	1.799***	2.954***	3.285***	1.479***	1.816***
	(0.069)	(0.286)	(0.038)	(0.109)	(0.033)	(0.102)	(0.029)	(0.090)	(0.061)	(0.186)	(0.031)	(0.088)
σ_2		1.122***		0.787***		0.659***		0.732***		0.591***		0.698***
		(0.037)		(0.023)		(0.019)		(0.024)		(0.019)		(0.023)
p^{11}		0.9356		0.9632		0.9412		0.9820		0.9605		0.9793
Regime 1		16		27		17		56		25		48
p^{22}		0.9822		0.9831		0.9824		0.9919		0.9877		0.9892
Regime 2		56		59		57		124		81		93
Log L.	-9066.7	-8190.0	-7725.6	-6917.9	-7503.4	-6177.0	-7190.4	-6451.0	-8816.8	-6148.5	-7304.0	-6469.8
Linearity test		1750.1***		1608.4***		2655.1***		1505.7***		5339.9***		1671***

Figure 1. Smoothed Probabilities of Listed Real Estate being in the Bear Market Regime over 1993-2010, by country.

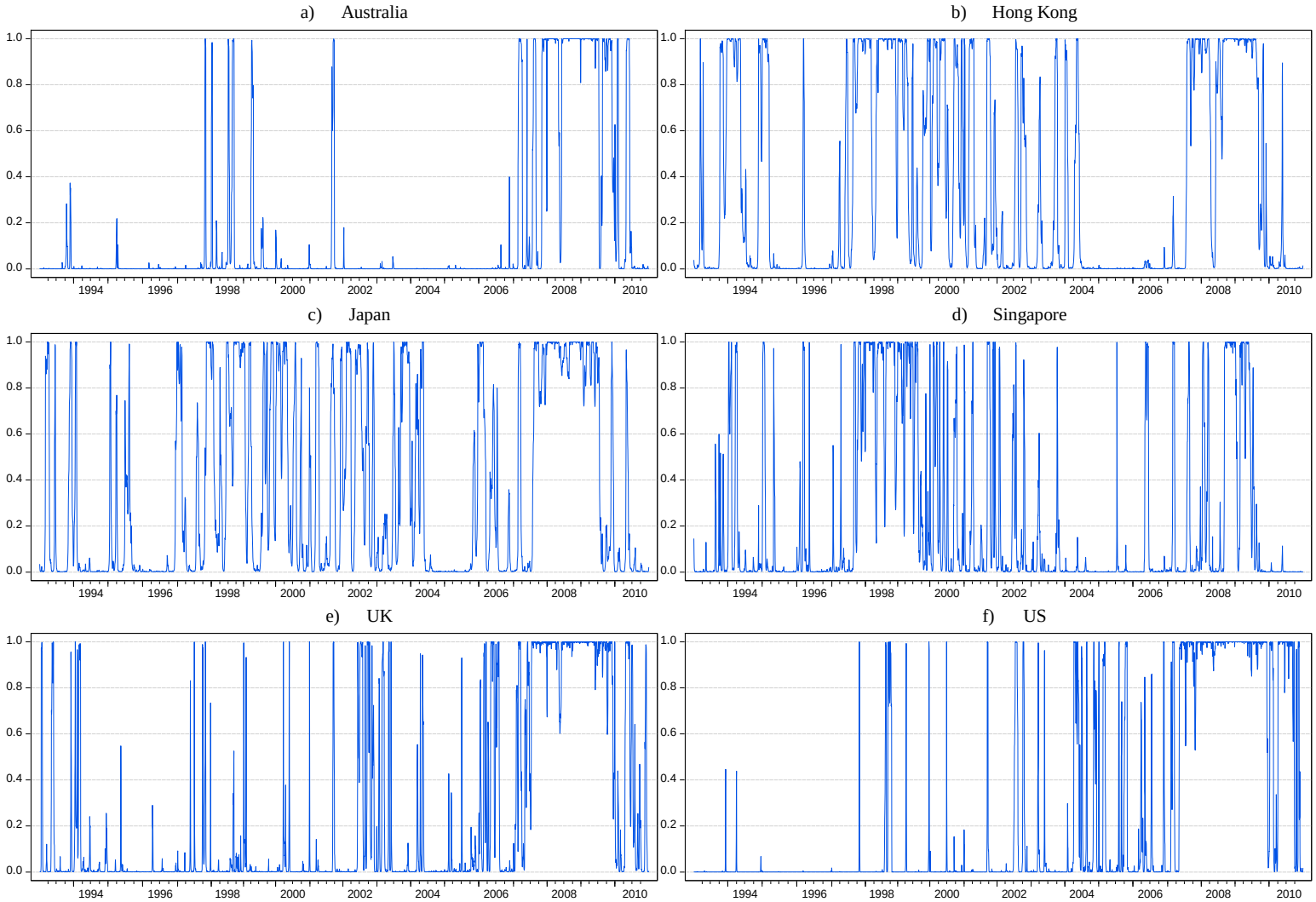

Table 2. Dynamic Markov-Switching Model Results, 1993-2010

	c_1	c_2	b_{11}	b_{12}	b_{21}	b_{22}	σ_1^2	σ_2^2	$b_{21}-b_{22}$	Wald
Australia										
1-m	-0.076	0.012	1.018***	0.582***	1.925	0.161	1.989***	0.612***	1.764	2.327
	0.079	0.010	0.058	0.026	1.876	0.214	0.146	0.015		
3-m	-0.077	0.012	1.020***	0.582***	1.707	0.107	1.991***	0.612***	1.600	1.887
	0.079	0.010	0.058	0.026	1.801	0.207	0.146	0.015		
12-m	-0.088	0.014	1.026***	0.568***	0.428	0.177	1.989***	0.603***	0.251	0.159
	0.080	0.010	0.058	0.022	0.843	0.109	0.134	0.014		
10-y	-0.093	0.014	1.026***	0.567***	-1.126	-0.328**	1.988***	0.603***	-0.798	0.704
	0.081	0.010	0.057	0.021	1.290	0.134	0.133	0.014		
TERM	-0.087	0.014	1.023***	0.567***	-1.403	-0.312***	1.981***	0.602***	-1.091	2.119
	0.079	0.010	0.056	0.021	1.187	0.120	0.129	0.014		
Hong Kong										
1-m	-0.018	0.000	1.019***	1.087***	-0.012	0.008	1.187***	0.479***	-0.020	0.195
	0.031	0.011	0.023	0.012	0.024	0.079	0.056	0.015		
3-m	-0.018	0.000	1.019***	1.087***	-0.019	0.008	1.187***	0.479***	-0.027	0.236
	0.031	0.011	0.023	0.012	0.033	0.061	0.056	0.015		
12-m	-0.011	-0.003	1.020***	1.091***	-0.066	-0.103	1.192***	0.477***	0.037	0.118
	0.032	0.011	0.023	0.012	0.076	0.121	0.057	0.015		
10-y	-0.022	0.000	1.012***	1.080***	-0.611*	-0.442***	1.198***	0.477***	-0.169	0.277
	0.032	0.012	0.024	0.015	0.365	0.144	0.059	0.018		
TERM	-0.020	0.000	1.015***	1.081***	0.011	-0.188**	1.204***	0.480***	0.199	5.781**
	0.033	0.012	0.024	0.016	0.027	0.092	0.061	0.019		
Japan										
1-m	0.031	-0.006	0.947***	0.844***	0.545	-0.169	1.773***	0.773***	0.714	0.309
	0.040	0.020	0.029	0.024	0.595	1.278	0.070	0.025		
3-m	0.032	-0.004	0.948***	0.842***	3.763	0.789	1.771***	0.772***	2.974	0.736
	0.040	0.020	0.029	0.024	4.284	2.671	0.072	0.029		
12-m	0.031	-0.005	0.947***	0.843***	0.114	0.876	1.771***	0.770***	-0.762	0.068
	0.040	0.020	0.029	0.023	3.204	0.789	0.069	0.024		
10-y	0.030	-0.005	0.947***	0.843***	1.968*	0.143	1.772***	0.774***	1.825	2.036
	0.040	0.020	0.029	0.024	1.172	0.697	0.071	0.027		
TERM	0.030	-0.005	0.947***	0.844***	1.033	-0.046	1.772***	0.773***	1.079	0.863
	0.040	0.020	0.029	0.024	1.018	0.572	0.070	0.025		
Singapore										
1-m	-0.026	0.010	1.203***	0.915***	-0.459***	0.095	1.664***	0.688***	-0.554	7.537***
	0.047	0.014	0.063	0.024	0.132	0.130	0.145	0.031		
3-m	-0.027	0.010	1.205***	0.915***	-0.752***	0.130	1.667***	0.689***	-0.882	8.668***
	0.048	0.014	0.062	0.024	0.261	0.206	0.141	0.031		
12-m	-0.026	0.010	1.206***	0.914***	-1.015***	-0.074	1.663***	0.688***	-0.941	4.934**
	0.047	0.014	0.065	0.025	0.364	0.294	0.148	0.032		
10-y	-0.010	-0.002	1.112***	0.909***	0.053	-0.256	1.484***	0.617***	0.309	0.128
	0.045	0.015	0.040	0.022	0.775	0.293	0.069	0.022		
TERM	-0.012	-0.002	1.111***	0.909***	0.651	-0.153	1.482***	0.616***	0.804	1.929
	0.045	0.015	0.040	0.022	0.472	0.295	0.071	0.022		
UK										
1-m	-0.054	0.029***	0.901***	0.384***	0.188	-0.044	1.809***	0.604***	0.232	0.074
	0.062	0.011	0.055	0.017	1.147	0.223	0.095	0.015		
3-m	-0.047	0.029***	0.904***	0.384***	1.475	-0.423*	1.807***	0.604***	1.898	3.732
	0.063	0.011	0.054	0.017	0.912	0.253	0.095	0.015		
12-m	0.029***	-0.046	0.384***	0.902***	0.084	1.520*	0.604***	1.806***	-1.436	2.165
	0.011	0.062	0.017	0.055	0.129	0.873	0.015	0.095		
10-y	0.028**	-0.047	0.382***	0.909***	-0.315	1.223	0.605***	1.802***	-1.538	1.975
	0.011	0.065	0.018	0.060	0.234	1.602	0.016	0.097		
TERM	-0.054	0.029***	0.901***	0.384***	-0.320	0.003	1.809***	0.604***	-0.323	0.190
	0.063	0.011	0.055	0.017	0.927	0.179	0.095	0.015		
US										
1-m	0.024	0.032***	1.560***	0.282***	-0.631	-0.174	1.856***	0.507***	-0.457	0.110
	0.055	0.010	0.069	0.016	2.902	0.218	0.111	0.017		
3-m	0.024	0.032***	1.563***	0.283***	-0.811	0.053	1.856***	0.507***	-0.864	0.270
	0.055	0.010	0.070	0.018	3.172	0.386	0.110	0.018		
12-m	0.023	0.032***	1.570***	0.281***	-2.817**	0.100	1.845***	0.507***	-2.917	7.598***
	0.054	0.010	0.065	0.015	1.333	0.223	0.104	0.016		
10-y	0.029	0.032***	1.596***	0.283***	-2.093**	-0.244	1.853***	0.509***	-1.849	4.916**
	0.055	0.010	0.071	0.016	0.936	0.182	0.106	0.016		
TERM	0.027	0.032***	1.557***	0.284***	-1.751*	-0.247	1.850***	0.509***	-1.504	4.404**
	0.055	0.010	0.071	0.017	0.941	0.166	0.107	0.018		

Table 3. Modified GARCH Model with absolute interest rate changes, 1993-2010

	a_0	a_1	a_2	a_3	a_4	b_4	b_5	$a_3 - a_4$	$b_4 - b_5$	Adj. R^2
Australia: Real Estate Market Regimes										
1-m	0.015	0.985***	0.545***	-0.081	0.193	1.951*	0.045	-0.275	1.905*	0.39
	0.009	0.038	0.015	1.431	0.194	1.090	0.077			
3-m	0.015	0.986***	0.545***	-0.444	0.161	1.851**	0.012	-0.605	1.840**	0.39
	0.009	0.039	0.015	1.307	0.195	0.882	0.055			
12-m	0.031***	1.043***	0.554***	0.178	-0.018	1.674	-0.502***	-0.325	2.177	0.39
	0.011	0.044	0.015	0.734	0.175	1.334	0.055			
10-y	0.015	0.984***	0.543***	-0.177	-0.387***	0.945**	-0.055	0.210	1.000**	0.40
	0.009	0.040	0.015	0.754	0.138	0.450	0.045			
TERM	0.015	0.988***	0.542***	0.010	-0.390***	0.982**	-0.087**	0.400	1.069**	0.40
	0.009	0.040	0.015	0.721	0.119	0.419	0.044			
Australia: Stock Market Regimes										
1-m	0.014	0.714***	0.567***	-0.135	0.270	0.491	0.053	-0.404	0.438	0.36
	0.010	0.023	0.017	0.769	0.199	0.347	0.088			
3-m	0.015	0.714***	0.566***	-0.370	0.152	0.373	0.013	-0.522	0.360	0.36
	0.010	0.023	0.017	0.695	0.206	0.233	0.065			
12-m	0.016*	0.716***	0.563***	-0.603	0.244***	0.371*	-0.096***	-0.847**	2.265***	0.36
	0.010	0.025	0.017	0.403	0.089	0.214	0.024			
10-y	0.014	0.712***	0.561***	-0.330	-0.433***	0.081	-0.095**	0.102	0.175*	0.36
	0.010	0.024	0.016	0.428	0.143	0.097	0.041			
TERM	0.015	0.716***	0.562***	-0.183	-0.422***	0.152	-0.106***	0.239	0.258**	0.37
	0.010	0.024	0.017	0.384	0.128	0.127	0.039			
Hong Kong: Real Estate Market Regimes										
1-m	0.001	1.104***	1.049***	-0.027	-0.179*	0.038**	-0.069**	0.152	0.107***	0.83
	0.009	0.010	0.010	0.023	0.106	0.016	0.030			
3-m	0.001	1.104***	1.048***	-0.041	-0.258*	0.045**	-0.056	0.216	0.101**	0.83
	0.009	0.010	0.010	0.033	0.139	0.021	0.048			
12-m	0.008	1.071***	1.026***	-0.146*	-0.501	0.167**	-0.306**	0.355	0.473***	0.83
	0.015	0.010	0.014	0.080	0.382	0.066	0.149			
10-y	0.004	1.085***	1.037***	-0.352*	-0.498***	0.087*	-0.171***	0.146	0.258***	0.82
	0.009	0.011	0.011	0.194	0.170	0.051	0.044			
TERM	0.002	1.092***	1.039***	0.019	-0.193	0.034*	-0.085*	0.211	0.120**	0.82
	0.010	0.011	0.011	0.025	0.130	0.019	0.051			
Hong Kong: Stock Market Regimes										
1-m	-0.003	1.059***	1.088***	-0.017	-0.172	0.031**	-0.056**	0.156	0.087***	0.83
	0.009	0.010	0.010	0.022	0.108	0.016	0.028			
3-m	-0.003	1.059***	1.087***	-0.026	-0.266*	0.036*	-0.052	0.241*	0.088*	0.83
	0.009	0.010	0.010	0.030	0.140	0.020	0.046			
12-m	-0.009	0.926***	1.099***	-0.132	-0.365*	0.322**	-0.341***	0.347	0.663***	0.83
	0.010	0.012	0.011	0.096	0.217	0.128	0.053			
10-y	-0.001	1.032***	1.078***	-0.420**	-0.450***	0.069	-0.121***	0.030	0.190***	0.82
	0.009	0.012	0.010	0.206	0.167	0.050	0.045			
TERM	-0.002	1.036***	1.082***	0.001	-0.112	0.022	-0.053	0.114	0.074	0.82
	0.010	0.012	0.010	0.023	0.138	0.016	0.046			
Japan: Real Estate Market Regimes										
1-m	0.015	1.118***	0.770***	-0.456	0.462	4.611**	-0.264	-0.917	4.874***	0.53
	0.015	0.026	0.016	1.514	0.539	1.817	0.204			
3-m	0.015	1.121***	0.768***	3.106	1.529*	5.688***	-0.501**	1.577	6.188***	0.53
	0.015	0.029	0.016	2.414	0.877	1.987	0.208			
12-m	0.012	1.114***	0.769***	-0.341	0.968	5.410**	-0.725***	-1.309	6.136***	0.53
	0.015	0.027	0.016	3.102	0.762	2.132	0.197			
10-y	0.014	1.123***	0.767***	2.093*	0.391	2.769***	-0.287	1.701	3.056***	0.53
	0.015	0.029	0.016	1.101	0.460	0.842	0.251			
TERM	0.014	1.125***	0.768***	1.027	0.012	2.422***	-0.226	1.014	2.648***	0.53
	0.015	0.029	0.016	1.039	0.439	0.762	0.204			
Japan: Stock Market Regimes										
1-m	0.011	0.952***	0.878***	0.477	0.263	2.841	0.068	0.214	2.774	0.51
	0.016	0.026	0.016	1.815	0.606	2.044	0.286			
3-m	0.013	0.964***	0.875***	1.172	1.898*	1.463*	-0.203	-0.727	1.666**	0.51
	0.016	0.032	0.016	2.156	1.010	0.778	0.250			
12-m	0.010	0.955***	0.877***	-1.800	0.813	3.398*	-0.432**	-2.613	3.830**	0.51
	0.016	0.028	0.016	3.614	0.806	1.774	0.195			
10-y	0.012	0.961***	0.877***	1.381	0.605	1.793**	-0.058	0.776	1.851**	0.51
	0.016	0.030	0.016	1.417	0.448	0.724	0.256			
TERM	0.012	0.962***	0.878***	0.566	0.146	1.535**	-0.028	0.420	1.563**	0.51
	0.016	0.030	0.016	1.286	0.449	0.658	0.198			

Table 3 – Continued

	a_0	a_1	a_2	a_3	a_4	b_4	b_5	$a_3 - a_4$	$b_4 - b_5$	Adj. R^2
Singapore: Real Estate Market Regimes										
1-m	0.018	1.193***	0.877***	-0.268	0.020	0.524***	0.118***	-0.288	0.407***	0.66
	0.012	0.028	0.014	0.183	0.128	0.157	0.037			
3-m	0.018	1.192***	0.876***	-0.406	0.025	0.598***	0.132***	-0.431	0.466**	0.66
	0.012	0.028	0.014	0.265	0.188	0.201	0.050			
12-m	0.019	1.194***	0.876***	-0.741**	-0.185	0.811***	0.124*	-0.556	0.687**	0.66
	0.012	0.029	0.014	0.350	0.219	0.280	0.071			
10-y	0.007	1.152***	0.868***	0.853	-0.281	0.608**	-0.113	1.134	0.720**	0.68
	0.013	0.032	0.015	0.882	0.282	0.300	0.079			
TERM	0.007	1.152***	0.869***	0.805	-0.276	0.698***	-0.040	1.081*	0.737***	0.68
	0.013	0.032	0.015	0.526	0.238	0.260	0.077			
Singapore: Stock Market Regimes										
1-m	0.016	1.027***	0.938***	-0.206	-0.043	0.492***	0.107***	-0.163	0.385***	0.65
	0.012	0.020	0.019	0.202	0.130	0.141	0.034			
3-m	0.016	1.025***	0.938***	-0.434	-0.009	0.607***	0.118**	-0.425	0.489***	0.65
	0.012	0.020	0.019	0.284	0.193	0.184	0.048			
12-m	0.016	1.027***	0.937***	-0.627	-0.341	0.746***	0.094	-0.286	0.653***	0.65
	0.012	0.020	0.019	0.385	0.224	0.243	0.067			
10-y	0.004	1.000***	0.906***	-0.282	-0.139	-0.097	-0.061	-0.143	-0.036	0.66
	0.013	0.020	0.022	0.467	0.324	0.097	0.074			
TERM	0.005	1.001***	0.905***	0.092	-0.187	0.006	0.000	0.279	0.005	0.66
	0.013	0.021	0.022	0.348	0.286	0.087	0.073			
UK: Real Estate Market Regimes										
1-m	0.034***	0.952***	0.328***	-0.512	-0.050	7.521***	-0.112	-0.462	7.633***	0.39
	0.010	0.032	0.013	1.066	0.208	2.543	0.122			
3-m	0.036***	0.922***	0.327***	0.382	-0.450*	4.524***	-0.131	0.832	4.655***	0.39
	0.010	0.034	0.014	0.938	0.261	1.491	0.148			
12-m	0.053***	0.875***	0.330***	-0.192	0.862	3.472**	-0.901*	-1.054	4.373***	0.39
	0.011	0.032	0.014	0.804	0.573	1.511	0.513			
10-y	0.036***	0.911***	0.326***	0.588	-0.687***	5.387***	-0.049	1.275	5.435***	0.39
	0.010	0.039	0.013	0.859	0.200	1.127	0.167			
TERM	0.038***	0.930***	0.326***	0.292	-0.258	5.705***	0.135	0.550	5.570***	0.39
	0.010	0.037	0.013	0.712	0.175	1.074	0.173			
UK: Stock Market Regimes										
1-m	0.030***	0.439***	0.440***	0.237	-0.167	0.323	0.031	0.404	0.293	0.30
	0.010	0.019	0.017	0.542	0.248	0.199	0.099			
3-m	0.030***	0.440***	0.444***	0.364	-0.780***	0.291	-0.059	1.144	0.350*	0.30
	0.011	0.019	0.018	0.649	0.253	0.222	0.116			
12-m	0.033***	0.443***	0.441***	1.533***	-0.217	0.110	-0.166**	1.751***	0.276**	0.30
	0.010	0.019	0.017	0.475	0.157	0.148	0.067			
10-y	0.030***	0.446***	0.441***	0.622	-0.754***	0.309	-0.080	1.375**	0.389**	0.30
	0.010	0.020	0.018	0.505	0.225	0.203	0.095			
TERM	0.030***	0.445***	0.440***	0.211	-0.207	0.323*	-0.029	0.418	0.352**	0.30
	0.010	0.019	0.018	0.446	0.187	0.185	0.083			
US REITs Regimes										
1-m	0.026***	1.024***	0.247***	-0.622	0.073	1.491*	-0.121*	-0.695	1.612**	0.53
	0.008	0.064	0.010	1.493	0.324	0.768	0.069			
3-m	0.025***	1.029***	0.247***	-0.833	0.044	2.551**	-0.184***	-0.876	2.735**	0.53
	0.008	0.067	0.010	1.921	0.325	1.151	0.071			
12-m	0.025***	1.027***	0.247***	-1.055	-0.228	1.730***	-0.159***	-0.827	1.890***	0.53
	0.008	0.069	0.010	0.990	0.145	0.536	0.059			
10-y	0.026***	1.015***	0.246***	-1.524**	-0.295**	1.417***	-0.132**	-1.230	1.549***	0.53
	0.008	0.078	0.010	0.748	0.142	0.461	0.053			
TERM	0.025***	1.019***	0.246***	-1.267*	-0.243*	1.292***	-0.141***	-1.024	1.433***	0.54
	0.008	0.078	0.010	0.686	0.126	0.422	0.044			
US: Stock Market Regimes										
1-m	0.017**	0.305***	0.309***	0.397	-0.080	0.059	-0.098	0.477	0.158	0.23
	0.008	0.013	0.014	0.632	0.398	0.154	0.064			
3-m	0.016**	0.304***	0.308***	0.488	-0.176	-0.024	-0.147**	0.665	0.123	0.23
	0.008	0.012	0.014	0.502	0.317	0.124	0.059			
12-m	0.015*	0.305***	0.311***	0.162	-0.316*	0.031	-0.093**	0.477	0.124	0.23
	0.008	0.013	0.014	0.410	0.165	0.094	0.044			
10-y	0.014*	0.306***	0.310***	-0.424	-0.402**	-0.019	-0.099**	-0.023	0.080	0.23
	0.008	0.013	0.014	0.287	0.158	0.067	0.048			
TERM	0.014*	0.304***	0.310***	-0.465*	-0.300**	-0.028	-0.101**	-0.164	0.073	0.23
	0.008	0.013	0.014	0.267	0.140	0.058	0.039			

Table 4. Modified GARCH Model with interest rate volatility, 1993-2010

	a_0	a_1	a_2	a_3	a_4	b_4	b_5	$a_3 - a_4$	$b_4 - b_5$	Adj. R^2
Australia: Real Estate Market Regimes										
1-m	0.015	0.992***	0.543***	0.231	0.188	6.900*	0.007	0.043	6.893*	0.40
	0.009	0.041	0.015	1.416	0.194	4.013	0.111			
3-m	0.015	0.990***	0.543***	-0.509	0.155	7.420**	-0.088	-0.665	7.508**	0.39
	0.009	0.042	0.015	1.262	0.196	3.515	0.197			
12-m	0.017*	1.002***	0.538***	-0.664	0.183*	4.064**	-0.038	-0.847	4.102**	0.39
	0.010	0.043	0.015	0.623	0.109	2.039	0.024			
10-y	0.015	1.025***	0.554***	0.020	-0.332**	336.281***	-7.404***	0.353	343.684***	0.40
	0.010	0.048	0.015	0.915	0.139	45.428	2.592			
TERM	0.015	1.036***	0.552***	-0.261	-0.321***	226.600***	-6.555***	0.060	233.155***	0.40
	0.010	0.047	0.015	0.803	0.120	30.922	1.832			
Australia: Stock Market Regimes										
1-m	0.015	0.712***	0.564***	0.055	0.259	2.120*	-0.001	-0.204	2.122*	0.36
	0.010	0.023	0.017	0.684	0.201	1.137	0.113			
3-m	0.014	0.707***	0.563***	-0.287	0.151	0.901	-0.049	-0.438	0.949	0.36
	0.010	0.024	0.017	0.639	0.206	0.634	0.219			
12-m	0.017*	0.725***	0.564***	-0.682*	0.281**	1.856***	-0.141***	-0.962**	1.997***	0.36
	0.010	0.024	0.017	0.377	0.111	0.555	0.017			
10-y	0.014	0.709***	0.561***	-0.328	-0.429***	0.651	-0.403*	0.101	1.053	0.36
	0.010	0.024	0.017	0.421	0.143	0.688	0.224			
TERM	0.014	0.710***	0.563***	-0.207	-0.411***	0.942	-0.140	0.204	1.082	0.36
	0.010	0.024	0.017	0.374	0.130	0.850	0.196			
Hong Kong: Real Estate Market Regimes										
1-m	0.001	1.100***	1.050***	-0.022	-0.143	0.000	-0.060***	0.121	0.060***	0.83
	0.009	0.011	0.010	0.019	0.112	0.000	0.023			
3-m	0.000	1.099***	1.048***	-0.039	-0.220	0.000	-0.063	0.181	0.063	0.83
	0.009	0.011	0.010	0.030	0.143	0.000	0.040			
12-m	0.001	1.098***	1.053***	-0.111	-0.255**	-0.001	0.004	0.144	-0.004	0.83
	0.009	0.011	0.010	0.069	0.111	0.002	0.022			
10-y	0.002	1.083***	1.038***	-0.378**	-0.501***	0.133*	-0.286***	0.123	0.419***	0.82
	0.010	0.012	0.011	0.184	0.172	0.074	0.096			
TERM	0.001	1.086***	1.039***	0.017	-0.226*	0.000	-0.210***	0.243*	0.210***	0.82
	0.010	0.012	0.011	0.022	0.130	0.001	0.055			
Hong Kong: Stock Market Regimes										
1-m	-0.004	1.053***	1.088***	-0.015	-0.133	0.000	-0.062**	0.118	0.062**	0.83
	0.009	0.011	0.010	0.020	0.109	0.000	0.025			
3-m	-0.004	1.052***	1.087***	-0.032	-0.232	0.000	-0.081*	0.200	0.081*	0.83
	0.009	0.011	0.010	0.031	0.141	0.000	0.046			
12-m	-0.003	1.053***	1.093***	-0.103	-0.281**	-0.002	0.001	0.178	-0.003	0.83
	0.009	0.011	0.011	0.071	0.110	0.001	0.026			
10-y	-0.002	1.028***	1.080***	-0.453**	-0.461***	0.130*	-0.306***	0.008	0.436***	0.82
	0.010	0.012	0.010	0.205	0.167	0.079	0.088			
TERM	-0.003	1.028***	1.082***	0.007	-0.137	-0.001	-0.156**	0.144	0.156**	0.82
	0.010	0.013	0.010	0.023	0.140	0.000	0.067			
Japan: Real Estate Market Regimes										
1-m	0.014	1.126***	0.770***	-1.017	0.543	17.753**	-2.109	-1.559	19.863**	0.53
	0.015	0.028	0.016	1.413	0.525	7.553	1.383			
3-m	0.017	1.124***	0.768***	2.293	1.381	32.850**	-2.955**	0.912	35.805**	0.53
	0.015	0.027	0.016	2.556	0.876	14.780	1.403			
12-m	0.013	1.117***	0.771***	-0.295	0.713	72.706*	-6.840***	-1.008	79.546*	0.53
	0.015	0.026	0.016	3.013	0.751	39.750	2.524			
10-y	0.014	1.120***	0.769***	1.877*	0.377	42.033***	-3.179	1.500	45.212***	0.53
	0.015	0.027	0.016	1.115	0.459	13.568	2.443			
TERM	0.014	1.120***	0.768***	0.982	0.016	40.409***	-3.991**	0.966	44.400***	0.53
	0.015	0.026	0.016	1.056	0.438	12.514	1.790			
Japan: Stock Market Regimes										
1-m	0.011	0.961***	0.877***	-0.505	0.222	17.545*	0.331	-0.727	17.214*	0.51
	0.016	0.030	0.016	1.750	0.602	10.039	1.549			
3-m	0.013	0.963***	0.876***	0.924	1.889*	7.539	-1.521	-0.965	9.060	0.51
	0.016	0.030	0.016	2.181	1.027	5.670	1.525			
12-m	0.010	0.954***	0.879***	-1.258	0.685	46.069	-6.341***	-1.943	52.410	0.51
	0.016	0.026	0.016	3.118	0.806	31.392	2.328			
10-y	0.012	0.958***	0.877***	1.361	0.585	34.581**	-0.960	0.776	35.541**	0.51
	0.016	0.028	0.016	1.436	0.447	16.259	2.461			
TERM	0.012	0.958***	0.878***	0.644	0.121	27.052**	-1.485	0.524	28.537**	0.51
	0.016	0.027	0.016	1.298	0.447	13.577	1.962			

Table 4 – Continued

	a_0	a_1	a_2	a_3	a_4	b_4	b_5	$a_3 - a_4$	$b_4 - b_5$	Adj. R^2
Singapore: Real Estate Market Regimes										
1-m	0.018	1.190***	0.876***	-0.241	0.019	0.183	0.090*	-0.260	0.092	0.66
	0.012	0.028	0.014	0.168	0.125	0.133	0.049			
3-m	0.018	1.191***	0.876***	-0.373	0.026	0.363	0.233*	-0.399	0.131	0.66
	0.012	0.028	0.014	0.263	0.186	0.264	0.130			
12-m	0.018	1.189***	0.875***	-0.788**	-0.170	0.692	0.098	-0.618	0.594	0.66
	0.012	0.028	0.014	0.345	0.209	0.492	0.183			
10-y	0.007	1.152***	0.867***	0.872	-0.260	2.013	-0.208	1.133	2.221	0.68
	0.013	0.031	0.015	0.886	0.283	2.039	0.281			
TERM	0.007	1.152***	0.868***	0.789	-0.268	2.767**	-0.076	1.057*	2.843**	0.68
	0.013	0.031	0.015	0.520	0.237	1.305	0.347			
Singapore: Stock Market Regimes										
1-m	0.015	1.025***	0.937***	-0.209	-0.035	0.253**	0.052	-0.174	0.201	0.65
	0.012	0.020	0.019	0.209	0.128	0.123	0.047			
3-m	0.014	1.024***	0.937***	-0.386	-0.010	0.449*	0.153	-0.376	0.296	0.65
	0.012	0.020	0.019	0.290	0.193	0.237	0.121			
12-m	0.015	1.024***	0.936***	-0.674*	-0.331	0.790*	0.029	-0.343	0.761	0.65
	0.012	0.020	0.019	0.388	0.219	0.455	0.176			
10-y	0.005	0.999***	0.906***	-0.262	-0.137	-0.878	-0.160	-0.125	-0.718	0.66
	0.013	0.020	0.022	0.471	0.328	0.725	0.294			
TERM	0.005	1.001***	0.905***	0.097	-0.186	0.278	-0.035	0.283	0.312	0.66
	0.013	0.021	0.022	0.346	0.287	0.551	0.374			
UK: Real Estate Market Regimes										
1-m	0.034***	0.904***	0.326***	-1.404*	-0.071	30.070***	-0.010	-1.333	30.080***	0.39
	0.010	0.034	0.013	0.828	0.209	9.383	0.803			
3-m	0.036***	0.927***	0.327***	-0.261	-0.432	46.513***	-1.525	0.172	48.038***	0.39
	0.010	0.031	0.013	0.912	0.272	14.995	1.132			
12-m	0.035***	0.980***	0.328***	-1.001	0.079	90.899***	-0.168	-1.080	91.067***	0.38
	0.010	0.032	0.013	0.794	0.143	18.781	0.413			
10-y	0.027***	0.927***	0.330***	0.547	-0.526**	602.521***	-1.516	1.073	604.037***	0.39
	0.010	0.038	0.013	0.855	0.205	89.593	4.671			
TERM	0.029***	0.934***	0.330***	0.057	-0.187	371.017***	0.493	0.244	370.524***	0.39
	0.010	0.036	0.013	0.685	0.176	56.613	3.745			
UK: Stock Market Regimes										
1-m	0.031***	0.441***	0.438***	0.233	-0.144	2.656**	0.297	0.376	2.359*	0.30
	0.010	0.020	0.017	0.547	0.244	1.329	0.491			
3-m	0.030***	0.440***	0.443***	0.286	-0.766***	2.195	-0.662	1.052	2.857**	0.30
	0.010	0.019	0.018	0.670	0.254	1.386	0.571			
12-m	0.031***	0.442***	0.440***	1.426***	-0.278*	0.451	-0.195	1.704***	0.646	0.30
	0.011	0.019	0.017	0.497	0.166	0.424	0.156			
10-y	0.029***	0.444***	0.442***	0.575	-0.739***	3.630	-0.892*	1.314**	4.523**	0.30
	0.011	0.020	0.018	0.505	0.225	2.314	0.533			
TERM	0.029***	0.443***	0.441***	0.169	-0.196	2.135	-0.799*	0.365	2.934**	0.30
	0.010	0.020	0.018	0.451	0.187	1.439	0.442			
US REITs Regimes										
1-m	0.025***	1.021***	0.246***	-0.591	0.001	3.753	-0.021	-0.592	3.774	0.53
	0.008	0.063	0.010	1.321	0.301	2.974	0.261			
3-m	0.025***	1.034***	0.246***	-0.792	-0.243	21.068*	-0.983***	-0.549	22.051**	0.54
	0.008	0.066	0.010	1.789	0.292	10.755	0.339			
12-m	0.024***	1.035***	0.247***	-1.177	-0.217	10.961***	-1.112***	-0.960	12.072***	0.54
	0.008	0.065	0.010	0.956	0.153	3.990	0.420			
10-y	0.026***	1.022***	0.245***	-1.566**	-0.325**	22.237***	-1.529**	-1.241	23.766***	0.54
	0.008	0.079	0.010	0.770	0.145	6.680	0.708			
TERM	0.026***	1.037***	0.245***	-1.262*	-0.262**	18.724***	-1.395***	-1.000	20.119***	0.54
	0.008	0.078	0.010	0.691	0.126	5.642	0.351			
US: Stock Market Regimes										
1-m	0.016**	0.304***	0.310***	0.394	-0.124	-0.249	0.090	0.518	-0.339	0.23
	0.008	0.013	0.014	0.646	0.359	0.191	0.374			
3-m	0.016**	0.304***	0.307***	0.406	-0.193	-0.407	-1.190***	0.599	0.782	0.23
	0.008	0.012	0.014	0.510	0.290	0.292	0.393			
12-m	0.014*	0.305***	0.311***	0.163	-0.322*	0.453	-0.683*	0.485	1.136	0.23
	0.008	0.013	0.014	0.412	0.172	0.801	0.360			
10-y	0.014*	0.304***	0.309***	-0.431	-0.442***	0.087	-0.686	0.011	0.773	0.23
	0.008	0.013	0.014	0.291	0.160	0.894	0.606			
TERM	0.014*	0.303***	0.310***	-0.470*	-0.346**	-0.216	-0.697*	-0.124	0.481	0.23
	0.008	0.013	0.014	0.271	0.142	0.491	0.386			