An Examination of Volatility Dynamics in Australian REIT Futures

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Abstract

This study aims to examine the volatility spillover in Australian REIT futures over the study period of 2004-2008. An Exponential-Generalized Autoregressive Conditional Heteoskedasticity (EGARCH) model is employed to analyze the volatility series of REIT futures. The results show that REITs futures are heavily influenced by REITs and stocks, suggesting that the news originated from these markets will affect REITs futures. The results also illustrates that the equity market is more influential than REITs in affecting the volatility of REIT futures. It is also shown that REIT futures are more sensitive to negative news than positive news. These findings have provided additional insights into the volatility patterns of property futures.

Keywords: Volatility spillover, REIT futures, EGARCH, Australia.

1.0 INTRODUCTION

Real Estate Investment Trusts (REITs) has been one of the largest and most successful indirect property investment vehicles in Australia. In January 2008, 59 REITs were listed on the Australian Securities Exchange (ASX) with a total market capitalization of AUD$117.46 billion, representing around 9% of the total ASX market capitalization (AME, 2008, ASX, 2008). Currently, the Australia REIT market is the second largest REIT market in the world and accounts for approximately 14% of the total global REIT market capitalization (AME, 2008). In June 2007, over 4300 commercial properties in Australia and overseas were managed by Australian REITs (PIR, 2007). Besides, almost 58% of the total commercial properties in Australia were owned and managed by Australian REITs (ABS, 2007).

Given the significance of the Australian REIT market, the Australian Stock Exchange (ASX)[1] has introduced the first REIT futures in the world in 2002. This product has provided a more efficient risk management tool to institutional investors in managing their REIT portfolios. Nowadays, the REIT futures market has emerged as an appealing and effective tool for hedging, speculation, and arbitrage as well as transition management to fund managers, asset allocators and arbitrageurs. The increasing popularity of REIT futures among property investors and fund managers is also evident in recent years. As shown in Figure 1, the use of REIT futures has increased dramatically from 7,924 lots in July 2005 to 43,525 lots in December 2008.

[1] Australian Stock Exchange and Sydney Futures Exchange merged on 25 July 2006 in order to form the Australian Securities Exchange (ASX). The combined entity appears as the 9th largest listed exchange in the world (ASX, 2008).

In December 2007, the transaction volume also achieved a record high with 80,158 futures contracts valued at AUD$1.715billion.

(Insert Figure 1)

More recently, the growth of property futures has also been witnessed in other countries such as the United States (U.S.). The Dow Jones U.S. Real Estate Index Futures contracts have been launched on 21 January 2007 by the Chicago Board of Trade. This is the futures market based on the performance of U.S. real estate securities. Similar products for direct commercial real estate and housing were also launched by the Chicago Mercantile Exchange in the early 2007 and May 2006 respectively in the U.S. Similarly, a rapid growth of property derivatives is also evident in the United Kingdom (U.K.). The total volume of property derivatives traded in the U.K. reached £11.2 billion. The total notional of trades executed in Q42008 was also 5 times higher than at the end of 2005. This figure is expected to reach £100 billion by 2010 (Just and Feil, 2007).

Even though property futures are considered as the relatively new investment product in property investment, futures markets are well established for stocks, cash and other commodity markets. One of the areas of interest in the futures markets literature is the volatility linkages of futures markets and capital assets (stocks, bonds and cash). Generally, most previous research has shown that there are strong volatility linkages between futures markets and those of spot markets. In the real estate literature, a number of property studies have demonstrated the volatility linkages across international real estate markets and volatility spillover in REITs (Stevenson, 2002;

Liow *et al.*, 2005; Liow *et al.*, 2009). These studies have also presented the evidence of volatility clustering in real estate. However, little real estate studies have been concerned with the volatility of property futures. More specifically, no detailed study has been conducted on the volatility linkages between REIT futures and REITs, as well as other financial assets despite significant evidence of volatility spillover effects has been presented between stocks and stock futures such as Fleming *et al.* (1998) and Tse (1999). Importantly, these findings will not necessarily generalize into the property futures market since the Australian REIT futures market is a relative small futures market compared to other futures sectors (Newell and Tan, 2004). In addition, a sector effect in the derivative market was found by Bodnar *et al.* (1996) and Ceuster *et al.* (2000) in which the use of derivatives is strongly subject to sectors. More importantly, derivatives (including REIT futures) are employed by almost 80% of property funds in Australia for a range of reasons (Lee, 2009). For example, the Wholesale Australian Diversified Property Securities Fund employed REIT futures for hedging the market risk (AXA, 2009). Given the significant growth of REIT futures in recent years and the sector effect, a specific study on REIT futures is essential for providing some insights to property investors and professionals.

The aim of this study is to present a comprehensive investigation of volatility spillover in Australian REIT futures. There are two important contributions from this study. Firstly, this is one of the limited studies that comprehensively explored the property futures market. This paper is unique, in contrast to the previous property futures studies, which it employs Australian REIT futures. Importantly, Australian REIT futures being a world first for this type of property investment vehicle; offers a reasonable large dataset for examining the issues surrounding REIT futures. Secondly, this probably is the first study on the volatility transmission mechanism of REIT futures. The intuition behind for this investigation is to determine whether different assets affect REIT futures differently. In addition, the directions of causality between the volatilities of REIT futures and these financial assets were also investigated for the first time. An enhanced understanding of volatility linkages between REIT futures and financial assets is critical for a variety of investment and risk management decisions. As pointed out by Fleming *et al.* (1998), an expectation of increased volatility for an asset would lead investors and fund managers to reallocate or switch their funds to other asset such as bonds. Nonetheless, the risk reduction from the shift is subject to the volatility linkage between these assets. In other words, little diversification could be obtained if strong volatility interactions are presented in both assets.

The remainder of this paper is organized as follows. The following section provides a literature review on volatility spillovers in financial futures and real estate. The literature of property derivatives is also reviewed. Data and methodology are discussed in Section 3. Empirical findings are then reported and discussed in Section 4. The final section concludes the paper.

2.0 LITERATURE REVIEW

The volatility transmission between spot and futures markets has attracted a lot of attention in the finance literature in respect to the second moment (volatility) has been viewed as an important variable that contains essential information. Most importantly, Ross (1989) employed the no-arbitrage martingale analysis and reported that the volatility of an asset is directly related to the rate of information flow to the market rather than the changes of the asset. In other words, understanding and modeling the volatility pattern of an asset is crucial.

Kawaller *et al.* (1990) probably the first attempt to investigate the volatility linkages between S&P 500 futures prices and S&P 500 index. The results revealed that the volatility of futures exceeds the volatility of S&P 500. The Granger causality tests showed little evidence of futures volatility was systematically leading the volatility of index. Comparable results were also reported by Cheung and Ng (1991) in the U.S. Arshanapalli and Doukas (1994) found little evidence of the interdependence between stock and stock futures in the second moment. Additionally, their results also exhibited that the volatility of futures and stocks are time varying and do not share a common volatility process. The lead-lag volatility results from Abhyankar (1995) also did not find any interdependence relationships between the U.K. stocks and its futures volatility.

Chan *et al.* (1991), however, offered the evidence of inter-market dependence in the volatility of futures and stocks by utilizing a bi-variate AR(1)-GARCH(1,3) model. Besides, a strong persistence in the volatility of both markets is also documented, reflecting that the time variation in the volatility of intraday stock and futures returns. Tse (1999) studied the price discovery and volatility spillovers in Dow Jones Industrial Average Index and the index futures. The results supported the dominant role of DJIA futures in returns. A bidirectional volatility spillover in the DJIA index and the index futures is also evident; the spillovers from futures to index appear to be more significant than from index to futures. Similar results are also documented by Min and Najand (1999) in the Korean stock market. Volatility spillover effects are also found in the Australian spot and futures markets by Bhar (2001). Fleming *et al.* (1998) and Kim *et al.* (2001) studied the volatility linkages between the stock, bond and money futures markets. Significant volatility linkages among these financial futures markets are also demonstrated in the U.S. and Australia, suggesting that these markets are highly correlated with reference to the volatility movements and news originated in one futures market has significant effects on the volatility of other futures markets.

The evidence concerning the volatility relationships across markets have also been presented by numerous real estate studies. Most studies emphasized on the volatility relationships across international real estate markets such as Garvey *et al.* (2001), Liow *et al.* (2005), Zhu and Liow (2005) and Michayluk *et al.* (2006). Several real estate studies have also demonstrated the volatility linkages between REITs and capital assets. For instance, Stevenson (2002) found that small cap and value stocks have strong influence on U.S. REITs. Cotter and Stevenson (2006), however, utilized a multivariate VAR-GARCH model and offered evidence of the volatility spillovers in U.S. REITs with higher frequency data. The results also illustrated that the influences of small cap and value stocks are weaker on daily returns basis. Nevertheless, the general equity market appears to be more influential with higher frequency data. Lee (2008) examined the volatility spillovers in Australian direct commercial property. Strong volatility linkages among direct property, LPTs and bonds are also identified in this study. In addition, the persistence of time-varying volatility (or volatility clustering)[2] is also presented in the housing and real estate markets (Crawford and Fratantoni, 2003, Cotter and Stevenson, 2006, Miller and Peng, 2006).

However, there is far less formal attention has been placed to the dynamics of property futures volatilities. This is attributed to the lack of data in light of the short history of property futures. Although the first futures contract based on property was introduced in the United Kingdom (U.K.) in 1991, the uneconomically trading intensity has caused the suspension of this product (Patel, 1994). The author also found that the failure of providing hedging benefits, high transaction costs and long time lags involved, are the main reasons for the failure of property futures in the U.K.

Newell and Tan (2004) probably was the first study to examine the hedging benefits of the Australian LPT futures market. Their results exhibited that institutional investors can effectively hedge their LPT portfolios using Australian LPT futures. Importantly, the hedging benefits have been also argued as one of the key factors in the success of futures markets (Nothaft *et al.*, 1995). More recently, Wong *et al.* (2007) have provided some evidence of housing forwards. They found that the volatility of housing forwards market (pre-sales) leads the spot housing market. Besides, Wong *et al.* (2006) also showed the evidence of housing forwards stabilizing the Hong Kong housing market. On the other hand, Jud and Winkler (2008) examined the return and risk of the U.S. housing futures market. The empirical results demonstrated that there is little evidence of any systematic relation between the movement of housing futures and housing price indices. Comparable evidence is also

[2] The presence of time-varying volatility in an asset series, indicating that conducting a detailed analysis on the volatility of the asset is essential.

found by Hinkelmann and Swidler (2008). More importantly, the results also highlighted the inefficient of hedging house portfolio in respect to the low correlation between several state and regional house price indices.

In conclusion, many studies have been sought to understand the volatility linkages between stock futures and spot markets, whereas relatively little attention has been devoted to REIT futures. Importantly, the underlying asset of REIT futures (REITs) has several unique characteristics in comparison to stocks such as tax transparency, high dividend payout ratio and others. Moreover, extensive empirical studies have demonstrated that the empirical results from stocks may not be automatically extended to the REIT market due to the unique characteristics of REITs. Therefore, an investigation specifically for the REIT futures market is essential.

3.0 DATA AND METHODOLOGY

Data

To assess the volatility linkages between REIT futures and capital assets, the study utilized the daily closing prices of the S&P/ASX 200 A-REIT Index futures, S&P/ASX 200 A-REIT Index, S&P/ASX 200 Index and UBS Australian Composite All Maturities Bonds Index over the study period from 6th December 2004 to 18th December 2008 with 17 contracts and 1022 observations[3]. The historical data of the

[3] Daily data rather than intraday data were employed in this study in order to minimise problems of non-synchronous. It should be noted that the transaction volume of REIT futures is still relatively small in comparison to the futures of stocks and commodities. The pilot test also showed that it is not feasible to employ intraday data of REIT futures with respect to the low trading volume.

S&P/ASX 200 A-REIT Index, S&P/ASX 200 Index and UBS Australian Composite All Maturities Bonds Index were obtained from DataStream. However, the S&P/ASX 200 A-REIT Index Futures were extracted from Bloomberg. Missing data was collected manually from the Australian Financial Review.

In Australia, the REIT futures market has four REIT futures contracts with different maturity dates (March, June, September and December) that are listed on the same time. Each contract has a year of life. Table 1 summarizes the main features of A-REIT futures. Although the A-REIT futures market was introduced for the first time in 2002, the transaction volume of this market in 2002 and 2003 was relatively thin. For example, in November 2003, the trading volume of A-REIT futures was only 843 lots (ASX, 2009). As highlighted by Stoll and Whaley (1990), the infrequent trading effects must be controlled. Thus, the study commenced from 6th December 2004, which this dataset offers daily data with a reasonable large trading volume. Returns of REIT futures were calculated by the first difference of the natural logarithm of the daily indices. For consistency, returns for REITs, stocks and bonds were also calculated in identical fashion to the REIT futures returns as above.

(Insert Table 1)

To create a matched futures-spot prices series, a continuous series of returns were constructed by switching to the next nearby contract with at least 7 days to maturity. The advantages of this method are to provide greater liquidity and pricing information. On the switching day, the return is computed based on the next nearby contract with using the current day’s and previous day’s prices. As highlighted by Baillie *et al.*

(2007), returns are computed on the same futures contract in order to maintain a uniform measurement. In other words, daily returns of REIT futures are never computed by using prices from two different contracts with different maturity dates. These procedures are also employed by Fleming *et al.* (1998) and Kim *et al.* (2001). The descriptive summary is stipulated in Table 2.

(Insert Table 2)

As it can be seen from Table 2, the average return of REIT futures (-0.06%) is lower than its underlying asset (REITs), indicating that a long position of REIT futures would unable to outperform REITs. Interestingly, the average return of bonds was the highest over this study period. This can be attributed to the recent global financial crisis in which the turmoil has significantly affected the stability of financial markets, particularly stocks and REITs as reflected in the downward bias on both markets in which sharp declines were observed.

The volatility dimension has further reinforced this point where the standard deviations of REIT futures, REITs and stocks are 1.718%, 1.753% and 1.307% respectively. These figures are substantially higher than the unconditional volatility of bonds (0.176%). This also highlights the defensive characteristics of bonds. It should also be noted that the volatility of REITs appears as the highest in comparison to other assets. A volatile REIT market is important for the growth of a REIT futures market. Specifically, it would increase the use of REIT futures, although a volatile spot market is not a pre-requisite for a success futures market (Holland and Fremault, 1997). Excess skewness and kurtosis is also identified for all series in Table 2, suggesting that these series are not normally distributed.

Methodology

Augmented Dickey-Fuller and Phillips-Person tests were performed in order to examine the stationary of all series. The results indicate that all series are stationary at the 5% significance level. In other words, no evidence of unit root is presented in these series.[4] Thereafter, the constructed futures index was then used to examine volatility clustering effects. This can be examined with 1) Ljung-Box test and 2) Engle (1982) LM test for ARCH of order of p tests. The Engle (1982) LM test is estimated as follows:

$$\varepsilon_t^2 = \phi_0 + \phi_1 \varepsilon_{t-1}^2 + \phi_2 \varepsilon_{t-2}^2 + ... + \phi_p \varepsilon_{t-p}^2 \tag{1}$$

where ε_t^2 is the squared residuals, and LM test is performed by $LM = T * R^2$ (2)

T is the sample size

R^2 is derived from the Equation (1)

To investigate the volatility linkages between REIT futures and capital assets, Exponential GARCH (EGARCH) model was utilized. The EGARCH model was developed by Nelson (1991) in which it allows for testing the asymmetric and volatility clustering simultaneously. The importance asymmetric issue has been discussed by Michayluk *et al.* (2006) and Bekaert and Wu (2000). Most importantly,

[4] The results are available from the author.

Engle and Ng (1993) and Stevenson (2002) have offered the evidence in favorite of the EGARCH model. The appropriateness of using these models in the real estate context has been widely demonstrated by Stevenson (2002) and Liow *et al.* (2005) and Lee (2008).

The model of EGARCH (1,1) for REIT futures is estimated as follows:

Mean Equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{REITs} + a_3 R_{Stocks} + a_4 R_{Bonds} + \mu_t \tag{3}$$

where R_t is the return of housing at the time t, μ_t is the residual.

Variance Equation:

$$\log(h_t^2) = \beta_0 + \gamma_1 \left| \frac{\mu_{t-1}}{h_{t-1}} \right| + \gamma_2 \frac{\mu_{t-1}}{h_{t-1}} + \gamma_3 \log(h_{t-1}^2) + \gamma_4 \mu_{REITs}^2 + \gamma_5 \mu_{stocks}^2 + \gamma_6 \mu_{bonds}^2 \tag{4}$$

where β_0 is the constant term of variance equation, μ_{t-1}^2 represents the lag of the squared residual from the mean equation, h_t^2 is the lagged h_t term, γ_2 examines leverage effect (asymmetric) in which if the asymmetric is presented, then the $\gamma_2 < 0$. Statistics significant values for γ_4, γ_5 and γ_6 suggest that past volatility shocks in REITs, stocks and bonds influence current volatility of REIT futures.

4.0 RESULTS AND ANALYSIS

Correlation Analysis

Correlation analysis was first performed to examine the inter-asset linkages between REIT futures, REITs, stocks and bonds. The results are expected to provide some preliminary insights into the linkages between REIT futures, REITs, stocks and bonds. The correlation coefficients between these assets are exhibited in Table 3.

(Insert Table 3)

A strong correlation coefficient is recorded between REIT futures and REITs (0.93), indicating that these assets are almost perfectly correlated. As discussed by Patel (1994), the perfect correlation is essential to minimize the cross-hedge basis risk and enhance the hedging effectiveness of a futures market. In other words, there is no evidence available to support the view that the hedging effectiveness of REIT futures is deterred by the basis risk in response to the insignificance of basis risk between both assets. Importantly, the hedging effectiveness of Australian REIT futures has been demonstrated by Newell and Tan (2004). Additionally, the perfect correlation also implies that REITs has a strong link with REIT futures.

The strong correlation coefficient between REIT futures and stocks (0.69) also suggests that there is a strong connection between these assets. However, REIT futures are weakly correlated with bonds, suggesting that the influence of bonds on REIT futures is marginal. The lowest correlation coefficient is evident between REITs and bonds, reflecting diversification benefit can be obtained by including bonds in a REIT portfolio.

Overall, REIT futures are strongly correlated with its underlying asset (REITs) and stocks, implying that the movements of these assets could have strong influence on REIT futures. However, no similar evidence is found for bonds, suggesting that the influence of bonds on REIT futures is minimal. Moreover, it is also shown that the cross-hedge basis risk between REIT futures and REITs is negligible.

Volatility Clustering

The above section has provided some preliminary results of the linkages of REIT futures with other assets, whereas a more formal test, the EGRACH model was also performed in order to examine the volatility linkages among these assets. The validity of the application of EGARCH models in REIT futures was examined by the Ljung Box test and Engle (1982) LM test. Table 4 displays the empirical results of the Ljung-Box and LM tests for up to twenty fourth order ARCH.

(Insert Table 4)

The results indicate that volatility of these assets are time varying and clustering in which both Q(24) and $Q^2(24)$ statistics are statistically significant at the 1% level. The only exception is bonds with Q-statistic. Stronger persistence of volatility is also observed for REITs. This means that the volatilities of these assets are not constant over time. Indeed these series are changing over time and that high periods of volatility tend to be clustered and vice versa. Moreover, similar time varying results are also documented by the LM test. The strong and significant statistics of ARCH test confirm that the volatility clustering or ARCH effect is presented in the series. These results are consistent with previous volatility studies in real estate (Stevenson, 2002, Cotter and Stevenson, 2006) and stock futures (Chan *et al.*, 1991).

The strong evidence of persistence in volatility for these assets suggests that the constant risk measure would underestimate the actual risk level of the assets. Most importantly, this finding asserts that it is important to model the volatility pattern of REIT futures. In fact, investors and risk managers should understand the characteristics of REIT futures volatilities in order to assess the risk of REIT futures accurately. In other words, the application of EGARCH processes (volatility modeling) in REIT futures should be carried out in light of the strong ARCH effects.

Mean and Volatility Spillovers

The mean and volatility spillovers in REIT futures were examined by the EGARCH(1,1) model. The model specification of EGARCH(p,q) model was determined by comparing the EGARCH(1,1) with higher-order of EGARCH(p,q) based on Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC). The results exhibit that the EGARCH(1,1) model is the preferable model for modeling the volatility pattern of REIT futures. [5] The empirical results of EGARCH(1,1) are reported in Table 5.

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[5] The results show that the EGARCH(1,1) model is the best specification in which it has the lowest SIC and AIC statistics compared to other EGARCH(p,q) models with higher-order. Although the full results are not reported for brevity, these are available from the authors upon request.

(Insert Table 5)

Panel A of Model I shows the explanatory power of REITs, stocks and bonds returns to REIT futures returns (the first moment). An insignificant positive coefficient of REITs is evident in Model I, suggesting a lack of inter-linkages between REITs and REITs futures. In other words, REITs have little explanatory power in explaining the returns of REIT futures. This indicates that the returns of REITs contain little information of REIT futures and there is a weak relationship between the movements of REITs and the corresponding REIT futures. The results provide some indirect support to the empirical evidence of Jud and Winkler (2008) where the returns of housing futures have little connection to the returns of the corresponding housing price indices. The lack of inter-linkages between both markets could be attributed to the flow of information is better captured by the volatility of an asset (Ross, 1989). Therefore, the volatility transmission mechanism in REIT futures should be given the primary consideration.

Similar results are also found for bonds in which the coefficient of bonds is positive and statistically insignificant, showing that past bond returns have little linkages with current REIT futures returns. The results reported here can be explained by the underlying asset of REIT futures (S&P/ASX 200 A-REITs). It should be noted that all REITs in Australia are considered as Equity-REITs. Importantly, Stevenson (2002) has demonstrated that Equity-REITs are less sensitive to the interest rates of bonds compared to Mortgage-REITs in the U.S. Thus, it is reasonable to expect that there is no significance connection between REIT futures and bonds with given the characteristics of Equity-REITs.

Interestingly, Model I also illustrates that the coefficient of stock is negative and statistically significant at the 1% level, reflecting that a strong link is available between REIT futures and stocks. Although REIT futures are constructed based on REITs, the equity market has a great influence on REITs. As demonstrated by Cotter and Stevenson (2006), the stock market plays an important role on REITs in which stocks are found to significantly influence REITs, particularly Equity-REITs. As a result, it is not too surprisingly that the movements of stocks have an effect on REIT futures.

Turning to the volatility modeling in Panel B, significant volatility spillover effect is evident for REITs. More specifically, a positive and statistically significant coefficient of REITs in Model I suggests that past volatility shocks of REITs has considerable impact on current REIT futures volatility. In other words, the volatility of REITs conveys the information of REIT futures. Interestingly, this result is inconsistent with the findings of REITs from the mean equation, indicating that the first-moment (return) and second-moment (volatility) contain different set information. This point has also been discussed by Kallberg *et al.* (2002). The results have important practical investment implications in which it is crucial for investors to analyze the volatility pattern of REIT futures since the first- and second-moment contain different information.

The strong volatility spillover effect is also identified for stocks in which the coefficient of stocks is negative and statistically significant at 1% level. The negative link between both markets can be attributed to the hedging practice of institutional investors. Bodner *et al.* (1996) found that derivatives are mainly used for hedging purposes by the U.S. non-financial firms. A recent survey of property fund managers has offered comparable evidence in which derivatives are mainly used for hedging instead of speculative purposes (Lee, 2009). In other words, derivatives are more likely used by property fund managers during a bear market for hedging against the market risk. This point can be supported by Figure 1 in which a rapid growth of REIT futures was observed during the global financial crisis. Hence, it is sensible to obtain a negative relation between both assets.

The results also confirm the findings of mean spillover of stocks, signifying that past volatility of stocks are correlated with current volatility of REIT futures. Again, this makes intuitive sense in that the significant influence of stocks on REITs could potentially plays a role in this case. This implies that investors do not view REITs and stocks as different types of assets. As a consequence, it is reasonable to expect that stocks provide the cause of significant volatility spillovers to REIT futures. In fact, given the higher significance level of stock coefficient in comparison to REITs, stocks emerge as a more influential asset in influencing the volatility of REIT futures. Interestingly, the survey results of property funds also demonstrated that property investors tend to agree that stocks have the strongest impact on the movement of REIT futures (Lee, 2009).

In contrast, the volatility linkage between REIT futures and bonds is generally weak. A negative and statistically insignificant coefficient is documented for bonds in Panel B of Table 5. This shows that a lack of evidence to support significant volatility influence of bonds to REIT futures. The weak findings reported for the volatility of bonds is consistent with the findings of Panel A, suggesting that bonds has little influence on REIT futures. As discussed earlier, the nature characteristics of Equity-REITs are less sensitive to the interest rates of bonds. Therefore, it is sensible to find that bonds have little impact on Equity-REIT futures. The reported results here can be explained in a similar fashion.

There is another important observation from Table 5 in which the significance of leverage effect variable (RES/SQR[GARCH](1)) indicates that REIT futures are asymmetric to news. More specifically, the results show that the volatility of REIT futures has increased more in response to bad news than good news. The degree of asymmetry, on the basis of the measured leverage effect coefficient, is estimated at 1.13[6], suggesting that negative innovations increase volatility approximately 1.13 times more than positive news. This asymmetric reaction in volatility is supportive of the view that investors are more concern with negative news. The asymmetric results are also documented by Michayluk *et al.* (2006) and Lee (2008) in the direct and indirect property markets. Furthermore, the volatility persistence of REIT futures is very high and suggests that unconditional variance is finite in respect to the statistic of EGARCH(1) is very close to, but less than, unity (1). The diagnostics tests for standardized residuals based on the LM and Ljung-Box statistics further confirm that the EGARCH model is well specified and it has successfully accounted for serial dependence in the residual series.

To distinguish the effect of strong association between REITs and stocks, the volatility linkages between REIT futures and capital assets were investigated by

[6] The degree of asymmetry is estimated by $\left|-1+\gamma_2\right|/(1+\gamma_2)$

performing separate tests for each asset. The results are reported in Models II-IV. A positive and significant coefficient of REITs in Model II reflects that there is a strong volatility spillover between REITs and its futures market. Model III also presents a strong volatility inter-linkage between stocks and REITs futures, whereas only marginal role is found for bonds (Model III). The results are quite comparable to the results from Model I. Moreover, the results also reveal that the stock market has a stronger impact on the volatility of REIT futures.

Overall, REIT futures appear to be strongly associated with stocks in the first- and second-moment. On the other hand, REIT futures and REITs are only correlated in the second-moment and no similar results are evident in the first-moment. Additionally, there is little evidence to show that bonds can explain the return or volatility of REIT futures. However, this study covers the sample of pre- global financial crisis and post-global financial crisis. Most importantly, a sharp increased of volatility and transaction volumes for REIT futures after the crisis are also identified. Thus, the structural stability should be further investigated.

Sub-period Analysis

A sub-period analysis was performed in this section in order to examine the potential changing dynamics of the REIT futures market in Australia in response to the global financial crisis. The full period of December 2004 to December 2008 was sub-divided into two different sub-periods of December 04- September 07 and October 07-December 08. The sub-period analysis results of Australian REIT futures are exhibited in Table 6.

(Insert Table 6)

It is emerged from Panel A of Table 6 that stocks have shown a consistent associated with REIT futures over these two sub-periods, suggesting that the returns of stocks contain the information that are related to REIT futures. However, the contemporaneous relationship between these markets has diminished over time in which the coefficient of stocks is only significant at 10% in Period 2. This probably can be explained by the maturity of REIT futures in which there was a rapid growth of REIT futures in terms of the trading volume in the second period. In other words, REIT futures has been gaining the attention of property investors by acknowledging that it is a derivative product specifically designed for property investors.

Coincidentally, an increased on the efficiency of REITs in explaining the return variations of REIT futures is also demonstrated with the increased significance level of REIT coefficient in Period 2. This result further reinforces the above argument. However, coefficients are statistically insignificant, suggesting that the link between both assets in the first-moment is still marginal. Interestingly, the results also show that the bond market has emerged as an important variable in explaining the returns of REIT futures, especially in Period 2, where the coefficient is positive and statistically significant.

The volatility interactions of REIT futures for the Periods 1 and 2 are reported in Panel B of Table 6. There is no evidence to show that substantial change of the picture when we look at the estimates of the model for both periods. The interactions now are very similar to those documented for the entire period. The volatility spillovers from REITs and shares to REIT futures are demonstrated in relation to the significant coefficients of both variables. All of these indicate that news originated in stocks and REITs have significant effects on the volatility of REIT futures. Moreover, an insignificant coefficient of bonds is also evident in both periods, suggesting that there is little interdependence relationship between the volatilities of bonds and REIT futures. Significant asymmetric effects are also found in both periods, suggesting that the volatility transmission mechanism of REIT futures is consistently asymmetric in the sense that bad news has a greater impact on the volatility of REIT futures.

In general, a comparison of the results from sub-period analysis and the entire study period reveals little time variation in the influence of REITs and shares on REIT futures. Both mean and volatility spillovers are quite consistent over both sub-periods, confirming that there exists strong interdependencies among REIT futures, stocks and REITs. This suggests that REIT futures contain information from the REIT and share markets. Importantly, these results have also demonstrated the robustness of primary results with respect to time.

Monetary Policy and Day-of-the-week Effects

There are several remaining concerns that need to be addressed in this study. The baseline results reveal strong volatility linkages between REIT futures, REITs and stocks, but the analysis does not address the relative importance of common information spillover in generating these linkages. As highlighted by Kim *et al.* (2001), there is a common macroeconomic factor that influencing financial futures markets. In addition, their empirical results also showed that there are significant differences between Monday and the other weekdays. To shed more light on the effects of macroeconomic policy change and calendar on REIT futures, the primary results are further controlled by the unofficial cash rate and the day-of-the-week effects. The results are depicted in Table 7.

(Insert Table 7)

Model I reveals that there is no significant difference between Monday and other weekday in which a negative and statistically insignificant coefficient is found for day-of-the-week variable in mean and variance equations. These results are inconsistent with the finding from Kim *et al.* (2001) for the Australian financial futures markets. This can be explained by the relative small of the Australian REIT futures market in comparison to other financial futures markets. Furthermore, no significant variation is observed by comparing the results from Tables 7 and 5 with reference to the interdependence linkages between REIT futures and capital assets after controlling the day-of-the-week effect. More specifically, significant volatility linkages between REIT futures, stocks and REITs are also documented.

The monetary policy effects on REIT futures are captured by the coefficient $\log(C_t)$. The coefficient is negative and statistically insignificant in Panel A, indicating that the unofficial cash rate has little impact on REIT futures returns. However, in Panel B, the coefficient $\log(C_t)$ measures the effects on the volatility of REIT futures is significant, suggesting that the monetary policy has a simultaneous effect on the volatility of REIT futures. In other words, changes in the Australian monetary policy by the Reserve Bank of Australia have directly impacted on the volatility of REIT futures. These results are consistent to the results of Kim *et al.* (2001) in the Australian stock, bond and money futures markets. Compared to the coefficients of the benchmark model in Table 5, the degree of volatility linkages between REIT futures and REITs has decreased slightly; it remains statistically significant at the 10% level. Besides, the significant spillover effect of shares in REIT futures is also observed. All other parameter estimates are close to the results in Table 5. In other words, no significance alteration is found once the monetary policy is controlled.

In brief, the volatility transmissions of REIT futures are robust in respect to the day-of-the-week and monetary policy effects even though the changes in monetary policy appears to have a direct impact on the volatility of REIT futures. This also suggests that there is a common macroeconomic factor that influencing these markets.

Granger-Causality Tests

Although the preceding sections have offered some insights into the volatility transmission mechanism of REIT futures, the directions of causality between REIT futures and capital assets should also be addressed. To shed more light on the volatility linkages between stocks, REITs and REIT futures, Granger causality tests were performed. This attempt aims to identify the information flow between these markets. Specifically, the lead-lag relationships between the volatilities of these markets were investigated. The results are exhibited in Table 8.

(Insert Table 8)

As it can be seen from Table 8, a bi-directional volatility spillover in the S&P/ASX A-REITs and its futures is evident. Similar results are also evident between stocks and REIT futures, suggesting that the volatility changes in these markets are expected to occur at the same time. This implies that investors should keep a close eye on these markets because the news originated in a market has significant effects on the volatility of other markets. These results are consistent with the previous findings of Tse (1999) and Min and Najand (1999) in the share market.

The Relation between Volatility and Expected Returns

Recognizing the importance of volatility transmission in REIT futures, the nature of REIT futures market volatility and its relation to expected returns is also explored in this study. The relationship was investigated by an EGARCH-M model[7]. The results are reported in Table 9.

(Insert Table 9)

The model finds a negative relation between the conditional mean and the conditional variance of REIT futures with reference to the negative coefficient of Log(GARCH), whereas the variable is only statistically significant at the 10% level. The results provide some support to the findings of Theodossiou and Lee (1995). Again the purpose of using derivatives by property investors could be the possible explanation. Property investors use derivatives for hedging rather than investment purposes. Hence,

[7] The EGARCH-M for the linear, square root and logarithmic specifications of the conditional mean equations were performed, the results of all specifications were not reported since the conclusions do not alter by using different specifications.

a risk premium (or a positive and significant relationship between the conditional mean and variance) is not necessarily required by property investors in this case. More importantly, Nelson (1991) and Glosten *et al.* (1993) also found a negative link between stock return and its conditional volatility.

Robustness Checks

To reinforce these findings, the baseline results for volatility linkages between REIT futures and capital assets were further examined with different return estimations. There is another commonly used futures return estimation method (discrete rates of return) in the literature, which is $(P_t - P_{t-1})/P_t$.

The estimated coefficients from the model are similar to those reported in Table 5, suggesting that the alternative return estimation has little influence on the primary results. Specifically, the strong influences of REITs and stocks on REIT futures are also demonstrated. Little influence of bonds on REIT futures is also evident. Thus, the information transmission mechanism among REIT futures, REITs and stocks is robust with regard to different return measurements. In addition, the asymmetric results of REITs futures in respond to negative and positive news are also demonstrated.

The baseline results were also further controlled by using small capitalization stocks and value stocks with respect to Stevenson (2002) found that both sectors instead of the general stock market have strong influence REITs. The results are presented in Table 10.

(Insert Table 10)

Obviously, no significant variation is found by comparing the results of Table 10 and the baseline results. Specifically, negative and statistically significant coefficients of value and small cap stocks are evident, suggesting that value stocks and firms with small market capitalization have strong influence on REIT futures. Moreover, the volatility spillover from REITs to REIT futures is also documented. The results also show little volatility linkages between bonds and REIT futures. In other words, the conclusions did not altered by using value and small cap stocks in the model.

In general, there are clear evidence to support the view that the volatilities of stocks and REITs will be transmitted to REIT futures in light of the strong volatility interdependences between REIT futures, REITs and stocks. Therefore, it is unlikely that the results from Table 5 are attributed to return estimation and different types of stocks.

5.0 PROPERTY INVESTMENT IMPLICATIONS AND CONCLUSIONS

A fairly extensive formal literature has been developed on the issues surroundings financial futures, particularly the volatility linkages between financial futures and financial assets. Nevertheless, there is little study has been placed on REIT futures even though this will yield an improved understanding of property investment. This study examines the volatility spillovers in Australian REIT futures over the study period of 2004-2008 by an EGARCH model.

Several important findings have been found in this study. Firstly, the results confirm that the volatility clustering effect is evident in REIT futures. This shows that the volatility clustering is a usual feature for real estate and financial assets series. Hence the employment of traditional constant risk measure could be inappropriate. More specifically, the measure could underestimate the actual risk level of REIT futures, particularly during volatile periods such as the current global financial crisis. In turn this would also affect the optimal asset allocation in a mixed-asset portfolio. Secondly, the results also illustrate that REIT futures are strongly influenced by stocks and REITs in terms of volatility. Interestingly, the general equity market influence is of greater importance for REIT futures than REITs. The results are not too surprisingly given the strong association between REITs and stocks. Importantly, this also implies that investors, in general, do not view REITs futures as a unique futures market that is designed specifically for REITs, although some improvement is evident from the sub-period analysis.

Thirdly, there is evidence of asymmetric effects in REIT futures, suggesting that REIT futures are more sensitive to bad innovations in which bad news will increase the volatility of REIT futures 1.13 times than positive news. These results are intuitively appealing in which downside variability or negative news appears to be the main concern of property investors (Lee *et al.*, 2008). Moreover, the sub-period analysis also reveals little evidence that the dynamics of REIT futures have been changed in recent years, although the slight decreased importance of stocks on information transmission of REIT futures has been found in recent years. Finally, the results also documented that there is little day-of-the-week effect on REIT futures, whereas the monetary policy change has a simultaneous effect on the volatility of REIT futures. Nonetheless, both effects did not alter the baseline results. All of these findings have provided further insights into the dynamics of REIT futures.

These findings also have several property investment implications. The finding of volatility clustering in REIT futures asserts that it is important to analyze the volatility pattern of REIT futures since its volatility is not constant over time. Besides, the findings in respect to volatility interactions also have important implications for fund managers who differentiate between REITs futures and financial futures. It would emerge that investors do not distinguish REITs futures and financial futures in terms of volatility. In addition, the findings also bring some insights for policy makers. Given REIT futures are more sensitive to negative news and heavily influenced by the monetary policy change, it is essential for policy makers to assess the potential effect of their policy prior to its implementation, particular the policy with potential negative impacts.

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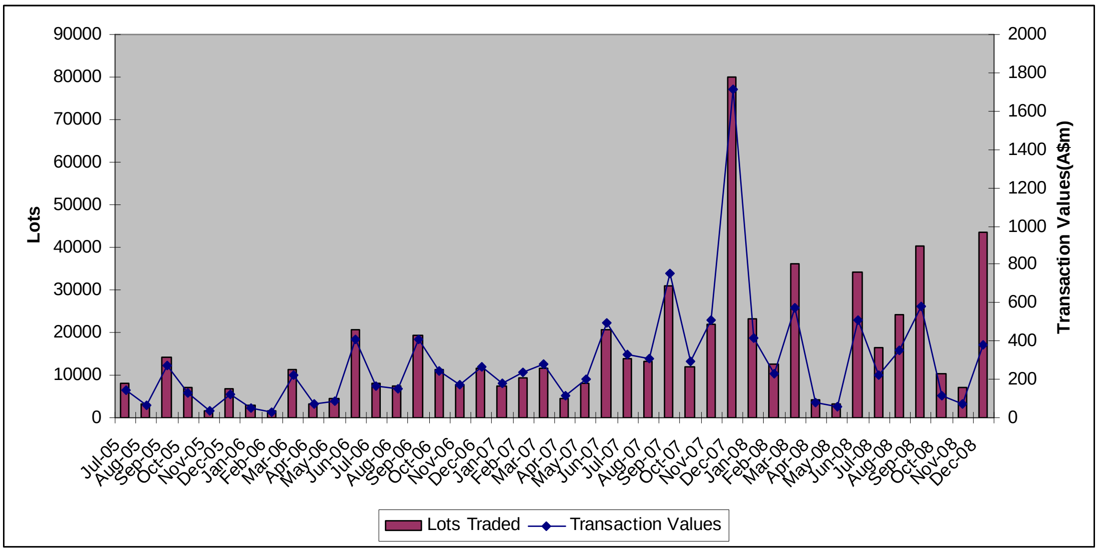
Figure 1: Transaction Volume of Australian REIT Futures



Source: ASX (2009)
Notes: AUD$1=US$0.70 (31/12/08)

Table 1: Main Features of S&P/ASX A-REIT Futures

Trading Unit	AUD$10 per index point
Trading Months	March, June, September, December up to four quarter months ahead
Last Trading Day	12 noon on expiry Thursday
Trading Hours	6.00 am to 5.00pm and 5.30pm to 8.00pm (Sydney time)
Settlement	In cash on the expiry morning based on the opening prices of the stock index
Contract Code	The first 3 characters represent the ASX code of the index, XPJ. The 4th letter indicates the year of maturity and the last character is the maturity month.

Source: ASX (2009)

Table 2: Descriptive Summary

Asset	**REIT Futures**	**REITs**	**Stocks**	**Bonds**
Mean (%)	-0.060	-0.043	0.007	0.025
Standard deviation (%)	1.718	1.753	1.307	0.176
Skewness	-0.809	-0.927	-0.532	0.2456
Kurtosis	9.813	10.700	8.912	6.0411
Count	1022	1022	1022	1022

Notes: The first two moments (mean and standard deviations) are expressed in percentage form. The skewness and kurtosis statistics have a value of 0 for a normal distribution and these statistics give a preliminary indication of the normality of these series.

Table 3: Correlation Analysis

Asset	REIT Futures	REITs	Stocks	Bonds
REIT Futures	1.000			
REITs	0.930	1.000		
Stocks	0.654	0.693	1.000	
Bonds	-0.283	-0.272	-0.347	1.000

Notes: The correlation coefficients among REIT Futures, REITs, stocks and bonds provide a preliminary indication of the linkages between these indices.

Table 4: LM Tests

Asset	Q(24)	$Q^2(24)$	ARCH(24)
REIT Futures (ρ -value)	96.981 (0.000)***	1226.864 (0.000)***	270.024 (0.000)***
REITs (ρ -value)	102.540 (0.000)***	1591.710 (0.000)***	303.189 (0.000)***
Stocks (ρ -value)	43.469 (0.009)***	1410.357 (0.000)***	294.796 (0.000)***
Bonds (ρ -value)	32.006 (0.127)	778.530 (0.000)***	269.477 (0.000)***

Notes: This table reports the estimated results from the Ljung-Box and Engle (1982) LM tests. Q(24) and Q2(24) are the Ljung-Box tests on the returns and the squared returns series respectively. ARCH(24) exhibits the LM test on the returns up to 24-order. * denotes significance at the 10% level; ** represents significance at the 5% level and *** denotes significance at the 1% level

Table 5: Mean and Variance Spillovers in REIT Futures

Model	**I**	**II**	**III**	**III**
	EGARCH(1,1)	**EGARCH(1,3)**	**EGARCH(3,1)**	**EGARCH(1,3)**
Panel A: Mean Equation				
Constant	0.000 (0.652)	0.000 (0.552)	0.000 (0.650)	0.000 (0.904)
Lag Return	-0.030 (-0.417)	-0.022 (-0.285)	0.051 (1.239)	-0.014 (-0.410)
REITs	0.125 (1.566)	0.031 (0.399)		
Stocks	-0.144 (-2.917)***		-0.116 (-2.480)**	
Bonds	0.039 (0.171)			-0.079 (-0.354)
Panel B: Variance Equation				
Constant	-0.208 (-4.932)***	-0.201 (-3.945)***	-0.200 (-4.517)***	-0.228 (-4.452)***
|RES|/SQR[GARCH](1)	0.118 (6.617)***	0.161 (6.903)***	0.181 (2.962)***	0.180 (7.767)***
|RES|/SQR[GARCH](2)			0.052 (0.636)	
|RES|/SQR[GARCH](3)			-0.132 (-2.150)**	
RES/SQR[GARCH](1)	-0.054 (-2.298)***	-0.097 (-3.711)***	-0.031 (-1.948)*	-0.067 (-3.619)***
EGARCH(1)	0.986 (250.256)***	1.196 (122.571)***	0.986 (238.157)***	1.153 (51.540)***
EGARCH(2)		-1.120 (-55.322)***		-1.032 (-32.445)***
EGARCH(3)		0.915 (53.280)***		0.868 (33.405)***
REITs	4.298 (2.096)**	2.711 (2.345)**		
Stocks	-11.029 (-4.057)***		-6.976 (-3.253)***	
Bonds	-14.408 (-1.522)			5.064 (0.498)
Q(24) (ρ-value)	23.513 (0.490)	23.485 (0.491)	23.824 (0.498)	23.228 (0.506)
$Q^2(24)$ (ρ-value)	10.105 (0.994)	12.830 (0.969)	10.087 (0.996)	12.580 (0.973)
LM(24) (ρ-value)	10.521 (0.992)	14.424 (0.937)	10.431 (0.995)	13.305 (0.961)

Notes: This table reports estimated coefficients for mean and variance equations of EGARCH(1,1). The model is estimated by:
Mean Equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{REITs} + a_3 R_{Stocks} + a_4 R_{Bonds} + \mu_t$$

Variance Equation:

$$\log(h_t^2) = \beta_0 + \sum_{j=1}^{q} \chi_j \left| \frac{\mu_{t-j}}{h_{t-j}} \right| + \gamma_2 \frac{\mu_{t-1}}{h_{t-1}} + \sum_{i=1}^{p} \delta_i \log(h_{t-1}^2) + \gamma_4 \mu_{REITs}^2 + \gamma_5 \mu_{Stocks}^2 + \gamma_6 \mu_{Bonds}^2$$

*, **, *** denotes significance at the 10%, 5% and 1% level respectively.

Table 6: EGARCH Model for REIT Futures: Sub-Period Analysis

Model	**EGARCH(2,3)**	**EGARCH(3,3)**
Sub-Period	**Period 1**	**Period 2**
Panel A: Mean Equation		
Constant	0.001 (1.544)	-0.004 (-4.509)***
Lag Return	0.032 (0.506)	-0.141 (-1.033)
REITs	0.076 (0.979)	0.222 (1.534)
Stocks	-0.134 (-2.512)**	-0.154 (-1.807)*
Bonds	-0.069 (-0.258)	0.855 (2.287)**
Panel B: Variance Equation		
Constant	-0.696 (-2.523)**	-0.523 (-2.397)**
|RES|/SQR[GARCH](1)	0.157 (4.172)***	0.603 (6.720)***
|RES|/SQR[GARCH](2)	0.097 (2.636)**	0.218 (1.878)*
|RES|/SQR[GARCH](3)		-0.625 (-5.130)***
RES/SQR[GARCH](1)	-0.227 (-4.310)***	-0.375 (-3.453)***
EGARCH(1)	-0.192 (-5.403)***	0.202 (3.763)***
EGARCH(2)	0.296 (13.630)***	0.163 (2.396)**
EGARCH(3)	0.843 (22.968)***	0.580 (7.742)***
REITs	32.351 (5.397)***	13.693 (2.768)***
Stocks	-24.875 (-4.355)***	-15.328 (-3.506)***
Bonds	14.693 (0.619)	-17.875 (-0.528)
Q(24) (ρ-value)	32.011 (0.127)	29.664 (0.196)
$Q^2(24)$ (ρ-value)	9.906 (0.995)	15.567 (0.903)
LM(24) (ρ-value)	12.409 (0.975)	17.824 (0.812)

Notes: This table reports estimated coefficients for mean and variance equations of EGARCH (*p*,*q*) model. The model is estimated by
Mean Equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{REITs} + a_3 R_{Stocks} + a_4 R_{Bonds} + \mu_t$$

Variance Equation:

$$\log(h_t^2) = \beta_0 + \sum_{j=1}^{q} \chi_j \left| \frac{\mu_{t-j}}{h_{t-j}} \right| + \gamma_2 \frac{\mu_{t-1}}{h_{t-1}} + \sum_{i=1}^{p} \delta_i \log(h_{t-1}^2) + \gamma_4 \mu_{REITs}^2 + \gamma_5 \mu_{Stocks}^2 + \gamma_6 \mu_{Bonds}^2$$

*, **, *** denotes significance at the 10%, 5% and 1% level respectively.

Table 7: EGARCH Model for REIT Futures Controlled with Day-of-the-Week and Monetary Policy Effects

Model	**I**	**II**
	EGARCH(1,1)	**EGARCH(1,1)**
Panel A: Mean Equation		
Constant	0.000 (0.628)	-0.013 (-0.771)
Lag Return	-0.036 (-0.496)	-0.026 (-0.349)
REITs	0.130 (1.623)	0.101 (1.202)
Stocks	-0.144 (-2.893)***	-0.126 (-2.327)**
Bonds	0.029 (0.121)	0.138 (0.508)
Day-of-the week	-0.000 (-0.194)	
Monetary Policy		-0.010 (-0.761)
Panel B: Variance Equation		
Constant	-0.164 (-3.954)***	0.199 (2.684)***
|RES|/SQR[GARCH](1)	0.108 (5.926)***	0.067 (4.908)***
RES/SQR[GARCH](1)	-0.056 (-2.456)**	-0.052 (-3.531)***
EGARCH(1)	0.987 (256.997)***	0.973 (230.137)***
REITs	4.175 (2.010)**	2.948 (1.914)*
Stocks	-10.304 (-3.773)***	-10.154 (-5.126)***
Bonds	-13.863 (-1.534)	-5.193 (-0.698)
Day-of-the week	-0.061 (-1.393)	
Monetary Policy		0.387 (5.990)***
Q(24) (ρ -value)	23.381 (0.497)	26.794 (0.314)

$Q^2(24)$ (ρ-value)	10.955 (0.989)	10.775 (0.983)
LM(24) (ρ-value)	11.363 (0.986)	11.754 (0.991)

Notes: This table reports estimated coefficients for mean and variance equations of EGARCH (1,1) model. The model is estimated by
Mean Equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{REITs} + a_3 R_{Stocks} + a_4 R_{Bonds} + a_5 N_i + a_6 \log(C_t) + \mu_t$$

Variance Equation:

$$\log(h_t^2) = \beta_0 + \sum_{j=1}^{q} \chi_j \left| \frac{\mu_{t-j}}{h_{t-j}} \right| + \gamma_2 \frac{\mu_{t-1}}{h_{t-1}} + \gamma_3 \log(h_{t-1}^2) + \gamma_4 \mu_{REITs}^2 + \gamma_5 \mu_{Stocks}^2 + \gamma_6 \mu_{Bonds}^2 + \gamma_7 N_i + \gamma_8 \log(C_t)$$

*, **, *** denotes significance at the 10%, 5% and 1% level respectively.

Table 8: Granger-Causality Tests

Assets	χ^2
REIT Futures → Stocks	68.264***
REIT Futures → REITs	353.186***
REITs → REIT Futures	114.302***
Stocks → REIT Futures	319.638***

Notes: This table reports the bivariate causality results for the volatility linkages between REIT futures, REITs and stocks. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

Table 9: EGARCH-M Models

Model	**EGARCH(3,3)**
Panel A: Mean Equation	
Constant	-0.008 (-1.687)**
Log(EGARCH)	-0.001 (-1.760)**
Lag Return	-0.039 (-0.551)
REITs	0.135 (1.684)*
Stocks	-0.153 (-3.073)***
Bonds	0.016 (0.068)
Panel B: Variance Equation	
Constant	-0.195 (-4.479)***
|RES|/SQR[GARCH](1)	0.123 (6.643)***
RES/SQR[GARCH](1)	-0.048 (-1.936)*

EGARCH(1)	0.987 (240.179)***
REITs	4.075 (1.881)*
Stocks	-11.364 (-4.135)***
Bonds	-17.393 (-1.876)*
Q(24) (ρ-value)	23.291 (0.503)
$Q^2(24)$ (ρ-value)	10.488 (0.992)
LM(24) (ρ-value)	10.800 (0.990)

Notes: This table reports estimated coefficients for mean and variance equations of EGARCH (*p*,*q*) –M model for the logarithmic specification of the conditional mean equation. The model is estimated by Mean Equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{REITs} + a_3 R_{Stocks} + a_4 R_{Bonds} + \delta \log(h_t^2)$$

Variance Equation:

$$\log(h_t^2) = \beta_0 + \sum_{j=1}^{q} \chi_j \left| \frac{\mu_{t-j}}{h_{t-j}} \right| + \gamma_2 \frac{\mu_{t-1}}{h_{t-1}} + \sum_{i=1}^{p} \delta_i \log(h_{t-1}^2) + \gamma_4 \mu_{REITs}^2 + \gamma_5 \mu_{Stocks}^2 + \gamma_6 \mu_{Bonds}^2$$

*, **, *** denotes significance at the 10%, 5% and 1% level respectively.

Table 10: Mean and Variance Spillovers in Small Cap and Value Stocks

Model	**I**	**II**
	EGARCH(2,2)	**EGARCH(1,1)**
Panel A: Mean Equation		
Constant	0.000 (0.769)	0.000 (0.675)
Lag Return	-0.043 (-0.588)	-0.031 (-0.397)
REITs	0.155 (1.795)*	0.079 (0.943)
Value Stocks	-0.162 (-2.789)***	
Small Cap Stocks		-0.063 (0.210)
Bonds	-0.020 (-0.084)	0.099 (0.433)
Panel B: Variance Equation		
Constant	-0.329 (-4.175)***	-0.289 (-5.984)***
|RES|/SQR[GARCH](1)	0.154 (3.657)***	0.136 (6.522)***

|RES|/SQR[GARCH](2)	0.051 (0.961)	
RES/SQR[GARCH](1)	-0.092 (-2.824)***	-0.055 (-2.188)**
EGARCH(1)	0.354 (2.058)**	0.978 (208.634)***
EGARCH(2)	0.626 (3.657)***	
REITs	5.860 (1.735)*	4.233 (2.081)**
Value Stocks	-10.996 (-2.578)***	
Small Cap. Stocks		-10.234 (-5.296)***
Bonds	5.009 (0.372)	-23.796 (-2.397)**
Q(24) (ρ -value)	23.407 (0.496)	23.097 (0.514)
Q^2(24) (ρ -value)	10.002 (0.995)	10.699 (0.991)
LM(24) (ρ -value)	10.271 (0.993)	10.726 (0.991)

Notes: This table reports estimated coefficients for mean and variance equations of EGARCH(1,1). The model is estimated by:

Mean Equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{REITs} + a_3 R_{Value,SmallStocks} + a_4 R_{Bonds} + \mu_t$$

Variance Equation:

$$\log(h_t^2) = \beta_0 + \sum_{j=1}^{q} \chi_j \left| \frac{\mu_{t-j}}{h_{t-j}} \right| + \gamma_2 \frac{\mu_{t-1}}{h_{t-1}} + \sum_{i=1}^{p} \delta_i \log(h_{t-1}^2) + \gamma_4 \mu_{REITs}^2 + \gamma_5 \mu_{Value,SmallStocks}^2 + \gamma_6 \mu_{Bonds}^2$$

*, **, *** denotes significance at the 10%, 5% and 1% level respectively.