AN ASSESSMENT OF INTERNATIONAL REAL ESTATE SECURITIES MARKET INTEGRATION

LIU JINGRAN

(B.Eng, PKU)

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Summary

Over the past two decades, international real estate securities markets have undergone an extremely huge development and rapid growth. The investigation on market integration is paramount for investors to adjust portfolio and avoid risk. Previous research has examination extensively on common stock markets. This study focus on securitized property markets and cover 9 countries (Japan, Hong Kong, Singapore, Australia, UK, France, Germany, Netherland and US) in 3 regions (Asia, Europe and US) from July, 1992 to March, 2010. The time period incorporate Asian Financial crisis and Global Financial Crisis. Market integration is examined in two aspects in this research – volatility transmission and dynamic correlation. Several dynamic econometric methodologies – VAR-BEKK-GJR model, Volatility Threshold Asymmetric Dynamic Conditional Correlation (VT-ADCC) model and Bai and Perron (BP) test are applied in order to investigate the international securitized real estate returns and risks focus on volatility transmission and dynamic correlation analysis.

The empirical result supports the world-wide market integration and US is the biggest volatility producer in major international real estate securities markets. For European market, the suffered a lot from global financial crisis and receive volatility transmission from US. For Asia-Pacific region, they take over

volatility spillovers from both US and European markets with little feedback. Australia performs more independent with other Asian markets. In terms of dynamic correlation in securitized real estate markets, the results indicate the correlation performs differently in especially high volatility period between cross-region pairs and within-region pairs. In crisis, the correlation of cross-region pairs would be decreased, they response differently on extreme high volatility. Within a specific region, either Asia or Europe, the correlation would increase when volatility is very high, they have strengthened co-movement. The volatility transmission and dynamic correlation analysis results would have important implication for international portfolio diversification and asset allocation.

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Chapter 1 Introduction

1.1Research Background and Motivation

Investment in real estate has become one of the world's biggest businesses in recent decades. Institutional investors have included in their portfolios real estate investments outside their home countries and are increasingly exploring worldwide opportunities. International property investment has expanded geographically from traditional mature property markets (e.g. US Europe) to the emerging property markets. This has particularly been the situation in Asia, given the significant economic growth and increased market maturity in the region in recent decades. (Newell, 2009).

It is necessary to include real estate investment into research in portfolio management since it is an important part in international investment allocation. Investment in real estate markets is categorized as direct and indirect real estate investment. The indirect investment which focuses on real estate securities is considered more suitable to be comprised into portfolio due to its better liquidity and transparency, comparing with direct investment (which consists of buying and selling real estate properties). There is inevitable connection between real estate securities and its corresponding stock markets, since real estate securities

is part of the common stock market. Over the past 20 years, real estate securities have performed magically, especially with the development of both high yield securitized real estate debt and equity products represented by Mortgage Backed Securities (MBS), Collateralized Debt Obligation (CDO), etc. and securitized Real Estate Investment Trusts (REITs).

Concerning the relationship between real estate securitized debt markets and real estate securitized equity markets, in long term time framework, mortgage real estate markets would be influenced by the volatilities in commercial real estate markets as proxied by real estate investment. The two assets share limited common risks, own different return profiles, and attract different types of investors. However, the correlation between the two markets is not as high as the ones with common stock markets, especially when market is volatile which shows the potential hedging opportunity between debt and equity securitized real estate markets (Yang and Zhou (2009)).

Recent global financial crisis was triggered by subprime securitized mortgage products, with the sharp decline in worldwide stock markets, contraction of credit markets, and economic recession in several major worldwide economies, investors realize the high risk of securitized debt real estate markets and begin to allocate their assets more weighted to listed real

estate equities markets such as REITs and property markets stakes. As there is limited interaction between debt and equity securitized real estate markets, and given the fact that investors' attention always focuses on real estate equity markets in post-crisis period, it is more meaningful to investigate on real estate equity markets diversification opportunity to help investors to allocate assets in these assets. (Real estate securities markets would indicate securitized real estate equity markets proxied by Real Estate Investment Trusts (REITs) and listed property companies in the following parts of this thesis.)

Listed property has internationally become an important property investment vehicle. Serving as evidences, REITs has developed fast in the United States, Listed Property Trusts (LPTs) was founded in Australia, and some other equivalent REIT vehicles have been established in Europe and Asia recently. Real estate securities markets will definitely be playing an important role in international asset portfolio.

Evidence shows the international real estate securities markets have become more integrated. In spite of the focus on the growth and yield of international securitized real estate markets, market risk and its relationship with market returns are of the investors' most concerns. In short period, different markets would transmit information and volatilities to each other. The spillover effect

could adjust performance in short time, and ruin diversification opportunity. The volatility spillover effect comes from both economic connection and geographical connection. Based on Markowitz (1952) portfolio theory, if the markets are highly correlated and have instant influence of volatilities and return on each other, it is hard to get diversification effect and safe return to incorporate these markets in portfolio. Hence, volatility transmission and dynamic correlation could be two important issues of market integration.

Numerous empirical researches suggest the importance of investigation on market integration in common stock markets. Considering the huge developed in real estate securities markets, there are some motivations for us to investigate the international property market integration from a dynamic perspective by applying five-variable VAR-BEKK-GARCH and Volatility Threshold Asymmetric Dynamic Conditional Correlation (VTADCC) model.

Firstly, market connection and market volatility are two key points for market integration research, which could guide portfolio management. The research upon volatility transmission and correlation in international markets could help arrange portfolio in cross-countries especially in crisis period. With lower correlation of returns and less spillover of volatilities, for the investment markets, the investors could reduce their portfolio risk without decreasing the return.

Knowing the direction and the degree of volatility spillover between countries, investors could avoid risk or gain less risk. However, since both the markets co-integration and correlations in different pairs are time-varying, they could move with the change of volatility. The dynamic models such as VAR-BEKK-GARCH and VTADCC could catch the time-varying characteristics in volatility transmission and the relationship between volatility and correlation. This would lead to instigation in market integration performance for recent two decades, which will help to organize portfolio concerning international real estate securities markets.

Secondly, in recent 20 years, the international property stock market has grown rapidly and developed dramatically worldwide. The launch of Euro accelerated the speed of market integration in all economic prospects of Europe. In Asia markets, compared to European markets, since it is more volatile and has recovered from several crises, diversification opportunities for international investment used to be high but have been reduced after crisis. It is important to investigate market integrations separately between European and Asian regions to see the different reaction and the connection between the two regions, as well as the relationship with United States.

Finally, regional and international financial crisis could both destroy real

estate securities markets in different level. Previous researches have investigated on the influence of major crisis, such as the 1987 market crash and the 1997-1998 Asian financial turmoil on possible changes in the market relationships in the long and short term. Moreover, the recent global financial crisis has wider and deeper negative effect on international property securities market. Hence, it is quite necessary to pay attention on influence of crisis for real estate securities market integration, especially the influence that global financial crisis has had upon their correlations and volatility transmission across regional and national securitized property market.

1.2 Research Objective

The research objective of this thesis is to investigate real estate securities market integration. This research objective could be explained into two aspects: (1) how to evaluate the volatility transmission and (2) the relationship between dynamic correlations of international major real estate securities markets and related market volatilities.

In terms of specific issues, we hope to settle the following questions by using real estate securities index of major international markets:

1. To assess the market transmission behaviors of securitized property market in both return and volatility, especially on the spillover degree and direction.

2. To investigate the asymmetric dynamic conditional correlation and its relationship with market volatility including volatility threshold effect.

3. To explore the influence on real estate securities market integration caused by financial crisis. The recent global financial crisis would be an important point.

1.3 Research Sample and Data

This research focuses on major international real estate securitized market. The sample includes nine major real estate markets. Besides US (United States) the most important market in the world, four European markets – UK (United Kingdom), France, Germany and Netherland, four Asian – Pacific markets – Japan, Hong Kong, Singapore and Australia are incorporated. They are all the biggest developed markets in corresponded regions also as major International Financial Centers (IFCs). US plays the leading role in listed real estate assets; UK real estate market acts as the key leader in European property markets.

France, Germany and Netherland are the major European real estate markets with data available, which have REITs listed recently. Japan is a significantly developed market in Asian and has a long history of listed real estate. The same story happened in Hong Kong, Singapore and Australia; they all have established public issued REITs; their property stocks play an important role in relevant common stock market. What is more, the nine markets counts about 95% percent of the global securitized real estate market and have the most significant listed real estate markets in their respective regions. (UBS Investment Bank, 2009).

The data used in this paper are real estate securities returns in 9 countries. Upon the data availability, and the research objective – to examine international real estate securities market integration especially in current financial crisis period, we collect data from Jul. 8th 1992 to Apr 2nd 2010. Weekly data is analyzed to reduce Synchronous effect in different time zones. The countries included in this research are Japan(JP), Hong Kong(HK), Singapore(SG) and Australia(AUS), – four developed markets in Asia – Pacific; United Kingdom(UK), France(FRA), Germany(GER) and Netherlands(NETH) – four major markets in Europe; US – the most important market in international financial markets which will transmit volatilities to other markets. The research data come from S&P/City group property index, Data stream. The original data is organized into weekly return with US Currency presented.

1.4 Research Methodology

Empirical studies which estimate financial market integration focus on the influence of a single market to the international markets and the correlation between different markets by applying CAPM, GARCH, VAR, VECM, DCC, etc. In this study, market integration is investigated in two prospects: volatility transmission and dynamic correlation. Briefly, there are three major methodologies involved:

Firstly, concerning about the volatility transmission across real estate securities markets, an asymmetric VAR-BEKK-GARCH model is conducted. The VAR framework helps to detect return transmission; BEKK-GARCH helps to take variance transmission into account. We employ five variables in this methodology to examine the interaction and time-varying variance and covariance transmission in a region and cross regions.

Secondly, for the whole market sample, a newly developed VTADCC methodology is adopted to carry on further time-varying correlation analysis after volatility transmission removed after the first step. In addition, the dynamic correlation and its relationship with relevant markets' volatilities could be interpreted under volatility threshold framework in this methodology. The market

reaction in high volatility period with bad market information could provide more valuable guide for investors.

Finally, analysis on dynamic correlation incorporates not only the relationship between correlation and volatility but also the regimes in longtime correlations. Therefore, Bai and Perron (BP) test is employed to examine the structural breaks in time-varying correlations. In addition, news impact surface is carried out for further analysis.

The empirically result in this study combine these three methodology. VAR-BEKK-GARCH methodology examines the return and volatility transmission in short period with region and across regions. VTADCC model and BP test analyze time-varying correlation performance and its relationship with volatility in long period. Volatility transmission and dynamic correlation are two major prospects of market integration analysis. These methodologies investigate the degree of international real estate securities market integration with the extended analysis on recent financial crisis.

1.5 Expected Contribution

This research applies several econometric techniques in order to investigate

the degree of international real estate securities markets integration. Market integration is expressed in two prospects: volatility transmission and dynamic correlation especially in crisis period.

This research work is expected to have several major contributions on literature:

First, it applies five-variant asymmetric VAR-BEKK-GJR model in securitized property market. This model could examine the return and volatility transmission together in the five markets. Second, this study investigates 9 major international real estate securities markets, both within-region and cross-region relationship have been examined and contrasted to provide guide on world-wide portfolio management. Third, a newly developed VTADCC model is employed to investigate relationship between time-varying correlation and volatility under volatility threshold framework.

1.6 Organization of Research

The following part of this dissertation is divided into five chapters.

Chapter 2 includes the related literature review. This review will be categorized into three main aspects: theories of financial market integration,

empirical literature on stock market and literature related to real estate securities market.

Chapter 3 goes through market review and introduction of sample data. The brief market development history and macroeconomic background are introduced by regions and by nationalities. Data summary and basic analysis are also included in this chapter

Chapter 4 and Chapter5 present the empirical investigation of the study. In Chapter 4, an extensive investigation on the return and volatility transmission in international real estate securities markets is conducted by applying VAR-BEKK-GARCH model.

Chapter 5 investigates the dynamic conditional correlation in two prospects: the relationship with volatility and high volatility threshold and asymmetric effect in international real estate securities markets from Jul. 1992 to Mar. 2010, the time-varying correlation regimes analysis in common and specific structural breaks. These two aspects are examines by employing VTADCC model and BP test.

The final part (Chapter 6) concludes main findings and implication of the

thesis. Both contribution and limitation of the study are discussed in this chapter.

Chapter 2 Literature Review

2.1 Introduction

This chapter provides an in-depth review of the various finance and real estate literature underpinning this study. The literature view is organized into three major parts. Section 2.2 provides the brief review of the concept, and aspects of financial market integration. Section 2.3 focuses on the empirical evidence on market integration. We review literature in two aspects: volatility transmission and dynamic correlation. Section 2.4 provides a review of the literature of real estate market integration including studies on real estate investment, real estate securities market and securitized property market integration. The final Section 2.7 provides a summary of this chapter.

2.2 Theory of Financial Market Integration

2.2.1 Market Integration Concept

Historically, policy-makers and finance specialists have given considerable

attention to the relationships between national stock markets and whether or not they exhibit similar price characteristics and are converging over time, or indeed, are already fully integrated (Fraser,2005). The term ‘international stock market integration’ represents a broad area of research in financial economics that encompasses many different aspects of the interrelationships across equity markets.

The original research on financial market integration focuses on the reason why stock markets are integrated. These significant factors include the two measures of bilateral import dependence, the geographic distance between markets, the size differential across markets, a time trend, and dummy variables for different blocks of countries whose trading hours overlap, e.g. : Bodurtha (1989), Campbell and Hamao(1992), Bracker, et al. (1999),

In early research, financial market integration is estimated in straight method. Campbell and Hamao (1992) consider the extent of integration is to look for direct evidence of barriers to arbitrage across markets (legal restrictions on foreign share ownership, transactions taxes, and so forth), or for evidence that cross-border transactions in financial assets are limited in scale. Bekaertb and Harvey (1995) also directly explore the return data in international financial markets. They focus on the economic foundation influence on market

co-movement. The insignificant integration in this framework is supported with the research time period in 1960s and 1970s.

Then the research upon financial market integration focuses on the interrelationships in different regions, with different level markets. E.g. Kasa (1992), Corhay et al. (1993), Fraser and Oyefeso (2005), Kim et al. (2005) focus on market integration in European markets, especially after the launch of Euro.

Cheung and Ho (1991), Cheung and Mak (1992), Johnson and Soenen (2002) concentrated on Asian markets. The market integration before and after Asian financial crisis, and the influence under US and Japan market are two major issues.

2.2.2 Market Integration Aspects

Originally, the basic market connection and co-movement measurements like co-integration degree are adopted to analyze financial market integration. Cheung and Mak (1992) employ the ARIMA model to investigate stock market integration of Asian-Pacific region with US and Japan. The results reveal US and Japan lead Asian markets while Japan plays a second important role. Korajczyk, (1996) provides an asset pricing model to estimate market integration degree. The results also support market is more integrated. However, emerging market

and developed market are less integrated. Chan, et al. (1997) investigates the world stock market integration in eighteen nations concentrated in 1987 financial crisis. They examine integration degree by estimating market co-integration. Their results support globalization before crisis in international stock markets with market integration weakened after crisis. Bracker, et al. (1999) employ the term to focus on one aspect—the nature and extent of interdependence across the daily asset returns for a pair of national equity markets. They investigate stock market of 9 countries in 22 years. By estimating Geweke Measures, high interdependence in 24 hours is founded. The results support the world market becomes more integrated.

In recent decade, more complicated technical models are adopted to investigate market integration. The aspects as return and volatility transmission and dynamic correlation are two domain aspects. Johnson and Soenen (2002) employ VAR model to examine return transmission. Some common factors and more integrated markets are supported. Kim. Concerning volatility transmission, several complicated time series model are proposed and extended to examine bi-variant and multi-variant volatility transmission. E.g. Moshirian, et al. (2005) apply EGARCH model to examine European market integration and confirmed the acceleration in connection after the launch of Euro. Diamandis (2008) apply DCC-GARCH AND SWARCH model to estimate market integration in terms of

dynamic correlation in Latin American Markets.

2.3 Empirical literature on stock market integration

2.3.1 Volatility transmission in stock market integration

On the topic of spillover effect of volatility and return, most papers apply VAR and GARCH approach since 1990s. The region concentrated on US, Europe and Japan. Eun and Shim (1989) finished a research on international stock markets. By using VAR model, this paper could detect the international information 20days before. US has the most significant spillover effect to the other countries. The speed of this transmission is fast in one day lag. Hamao, et al. (1990) applied GARCH model in three major markets, and detected strong volatility and mean return spillover effect from London and New York to Tokyo market. But there is no evidence for the transmission on the opposite direction. This result is consistent with global market integration. Panayiotis and Unro (1993) adopted GARCH-M model to receive similar results, what is more they found less significant mean spillover effect compared to volatility spillover. And most of the spillovers are imported from US. Koutmos and Booth (1995) concluded a similar result using an Extended Multivariate EGARCH model. But they added asymmetric effect on previous volatility spillover theory. These make research on volatility spillover be

more in accordance with investors' attention.

Theodossiou, et al. (1997) had a research upon US, UK and Japan markets either on spillover effect. They applied ADC (Asymmetric Dynamic Covariance) model, which would also encompass asymmetric effect. Unlike the previous literature, they found spillover effect with asymmetric effect from Europe to US besides from US to the other countries. Masih and Masih (2001) use both VEC and VAR model to construct long and short time relationship between domain stock markets. They confirm market co-integration and volatility spillover from US, UK and Japan to the whole financial markets. The total influence would take 75% in the whole.

Besides the volatility spillover effect across stock markets, Kanas (2003) investigate the relationship between exchange rate and stock markets. Only the volatility spillover from stock markets to exchange rate has been found to be significant and increased after financial crisis.

Volatility spillovers from US, Japan and some other developed countries to Asian markets was confirmed by Janakiramanan and Lamba (1998) and Cha and Cheung (1998) upon the VAR model; Ng (2000); Worthington and Higgs (2004) upon GARCH model; Kim (2005) upon information spillover effect. Further

evidence has been proved that this kind of inter-relationships could be strengthened during crisis time.

Liu and Pan (1997) investigate volatility spillover effect from US and Japan to four Asian major stock markets, including Hong Kong, Singapore, Taiwan and Thainland. By applying ARMA-GARCH model, they confirm US transfer more volatility to Asian markets than Japan. And volatility spillover effect is not the only one issue in research on cross-country equity. In (2001) examined only three Asian stock markets by a VAR-EGARCH model. The main research period is financial crisis. A strong volatility spillover effect from Hong Kong to Korea and Korea to Thailand is captured, which means Hong Kong would produce main volatility in the Asian Financial Crisis. While only three countries are included in this paper which seems lack persuade power. Dekker, et al. (2001) also focus on Asian-Pacific market by applying Generalized VAR model. They conclude that the markets with more economic and geographic connection would have more efficient linkage in equity market.

Huang, et al. (2000) investigated causality and co-integration relationship between great Chinese region, US and Japan. They find US has more influence in this region than Japan especially for Hong Kong markets.

Wu (2005) investigate the influence of Asian financial crisis on volatility transmission between exchange rate and stock markets. Increased spillover effect is found in post-crisis period, which indicate the market integration after financial crisis.

Qiao et al. (2008) finish a research on China A-share and B share stock markets. They apply FIVECM model to conclude that A-share stock market has significant volatility spillover effect on B-share market. The transmission is bi-directional. Both long-term and short-term relationship is investigated in this research.

2.3.2 Dynamic Correlation in Stock Market Integration

The correlation for stock markets has attracted many attention and research. At the begging–period, researchers focus on the dynamic volatility, and covariance, correlation used to be considered constant. Most literature was on the topic of spillover effect of volatility and return. Eun and Shim (1989) finished a research on correlation of international stock markets. They found the positive correlation in almost all the developed markets. What is more, US has the most significant spillover effect to the other countries. By using VAR model, this paper could detect the international information 20days before. While, the dynamic

correlation and volatility is neglect in this paper, a sub-period robust analysis is neglected too. Hamao, et al. (1990) applied GARCH model in three major markets, and detected strong volatility and mean return spillover effect from London and New York to Tokyo market. Koutmos and Booth (1995) concluded a similar result using an Extended Multivariate EGARCH model. However these papers pay more attention on the time-varying conditional volatility than the correlation of return. Although the asymmetric effect has been reported in these researches, the high volatility which could influence portfolio performance more is not revealed.

Unlike the literature mentioned above, Longin and Solnik (1995) first issued that the conditional correlation may not be constant, it could be time-variant as the conditional volatility and the conditional covariance. By applying a multivariate GARCH model, they found evidence to reject the hypothesis of constant conditional correlation (CCC) in the research period. Furthermore, some determinant that could influence the conditional correlation to change has been investigated. Information such as dividend and interest rate would be important to conditional correlation. They also point out the correlation would be high in high volatility time. However, they admit they could not find a satisfactory model to deal with this effect.

Theodossiou, et al. (1997) had a research upon US, UK and Japan markets

either on spillover effect. Similar to the previous literature, they also found strong spillover effect in return from US to the other countries. However, they have another issue on the pre-crash and after-crash volatility. They apply the time-varying correlation, but they have a conclusion that the correlation before and after crash in 1987 doesn't change much. The neglect of during crash correlation examination makes this paper not sufficient in explaining dynamic conditional correlation.

By accepting the time-varying conditional correlation, Ramchand & Susmel (1998) developed the GARCH model into SWARCH model to detect the relationship between correlation and volatility. They focus on the correlation between other countries with US; a significant increase of correlation in high US volatility period is detected. The asymmetric effect is pointed out either even not statistical significant in the paper. Although the approach in this paper could better evaluate the dynamic conditional correlation with volatility, similar to some previous literature, - King and Wadhwani (1990), Bertero and Mayer (1989) -, they use sub-period method to differentiate low volatility period and high volatility period instead of dynamic volatility.

Berben and Jansen (2003) only applied GARCH model on the stock markets of Germany, Japan, UK and US in the period of 1980-2000, the correlations

appear different in these correlated pairs, Germany, UK and US has a significant improvement in correlation since 1990 and even double, they have a co-movement. However, Japan has an immobile correlation with these countries. Just like many other researches this article also confirmed the correlation in stock markets is not constant, but time - varying. While, this paper still couldn't estimate how the dynamic conditional correlation moves with the volatility.

Under the development of DCC (Dynamic Conditional Correlation) model, proposed by Engle (2002), this powerful instrument was added in research on capturing the dynamic correlation changed with volatility of stock markets.

In the study of worldwide linkages in the dynamics of volatility and correlations of bonds and equity markets Capiello, et al. (2006) showed that there were strong asymmetries in conditional volatility of equity index returns while bond index returns have little evidence of this behavior. They estimated the correlations of stock and bond indices of four major regions assuming the same dynamic condition for the correlations.

On the other hand, Billio, et al. (2003) introduced Block Dynamic Conditional Correlation (BDCC) which assumes different dynamic condition for correlation of assets within a certain block of assets. BDCC does not account for

asymmetries between blocks while the Asymmetric DCC (ADCC) model of Cappiello, Capiello, et al. (2006) does not consider the asymmetric correlations between blocks of assets per se. Cappiello, they only took the average dynamic correlations of individual indices to represent regional dynamic conditional correlations.

Yang (2003) carried an analysis based on DCC model in five Asian countries. The correlation and volatility fluctuate characteristic is confirmed as the research on international stock market research. Increased correlation was found during high volatility period. A volatility spillover effect is also examined in this paper. What is more, Japan is considered a good place for diversification in crisis period which could be inconsistent with other researches.

Vargas (2006) proposed ABDCC model, which combines ADCC and BDCC. This approach introduces asymmetric effect of conditional correlation between blocks of stock returns. The simulation result showthat the Asymmetric Block DCC model is competitive in in-sample forecasting and performs better than alternative DCC models in out-of-sample forecasting of conditional correlation in the presence of asymmetric effect between blocks of asset returns.

Antoniou, et al. (2007) examined the correlation of stock markets between

US, UK and the Europe with DCC model; they found UK has higher correlation with European countries more than US. And the high correlation is significant when there is a crisis which means high volatility. They also applied MV-GARCH to examine the spillover to UK stock market, and found US stock market produces the highest market-wide volatility transmission effects.

Yu, et al. (2007) hold an explicit review on the method of examining markets integration. After contrasting six methods upon 10 Asian markets and US market, although different results appeared, they still could conclude that Asian markets are higher integrated since recent ten more years, but the integration has weakened since 2002. The DCC model reveals high correlation in developed countries in this region than the emerging countries. However, this paper is good at multiple methods in evaluating integration degree, but it lacks the contrast between these methods and volatility variable is not included in the paper.

Gupta and Mollik (2008) focus on the correlation between Australia with other emerging countries by applying ADCC model, and provided further evidence on positive relationship between correlation and volatility.

Hyde, et al. (2008) applied AG-DCC-GARCH model in 13 Asia-Pacific countries, Europe and the US, and found the correlation apparent in more

integrated markets. The Asian markets perform high correlation during crisis with high market volatility but the correlations with US and UK have no increase. After 2000, the post crisis period, the correlations within the region and across region all have increased. The covariance are also investigated in this paper, with the covariance decreased after the crisis, the correlation still increased, which means the volatility falls. This could support the global integration after Asian crisis.

Dunger, et al. (2008) has another research focus on the Asian financial crisis. Other than the analysis basic on dynamic conditional correlation, they choose the change of correlation as the main variable. Their result is inconsistent with the previous literature in that they find that the contagion in crisis time is not too much different in developed and emerging markets, however the volatility spillover effect comes from the developed markets. They also point out correlation may not be a good indicator for contagion.

Chiang, e (2007) and Essaadi, et al. (2007) use the similar sample and similar approach to investigate the dynamic correlation in Asian stock markets. They also confirm the high correlation in high volatility period. The foregoing one pays attention on the persistence influence of crisis, and point out after crisis, the high correlation still exists as a result of influence by foreign factors and local factors. This means Asian has lost the diversification effect. The latter one applies a

regime break approach to conclude the Asian Financial Crisis may start from the devaluation of Thai baht. A continuance of high correlation after crisis is also supported in this paper.

Savva (2008) extended an EGADC model on the stock markets of US and some European countries. Similar to the above research, the high correlations were found, and investment would suffer from the combined shocks, these markets are integrated especially since the launch of Euro. Moreover the price spillover effect from US to Europe is confirmed without feedback effect, while the volatility spillover effects are interactive. Diamandis (2008) turned his view to the emerging markets, and used four Latin American stock markets as a sample with a financial crisis in the period. Under DCC model, the author pointed out the stock markets in these countries have high volatility these years due to financial crisis, and they have high conditional correlations with US stock market. However, before the world financial crisis, Latin American stock markets have lower correlation with US stock market, which could offer diversification in portfolio. An episode of high volatility in all four Latin American stock markets is confirmed by a regime switching model – SWARCH.

With the purpose of capturing the dynamic conditional correlation in high volatility period, Kasch and Caporin (2007) developed a volatility threshold on the

original DCC model – VT-GDCC model. It is more effective in evaluating high underlying volatility in markets. They used the data of stock market indices from several developed countries to test the hypothesis whether high volatility values of the underlying assets are associated with an increase in their correlation values. What is more, it enables the distinction of correlation movements associated with volatility spillover effects from the changes in the correlation levels associated with pure contagion events. They concluded that for most developed markets, high volatility could be consistent with high correlations in the sample pairs.

Besides the spillover effect, there is strong evidence for a long-time equilibrium relationship. But during the crisis period, Yang, et al (2004) found there is no long run co-integration relationship. However the short run dynamics around this period is strengthened and the markets remained integrated after crisis.

Chakrabarti, and Roll (2002) applied a clinical method and confirmed the correlation has significantly increased after Asian crisis both in Asia and European stock markets, while Asian stock markets increased more, which reduced their roles as diversification in portfolio.

Bhar and Nikolova (2009) examine the BRIC countries equity market during their related region by BVGARCH model, and confirmed the negative volatility

relationship, which could be an indicator for portfolio diversification.

2.4 Empirical literature on real estate market integration

Liow and Yang (2005) applied FIVECM model on real estate securities markets and stock markets to investigate long-term memory and short-term adjustment between these two asset markets. The results support there exist fractional co-integration in securitized real estate markets, stock markets and macro economic factors in long-term framework. For short-term adjustment, the speed under fractional error correction is faster than ordinary vector error correction for it contains longer information in co-integration. This research approve the importance of long-term and short-tem dynamic in real estate securities markets.

Chen and Liow (2006) investigate the volatility spillover effect in securitized real estate markets by applying VAR-GARCH-M model. Then conclude in real estate markets, it also exists significant volatility transmission with asymmetric effect, which indicate market integration. The magnitude of spillover effect in Asia is significant higher than cross-region effect. This indicates the real estate securities markets exhibit continental segmentation.

Michaylun, et al. (2006) focus on US and UK real estate securities markets, they also confirm there is asymmetric volatility spillover in these two markets. The transmission would be higher when there is bad news. But this asymmetric effect is only in one direction. This is in accordance with economic size.

2.4.1 Investment in Real Estate

However, the former literatures mainly focus on the whole stock markets. The research involving real estate investment considers it as an important part in a mixed portfolio first. While the investment could be divided into two parts: direct investment (buy and sell the property) and indirect investment (the stock of property company and REITs). First, the researches pay more attention on the direct real estate investment; many literatures consider it is a good investment for the whole portfolio mean-variance and could provide low risk. Sirmans and Worzala (2003) have a detailed literature review on the direct investment in real estate markets. Although a sufficient number of researches in this area, for the limitation of data and measurement standards, it is hard to capture the real correlation accurately. Ziobrowski and Ziobrowski (1997) proposed the previous opinion on real estate investment has under - evaluated the risk. The face risk is not high in real estate risk, after adjusting it with low liquidity and inconvenience, the risk may not proper for low risk expectation portfolio. However this article

only examines the diversification effect (risk) for real estate in mixed portfolio, the dynamic volatility and correlation is neglected.

Newell and Webb (1996) did a similar research with the former one, and pointed out the most important for international real estate investors is the diversification effect in this area. So the risk and correlation in returns are what need to be investigated. They conclude the risk adjustment depends on several external factors either. However, they only used the approach of sub-groups and constructed index. The lack of Time series model makes it less convincible.

Stevenson (2000) examines the diversification effect for international real estate securities by a constructed hedging index. A rising diversification effect is proposed. Although the indirect index could be a proxy for volatility, the author himself also points out the potential method in this approach, so it is not recommended in future research. The different result coming from direct and indirect data also leads to contrary conclusion with the previous literature.

2.4.2 Investment in Real Estate Securities

With the development of REITs, more attention has been attracted to the indirect investment in real estate markets - the real estate securities markets, which are more liquid and transparent. Gordon, et al. (1998) first examined the

diversification effect coming from the real estate securities markets. Then found the correlation between real estate securities and correspond stock markets is low which leads to diversification opportunity.

Clayton and MacKinnon (2001) recognized the time-varying feature of real estate securities. However the correlation here in this paper is the correlation between REITs (securitized real estate markets), real estate properties (unsecuritized real estate markets), and financial markets. The result revealed that the correlation is time varying and cyclical. REITs are more correlated with real estate property markets, but it has more liquidity and could be a better investment instrument. As a contrast, Georgiev (2002) consider the real estate securities markets are more linked to the common equity markets and it could not be a good substitute for direct real estate investment.

Liow and Sim (2006) have an investigation in both mixed portfolio and pure real estate portfolio. The correlations between real estate securities markets and with common stock market are both examined. The low correlation of Asian real estate markets and US, UK real estate markets shows diversification effect in pure real estate portfolio. However the within-region correlation of real estate securities markets and the correlation of real estate markets with local stock markets are high. Although there is a system analysis in this paper, the correlations are only

investigated by subgroups approach, and only unconditional correlation is included. If the volatility and the dynamic conditional correlation could be added into the research, it could make more contribution.

2.4.3 Market Integration in Real Estate Securities

Over recent years, whether regional/international real estate markets are integrated attracts researchers' attention. However, most of the relevant investigations focus on direct real estate markets.

Evidence illustrating the real estate markets are integrated includes research by Myer et al (1997), Wilson and Okunev (1990), and Case et al (2000). They employ co-integration method and regression techniques to support the international real estate markets are integrated. There is a trend of globalization in world property markets.

However, the segmentation in real estate markets is also discussed by some studies. Since real estate is a location specific business, the market integration could not be too strong. Using the data from USA, Britain and Japan, Zibrowski and Curcio (1991) observe that US real estate shows low correlation with British and Japanese domestic assets. There is also literature to show the correlation coefficients between prime office indices in major cities across the world were

negative, thus implying that these international real estate markets are not integrated. Eichholtz et al (1998) also find segmentation generally between continents but integration within continents. This is particularly so for Europe and true to a extent for North America. They find Europe investors would need to look outside Europe for diversification benefits.

There is not too much literature on international real estate securities markets integration.

Zhu and Liow (2005) find there is long term contemporaneous relationship between the Shanghai and Hong Kong property markets and error correcting price adjustments occur in the two markets to maintain the long term equilibriums.

Liow, Ho, Ibrahim and Chen (2008) confirmed a similar conclusion with the common stock markets, upon the data from five developed countries. What is more, they extended the research into real estate securities. Although the correlations between real estate securities returns are lower than those of the broad stock markets, they perform the same strong positive connection between volatilities and conditional correlations. Also the two kinds of markets – real estate securities and stock market – are linked tightly and own a co-movement. This

extension into real estate market area makes more sense on international portfolio diversification management and asset allocation.

Yang and Zhou (2009) applied ADCC model to examine the asymmetric correlation between real estate debt securities and equity securities, limited interaction was found between the two assets, potential hedging opportunity exist in the two markets.

2.5 Summary

According to the literature review, the current research on stock market integration and real estate market integration has reported numerous results domestically and internationally. Furthermore, market integration could be interpreted in several aspects. Recently, with the application of dynamic models, volatility transmission and dynamic correlation are two important aspects in research on financial market integration. However, in real estate academic area, the applications of dynamic research on market integration are very limited. Additionally, international real estate stock market research has not covered recent financial crisis. Moreover, the previous research focus on a specific region, the investigation between two regions is seldom. It is necessary to examine real estate securities market integration systemically in term of volatility transmission

and correlation analysis.

Chapter 3 Sample Market and Data

3.1 Introduction

International real estate investment has become an important part of global efficient portfolio. It has been dominated by two major circles in the past two decades. Followed 1980s and early 1990s, the major recession, a bursting of tech bubble then leads to a peak in real estate markets in early 2000s. More recently, the past decade has witnessed rapid development of securitized real estate investment worldwide, cross-market flow of real estate capital and diversified investment products and vehicles in a global scope. With this trend, the market capitalization of international real estate securities developed magically; and more and more investors have included in their portfolios real estate investments outside their domestic markets and positive in exploring global opportunities. Especially after recent financial crisis, risk management has become the biggest concern in construction worldwide portfolio. Meanwhile, the globalization and integration of financial markets throughout the world brought the more integrated world real estate securities markets till the deep economic recession in 2008 and 2009. This capital-market driven crisis resulted huge declines in securitized property market.

Market connection and integration also changed during and after this world-wide financial crisis.

This chapter introduces the market background of this research sample throughout the research period in Section 3.2. The summary and brief analysis of research data are also conducted following in Section 3.3and Section 3.4. Section 3.5 summaries this chapter. The review of sample market and research data could give a brief picture of market development history and direct relationship.

3.2 Sample markets

Asian real estate securities markets

With increased allocation of US pension funds to global investments and an expansion in global market capitalization represented by Asian markets, as well as specific events such as the Asian financial crisis and the rise of China as a new economic giant, considerable attention has been given to Asian stock markets (Garvey et al, 2001). Real estate securities markets are considered to provide stronger diversification benefit compared to international stock market portfolio (Hartzell, Watkins and Laposa 1996). In Asia, REIT markets have been successfully established in Japan, Singapore, South Korea and Taiwan first,

followed by the establishments in Hong Kong, Malaysia and Thailand late in 2005. As such, Asian real estate markets offer long-term diversification benefits for international real estate securities funds that have invested in real estate companies in several Asian countries (Bond, Karolyi and Sanders, 2003; and Garvey, Santry and Stevenson, 2001). The emergence of real estate securities markets in Asia offers new opportunities for international funds to diversify into real estate assets in these Asian countries (Newell, et al. 2005).

Japan, Hong Kong and Singapore represent developed Asian property markets, with sophisticated commercial real estate and financial markets. This sees Tokyo, Hong Kong and Singapore as being major International Financial Centres (IFCs), both in the Asia region and internationally. This has resulted in office rents in these IFCs being internationally competitive; namely Tokyo ($14.85 psf/month), Hong Kong ($9.72 psf/month) and Singapore ($11.85 psf/month) in Q2: 2008 (CBRE, 2008). Both property values and transaction volumes are extremely high for these regions in Asia-Pacific. Given the significance of Tokyo, Singapore and Hong Kong as IFCs in Asia, it is important to assess the specific performance of property securities in these Asian IFCs to represent Asian real estate securities market integration and diversification opportunity.

As to these Asian IFCs, they all suffered in the 1997 Asian financial crisis, especially a significant decline in real estate markets. The 1997 financial crisis would also influence the interdependence among Asia-Pacific real estate markets especially to the core markets in this financial storm – Hong Kong and Singapore. The benefit of diversifying in these real estate markets is altered because of the crisis. Asian real estate securities tend to be more integrated after this.

The major real estate securities form in Australia is LPT (Listed Property Trust) which takes significant portion in Australia property market. LPT in Australia would be more linked to local common stock markets and less with other real estate markets due to limited fundamental connections. Still it is an important asset allocation target when construction international real estate securities portfolios. Hence it is necessary to include Australia real estate securities markets in to international integration analysis.

3.1.1 Japan Macro Economics and Real Estate Securities Market

The economy of Japan is the third largest in the world. In the recent decades, Japan economic has seen a serious decline after 1993. During this period, the Japanese economy was in serious trouble though the government attempted to take some measure. However, even during the recession, Japan's economy was

still the second largest only after the US. Real GDP of Japan began to turn upward after 1996 and plunged downward again in 1998. Since 1999, Japan entered the period of low economic growth, its GDP growth rate has fallen behind most East and Southeast Asian economies. The problems of the 1990s may have been exacerbated by domestic policies intended to wring speculative excesses from the stock and real estate markets. Followed governments' efforts effectively raise GDP on an average of 2.1% annually from 2003 to 2007. Subsequently, the global financial crisis and a collapse in domestic demand saw the economy shrink 1.2% in 2008 and 5.0% in 2009. Japan has the highest public debt in the world with 225% of GDP.

Even in the recession period, Japanese Yen was constantly strong compared to US dollars. Japanese government and Bank of Japan tried to weaken yen to encourage exports and domestic business condition. However, Japanese currency stays stable and strong. Until 2000, the exchange change has appeared volatile.

After the World War II, properties in Japan were rebuilt. As the recovery occurred, the property market reached the peak in the early 1990s. Since the burst of the real estate bubble in 1990, property prices in Japan have seen steady drops through 2004, with some signs of price stabilization and possibly price increase in 2005 and 2006.

There has been a long history for many Japanese real estate companies offer securities under the real estate sub-sector of the stock exchange. Japan is also one of a handful of countries in Asia with REIT legislation (which permitted their establishment in December 2001). Some see J-REITs as a way to increase investment in the real estate market, although notable increases in asset values have not yet been realized.

Japan real estate market is more influenced by local economy and property market circle. Both Asian financial crisis and recent global financial crisis has lower influence in Japan market, which shows its long-term reliance on the growth of the US is diminishing as a result of rising intra-Asia growth.

3.1.2 Hong Kong Macro Economics and Real Estate Securities Market

As one of the world's leading international financial centers, Hong Kong has a major capitalist service economy characterized by low taxation and free trade, and the currency, Hong Kong dollar, is the ninth most traded currency in the world. The strong economic performance in Hong Kong relies heavily on its relationship with China mainland. Hong Kong has relocated most industry to areas of south China, and transformed to a service based economy.

With the fundamental economy more linked to China mainland, Hong Kong's exchange rate and interest rates are linked to US rates. This linkage reflects US's contagion effect to Hong Kong. In 1997 Asian Financial crisis, unlike most Asian countries, Hong Kong Special Administrative Region and mainland China maintained their currencies' exchange rates with the U.S. dollar rather than devaluing. Hong Kong has gone through the speculative financial attack and kept stable in both money supply and interest rate. The longer-term impact of the crisis has been to increase the intensity and importance of Hong Kong's trade and investment links with the PRC.

Hong Kong's economic growth moderated significantly to 2.5% in 2008, down from 6.4% in 2007, and received hardest hit in 2009, with the annual growth at -2.5%. Despite the downturn, Hong Kong's economic strengths, including a sound banking system, virtually no public debt, a strong legal system, ample foreign exchange reserves, rigorous anti-corruption measures and close ties with the mainland China, enable it to quickly respond to changing circumstances

Hong Kong is a densely populated island with large population living in limited available lands. Due to this scarcity the total value of properties is higher than the total value of all other shares. The property cycles in Hong Kong are

influenced by the economic cycles. There are several booms and recessions during the recent sixty years. In the late 1980s, the property market began to revive a highly expanding period. In 1997, due to the resumption of sovereignty, the property price rose by 50%. Under the influence of Asian financial crisis, the price dropped 30% quickly. After 2000, Hong Kong's economy integrated with China mainland more closely. The property market recovered strongly in 2004. In global financial crisis, the market benefits from exposure to China, it is also affected by global trends as many of the city's residents and businesses are dependent on global trade and finance.

Before 1995, property and construction company stocks contributed approximately 25% to Hong Kong total stock market capitalization. According to Tse (2001), this number increased into 30%. The significance of listed property company shares to the stock market capitalization may come from heavy capital investment expenditure in property. REITs have been in existence in Hong Kong since 2005, there have been 7 REIT listings as at July 2007, most of which, including Sunlight REIT have not enjoyed success due to low yield. Except for The Link and Regal Real Estate Investment Trust, share prices of all but one are significantly below IPO price.

After 2000, Hong Kong's economy is more integrated with China Mainland

due to China's entrance of WTO. This linkage also appears in property markets. The fast development and influx from China has rebound Hong Kong property markets. The 1997 Asian financial crisis has speeded up markets integration between Hong Kong and other Asian real estate markets due to sharp drop in values and share of common volatility.

3.1.3 Singapore Macro Economics and Real Estate Securities Market

Singapore is a well planed country and has undergone huge constant developments in decades. It has an open business environment, relatively corruption-free and transparent, stable prices, and one of the highest GDP per capita in the world. Since 1965, its independence, significant performance in economics has been seen. Singapore's GDP growth kept at an average of above 8% per annum during the 30 years after independence. The GDP per capital also rise dramatically in this period.

Singapore started to diversify economic in to business and finance service sectors, and succeeded developed to an international financial center. During recent two decades, it has attracted reputable international financial institutions to set up operations or even Head Quarters. Singapore's economy's high growth used to be strong negative influenced by 1997 Asian financial crisis. However, it

recovered swiftly since 1999, and achieved an unprecedented peak in 2000. In 2006 GDP growth was 7.9%, higher than the originally expected 7.7%. After slight decline in 2008k Singapore's unemployment rate is around 2.2% as of 20 February 2009. As of 8 August 2010, Singapore is the fastest growing economy in the world, with a growth rate of 17.9% for the first half of 2010.

Singapore property market with the sub markets in commercial, residential and industrial is highly correlated with the local economy. Since 1980s, Singapore has gone through two distinct periods when residential property price movements rose and fell in tandem with real GDP growth. From 1989 to 1993, private property prices grew but vulnerable. Since the government introduced anti-speculation measures in 1996, which along with the subsequent Asian financial crisis in 1997, caused prices of the different real estate markets to decline in later years. During the current financial crisis, after the recovery began to take shape in China, Singapore’s housing market transformed from moribund to booming by the end of June, 2009, surprising even the most optimistic forecasters. At present, the average office rental rate is roughly 40-50% below the peak, but rising quickly.

The securitized property sector is no doubt a significant sector in the Singapore Stock Exchange (SGX). The majority of the listed property companies

represent a combination of investment and development, including the common stocks of companies with commercial real estate ownership. The REITs in Singapore is commonly referred to as S-REITs. There are currently 20 REITs listed on the SGX, starting with CapitaMall Trust in July 2002. The risk-return scheme and risk adjusted performance of Singapore securitized real estate markets move with economy and highly influenced by local market situation.

3.1.4 Australia Macro Economics and Real Estate Securities Market

Australia is a major world economic which used to suffer several recessions during 1970s and 1990s. After that, its macro economic developments appeared to be successful with an averaged 3.5% of GDP growth. After 2000, Australia's economy experienced a temporary slowdown and returned to be on the fastest growing economics in the developed countries. Australia economic growth highly relies on consistent and credible macroeconomic policies and positive program. There is a counter-cyclical fashion for country output and prices. In recent global financial crisis, Australia economy is influenced slightly with only the Q1 of 2009 negative GDP growth.

In Australia, a very high proportion of national wealth is held in real estate. Australia property market plays a key role in Asia-pacific region. In 2004, its

performance was marginally ahead of the United States and United Kingdom. It scored highly on all categories and stand out most in term of its legal frame work, the availability and performance indices.

LPT (Listed Property Trust) is a popular choice for Australians with over 800,000 investors. LPT sector is the largest sector in Australia Stock Exchange and accounts for 10% of world listed properties. Till now, the number of LPTs in Australia has been counted as 42 and has provided investors with high yields, capital growth and relatively low levels volatility. Since the 1900s, the LPT sector in Australia has undergone major structural changes. However, in financial crisis period, it appears that Australia "missed" the financial market crisis. In fact, it has been the only market to raise interest rates in 2009 and probably will be the only major market to do so. Recently, LPTs have been confirmed as a "safe haven" investment with less contagion effect from other markets..

European real estate securities markets

Shares in listed property companies or trusts in Europe provide opportunities to invest in diversified portfolios of real estate assets with liquidity similar to other publicly traded shares but with much greater liquidity than direct ownership of real property. Furthermore, real estate securities have been shown to provide

inflation hedging benefits and to act as defensive stocks. Public real estate markets in Europe have performed strongly over the last few years and this strong performance has rekindled investor interest.

European real estate assets' diversification effect is especially true following the 2000 stock market decline. In this latter period, adding real estate to a mixed asset portfolio increases return and decreases risk. First, real estate has added significantly to overall portfolio outcomes in terms of increasing return and decreasing risk. Second, real estate is a low beta investment and performs well during periods of market change—it was especially useful during the general market adjustment in 2000. Third, European real estate has performed strongly following the 2000 stock market decline. Over the last decade public real estate markets in Europe have performed very strongly. On a risk adjusted basis real estate markets have outperformed equities in all of the major markets. However, this may be related to the specific period of analysis. Our analysis seems to indicate that over the long term, real estate performs at a similar level to the overall stock market when adjusted for risk.

Besides the strong performance, European International integration of financial markets has increased dramatically in the last two decades, due in large part to elimination of government-imposed barriers to international capital flows.

In our research period, Monetary Union (EMU) was established, which was a landmark in regional economic integration. By implementing a new common currency (i.e., the Euro), coordinating fiscal policy, and developing a single monetary policy among eleven European Union member countries as of January 1999, the EMU marked the most dramatic development in international finance since the collapse of the Bretton Woods system. Given that the EMU likely impacted real estate markets within Europe, evidence Generally speaking, the European real estate market is most appropriately described as a partially segmented market. The degree of European real estate market integration is dependent on a variety of macroeconomic and financial factors that affect real estate prices : (1) macroeconomic factors, such as real GDP growth, employment, inflation, monetary policies, and fiscal policies; (2) microeconomic/financial factors, including rental costs as well as real property financing, construction, and transaction costs; and (3) regulatory factors, such as property laws, tax rules, and leasing regulations associated with real estate. Among microeconomic/financial factors, freer capital flows should contribute to harmonization of financing and transactions costs across borders. Finally, because the EMU led to more similar legal and regulatory frameworks within member countries, legal barriers to real estate investment can be expected to diminish to facilitate capital movements among EMU countries. For these reasons increased market integration is

anticipated among member countries after the implementation of the EMU. Based on generalized forecast error variance decomposition, it is found that several EMU markets (Germany, France and the Netherlands) which are also major real estate investment located became more integrated with other European markets after EMU. Also, mixed evidence is found for the non-EMU countries of the United Kingdom, Switzerland and Denmark, with either no change or less integration after EMU.

Due to market capitalization rank and investment focus, we would choose Unite Kingdom (UK), France, Germany and Netherland as the sample markets in our research representing Europe real estate securities markets. As discussed before, although UK is the biggest economy in this regions, more integrated linkage is expected within the left three markets.

3.1.5 United Kingdom Macro Economics and Real Estate Securities Market

United Kingdom was the first country starting industry revolution, currently; it is the six biggest economy in the world, caught by France in 1998.

UK has suffered a more volatile period than other economics in 1980s and 1990s. After 1992, the inflation index fell sharply also with the downward

interest rate. After this periods, UK economy has grown steadily with the unemployment fallen, inflation and interest rate been kept stable. Still, it is one of the major economics in the world especially in European continent.

The UK entered a recession in Q2 of 2008, and exited it in Q4 of 2009. On 23 January 2009, Government figures showed that the UK was officially in recession for the first time since 1991. At the beginning of 2010, it was confirmed that the U.K. had left its recession, economy grew by 0.4% In Q2 of 2010 the economy grew by 1.2% the fastest rate of growth in 9 years, in Q3 of 2010 figures released showed the UK economy grew by 0.8%; this was the fastest Q3 growth in 10 years. t has been suggested that the UK initially lagged behind its European neighbors because the UK entered the 2008 recession later. However, the negative effect on UK economy is more serious than the relative economics.

At the beginning of 1990, the UK property market crash covered all the sub-sector such as residential, commercial and industrial. The impact was so wide that it slowed down the economic recovery in later years. In 1992, the markets were on the way of weakly recovery, property companies took advantage of the booming stock market to repair their balance sheets. The number of the listed property companies increased over time, at April of 2002,

the market capitalization of the total sector is about 1,661 million.

UK REITs were founded in 2006. UK property stocks have delivered superior risk-adjusted returns over 1993- 2002, with enhanced portfolio terminal wealth at the higher levels of property stocks in the portfolio. Portfolios with UK property stocks out-performed portfolios without UK property stocks at all risk levels. During the first half of 2009, capital values declined nearly 50% off the peak, and rental rates in high quality locations declined sharply, making London one of the most affordable cities in the world. UK market has gone through slow recovery after 2009 June.

3.1.6 France Macro Economics and Real Estate Securities Market

France has long been part of the world's wealthiest and most developed national economies. France is the fifth of the world's largest and wealthiest economy. It is the second largest economy in Europe following its economic partner Germany. French economy is high relied on the government's policies. After 1983, Government of France largely retreated from economic intervention, the French economy grew and changed under government direction and planning much more than in other European countries. Despite being a widely liberalized economy, the government continues playing a significant role

in the economy: government spending taking 53% of country’s total GDP.

In recent financial crisis, France's economy is delayed affected, and recovered earlier than most comparable economies, only enduring four quarters of contraction. As of September 2010, France's economy has been growing continuously since the second quarter of 2009.

A specific tax regime - similar to that applicable to REITs in the US was introduced on January 2003 in France to allow listed real estate companies to elect to benefit from a French corporate tax exemption on their rental income and real estate capital gains, provided certain conditions are met. Further adjustments were made to this regime in the Finance Act for 2005 and in the Rectificative Finance Act for 2005 so as to broaden its scope, to facilitate reorganizations between real estate listed companies and to encourage corporate property owners to externalize their real estate assets. Regulations on French REITs are very liberal. There are no limits on stakes for shareholders. Consequently, the SIIC are attractive for foreign investors which want to save taxes, even if the real estate is outside France. The most important REITs-sector in France had been offices in Paris. But competition is high and yields have declined. Thus, investors are looking for other choices.

French property stocks have delivered superior risk-adjusted returns over 1993-2002, with enhanced portfolio terminal wealth at the higher levels of property stocks in the portfolio. Portfolios with French property stocks out-performed portfolios without French property stocks at all risk levels. During crisis, the renew rate has increased to take advantage of low rental. There is strong liquidity problem. These billion dollar plus transactions demonstrated that market liquidity is returning and the public companies have better access to low-cost acquisition capital than their private peers.

3.1.7 Germany Real Estate Securities Market

Germany is the largest country in Europe in GDP terms. However the German economy practically stagnated in the beginning of the 2000s. The worst growth figures were achieved in 2002 (+1.4%), in 2003 (+1.0%) and in 2005 (+1.4%).Unemployment was also chronically high. Due to these problems, together with Germany's aging population, the welfare system came under a lot of strain. This led the government to push through a wide-ranging program of belt-tightening reforms.

Affected by global financial crisis, the nominal GDP of Germany contracted in the second and third quarters of 2008, putting the country in a technical

recession following a global and European recession cycle. Germany exited the recession in the second and third quarters of 2009, mostly due to rebounding manufacturing orders and exports - primarily from outside the Euro Zone - and relatively steady consumer demand.

However, Germany has limited listed real estate markets in the region. In fact, there are only three German real estate companies which are constituents of the FTSE EPRA/NAREIT Global Real Estate Index. Germany has total estimated real estate properties of $8,500 billion, by far the largest real estate properties in Europe, however, only a small fraction is held by institutional real estate investors (approximately $470 billion). Therefore, the opportunity to repackage, or mobilize, a portion of this real estate is significant.

Germany is also planning to introduce German REITs (short, G-REITs) in order to create a new type of real estate investment vehicle. A law concerning G-REITs was enacted 1 June, 2007, and is retroactive to 1 January, 2007. German property stocks have not delivered enhanced risk-adjusted returns over 1993-2002. While there is evidence of lower correlation between property stocks and shares than for most European countries, reduced portfolio terminal wealth occurs at the higher levels of property stocks in the portfolio.

3.1.8 Netherland Real Estate Securities Market

Currently, Netherlands is the 16th largest economy of the world. Between 1998 and 2000 annual GDP growth averaged nearly 4%, well above the European average. Netherlands is the founding member of Europe Union, its interest rate, inflation rate and unemployment rate are significantly lower than other European economies.

As an open economy, in the recent financial crisis, Netherlands' relatively large banking sector was partly nationalized and bailed out through government interventions. Large unemployment, double the current rate of 4% is expected. A large deficit in government accounts of 5% is expected for 2009. The government wants to stimulate the economy by accelerating already planned projects. Fundamental reforms for long term recovery will be implemented as well.

The "Fiscale Beleggingsinstelling" (FBI) was introduced into the Dutch Corporate Income Tax Act of 1969 as a format of REITs. Currently discussions are taking place to relax restrictions for FBIs in terms of their development actives, capital taxes, foreign shareholders restrictions, withholding taxes and the abolition of the minimum required payout. Under the current trend towards REIT

introductions in Europe, the current FBI structure has become outdated. The Netherlands is losing many investment funds to Luxembourg. Moreover, the French and Germany REIT structures are a lot more flexible and less restrictive than the current FBI. Quite simply, changes are required for the FBI to become competitive again.

Netherlands property stocks have not delivered superior risk-adjusted returns over 1993-2002, with reduced portfolio terminal wealth at the higher levels of property stocks in the portfolio. Portfolios with Netherlands property stocks out-performed portfolios without Netherlands property stocks at all risk levels.

3.1.9 US Macro Economics and Real Estate Securities Market

The US economy has been the largest one in the world for several decades. The economic growth kept stable and relatively high even after entering the new century though it also experience several great declines in the beginning the 20th century and the 1980s. After the economic calm in 1990s, prices in US recovered to stable, unemployment dropped to the lowest, the stock market also underwent a significant boom.

In the 21st century, US's economy turned into a healthy performance period,

trade opportunities expanded dramatically, technological innovations brought a revolutionized growth path. Combined with low inflation and unemployment rate, strong profits sent the stock market surging and hit the record mark, adding substantially wealth to the economy.

The break out of subprime mortgage crisis in 2007 led to a huge recession in US economy. However it started to recover swiftly from the second half of 2009. The widely spread of this financial crisis to the whole wide prove the dominative influence of US economy.

Real estate is a huge business in US. As an investment vehicle, Real Estate Investment Trust (REIT) had not become popular until the late 1960s. In 1990s, the government set down a series important policies to make REITs sector modernized. With these impetuses, the total market value of REITs was near 130 billion dollar in the end of 1990s. It has always been the biggest contagion producer in the world. US's real estate markets could affect other worldwide markets in both return and volatility. Current global financial crisis was triggered by the real estate debt securities markets and widely spread to all over the world.

During the financial crisis, the US REIT sector got off to a rough start in the first quarter of 2009, following a rally that saw the group move up over 50% in

the final six weeks of 2008. REITS bottomed in early March as concerns regarding the global economy and global credit markets reached their peak; however, as fears started to abate, the asset class rallied strongly in the second half of March. The positive momentum continued as the market rose around +30% for the second quarter. The bulk of the strong performance was “front-loaded” to April and coincided with a positive reception to REITs issuing large amounts of equity. When entering the new era, the REIT structure is still improved consistently to meet the investors’ requirement.

The major macroeconomic fundamental statistics are showed in Table 3.1. As discussed before, there is wide connection in macro economics within a specific region due to currency, trade, policy and regulatory linkages. As a result, the real estate securities markets in this region would be correlated and integrated in some depth. In this thesis, this linkage is expected and analysis. Both country and region levels would be investigated to eliminated the fundamental influence in the sample.

The market value performance for real estate securities markets are plot in Figure 3.1. It is quite necessary to have a consideration on the correlation between these real estate securities markets, and find out how the market integration is, how the correlation could structure change in these markets and how the

diversification opportunity is.

3.3 Data Description

Based on the research target and the previous research in this area, the data used in this paper are real estate securities returns in 9 countries. Upon the data availability, and the research objective – to examine the volatility transmission and correlation especially in current financial crisis period, we collect data from Jul. 8th 1992 to Apr 2nd 2010. Weekly data is adopted to reduce Synchronous effect in different time zones. The countries included in this research are Japan(JP), Hong Kong(HK), Singapore(SG) and Australia(AUS), – four developed markets in Asia – Pacific; United Kingdom(UK), France(FRA), Germany(GER) and Netherlands(NETH) – four major markets in Europe; US – the most important market in international financial markets which will transmit volatilities to other markets.

The data could come from S&P/City group property index, Data stream. Companies included in these indices are involved in a wide range of real estate-related activities, such as property management, development, rental, and investment. So both listed property companies and REITs companies of each market are included in this database.

The original data is processed into excess return format with the consideration of risk free rate. The risk free rate in US currency is considered as the US three months treasure bills.

$$R_{i,t} = 100 \times [LN(PI_{i,t}) - LN(PI_{i,t-1})] - R_f \quad (1)$$

R is the return used in this paper, PI is the index from database, Rf is the risk free rate, i is the concerned market, t is the week in sample period.

In our research, the sample market would be divided into two groups, one is US with European markets, and the other is US with Asian market. The volatility transmission would be examined in each group. Since US has wild influence on the world market, it is included in either group. To have a further investigation on current global financial crisis, the research would also do sub-period test, which is Apr, 2004 – Mar, 2007 and Apr, 2007 – to Mar, 2010. Then represent for the period before and during-post current global financial crisis.

3.4 Data Analysis

Figure 3.1 lays out the index movement of major international real estate securities markets in the research period. Property markets in these international developed markets are under influence of the relevant economic conditions.

Global financial crisis has strong destruction on all the real estate securities markets with least influence on Japan and Germany market. Singapore and Hong Kong also experienced depression in Asian financial crisis. All the markets began to recover slowly after 2009. In different regions – Asian and Europe, the markets are more integrated, they have similar index performance and response on market shocks. France and UK, Hong Kong and Singapore are more integrated based on index trends.

Figure 3.1 Return Index Performance in international real estate securities markets (July, 1992 – March, 2010)

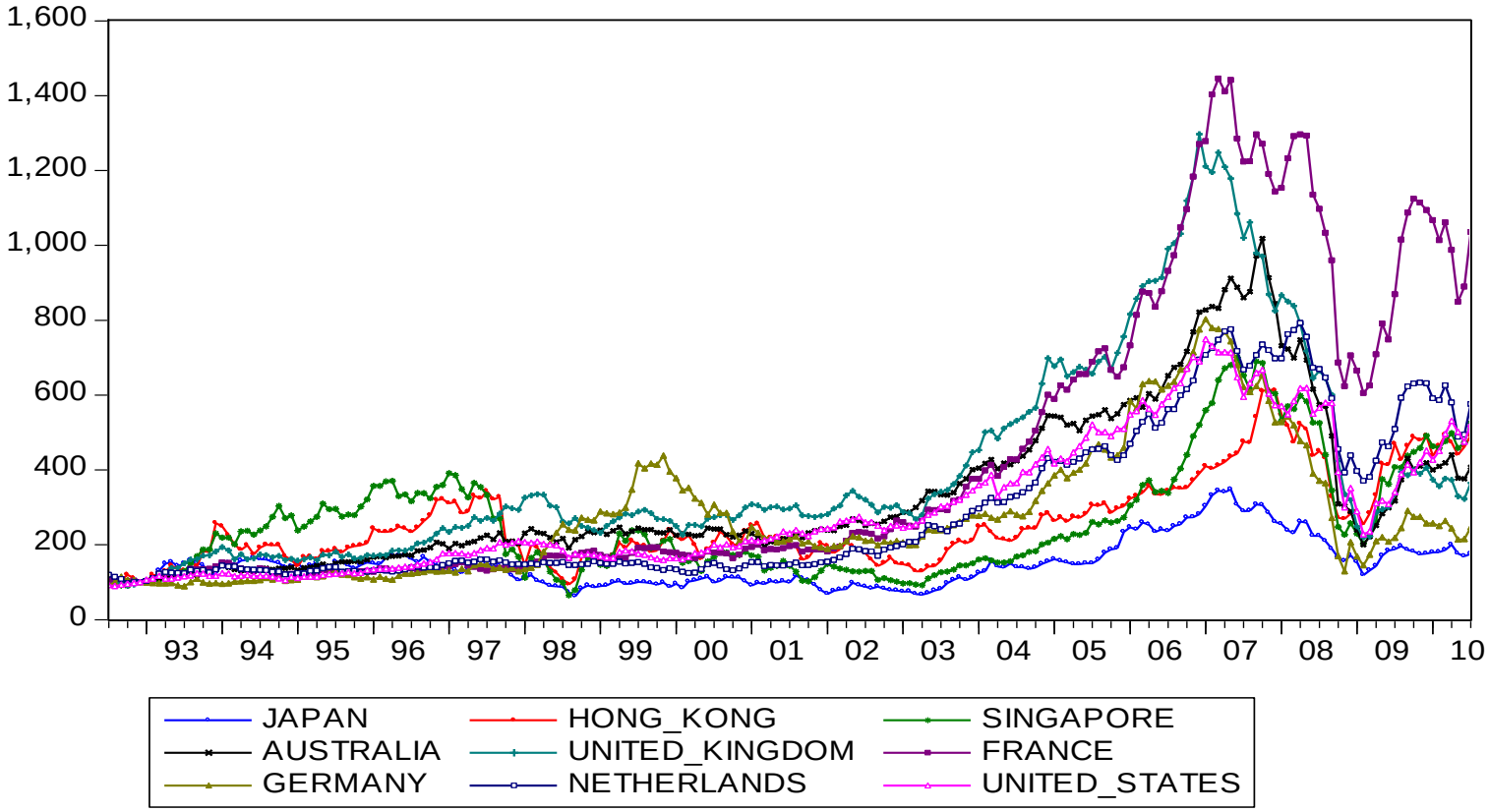


Figure 3.2 Market Capitalization in international real estate securities markets (July, 1992 – March, 2010)

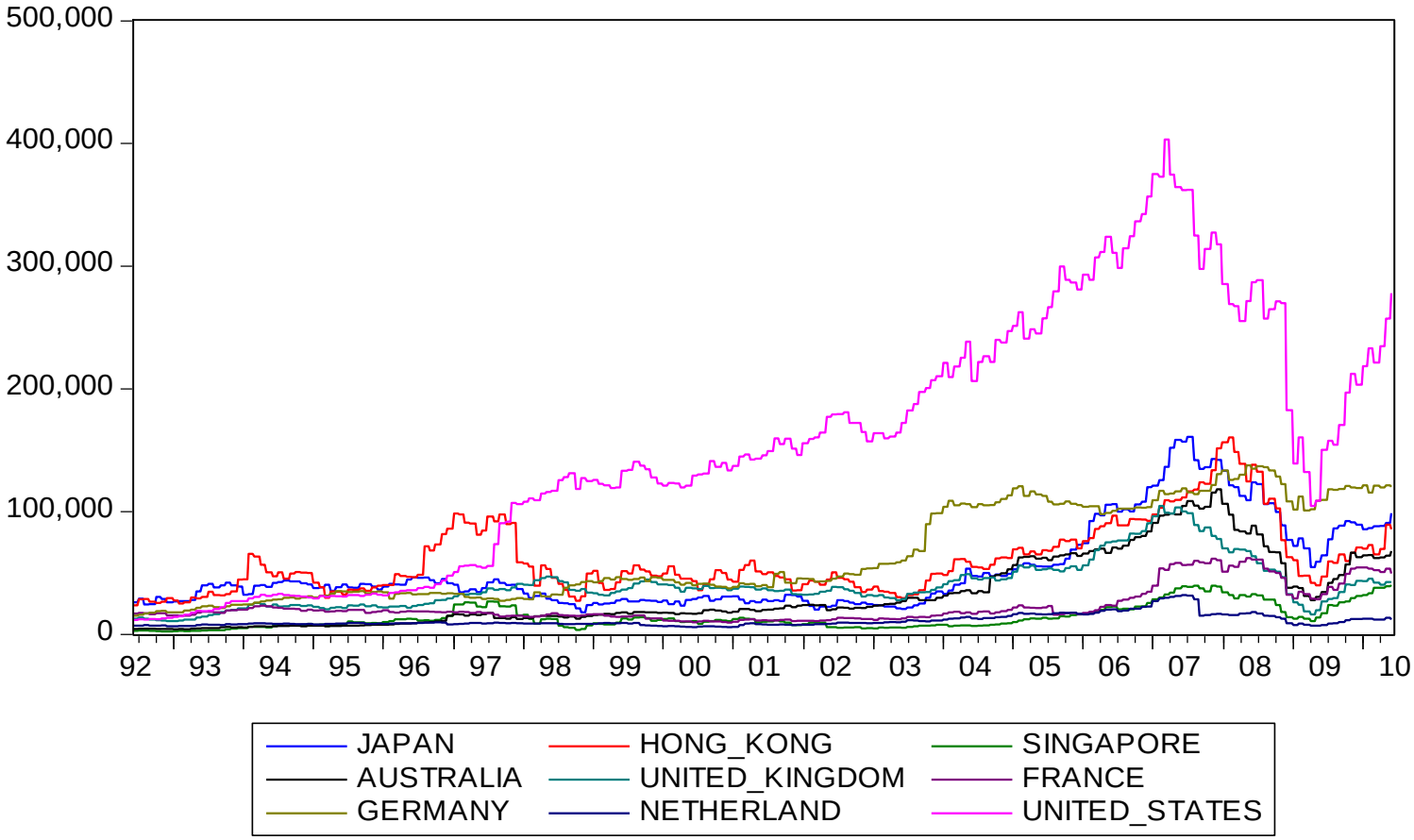


Table 3.1 Key Markets Fundamental Statistics

	Japan	HK	Singapore	Australia	UK	France	Germany	Netherland	US
Macroeconomics									
GDP (Current Price) (US bn)*	5,458.87	225.003	222.699	1,235.54	2,247.46	2,582.53	3,315.64	783.293	14,657.80
GDP (Per Capita) (US Dollar)*	42,820.39	31,590.68	43,116.69	55,589.55	36,119.85	41,018.60	40,631.24	47,172.14	47,283.63
GDP Growth*	3.94%	6.81%	14.47%	2.75%	1.25%	1.49%	3.504	1.748	2.834
Average CPI Growth*	-0.70%	2.40%	2.82%	2.85%	3.34%	1.74%	1.15%	0.88%	1.65%
Unemployment rate*	5.07%	5.24%	3.03%	5.60%	7.45%	9.50%	7.49%	3.40%	9.26%
Exchange rate**	82.3	7.7706	1.235	1.0722	1.6499	1.4545	1.4545	1.4545	1
Interest rate**	0.34%	0.21%	0.25%	4.90%	0.56%	0.94%	1.25%	0.87%	0.05%
Securities Markets									
Stock Market Cap (US bn)**	3790.00	3630.00	638.41	1740.00	3900.00	2150.00	1820.00	531.53	18320.00
Listed Companies**	3760	1435	770	1900	2588	1196	2167	141	14537
Real Estate Securities Markets									
Real Estate Market Cap (US bn)**	121.29	331.00	110.81	98.08	67.74	79.28	19.89	16.43	480.83
Market Cap Percentage**	3.20%	9.12%	17.36%	5.64%	1.74%	3.69%	1.09%	3.09%	2.62%
Listed Real Estate Companies**	151	152	67	94	134	76	117	12	370

Notes: (1) * indicates data coming from IMF database on Dec 31 2010, except for Unemployment rate on Dec 31 2009

(2) ** indicates data coming from Bloomberg on Apr 25 2011

(3) Interest rate indicates the 3-month treasure bill yield.

Table 3.2 Statistical Description of securitized real estate weekly returns (Jul.1992-Mar.2010)

	JP	HK	SG	AUS	UK	FRA	GER	NETH	US
Mean	0.08	0.15	0.16	0.15	0.13	0.25	0.12	0.18	0.19
Median	-0.02	0.23	0.22	0.36	0.25	0.25	0.20	0.23	0.26
Maximum	21.16	21.23	26.96	18.48	25.07	12.27	19.85	11.40	30.14
Minimum	-20.69	-23.50	-24.46	-24.56	-24.87	-19.71	-30.16	-18.97	-39.57
Std. Dev.	4.63	4.39	4.83	3.11	3.52	2.83	3.91	2.73	3.30
Skewness	0.31	-0.14	0.00	-0.97	-0.57	-0.66	-0.97	-0.88	-1.77
Kurtosis	5.26	5.65	7.08	12.75	12.75	9.71	11.81	10.58	41.69
Jarque-Bera	210.98	274.19	643.82	3813.72	3713.74	1804.18	3142.95	2339.55	58236.00
Q(10)	35.56***	22.20**	39.50***	36.65***	28.42***	37.33***	24.99***	20.05**	79.58***
Q(20)	52.17***	31.65**	46.83***	75.09***	66.16***	54.2***	42.27***	32.76**	137.36***
Q^2(10)	112.43***	122.73***	523.08***	461.62***	601.10***	418.4***	529.96***	514.85***	302.72***
Q^2(20)	153.01***	213.00***	750.81***	952.66***	958.17***	749.07***	745.19***	824.08***	398.19***
ARCH LM test	8.67***	34.13***	114.72***	77.58***	68.01***	51.34***	129.15***	35.32***	137.15***

Notes:1. ***,** and * indicate significance in 1%, 5% and 10% level

2. Q(10),Q(20),Q^2(10) and Q^2(20) indicate Ljun - Qbox statistics for returns and squred returns

Table 3.2 Statistical Description of securitized real estate weekly returns: (Apr.2004-Mar.2007)

	JP	HK	SG	AUS	UK	FRA	GER	NETH	US
Mean	0.59	0.39	0.79	0.45	0.68	0.77	0.67	0.56	0.45
Median	0.56	0.30	0.77	0.72	0.86	0.98	0.75	0.83	0.67
Maximum	10.64	8.78	6.24	6.13	8.98	6.42	9.64	7.13	6.46
Minimum	-8.88	-6.30	-6.80	-4.60	-8.05	-8.87	-10.89	-7.07	-8.83
Std. Dev.	3.49	2.68	2.40	1.99	2.59	2.44	3.07	2.17	2.28
Skewness	-0.02	0.09	-0.61	-0.07	-0.22	-1.04	-0.37	-0.62	-1.05
Kurtosis	2.86	3.38	3.82	3.09	3.88	5.41	4.57	4.11	5.46
Jarque-Bera	0.14	1.13	13.91	0.19	6.30	66.10	19.58	18.13	68.00
Q(10)	11.76	11.96	5.05	10.25	11.56	10.15	6.58	14.37	8.02
Q(20)	21.75	25.47	19.87	18.19	21.73	18.3	22.87	21.5	13.83
Q^2(10)	19.31**	19.74**	9.22	13.59	44.44***	45.86***	60.92***	38.69***	11.15
Q^2(20)	26.14	45.57***	18.11	20.99	60.57***	51.64***	82.39***	47.58***	16.41
ARCH LM test	0.01	4.61**	0.56	3.15*	3.05**	4.21**	9.91***	3.92**	3.04**

Notes:1. ***,** and * indicate significance in 1%, 5% and 10% level

2. Q(10),Q(20),Q2(10) and Q2(20) indicate Ljun - Qbox statistics for returns and squred returns

Table 3.3 Statistical Description of securitized real estate weekly returns(Apr.2007-Mar.2010)

	JP	HK	SG	AUS	UK	FRA	GER	NETH	US
Mean	-0.24	0.15	-0.03	-0.39	-0.72	-0.09	-0.63	-0.06	-0.19
Median	-0.29	0.26	0.06	0.10	-0.70	-0.33	-0.30	0.02	-0.04
Maximum	16.67	19.03	21.33	18.48	25.07	12.27	19.85	11.40	30.14
Minimum	-20.69	-15.23	-17.46	-24.56	-24.87	-19.71	-30.16	-18.97	-39.57
Std. Dev.	5.13	4.72	4.97	5.79	6.41	5.01	6.64	4.89	6.55
Skewness	-0.22	0.18	0.20	-0.55	-0.12	-0.41	-0.73	-0.66	-1.04
Kurtosis	5.23	4.46	5.17	5.35	5.77	4.75	6.21	5.07	14.21
Jarque-Bera	36.55	16.02	34.44	47.83	54.73	26.37	88.01	42.55	920.49
Q(10)	24.82***	6.75	22.36**	16.76*	10.09	11.94	12.39	9.93	30.15***
Q(20)	40.04***	16.16	31.83**	33.19**	30.38*	22.91	23.82	16.73	52.67***
Q^2(10)	49.44***	27.80***	48.45***	28.28***	65.52***	23.58***	68.11***	39.14***	41.47***
Q^2(20)	66.30***	32.72**	51.95***	63.51***	92.12***	47.34***	89.44***	59.34***	48.76***
ARCH LM test	13.25***	0.18	4.51**	5.41**	4.19**	2.61*	19.72***	1.3	21.12***

Notes:1. ***,** and * indicate significance in 1%, 5% and 10% level

2. Q(10),Q(20),Q2(10) and Q2(20) indicate Ljun - Qbox statistics for returns and squred returns

Figure 3.2 shows the market capitalization of research market from 1992 to 2010. US is the biggest market followed by Japan, Hong Kong, UK, Germany, Australia, France, Singapore and Netherland. The trend of market capitalization has similar performance with index movement.

Table 3.2 gives several description statistics of the data sample in our research, which includes weekly excess return series of 9 countries. We report several basic analysis on the mean, standard deviation, the range (maximum and minimum), the skewness and kurtosis of the return series. As what can be seen, all the average returns are positive with France real estate securities markets having the highest average weekly return (0.25%) and Japan the lowest average return (0.08). Japan also appears to be the highest risky market in the sample with the highest standard deviation (4.63%), the most stable market is Netherland (2.73%). On average, Asian real estate securities markets are more volatile than European markets. Except Japan and Singapore markets, the sample markets all have negative skewness but not large. Particularly, all markets appear to have kurtosis measures higher than 3. This shows there exists fat tail distribution in all the return series. Especially, the values for Auto-correlation and ARCH effect examination – Q statistics and LM statistics are all significant. This evidence suggests for all the weekly return series, they have strong auto-correlation and ARCH effects.

To examine the effect of global financial crisis on real estate securities markets, we also investigate two sub-period weekly excess returns. During the period before global financial crisis (Apr, 2004 – Mar, 2007), all markets have positive returns which are higher than the whole research period. Asian markets still have higher volatility with the perk in Japan markets (standard deviation 3.49%) from what is shown in Table 3.2. Asian markets have lower kurtosis, some are even lower than 3. This indicates that Asian countries in the short period before crisis don't have fat tail distribution. What is more, the auto-correlation effect is also insignificant in this sub-period research sample judging from the Q-statistics. The ARCH effect is more significant in European markets.

From Table 3.3, in the period during and post financial crisis (Apr, 2007 – to Mar, 2010), except for Hong Kong real estate markets, the other return series all have negative average values. This evidence suggests the loss in financial crisis. The volatility turns to be higher with the highest in Germany (6.64%). Opposite to the period before crisis, Asian markets are less volatile than European markets in Crisis period. US is the most significant on in fat-tail distribution according to kurtosis value. Almost all the weekly return series have Auto- correlation effect and ARCH effect, while the AC effect is less significant in European markets.

In conclusion, during crisis, all markets have less return and higher volatility, and the crisis has more influence on European markets than on Asian markets.

3.5 Summary

This chapter has provided a review of the real estate market especially the securitized property markets in 9 domain international developed markets included in this research. The knowledge about the markets helps to understand the issues examined in this study. The details about the data sample are also illustrated in this chapter. The main findings are: Real estate securities markets are impacted by the relevant finance market. Each securitized property market has experience major cycle movements. The markets in same regions share move co-movement with similar trend. Recent global financial crisis have impacted real estate securities markets worldwide.

Chapter 4 Volatility Transmission in international real estate securities markets

4.1 Introduction

As mentioned above, there are two relevant important prospective in financial market integration research. The first aspect is volatility interdependence. To investigate real estate securities markets integration, this chapter provides an extensive investigation on the return and volatility transmission in international real estate securities markets. Section 4.2 presents an illustration on the spillover models – VAR-BEKK-GJR. The result is displayed in two lower sections: the empirical result for the whole research period is discussed in Section 4.3.1; the two sub-period investigation result is presented in Section 4.3.2. At last, the summary for this chapter is presented in Section 4.4.

4.2 Methodology

Sims (1980) first proposes the VAR model to resolve the over-identified problem in econometrics. This methodology has been applied in later research extensively to examine the dynamic relationship of several series. It is widely incorporated for estimating volatility transmission as a powerful methodology.

Besides VAR model, autoregressive conditional heteroscedastic (ARCH) processes was proposed by Engle (1982) and developed into GARCH by Bollerslev (1986) which allows volatility to be time different and takes past error terms and conditional variances into estimation simultaneously. CCC-MGARCH was extended to solve multivariate problem. Engle and Kroner (1995) take another constraint into consideration and guarantee the stationarity of the covariances and the positive definiteness of the conditional covariance matrix which is BEKK-GARCH model. In BEKK-GARCH model, the estimation of volatility allows covariance terms to enter the conditional variance equations. This is paramount to our investigation of cross-market interaction in related commodity markets.

Following stock market literature, we consider a multivariate framework and use the VAR(1)-BEKK-GJR model which provides volatility transmission effects in the variance equation and also guarantees positive semi-definiteness. Kroner and Ng (1998) extends the BEKK model into asymmetric responses of volatility, since stock volatility tends to rise more in response to negative shocks (bad news) than positive shocks (good news). The models are expressed as below:

VAR(1) model Mean equation:

$$R_t = \mu + \lambda R_{t-1} + \theta H_t + \varepsilon_t \qquad (2)$$

$$R_t = \begin{pmatrix} R_{1,t} \\ \vdots \\ R_{n,t} \end{pmatrix} \quad \mu = \begin{pmatrix} \mu_1 \\ \vdots \\ \mu_n \end{pmatrix} \quad \lambda = \begin{pmatrix} \lambda_{11} & \dots & \lambda_{1n} \\ \vdots & \ddots & \vdots \\ \lambda_{n1} & \dots & \lambda_{nn} \end{pmatrix} \theta = \begin{pmatrix} \theta_1 \\ \vdots \\ \theta_n \end{pmatrix}$$

$$H = \begin{pmatrix} H_{11} & \dots & H_{1n} \\ \vdots & \ddots & \vdots \\ H_{n1} & \dots & H_{nn} \end{pmatrix} \qquad \varepsilon_t = \begin{pmatrix} \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{n,t} \end{pmatrix} \qquad \varepsilon_t | I_{t-1} \sim N(0, H_t)$$

BEKK-GJR model Variance equation:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B + G'\eta_{t-1}\eta'_{t-1}G \qquad (3)$$

$$C = \begin{pmatrix} c_{11} & \dots & 0 \\ \vdots & \ddots & \vdots \\ c_{n1} & \dots & c_{nn} \end{pmatrix} \qquad A = \begin{pmatrix} \alpha_{11} & \dots & \alpha_{1n} \\ \vdots & \ddots & \vdots \\ \alpha_{n1} & \dots & \alpha_{nn} \end{pmatrix}$$

$$B = \begin{pmatrix} \beta_{11} & \dots & \beta_{1n} \\ \vdots & \ddots & \vdots \\ \beta_{n1} & \dots & \beta_{nn} \end{pmatrix} \qquad G = \begin{pmatrix} g_{11} & \dots & g_{1n} \\ \vdots & \ddots & \vdots \\ g_{n1} & \dots & g_{nn} \end{pmatrix}$$

Equations (2) shows the VAR(1) model, the mean equation of the whole model, where $R_t = \begin{pmatrix} R_{1,t} \\ \vdots \\ R_{n,t} \end{pmatrix}$ is the excess return in the sample markets; $\lambda = \begin{pmatrix} \lambda_{11} & \dots & \lambda_{1n} \\ \vdots & \ddots & \vdots \\ \lambda_{n1} & \dots & \lambda_{nn} \end{pmatrix}$ is the degree of mean spillover effects from one market to the others, or the current returns which could be used to predict future returns in other markets. This coefficient is used to measure the effect for returns coming from its

own and other markets' lag returns; $\varepsilon_t = \begin{pmatrix} \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{n,t} \end{pmatrix}$ is assumed to follow a normal distribution with zero mean and $H = \begin{pmatrix} h_{11} & \dots & h_{1n} \\ \vdots & \ddots & \vdots \\ h_{n1} & \dots & h_{nn} \end{pmatrix}$ variance. I_{t-1} is all the information set in time *t-1*. h_{ii} stands for the variance of each market and h_{ij} represents the covariance between two markets.

In the BEKK-GJR model, C, A, B, G are N x N parameters with C is an up triangle matrix. Volatility spillovers effects are examined from the GARCH estimates ($\alpha_{ij}\ and\ \beta_{ij}$). Among them, α_{ij}measures the degree of market shock transmission, β_{ij} indicates the persistent volatility transmission between markets. The asymmetrical part of this BEKK-GJR model comes from the news in time *t-1* with $\eta_t = min(0, \varepsilon_t)$. With this market condition estimation, we could investigate volatility transmission under the sign of shocks.

The BEKK-GJR model is estimated by maximizing the following log-likelihood function

$$L(\theta) = -\frac{TN}{2} ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}(ln|H_t(\theta)| + \varepsilon_t H_t^{-1}(\theta)\, \varepsilon_t) \qquad (4)$$

T is the number of observations; N is the number of variables in the system and θ is the vector of all the parameters to be estimated. The estimation is

carried out using the quasi maximumlikelihood estimation with the optimization algorithm of BFGS by RATS software.

Based on the estimation result, it is also possible to calculate a correlation series using the H_t matrix. This correlation changes with the conditional covariance and volatility transmission. The calculation is as the equation followed,

$$\rho_{ij,t} = \frac{h_{ij,t}}{\sqrt{h_{ii,t}}\sqrt{h_{jj,t}}} \qquad (5)$$

4.3 Empirical Results

In this section, we report the estimation result of the VAR-BEKK-GJR model, which can investigate both the volatility and return transmission with asymmetric effect between real estate securities markets. The estimation result could also be a foundation for next stage examination of dynamic correlations. We first carry out full-time period investigation into two groups – European markets and Asian markets. The evidence of transmission would be reported in 4.3.1. In 4.3.2 we illustrate the estimation result for two sub-period samples. They indicate the cross market linkage before and during-post global financial crisis period.

4.3.1 Full period VAR-BEKK-GJR

The mean equation (2) and the variance-covariance equation (3) are estimated and maximum likelihood equation (4). The European group five-variable asymmetric VAR-BEKK-GJR model converges after 405 iterations and the results are reported in Table 4.4.

(a) European Group:

We first investigate the return transmission captured by the parameter λ in mean equation. The results are displayed in Table 4.1 Panel A. This parameter is a matrix and could indicate the return linkage across markets. The diagonal element is the degree how the return depends on their lag values. Only France has a significant diagonal parameter which means the return of France real estate securities markets positively depend on past return. The cross market return linkages are represented by the other parameters. They could indicate both degree and direction between markets. In the long period, all transmissions are in one direction; the significant ones include US to UK, France and Netherland (positive influence), France to UK and Netherland (positive effect) and Germany to Netherland (negative influence). These uni-directional return spillovers are consistent with the hypothesis, European real estate markets is under the

influence of major financial market US. UK has less news spillovers to the other European markets; the other European markets are more integrated as the result of money and finance system under Europe Union especially after the launch of Euro.

Then we examine the estimated results of the variance–covariance. The matrices for coefficient β reported in Table 4.1 Panel B help to examine the volatility transmission between different markets. The matrices for coefficient α reported in Table 4.1 Panel C help to examine the market shock transmission between different markets. The diagonal elements in these two markets indicate the own GARCH and ARCH effect. As what is shown in the result, the estimated diagonal parameters are all statistically significant, indicating a strong GARCH process. The past shocks and volatility have strong influence on the current volatility in these real estate securities markets

The other off-diagonal elements of matrices β and α capture the cross-market effects such as volatility and market shock spillovers among the five securities markets. US offers strong positive volatility spillovers to the other four European markets (between 0.0659 to 0.3006). On the other direction, only Germany and Netherland have volatility feedback on US market, but the degree is far less than what coming from US market (0.0774 and 0.1159). UK real estate

securities markets have volatility transmission to all the other three European markets (between 0.0832 and 0.2418), especially on France (0.2418). On the other hand, there are bi-directional volatility transmissions between UK with France and Netherland, not with Germany. And these transmissions to UK are higher than the ones coming from UK markets (0.6381 and 0.8332). France market has bi-directional volatility spillovers with UK and Netherland, but only has uni-directional volatility transmission coming from Germany. Among all the markets, France has the tightest connection with UK markets. Germany markets have only significant bio-directional volatility spillovers with US and Netherland markets (from German: 0.0774 and 0.0558, to Germany: 0.3006 and 0.3328) with uni-directional volatility transmission to France (0.1045). As shown from the result, Netherland shares bi-directional volatility spillovers with all the other four real estate securities markets (from Netherland: between 0.1159 and 0.8332 highest with UK; to Netherland: between 0.0558 and 0.3776 highest with France). The results show that US is the biggest volatility spillovers maker to European markets, this transmission is more significant in one direction. The results indicate that European Union markets are more integrated and have strong volatility transmission among the three markets with Germany less integrated. UK has tighter connection with France than the other European markets. All European markets receive volatility transmission from US.

Table 4.1 VAR-BEKK-GJR results in European markets (Jul.1992-Mar.2010)

	From				
To	**US**	**UK**	**FRA**	**GER**	**NETH**
Panel A: Return Transmission λ					
US	-0.0265	0.0184	-0.0188	0.0135	0.0058
UK	0.1186***	-0.0241	0.0257*	-0.0071	-0.0174
FRA	0.0806***	-0.0327	0.0593**	-0.0261	-0.0034
GER	0.0528	0.0260	0.0345	0.0019	-0.0591
NETH	0.0713***	-0.0118	0.1127***	-0.0336**	-0.0256
μ_i	0.2009***	0.2709***	0.1727***	-0.0133	0.1298***
θ_i	0.0229***	0.00313	0.0244***	0.0161***	0.0208***
Panel B: Volatility Transmission β					
US	0.8996***	0.0352	-0.0316	-0.0774***	-0.1159***
UK	0.0659*	0.6613***	-0.6381***	0.0474	0.8332***
FRA	0.0863***	0.2418***	0.6852***	0.1045***	-0.2359***
GER	0.3006***	-0.0832	-0.1198	0.6026***	0.3328***
NETH	0.2022***	-0.2099***	0.3796***	-0.0558*	0.6706***
Panel C: Market Shock Transmission α					
US	0.2075***	0.0684***	0.0742***	0.0258	0.1774***
UK	0.1436***	-0.0244*	-0.0115	0.0552**	0.3367***
FRA	-0.1100***	0.0877***	-0.0174*	0.0414*	0.1205***
GER	-0.1053**	0.3078***	0.0032	-0.3342***	0.2309***
NETH	-0.0768***	0.0343	0.1058**	0.0188	0.0343*
Panel D: Asymmetric Volatility Transmission g					
US	0.4761***	-0.1587***	0.0401	0.0510**	-0.0104
UK	0.1073**	0.0221	-0.3295***	-0.0738*	0.5009***
FRA	0.0901**	0.0804*	-0.1247**	0.1028***	0.1338***
GER	0.2019***	0.0371	0.0663	0.4890***	-0.5362***
NETH	0.0764**	0.1501***	-0.0572	0.0020	0.1771***
Panel E: Other parameter					
c	0.1111*	0.6449***	0.5459**	0.0008	0.0001

Notes: 1.***, ** and * indicate significance at 1%, 5% and 10% level;
2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)
3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

Concerning to the market shock transmission, there exist bi-directional spillovers among US and other European markets except Germany. The two-way shock spillover indicates a strong connection between the US and European

markets. The shock happened in the European markets has transmission effect on each other except for France to Germany and UK.

As far as coefficient matrix g, it indicates the asymmetric responses to negative shocks of own market and other markets. We find strong evidence to support asymmetric response on bad news. The bad information in US market has influence on all the market's volatility, while only UK and Germany offer asymmetric spillovers to US market. In case of asymmetric spillovers, UK has more influence than normal market shock transmission to the other European real estate securities markets.

The results in Europe group suggest that, US real estate securities market has strong volatility and return transmission to European markets with less feedback. The European Union countries – France, Netherland and Germany have more integrated securitized property markets compared to UK. However UK offers transmission to other European markets, it plays a more important role in this region. All the linkages in terms of volatility and return transmission are strengthened when market is in bad condition.

(b) Asian Group:

The results in Table 4.2 Panel A reveal that the return transmission effect in Asian group is not as significant as in European group. From the parameter λ, Only Japan and Australia has strong dependence on own lag return. US has strong positive return spillover effect on Japan, Singapore and Australia. These transmissions are uni-directional, with no feedback to US market. Except this, Singapore and Hong Kong has tight connection, they offer return spillover to each other. Singapore real estate securities markets have influence on Japan market, while Japan transmits return information to Australia market. This spillover effect is only in one direction.

Concerning to the variance-covariance estimation result, the significance of every diagonal element indicates strong own GARCH effect. In Asian real estate securities market, US only has volatility spillovers to Japan market (0.1003). On the other hand, only Australia market offers some volatility transmission to US(0.0218). All the other volatility spillovers are not significant between US and Asian markets. However, Asian markets are more integrated and have more inter-connection on volatility transmission. Also, these volatility transmission are more uni-directional, which shows the different influence power in Asian markets. Japan market spreads volatilities to all the other three markets, (between

0.0484 and 0.0780), with highest to Singapore and lowest to Australia. This transmission has no significant feedback. HK and Singapore have volatility spillovers on each other; apparently, they are in the same level in Asian markets with no significant volatility transmission to Australia. It seems Australia is still isolated with other Asian markets.

The market shock transmission is more bi-directional than volatility transmission effect in real estate securities markets Asian group. US, Japan and Hong Kong have stock information transmission to each other. However the information in US doesn't have significant effect on Singapore and Australia markets. Australia market is more independent with other Asian markets. Although there is only weak connection between US and Singapore markets, Singapore is more involved with Hong Kong and Japan, and has market shock transmission with each other.

For the asymmetric coefficient g, there is strong evidence to support asymmetric response on bad news. The bad information in US market has influence on all the market's volatility, but no markets offer asymmetric spillovers to US market. Among the Asian markets, Hong Kong and Japan have asymmetric spillover on each other, which means when the bad information will influence the other markets.

Table 4.2 VAR-BEKK-GJR result in Asian markets (Jul.1992-Mar.2010)

	From				
To	**US**	**JP**	**HK**	**SG**	**AUS**
Panel A: Return Transmission λ					
US	0.0237	-0.0010	-0.0052	0.0105	-0.0198
JP	0.1331***	-0.0513**	-0.0117	0.0583*	-0.0419
HK	0.0181	0.0016	0.0209	0.0544*	-0.0330
SG	0.1102***	-0.0027	0.1430***	0.0281	-0.0566
AUS	0.1528***	0.0280*	0.0128	0.0337	-0.1748***
μ_i	0.1913***	-0.0988	0.2602*	0.3304**	0.3303***
θ_i	0.0135***	0.0074	-0.0074	-0.0085	-0.0232***
Panel B: Volatility Transmission β					
US	0.8569***	0.0035	0.0065	-0.0071	0.0218*
JP	0.1003***	0.7224***	0.0183	-0.0104	0.0179
HK	0.0229	-0.0587**	0.9938***	-0.0572***	0.0125
SG	0.0238	-0.0780***	0.0609**	0.9162***	-0.0102
AUS	0.0003	-0.0484***	0.0023	0.0007	0.9781***
Panel C: Market Shock Transmission α					
US	0.2581***	0.0491***	-0.0393**	-0.0037	0.1996***
JP	-0.1604***	0.0278	0.1875***	0.2631***	-0.3061***
HK	-0.0961***	0.0482*	0.2097***	-0.1261***	0.0403
SG	-0.0526	0.1230***	-0.0710*	0.0325	0.0258
AUS	-0.0542	-0.0099	0.0371**	0.0220	0.0304
Panel D: Asymmetric Volatility Transmission g					
US	0.4809***	-0.0282	-0.0486	-0.0273	-0.0656
JP	0.2987***	0.1518	-0.2757**	-0.1611	0.0302
HK	0.2264***	0.1822***	-0.0179	-0.3227	-0.0540
SG	0.3178***	0.2929***	-0.0162	-0.4446***	-0.1416***
AUS	0.3341***	0.0012	-0.0786***	-0.0101	-0.2289***
Panel E: Other parameter					
c	0.4470***	2.2441***	0.1814	0.0001	-0.0001

Notes: 1.***, ** and * indicate significance at 1%, 5% and 10% level;
2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)
3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

In Asian groups, Japan, Singapore and Hong Kong real estate securities markets are more integrated, they have strong short-run dynamic connection in return and volatility. US plays the role as volatility producer, they transmit more

volatility than they receive from these markets. Australia securitized real estate market is less integrated in Asia-Pacific Region.

Table 4.3 VAR-BEKK-GJR result in different regions (Jul.1992-Mar.2010)

	From		
To	**Asia**	**Europe**	**US**
Panel A: Return Transmission λ			
ASIA	0.0194	0.1012***	0.0293
EUROPE	0.0099	0.0005	0.0550**
US	-0.0132	0.0296	-0.0177
μ_i	0.2077***	0.2641***	0.3213***
θ_i	-0.0076	-0.0038	-0.0019
Panel B: Volatility Transmission β			
ASIA	-0.1256***	0.1902***	0.0958***
EUROPE	0.0313***	0.273***	0.0665***
US	0.0557***	0.2507***	0.1755***
Panel C: Market Shock Transmission α			
ASIA	0.9547***	-0.0348***	0.0071
EUROPE	-0.0047**	0.9103***	0.01609***
US	0.0103***	-0.0859***	0.9009***
Panel D: Asymmetric Volatility Transmission g			
ASIA	0.3180***	0.0588***	-0.1509***
EUROPE	0.0352***	0.2270***	-0.1393***
US	0.1010***	0.1674***	-0.4660***
Panel E: Other parameter			
c	0.4243***	0.4219***	0.3278***

Notes: 1.***, ** and * indicate significance at 1%, 5% and 10% level;

2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)

3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

(c) Cross Regions:

The above investigation focuses on transmission effect within a region and the spillover effect coming from US. To examine the connection between different regions, we estimate another model with three members – Asia, Europe and US. The Asia and Europe are calculated from weighted average return of the four markets in relevant region. Table 4.3 shows the results.

Based on the result table, all the three regions have no dependence on their own lag return. The other return transmissions are also not significant, only Europe has influence on Asian returns and US market could affect European real estate securities markets. These transmissions are only in one direction. In the region level, the cross-region return transmission is less significant than the countries within a region.

Besides the significance of ARCH effect and GARCH effect, in the region level, there are significant volatility transmission and market shock transmission effect within the three regions. The highest volatility transmission is from Europe to US, with the parameter 0.2507, and the lowest is from Asia to Europe which is 0.0313 in parameter. Similarly, market shock transmissions exist in all the three regions except from US to Asia. The asymmetric transmission effect is also significant for all the market pairs. The markets do respond more when the market is in bad condition.

In region level, volatility transmission is weakened, which means market integration degree is lower that within a specific region. European real estate securities market and US market are more integrated compared to Asian property markets.

4.3.2 VAR-BEKK-GJR before and during-post global financial crisis

To examine the different performance caused by global financial crisis, we also estimate the VAR-BEKK-GJR model in two sub-periods. One is from Apr. 2004 to Mar. 2007 – before financial crisis, the other is from Apr. 2007 to Mar. 2010 – during and after global financial crisis.

(a) **Before crisis**

From what is presented in Table 4.4, in the three years before financial crisis, the return transmissions in European group are more significant in the long period. Except for the diagonal element which means dependence on own lag return, only two uni-directional transmissions are insignificant. The markets are more integrated and close connected during this sub-period.

The results for volatility transmission and market shock transmission with

asymmetric effect are similar with the whole period result. The influence from European market to US markets has been strengthened in this short period.

Table 4.4 VAR-BEKK-GJR result in European markets (Apr.2004-Mar.2007)

	From				
To	**US**	**UK**	**FRA**	**GER**	**NETH**
Panel A: Return Transmission λ					
US	-0.0493	-0.0498	0.3979***	-0.0756***	-0.5551***
UK	0.0546	-0.0628***	0.1396**	0.0647*	-0.3947***
FRA	0.0468***	-0.1998***	0.2318***	-0.0977***	-0.3156***
GER	0.0652	-0.1591***	0.3379***	0.0118	-0.4552***
NETH	0.1241***	-0.1170***	0.2298***	-0.0203	-0.3414***
μ_i	1.4182***	1.8568***	1.3800***	0.6860***	0.9735***
θ_i	-0.1264***	-0.2280***	-0.1008***	-0.0625***	-0.1205***
Panel B: Volatility Transmission β					
US	0.3403***	0.0704	-0.5206***	0.1192	0.3551***
UK	0.0124	0.9493***	-0.2275***	-0.0163	-0.0171
FRA	0.1307***	0.5131***	0.1265***	0.0988	-0.2815***
GER	-0.3141***	0.3616***	-0.6332***	0.3821***	0.7490***
NETH	0.2471***	0.3120***	-0.2550***	0.1766***	0.3551***
Panel C: Market Shock Transmission α					
US	-0.0304	-0.1856*	0.5041***	-0.0918	-0.8258***
UK	-0.0263	0.5057***	-0.0048	-0.3833***	0.1331
FRA	0.1955**	-0.1970***	0.2595***	-0.5822***	0.1145
GER	0.2255***	0.2714***	0.4270**	-0.3635***	-0.6592***
NETH	-0.0105	0.0125	-0.2732***	-0.2590***	0.3248***
Panel D: Asymmetric Volatility Transmission g					
US	0.7607***	-0.9701***	1.4792***	-0.6908***	-0.5728***
UK	0.5123***	-0.2602***	0.1890**	-0.1050	-0.0309
FRA	0.8114***	0.3797***	-1.3176***	0.3381***	0.4471***
GER	0.8627***	-0.1247	-0.9329***	0.3508***	0.7329***
NETH	0.5090***	0.1944**	-0.7664***	0.3367***	0.1892
Panel E: Other parameter					
c	1.1228***	-0.5616***	0.0003	-0.0006	0.0001

Notes: 1.***, ** and * indicate significance at 1%, 5% and 10% level;
2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)
3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

This shows theses markets become more integrated in the recent years before financial crisis.

As shown in Table 4.5, in the sub-period before global financial crisis, there are more significant return transmissions than the long period. Especially, the Asian markets have return spillover feedback to US market. Australia real estate securities market is still less integrated with other Asian-Pacific markets.

The volatility transmissions in Asian Group are significant in all the market pairs except from Singapore to Japan and from US to Australia markets. This indicates the five markets are highly integrated in this period. The domain stat of US in volatility transmission has been weakened. The less developed markets could also transmit volatilities to the previous volatility producer.

Table 4.6 presents the cross-region sub-period analysis. In the short period before crisis, there are more significant return transmissions between these three Regions. Asia market becomes more and more important compared to the long period results.

Table 4.5 VAR-BEKK-GJR result in Asian markets (Apr.2004-Mar.2007)

	From				
To	**US**	**JP**	**HK**	**SG**	**AUS**
Panel A: Return Transmission λ					
US	-0.2001***	-0.1095***	-0.0598*	-0.2206***	0.0604
JP	0.0284	-0.1097***	-0.2674***	-0.0534	0.2536***
HK	0.2803***	-0.0357*	0.0207	-0.0900***	0.0065
SG	0.0438	0.0566***	0.2190***	-0.1903***	-0.3436***
AUS	0.0868***	0.0029	0.0655***	-0.0098	-0.2798***
μ_i	2.2854***	1.6562***	0.5697***	2.7435***	0.6474***
θ_i	-0.3324***	-0.1207***	-0.0811***	-0.4839***	-0.0914***
Panel B: Volatility Transmission β					
US	0.1815***	-0.0441**	0.4579***	-0.2612***	0.3953***
JP	-0.3832***	0.6271***	0.4960***	-0.0687	0.2519***
HK	-0.1768***	0.2299***	0.9292***	-0.9443***	-0.1969***
SG	0.3204***	0.1883***	0.1695***	-0.9140***	0.3177***
AUS	-0.3984	0.0337**	0.3365***	-0.6483***	0.8659***
Panel C: Market Shock Transmission α					
US	-0.3581***	0.1047***	-0.0240	0.0802***	0.4668***
JP	-0.4289***	-0.0814**	-0.2024***	0.3632***	-0.3045***
HK	0.0277	0.3147***	0.1327***	-0.2548***	0.0938**
SG	0.0728***	0.1077***	0.1585***	0.0634***	-0.2079***
AUS	0.1993***	0.1880***	-0.1571***	0.0501	-0.1338***
Panel D: Asymmetric Volatility Transmission g					
US	0.3127***	0.3900***	-0.0482	-0.5178***	0.0805
JP	-0.4191***	-0.4789***	1.5020***	0.5804***	-0.1815
HK	0.0295	0.4999***	-0.2331***	-0.2713***	0.0714
SG	0.1396***	0.0127	0.3738***	-0.1547***	0.2971***
AUS	0.3790***	-0.0795	-0.3834***	0.5270***	-0.1255
Panel E: Other parameter					
c	0.0248	0.0335	0.0001	-0.0001	0.0001

Notes: 1.*, ** and * indicate significance at 1%, 5% and 10% level;**

2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)

3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

Table 4.6 VAR-BEKK-GJR result in regions (Apr.2004-Mar.2007)

To	From		
	Asia	Europe	US
Panel A: Return Transmission λ			
ASIA	-0.1074*	0.1083**	0.1677***
EUROPE	-0.0941***	-0.1083	0.1197**
US	-0.3264***	0.0567	-0.0553
μi	1.2265***	1.5792***	4.1990***
θi	-0.2553***	-0.1457***	-0.8024***
Panel B: Volatility Transmission β			
ASIA	-0.0719	0.2151***	0.0596
EUROPE	0.1244*	0.3010***	-0.0501
US	0.0935	0.1202***	-0.0231
Panel C: Market Shock Transmission α			
ASIA	0.5735***	0.4002***	-0.6826***
EUROPE	-0.0547*	0.8401***	0.1704***
US	0.2503***	0.0737**	-0.1523*
Panel D: Asymmetric Volatility Transmission g			
ASIA	0.5347***	-0.2898***	0.0431
EUROPE	-0.0489	-0.2833***	0.2902***
US	0.4880***	-0.3163***	-0.1251*
Panel E: Other parameter			
c	0.2599*	0.4136***	0.0008858

Table 4.9 VAR-BEKK-GJR result in regions (Apr.2007-Mar.2010)

To	From		
	Asia	Europe	US
Panel A: Return Transmission λ			
ASIA	0.1773**	-0.3525***	0.1991***
EUROPE	0.1422*	-0.3785***	0.1076*
US	0.06481	-0.2061*	-0.1589***
μi	-1.0717***	-1.5418***	-0.2587
θi	0.0594***	0.0350***	0.0089
Panel B: Volatility Transmission β			
ASIA	-0.1410	0.4890***	-0.1936*
EUROPE	-0.0220	0.2390**	0.1312
US	0.1618	0.2703	0.2371*
Panel C: Market Shock Transmission α			
ASIA	-0.1106	0.4104**	-0.0607
EUROPE	-0.3035	0.9523***	0.0533
US	0.2394	-0.0021	0.5454***
Panel D: Asymmetric Volatility Transmission g			
ASIA	-0.9279***	-0.3372**	1.0057***
EUROPE	-0.9145***	-0.2420***	0.7519***
US	0.3430	-1.1375***	0.7704***
Panel E: Other parameter			
c	2.2201***	0.5350*	0.1265

Notes: 1.***, ** and * indicate significance at 1%, 5% and 10% level;
2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)
3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

With the return transmissions strengthened, the volatility transmissions before financial crisis have been weakened before crisis. Only Europe has significant volatility spillover effect to other market. With the less significant volatility transmission, still there are strong market shock spillovers in all the markets pairs. This indicates, in this short period, the information on market

could spread fast, but the volatility change has less influence. The negative effect is not significant only from US to Asia and from Asia to Europe.

In the three years before global financial crisis, international real estate securities markets are more integrated in terms of significant return and volatility transmission in short run time. Information and risk could be transmitted to other markets in quick response. There is more tight linkage with a specific region.

(a) During and after crisis

Table 4.7 provides estimation result for this sub-period. The return transmissions in financial crisis period are still significant for almost all the market pairs in European groups. Netherland seems less affected in the crisis period compared to other major European real estate securities markets. Compared to the results before financial crisis, Germany is more involved in the whole market zone with more significant return transmission.

Based on volatility transmission result, Netherlands has less significant spillover with other markets. This also indicates that, it is less influenced under financial crisis compared to the degree before financial crisis and in the whole long research period.

Table 4.7 VAR-BEKK-GJR result in European markets (Apr.2007-Mar.2010)

	From				
To	**US**	**UK**	**FRA**	**GER**	**NETH**
Panel A: Return Transmission λ					
US	-0.0557*	0.0507**	0.0944**	0.0991***	-0.2630***
UK	0.4332***	-0.1936***	0.2786***	-0.1153***	-0.3578***
FRA	0.3282***	-0.0664***	-0.2074***	0.0528***	-0.0835***
GER	0.4590***	-0.3050***	0.0882**	-0.1668***	-0.0356
NETH	0.3534***	-0.1167***	0.0347	-0.0184	-0.2109***
μ_i	0.0120	-0.9370***	-0.6049***	-1.4145***	-0.5341&&&
θ_i	0.0055**	-0.0023	0.0006	0.0064***	0.0067***
Panel B: Volatility Transmission β					
US	-0.1509***	-0.0317	-0.1335	1.1264***	-0.3473***
UK	-0.0733***	0.7310***	0.0467**	0.1995***	0.0267
FRA	0.0706***	0.0203	0.3890***	0.1967***	0.1149***
GER	0.3248***	-0.1424***	0.5676***	0.2590***	-0.0167
NETH	0.0151	-0.1066	-0.0198	0.0693***	0.8757***
Panel C: Market Shock Transmission α					
US	0.2371***	0.1479**	-0.00041	0.2610***	-0.6794***
UK	-0.0005	-0.1742***	0.1548***	-0.1802***	0.0666
FRA	0.0816***	-0.3625***	0.4187***	0.0485**	0.1138***
GER	0.0100	0.0017	0.2799***	0.0295	-0.4100***
NETH	-0.0619***	-0.1752***	0.3933***	0.1682***	-0.3686***
Panel D: Asymmetric Volatility Transmission g					
US	0.5879***	0.1261	1.4944***	-0.1029	-1.3245***
UK	0.5026***	-0.0435	0.4059***	-0.3766***	0.4032***
FRA	0.4519***	0.6698***	-0.8613***	0.1859***	0.1356*
GER	1.1701***	-0.3188***	-0.6304***	0.5637***	-0.5186***
NETH	0.5734***	0.1009***	-0.4137***	0.0348	0.2359***
Panel E: Other parameter					
c	1.1019***	0.2385	0.0002	-0.0001	-0.0001

Notes: 1.*, ** and * indicate significance at 1%, 5% and 10% level;**
2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)
3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

Compared to the period before financial crisis, the return transmissions in Asian markets especially from less developed markets to highly developed markets have become less significant as shown in Table 4.8. US and Japan could

offer return transmission to other markets in only one direction with no feedback. Then the other markets have return transmission in two directions as a small group. This suggests in during-post financial crisis sub-period, US and Japan are two main important markets.

For the volatility transmission, in the short three years during and after financial crisis, there are significant volatility spillover effects in Asian real estate securities markets except Australia market. The connection between Australia and the other Asian markets has been weakened compared to the period before crisis.

In the crisis period, the return transmissions among the three regions become more serious. In 10% level, only Asia couldn't offer return transmission to US market. The international markets become more integrated and could affect each other in rapid way on returns.

For volatility transmission, there are more uni-directional ones. More are from Europe and US to Asia to spread volatility. This means in financial crisis period, US and Europe are the domain volatility producer. This also works in the same way for market shock transmission. However the negative market shock spillovers are significant in almost all the region pairs.

Table 4.8 VAR-BEKK-GJR result in Asian markets (Apr.2007-Mar.2010)

	From				
To	**US**	**JP**	**HK**	**SG**	**AUS**
Panel A: Return Transmission λ					
US	-0.0195	0.2141***	-0.0281	0.0649	-0.0340
JP	0.3096***	-0.2070***	0.0394	0.0534	-0.0601
HK	0.2841***	-0.0986**	-0.0051	0.2748***	-0.2748***
SG	0.3301***	-0.1101***	0.0817**	0.1112**	-0.2053***
AUS	0.5894***	-0.1034***	0.0694	-0.0045	-0.2716***
μ_i	-0.3827**	-1.1907***	-0.6948***	-0.2436	-0.5712***
θ_i	0.0223***	0.0723***	0.0381***	0.0288***	0.0194***
Panel B: Volatility Transmission β					
US	0.2294***	-0.3074***	-0.2722***	0.5927***	-0.1040
JP	0.4041***	-0.3657***	-0.0471	0.3382***	-0.1068*
HK	0.2351***	-0.4065***	0.5821***	0.2191***	-0.0475*
SG	0.02162	-0.6830***	0.3090***	0.5334***	0.0065
AUS	0.0512	-0.5460***	-0.0910	0.2744***	0.4578***
Panel C: Market Shock Transmission α					
US	0.3617***	-0.0872	-0.5311	-0.4398***	0.8612***
JP	0.0333	0.0069	-0.2683***	-0.4199***	0.2479**
HK	-0.0994*	0.2601***	-0.3554***	0.3602***	0.0200
SG	0.0927*	0.0470	-0.3373***	-0.4813***	0.4329***
AUS	-0.3603***	0.5380***	-0.5621***	0.1174	0.6177***
Panel D: Asymmetric Volatility Transmission g					
US	0.5617***	0.7059***	-0.2723**	0.4781***	-0.4535***
JP	0.6348***	-0.0478	0.5932***	-0.1886	-0.9883***
HK	0.6138***	0.0181	0.0988	0.3961***	-0.4291***
SG	0.8743***	-0.4508***	-0.2279*	0.5650***	-0.3322***
AUS	1.0146***	0.2960***	0.1556	-0.4656***	-0.2631***
Panel E: Other parameter					
c	1.8247***	2.4226***	0.5455	-0.0005	0.0001

Notes: 1.*, ** and * indicate significance at 1%, 5% and 10% level;**

2. The VAR-BEKK-GJR model is expressed in equation (2) and (3)

3. Panel A reports results for equation (2), Panel B, C, D and E report results for equation(3)

During and after global financial crisis, return transmission is strengthened in international real estate securities markets. The market loss is transmitted fast. However, volatility transmission is weakened, especially in Asian market. In

European markets, Netherland securitized property market becomes less integrated with other markets. Australia is also less integrated. They receive less volatility spillover from US. US and Europe regions have more linkage and high risk in this period. Asian markets have less co-movement with European markets and US, which indicates potential diversification opportunity.

4.4 Summary

This chapter examines the existence and nature of return and volatility transmission effect in international real estate securities markets during the period July, 1992 to March, 2010. Since the investment in real estate securities markets has grown into an important vehicle for institutional investors. The investigation in spillover effect in world-wide markets would shed light on the return analysis and risk management of securitized property markets and lead to optimal asset allocation. Under the huge attentions on potential loss in crisis period, two sub-period analyses also have been taken to examine the different performance before and during world financial crisis period.

The main findings are:

In the whole research period:

The European Union markets are highly integrated with return and volatility transmission in both directions among the four markets. US market transmits uni-directions spillover effect to European real estate securities markets. US and Japan are higher level markets in Asian region. They offer return and volatility spillovers to lower market with no significant feedback. Australia securitized real estate market is less integrated in Asia-Pacific Region. All the linkages in terms of volatility and return transmission are strengthened when market is in bad condition. In the region level, the cross-region return transmission is less significant than the countries within a region. However the volatility spillovers are significant between different regions.

Before crisis v.s. During-post and after crisis

In the short period before financial crisis, both European markets and Asian markets are strongly integrated. Within the regions, the markets have more spillovers to each others. Both Asian markets and European markets could offer relevant transmissions to US market. The role of volatility producer for US has been weakened with the globalization development. After financial crisis, Germany is more involved in the European markets, while Netherland shows loose connection. This also happens between Australia market and Asian markets. It is less influenced under financial crisis compared the integrity degrees before

financial crisis and of the whole long research period. After the breakout of financial crisis, US is still the biggest volatility producer. In Asian market, Japan is the second volatility source. However US and European markets both have volatility transmission to Asian markets. The asymmetric effect is significant in both before and after financial crisis period. US and Europe regions have more linkage and high risk in this period. Asian markets have less co-movement with European markets and US, which indicates potential diversification opportunity.

Chapter 5 Dynamic Conditional Correlation in international real estate securities markets with volatility threshold effect

5.1 Introduction

Besides volatility transmission, another important aspect of market integration is the analysis of time-varying correlation. The main objective of this chapter is to investigate the dynamic conditional correlation with volatility threshold and asymmetric effect in international real estate securities markets from Jul. 1992 to Mar. 2010. Section 5.2 describes the relevant analyzing methodology including Volatility Threshold Asymmetric Dynamic Conditional Correlation (VTADCC) model, Bai and Perron (BP) test and News Impact Surface. The empirical results are discussed in Section 5.3. It includes the results coming from VTADCC model and the correlation analysis based on the correlations generated from this model. A summary for this chapter is concluded in Section 5.4.

5.2 Methodology

5.2.1 VT-ADCC model

The DCC GARCH model proposed by Engle (2002) would be able to capture

the relationship between conditional volatilities and correlations. However, since our research period includes several financial crises which mean high volatility, we extend the original DCC model with volatility threshold proposed by Kasch (2007). The VT-ADCC-GARCH model is more effective in coping with high volatility underlying assets. By applying this model, we could investigate whether high volatilities are associated with high correlations. It is more valuable to offer information in high volatility period to investors for portfolio arrangement. The investigation on dynamic correlation under different volatility thresholds, one of which could indicate Financial crisis, is quite necessary. Furthermore, VT-ADCC model could detect the volatility spillover effects from the changes of the correlation. Once the dynamic correlation has been estimated, we could filter out the threshold effect and analyze the remaining part to understand the changing in correlation which could mean contagion. Specifically, the VT-ADCC is explicitly expressed by the correlation matrix as follows:

Let r_t be the vector of returns, it is assumed to be conditionally normal with mean zero and covariance matrix H_t :

$$r_t|\xi_{t-1} \sim N(0, H_t) \tag{6}$$

ξ_{t-1} is the all available information in time t-1. The H_t could be

decomposed as follows:

$$H_t = D_t R_t D_t \tag{7}$$

D_t is a diagonal matrix of conditional volatilities coming from the uni-variate GARCH models with $\sqrt{h_{it}}$ on the *i*th diagonal.

After estimating the volatility, the standardized residuals $\varepsilon_t = D_t^{-1} r_t$ are calculated and used to construct the correlation model.

$R_t = \{\rho_{ij,t}\}$ stands for the time-varying conditional correlation matrix. R_t could be decomposed in to

$$R_t = \left(diag(Q_t)\right)^{-\frac{1}{2}} Q_t \left(diag(Q_t)\right)^{-\frac{1}{2}} \tag{8}$$

Then the VT-ADCC model could be specified as follows,

$$Q_t = (\bar{Q} - A\bar{Q}A' - B\bar{Q}B' - \Gamma\bar{V}\Gamma') + A\left(\varepsilon_{t-1}\varepsilon_{t-1}'\right)A' + BQ_{t-1}B' + \Gamma V_{t-1}\Gamma' \tag{9}$$

V_t is a dummy variable matrix related to the volatility threshold structure.

The dynamic correlation of the individual elements of the matrix is specified:

$$q_{ij,t} = (1 - \alpha - \beta)\overline{q_{ij}} + \alpha\varepsilon_{i,t-1}\varepsilon_{j,t-1} + \beta q_{ij,t-1} + \gamma\left(v_{ij,t} - \overline{v_{ij}}\right) \qquad (10)$$

The dummy variables matrix V_t is defined as:

$$v_{ij,t} = \begin{cases} 1 & if \ \left(h_{i,t} > d\left(\{h_{i,t}\}_{t=1}^{T}\right) \ and \ \varepsilon_{i,t} < 0\right) \ or \ \left(h_{j,t} > d\left(\{h_{j,t}\}_{t=1}^{T}\right) \ and \ \varepsilon_{j,t} < 0\right) \\ 0 \end{cases} \qquad (11)$$

To calculate the threshold point, the fractile is based on all the assets' conditional volatility. This specification could reduce the threshold magnitude difference coming from different markets characteristics. Consequently, we standardize all the conditional volatility series in the whole sample and extract a uniform threshold point.

First we compute the mean μ and the variance τ of each series, then the standardized conditional volatility series is calculated as $\bar{h}_{i,t} = (h_{i,t} - \mu_i)/\tau_i$. Compute the threshold fractile $\bar{d}$ based on the new sequences and get back the fractile for each market sequence by computing$d_i = \bar{d} * \tau_i + \mu_i$. By adopting the calculation the threshold in this model is on common basis and could reduce the possible effect from different magnitude and disperse in all the conditional volatility sequences.

α and β, as the conventional indicators in DCC model, can reflect the effect of previous volatility and dynamic conditional correlations on current conditional

correlation. γ measure the sensitivity of the correlations between markets *i* and *j* to the levels of volatility in the underlying markets. This coefficient could effectively capture how are the correlations in real estate securities and stock markets influenced in high volatility periods.

The model could be estimated by a two-stage estimation applying likelihood function.

In our research, we use the result coming from previous VAR-BEKK-GJR model to replace the first step in VTADCC-GARCH, the ordinary GARCH model. We use the residual and volatility series to estimate the second step – the dynamic conditional correlation part.

5.2.2 Bai and Perron (2003) Methodology (BP)

BP proposes a methodology to test for infrequent structural breaks in financial markets. Using Monte Carlo experiments, BP (2004) find their methodology is powerful in detecting structural breaks and performs better than earlier methods. Compared to other structural break tests, the BP method allows for general specifications when computing test statistics and confidence intervals for the break dates and regression coefficients. These specifications include autocorrelation and heteroskedasticity in the regression model residuals as well

as different moment matrices for the regressor in the different regimes.

The BP method regress a time series (price index and volatility index in this study) on a constant and test for structural breaks in the constant. Consider a regression model with m breaks ($m+1$ regimes),

$$v_{i,t} = \beta_{i,j} + \varepsilon_{i,t}; \quad t = T_{i,j-1}+1,...,T_{i,j} \quad \text{..... (12)}$$

for $j = 1,...,m+1$, where $v_{i,t}$ is the index value for market i at period t. $\beta_{i,j}$ ($j = 1,...,m+1$) is the mean value in regime j. The m-partition ($T_{i,1},...,T_{i,m}$) represents the breakpoints for the different regimes (by convention, $T_{i,0} = 0$, and $T_{i,m+1} = T$). These breakpoints are unknown, and estimates of the breakpoints are generated using the least squares principle. For each m-partition ($T_{i,1},...,T_{i,m}$), the least squares estimates of $\beta_{i,j}$ are generated by minimizing the sum of squared residuals,

$$S_{i,T}(T_{i,1},...,T_{i,m}) = \sum_{k=1}^{m+1} \sum_{t=T_{k-1}+1}^{T_k} (v_{i,t} - \beta_{i,k})^2 \qquad (13)$$

Given that the regression coefficient estimates are denoted by $\hat{\beta}_i(\{T_{i,1},...,T_{i,m}\})$, where $\beta_i = (\beta_{i,1},...,\beta_{i,m+1})'$. Substituting these into Equation (2) the estimated breakpoints are given by

$$(\hat{T}_{i,1},...,\hat{T}_{i,m}) = \arg \min_{T_{i,1},...,T_{i,m}} S_{i,T}(T_{i,1},...,T_{i,m}) \quad (14)$$

The numbers of structural breaks (m) in equation (1) are identified using two statistics: the "double maximum" statistics for testing the null hypothesis of no structural breaks against the alternative hypothesis of an unknown number of breaks given an upper bound M . The first double maximum statistic is given by

$$UD\max = \max_{1 \le m \le M} SupF_{i,T}(m), \quad (15)$$

The second double maximum statistic applies different weights to the individual tests such that the marginal p -values are equal across values of m and is denoted as $WD\max$.

Additionally, in testing for the null hypothesis of l breaks against the alternative hypothesis of $l+1$ breaks, the $SupF_{i,T}(l+1|l)$ statistic is used to test whether the additional break leads to a significant reduction in the sum of squared residuals. BP derives asymptotic distributions for the double maximum and $SupF_{i,T}(l+1|l)$ statistics, and provide critical values for various values of π and M . Compared to other structural break tests, the BP method allows for general specifications when computing test statistics and confidence intervals for the break dates and regression coefficients. These specifications include

autocorrelation and heteroskedasticity in the regression model residuals, as well as different moment matrices for the regresses in the different regimes.

Finally, BP recommends the following parsimonious strategies to identify the number of breaks. The procedure should start with first examining the double maximum statistics to determine whether any structural breaks are present. If the double maximum statistics are significant, then the $SupF_{i,T}(l+1|l)$ statistics are evaluated to determine the number of breaks, choosing the $SupF_{i,T}(l+1|l)$ statistic that rejects the largest value of l. Finally, the trimming parameter of at least 0.15 (M=5) is recommended when allowing for heteroskedasticity and series correlation in the time series.

5.2.3 News Impact Surface

To investigate the response of correlation for good or bad news, we illustrate the asymmetric response of correlation to joint bad news and joint good news using news impact surfaces introduced by Kroner and Ng (1998). For the model considered in this article, the news impact surface for correlation will be asymmetric, having (potentially) greater response to joint bad news than to joint good news. The news impact surface for correlation is given by

$$f(\varepsilon_i, \varepsilon_i) = \frac{c_{ij} + (a+g)\varepsilon_i\varepsilon_j + b * \rho_{ijt}}{\sqrt{(c_{ii} + (a+g)\varepsilon_i^2 + b)\left(c_{jj} + (a+g)\varepsilon_j^2 + b\right)}} \qquad for\ \varepsilon_i, \varepsilon_i\ < 0,$$

$$f(\varepsilon_i, \varepsilon_i) = \frac{c_{ij} + a * \varepsilon_i\varepsilon_j + b * \rho_{ijt}}{\sqrt{(c_{ii} + (a+g)\varepsilon_i^2 + b)\left(c_{jj} + a * \varepsilon_j^2 + b\right)}} \qquad for\ \varepsilon_i, \varepsilon_i\ < 0,$$

$$f(\varepsilon_i, \varepsilon_i) = \frac{c_{ij} + a * \varepsilon_i\varepsilon_j + b * \rho_{ijt}}{\sqrt{(c_{ii} + a * \varepsilon_i^2 + b)\left(c_{jj} + (a+g)\varepsilon_j^2 + b\right)}} \qquad for\ \varepsilon_i, \varepsilon_i\ < 0,$$

$$f(\varepsilon_i, \varepsilon_i) = \frac{c_{ij} + a * \varepsilon_i\varepsilon_j + b * \rho_{ijt}}{\sqrt{(c_{ii} + a * \varepsilon_i^2 + b)\left(c_{jj} + a * \varepsilon_j^2 + b\right)}} \qquad for\ \varepsilon_i, \varepsilon_i\ < 0,$$

(16)

where ε are standardized residuals. a, b, and g are the coefficients from VT-ADCC model, ρ_{ijt} is the unconditional correlation, c_{ij} is the average correlation. As there are 45 pairs in our sample, we only choose several market pairs with significant VTADCC results including within-region pairs and cross-region pairs.

5.3 Empirical Results

5.3.1 Basic Unconditional Correlation Analysis

Table 5.1 displays the unconditional correlation matrix. The data series are

produced from previous VAR-BEKK-GJR estimation results. All the sample markets are included. US1 indicates residual of US real estate securities market from estimation with Asian Group; US2 indicates residual from estimation with European Group. Upper triangle in Table 5.1 incorporates unconditional correlation with lower triangle indicates covariance. The higher unconditional correlations (highest between France and Netherland 0.797) within European markets suggest European real estate securities markets are more integrated except European Union countries. The correlations between European market and Asian markets are generally lower (lowest between Hong Kong and Germany 0.2347). European real estate markets have more close connection with US market than Asia. This is in accordance with previous investigation in term of volatility transmission. The markets within a specific region are more integrated. Europe is more integrated with US than Asia.

Table 5.1 Unconditional correlation and covariance values for return residuals

	JP	**HK**	**SG**	**AUS**	**UK**	**FRA**	**GER**	**NETH**	**US1**	**US2**
JP	21.136	**0.276**	**0.306**	**0.304**	**0.272**	**0.292**	**0.235**	**0.287**	**0.201**	**0.215**
HK	5.547	19.149	**0.642**	**0.411**	**0.318**	**0.278**	**0.234**	**0.279**	**0.253**	**0.270**
SG	6.749	13.461	22.960	**0.389**	**0.322**	**0.333**	**0.271**	**0.339**	**0.269**	**0.283**
AUS	4.276	5.510	5.704	9.383	**0.493**	**0.520**	**0.468**	**0.546**	**0.428**	**0.437**
UK	4.368	4.853	5.387	5.278	12.191	**0.654**	**0.504**	**0.640**	**0.426**	**0.418**
FRA	3.824	3.476	4.559	4.548	6.516	8.140	**0.652**	**0.797**	**0.477**	**0.471**
GER	4.246	4.022	5.094	5.623	6.899	7.302	15.400	**0.646**	**0.481**	**0.477**
NETH	3.625	3.354	4.469	4.596	6.142	6.250	6.970	7.557	**0.478**	**0.475**
US1	3.105	3.712	4.316	4.397	4.986	4.567	6.332	4.402	11.246	**0.988**
US2	3.276	3.909	4.493	4.432	4.841	4.453	6.206	4.324	10.976	10.979

Notes: the values in upper triangle are correlations; in the lower triangle is covariance.

5.3.2 Volatility Threshold Asymmetric Conditional Correlation

To analyze the conditional correlation results in different threshold fraction. The model is estimated for different predefined volatility threshold levels for contrast: 50%, 75%, 90% and 95%. The series is defined as equation (11). In Kasch (2007) paper, the estimation result adopted delta method to calculate standard error; we still use the traditional way to compute the result, so the significance could be influenced under this approach. The accordant results are presented in Table 5.2, 5.3, 5.4 and 5.4. The residuals adopted in this model coming from the previous VAR-BEKK-GARCH estimation. US1 stands for the residual produced in Asia Group, and US2 indicates the residual produced from Europe Group.

First we investigate the traditional DCC parameters α and β. In these four threshold models, all correlation pairs have significant lag correlation coefficient (β in the model equation) with value close to 1. This is in accordance with traditional DCC expectation. The coefficient α stands for the traditional DCC volatility part. Only four pairs in 95%, five pairs in 90%, six pairs in 75% and four pairs in 50% have insignificant estimation results. It indicates that the

dynamic feature is obvious in our sample. There is ordinary positive relationship between time-varying correlation and common volatility, which is consistent with previous research and expectation.

To give an explicit summary on the volatility threshold part of our model, we gather all the coefficient c in Table 5.5. The cross-region market pairs show more negative sign for this extreme high volatility parameter $v_{ij,t}$. This is consistent in almost all the four percentage fractiles. It means the time-varying correlations performance lower in extreme high volatility period when the counterparts come from different regions. The exception is the performance between Hong Kong and European markets. They share more positive results than the other cross-region pairs. The negative signs for volatility threshold parameter in cross-region pairs suggest that in high volatility period, the co-movement in markets from different regions would be lower; they have instinct reaction on the crisis.

On the contrary, this kind of relationship inverses when it happens within one specific region – the correlation is positively affected by the volatility in one of the markets or both exceeding a predefined threshold. This could be interpreted as there is significant contagion effect in these markets. However, this contagion effect is not so strong to affect market outside the region. As a result, when

volatilities become extremely high, the correlation would be lower, they don't share similar trend. For the cross-regions pairs, Hong Kong and Australia have more co-movement with European markets when markets become instable and bad. They are more connected to European markets than Singapore and Japan markets. However, in European group, Netherland performs different with other markets. It has negative values for the threshold variable with other European markets. This is consistent with the results in VAR-BEKK-GARCH model. In crisis period, Netherland is less correlated with other European markets and receives less contagion.

The different estimation results under four percentage levels indicate the sensitivity of correlation with volatility degree. In accordance with the hypothesis, when fractile is higher the influence of volatility is more significant, which indicates crisis period would change correlations more. The significant result for each percentile estimation model is 4, 12, 10 and 18. Basically, when volatility threshold is higher, the extreme volatility effect is more significant. This is accordant with the crisis effect.

Table 5.2 VTADCC result with 95% Threshold volatiliy (Jul.1992 - Mar. 2010)

	a	b	c	LL		a	b	c	LL
jp-hk	0.0249**	0.9431***	0.0266***	-2588.03	aus-uk	0.0126***	0.9672***	0.0526***	-2525.92
	3.99496	1140.066	4.27434			(2.58)	(43.03)	(2.70)	
jp-sg	0.0122***	0.9871***	-0.0032	-2577.53	aus-fra	0.0180**	0.9761***	-0.0088	-2533.00
	3.12364	211.1424	-0.67494			(2.46)	(80.44)	(-0.39)	
jp-aus	-0.0041*	0.4990**	0.3961***	-2578.26	aus-ger	0.0224***	0.9725***	0.0197	-2545.06
	-0.18562	1.27556	1.52841			(2.66)	(84.32)	(0.62)	
jp-uk	0.0067*	0.9901***	-0.0156*	-2574.45	aus-neth	0.0197***	0.9761***	-0.0216	-2520.74
	1.75107	138.1871	-1.70812			(3.33)	(123.39)	(-1.17)	
jp-fra	0.0048	0.9876***	-0.0149	-2592.23	aus-us	0.0096	0.9481***	0.0951*	-2551.43
	(0.96)	(48.67)	(-1.08)			(1.01)	(25.61)	(1.65)	
jp-ger	0.0109**	0.9890***	-0.0200**	-2587.80	aus-us2	0.0126*	0.9408***	0.1368**	-2543.77
	(2.44)	(168.33)	(-1.99)			(1.78)	(31.96)	(2.08)	
jp-neth	0.0498**	0.8672***	0.0690	-2594.80	uk-fra	0.0156**	0.9761***	0.0154	-2434.27
	(2.28)	(12.24)	(1.09)			(2.35)	(76.08)	(0.47)	
jp-us	0.0134***	0.9819***	-0.0203***	-2591.28	uk-ger	0.0424***	0.9423***	0.0272	-2496.84
	(6.93)	(310.50)	(-12.82)			(2.64)	(37.61)	(0.59)	
jp-us2	0.0252***	0.9317***	-0.0173	-2589.48	uk-neth	0.0201***	0.9724***	0.0135	-2445.80
	(2.79)	(50.03)	(-0.53)			(0.0077)	(79.03)	(0.46)	
hk-sg	0.0264**	0.9348***	0.0403	-2414.11	uk-us	0.0040***	0.9644***	0.0284***	-2540.48
	(2.33)	(25.19)	(1.11)			(4.31)	(3.12)	(9.92)	
hk-aus	0.0111**	0.9817***	-0.0025	-2525.25	uk-us2	0.0215	0.8469***	0.0238	-2538.41
	(2.08)	(70.04)	(-0.23)			(0.82)	(4.95)	(0.43)	
hk-uk	0.0181	0.9635***	-0.0080	-2556.70	fra-ger	0.0248***	0.9676***	0.0484	-2444.93
	(1.51)	(38.49)	(-0.71)			(2.60)	(64.08)	(0.86)	
hk-fra	0.0174*	0.9727***	0.0022	-2591.25	fra-neth	0.0389***	0.9445***	0.0814*	-2280.05
	(1.79)	(50.19)	(0.18)			(3.26)	(51.85)	(1.77)	
hk-ger	0.0214***	0.9700***	0.0092**	-2585.69	fra-us	0.0226***	0.9334***	0.0852***	-2570.92
	(2.77)	(75.90)	(2.00)			(17.71)	(40.77)	(22.32)	
hk-neth	0.0248*	0.9623***	0.0084	-2588.08	fra-us2	0.0126*	0.9682***	0.0460	-2566.59
	(1.82)	(37.18)	(0.55)			(1.83)	(35.94)	(0.86)	
hk-us	0.0242**	0.9600***	-0.0079	-2566.40	ger-neth	0.0311***	0.9649***	0.0023	-2437.98
	(1.99)	(42.45)	(-0.73)			(3.16)	(75.68)	(0.06)	
hk-us2	0.0211*	0.9582***	-0.0025	-2562.85	ger-us	0.0684***	0.8439***	0.2032*	-2557.80
	(1.80)	(36.53)	(-0.19)			(2.79)	(13.94)	(1.84)	
sg-aus	0.0100***	0.9875***	-0.0057	-2539.17	ger-us2	0.0464*	0.8976***	0.1952*	-2557.39
	(2.63)	(163.31)	(-0.85)			(1.95)	(16.90)	(1.67)	
sg-uk	0.0112*	0.9790***	-0.0126*	-2548.34	neth-us	0.0215***	0.9623***	0.0332***	-2575.70
	(1.95)	(74.08)	(1.79)			(95.96)	(83.35)	(3.00)	
sg-fra	0.0152***	0.9804***	-0.0040	-2564.06	neth-us2	0.0112**	0.9854***	-0.0012	-2569.65
	(2.80)	(127.41)	(-0.56)			(2.41)	(97.83)	(-0.05)	
sg-ger	0.0142***	0.9842***	-0.0001	-2570.21	us-us2	0.0768***	0.8363***	-0.0435	-1025.76
	(3.16)	(162.63)	(-0.01)			(4.49)	(19.19)	(-0.62)	
sg-neth	0.0190***	0.9753***	-0.0096	-2563.88					
	(3.12)	(111.17)	(-1.21)						
sg-us	0.0113*	0.9792***	-0.0029	-2574.94					
	(1.77)	(72.46)	(-0.37)						
sg-us2	0.0105*	0.9809***	-0.0021	-2568.91					
	(1.70)	(72.13)	(-0.25)						

Notes:1.This is the estimation result for equation (10), the threshold isdefined as equation (11). 2.The values in the parentheses are t-statistics. LL indicate the log likelihood.

Table 5.3 VTADCC result with 90% Threshold volatility (Jul.1992 - Mar. 2010)

	a	b	c	LL		a	b	c	LL
jp-hk	0.0133**	0.9854***	-0.0025	-2586.26	aus-uk	0.0058***	0.9728***	0.0220***	-2525.71
	(2.55)	(144.27)	(-0.56)			(389.3)	(4558.13)	(303.78)	
jp-sg	0.0121***	0.9869***	-0.0028	-2577.49	aus-fra	0.0184***	0.9746***	-0.0018	-2533.06
	(2.91)	(185.4)	(-0.66)			(2.60)	(78.30)	(-0.12)	
jp-aus	0.0060*	0.9950***	-0.0118**	-2576.47	aus-ger	0.0229***	0.9735***	0.0054	-2545.22
	(1.89)	(196.28)	(-2.11)			(2.70)	(95.98)	(0.33)	
jp-uk	0.0076*	0.9875***	-0.0093	-2574.88	aus-neth	0.0203***	0.9752***	-0.0100	-2520.96
	(1.71)	(108.41)	(-1.63)			(3.14)	(113.01)	(-0.90)	
jp-fra	0.0105*	0.9857***	-0.0056	-2591.05	aus-us	-0.0126*	0.9782***	0.0390**	-2551.75
	(1.83)	(102.46)	(-0.65)			(-1.74)	(47.28)	(2.03)	
jp-ger	0.0113**	0.9865***	-0.0136*	-2587.44	aus-us2	0.0202***	0.9599***	0.0634**	-2543.26
	(2.17)	(138.26)	(-1.95)			(2.83)	(44.03)	(2.57)	
jp-neth	0.0491***	0.8512***	0.0773	-2594.15	uk-fra	0.0145**	0.9792***	0.0019	-2434.41
	(2.67)	(12.29)	(1.29)			(2.36)	(79.83)	(0.09)	
jp-us	0.0178***	0.9671***	-0.0239***	-2591.55	uk-ger	0.0401**	0.9467***	0.0058	-2497.07
	(2.65)	(105.53)	(-2.58)			(2.36)	(34.84)	(0.17)	
jp-us2	0.0083	0.9892***	-0.0115*	-2587.06	uk-neth	0.0198***	0.9734***	0.0033	-2445.92
	(0.98)	(95.62)	(-1.66)			(2.59)	(74.79)	(0.17)	
hk-sg	0.0276**	0.9317***	0.0312	-2414.21	uk-us	0.0117	0.9637***	0.0554*	-2538.58
	(2.17)	(21.12)	(1.01)			(0.98)	(45.12)	(1.65)	
hk-aus	0.0111**	0.9823***	-0.0020	-2525.25	uk-us2	0.0107	0.7718***	0.1563	-2536.48
	(1.92)	(66.01)	(-0.26)			(0.41)	(2.90)	(0.80)	
hk-uk	0.0200*	0.9593***	-0.0068	-2556.71	fra-ger	0.0250**	0.9652***	0.0389	-2444.89
	(1.63)	(33.37)	(-0.75)			(2.28)	(47.81)	(0.76)	
hk-fra	0.0196*	0.9669***	0.0058	-2591.12	fra-neth	0.0411***	0.9353***	0.0877*	-2279.03
	(1.79)	(38.98)	(0.45)			(3.11)	(39.67)	(1.89)	
hk-ger	0.0165**	0.9809***	0.0003	-2584.90	fra-us	0.0089	0.9379***	0.1066*	-2568.22
	(2.23)	(87.30)	(0.06)			(0.66)	(21.26)	(1.71)	
hk-neth	0.0314*	0.9472***	0.0146	-2587.79	fra-us2	0.0072	0.9298***	0.1232*	-2563.54
	(1.63)	(22.13)	(0.68)			(0.56)	(22.69)	(1.75)	
hk-us	0.0243**	0.9580***	-0.0054	-2566.46	ger-neth	0.0277***	0.9704***	-0.0130	-2437.85
	(1.90)	(41.07)	(-0.54)			(2.70)	(71.46)	(-0.58)	
hk-us2	0.0213*	0.9572***	-0.0014	-2562.86	ger-us	0.0671***	0.8037***	0.2736*	-2555.96
	(1.83)	(37.35)	(-0.15)			(2.76)	(11.81)	(1.95)	
sg-aus	0.0100***	0.9883***	-0.0055	-2538.90	ger-us2	0.0575***	0.8270***	0.2507	-2555.61
	(2.59)	(161.53)	(-1.17)			(2.58)	(12.81)	(1.88)	
sg-uk	0.0124**	0.9777***	-0.0083	-2548.91	neth-us	0.0114***	0.9861***	-0.0015	-2573.92
	(2.17)	(82.49)	(-1.16)			(2.58)	(99.84)	(-0.08)	
sg-fra	0.0152***	0.9807***	-0.0037	-2564.00	neth-us2	0.0115*	0.9753***	0.0171	-2569.49
	(2.99)	(133.99)	(-0.68)			(1.80)	(29.12)	(0.35)	
sg-ger	0.0142***	0.9842***	-0.0004	-2570.20	us-us2	0.0755***	0.8415***	-0.0249	-1025.85
	(4.32)	(202.60)	(-0.09)			(4.46)	(20.83)	(-0.45)	
sg-neth	0.0187***	0.9763***	-0.0079	-2563.83					
	(2.96)	(109.92)	(-1.24)						
sg-us	0.0109*	0.9800***	-0.0002	-2575.01					
	(1.86)	(77.27)	(-0.04)						
sg-us2	0.0104*	0.9814***	0.0006	-2568.94					
	(1.76)	(76.50)	(0.09)						

Notes:1.This is the estimation result for equation (10), the threshold isdefined as equation (11). 2.The values in the parentheses are t-statistics. LL indicate the log likelihood.

Table 5.4 VTADCC result with 75% Threshold volatility (Jul.1992 - Mar. 2010)

	a	b	c	LL		a	b	c	LL
jp-hk	0.0115***	0.9890***	0.0033	-258.36	**aus-uk**	0.0104**	0.9841***	-0.0004	-2525.84
	(9.87)	(4.50)	(0.67)			(2.14)	(124.08)	(-0.08)	
jp-sg	0.0121***	0.9870***	-0.0023	-2577.44	**aus-fra**	0.0181**	0.9737***	0.0014	-2533.06
	(3.19)	(202.92)	(-0.78)			(2.19)	(70.04)	(0.15)	
jp-aus	0.0054*	0.9955***	-0.0096***	-2575.36	**aus-ger**	0.0229***	0.9757***	-0.0037	-2545.16
	(1.71)	(191.40)	(-2.62)			(2.88)	(100.93)	(-0.51)	
jp-uk	0.0089	0.3561*	0.2030*	-2575.01	**aus-neth**	0.0197***	0.9742***	-0.0013	-2521.32
	(0.02)	(1.83)	(1.86)			(2.91)	(94.42)	(-0.16)	
jp-fra	0.0173***	0.9643***	-0.0003	-2591.92	**aus-us**	0.0603*	0.2723	0.1928	-2552.99
	(4.06)	(1170.73)	(-0.08)			(1.92)	(0.74)	(1.61)	
jp-ger	0.0133**	0.9847***	-0.0071*	-2587.91	**aus-us2**	-0.0087	0.9915***	0.0129**	-2546.61
	(2.40)	(127.47)	(-.71)			(-1.39)	(185.10)	(2.31)	
jp-neth	0.0532**	0.7864***	0.0971*	-2592.73	**uk-fra**	0.0135***	0.9844***	-0.0069	-2434.07
	(2.32)	(8.16)	(1.68)			(2.74)	(114.38)	(-0.93)	
jp-us	0.0103*	0.9873***	-0.0052	-2592.04	**uk-ger**	0.0354**	0.9577***	-0.0111	-2496.69
	(1.62)	(70.57)	(-1.11)			(2.48)	(49.12)	(-0.95)	
jp-us2	0.0167*	0.9314***	0.0185**	-2588.99	**uk-neth**	0.0181**	0.9790***	-0.0061	-2445.75
	(1.67)	(38.89)	(2.27)			(2.55)	(86.14)	(-0.66)	
hk-sg	0.0254**	0.9497***	0.0063	-2415.32	**uk-us**	0.0304**	0.9554***	0.0484***	-2536.65
	(2.42)	(39.45)	(0.63)			(2.19)	(35.98)	(2.58)	
hk-aus	0.0108*	0.9838***	-0.0025	-2525.20	**uk-us2**	0.0330***	0.9709***	0.0414***	-2533.18
	(1.87)	(65.38)	(-0.41)			(10.81)	(87.34)	(4.57)	
hk-uk	0.0201*	0.9600***	-0.0014	-2556.99	**fra-ger**	0.0203***	0.9754***	0.0059	-2445.38
	(1.64)	(30.40)	(-0.16)			(2.90)	(104.07)	(0.54)	
hk-fra	0.0180***	0.9722***	0.0013***	-2591.28	**fra-neth**	0.0417***	0.9382***	0.0305	-2280.08
	(2.02)	(19.56)	(35.78)			(2.91)	(39.18)	(1.21)	
hk-ger	0.0168**	0.9803***	0.0009	-2584.88	**fra-us**	0.0181	0.8258***	0.1322*	-2565.86
	(2.35)	(83.96)	(0.19)			(0.85)	(8.27)	(1.75)	
hk-neth	0.0320*	0.9440***	0.0115	-2587.86	**fra-us2**	0.0104	0.8912***	0.0802	-2563.61
	(1.72)	(22.10)	(0.70)			(0.41)	(7.57)	(1.21)	
hk-us	0.0247*	0.9549***	-0.0005	-2566.61	**ger-neth**	0.0282***	0.9706***	-0.0115	-2437.53
	(1.94)	(38.24)	(-0.06)			(3.62)	(108.00)	(-1.10)	
hk-us2	0.0165*	0.9504***	0.0078	-2562.94	**ger-us**	0.0598**	0.8138***	0.0953*	-2556.88
	(1.72)	(25.17)	(0.87)			(2.30)	(10.32)	(1.69)	
sg-aus	0.0099***	0.9889***	-0.0060	-2538.20	**ger-us2**	0.0513**	0.8506***	0.0673	-2557.85
	(2.73)	(184.24)	(-1.64)			(2.15)	(10.22)	(1.46)	
sg-uk	0.0119**	0.9804***	-0.0018	-2549.67	**neth-us**	0.0071	0.9801***	0.0121	-2573.24
	(1.90)	(73.51)	(-0.36)			(1.06)	(84.22)	(1.02)	
sg-fra	0.0146**	0.9819***	-0.0037	-2563.89	**neth-us2**	0.0170***	0.9537***	0.0170***	-2570.22
	(2.57)	(119.52)	(-0.82)			(2.51)	(4.03)	(1.82)	
sg-ger	0.0142***	0.9842***	-0.0015	-2570.12	**us-us2**	0.0723***	0.8560***	-0.1159***	-1018.57
	(3.18)	(163.76)	(-0.45)			(5.18)	(24.70)	(-3.74)	
sg-neth	0.0176***	0.9789***	-0.0069	-2563.89					
	(2.98)	(119.02)	(-1.35)						
sg-us	0.0076	0.7894***	0.0730	-2575.11					
	(0.44)	(4.44)	(1.15)						
sg-us2	0.0129	0.8557***	0.0485	-2569.21					
	(0.86)	(7.00)	(0.98)						

Notes:1.This is the estimation result for equation (10), the threshold isdefined as equation (11). 2.The values in the parentheses are t-statistics. LL indicate the log likelihood.

Table 5.5 VTADCC result with 50% Threshold volatiliy (Jul.1992 - Mar. 2010)

	a	b	c	LL		a	b	c	LL
jp-hk	0.0425***	0.9181***	-0.0028	-2590.47	**aus-uk**	0.0104**	0.9839***	-0.0003	-2524.79
	(22.67)	(29.01)	(-0.23)			(2.09)	(125.13)	(-0.07)	
jp-sg	0.0122***	0.9867***	-0.0022	-2577.44	**aus-fra**	0.0168**	0.9739***	0.0046	-2532.86
	(3.12)	(210.50)	(-0.71)			(2.14)	(81.11)	(0.65)	
jp-aus	0.0223**	0.9291***	-0.0134	-2580.36	**aus-ger**	0.0234***	0.9756***	-0.0053	-2544.86
	(2.15)	(30.49)	(-0.85)			(2.96)	(105.18)	(-0.90)	
jp-uk	0.0116***	0.8603***	0.0351***	-2576.21	**aus-neth**	0.0192***	0.9727***	0.0034	-2521.23
	(6.06)	(2.94)	(9.48)			(2.79)	(92.98)	(0.46)	
jp-fra	0.0109*	0.9830***	0.0003	-2591.23	**aus-us**	0.0340*	0.7073***	0.1224*	-2551.86
	(1.86)	(87.06)	(0.07)			(1.76)	(2.16)	(1.85)	
jp-ger	0.0141**	0.9831***	-0.0046	-2588.55	**aus-us2**	0.0400	0.4712	0.1738**	-2544.83
	(2.31)	(109.69)	(-1.05)			(1.51)	(1.53)	(2.32)	
jp-neth	0.0619**	0.7774***	0.0692	-2593.81	**uk-fra**	0.0147***	0.9801***	-0.0022	-2434.36
	(2.33)	(5.27)	(1.08)			(2.63)	(117.72)	(-0.35)	
jp-us	0.0134*	0.9760***	-0.0034	-2592.19	**uk-ger**	0.0389***	0.9519***	-0.0126	-2496.22
	(1.64)	(54.87)	(-0.49)			(2.89)	(51.86)	(-1.28)	
jp-us2	0.0125*	0.9790***	-0.0013	-2588.06	**uk-neth**	0.0195***	0.9767***	-0.0058	-2445.70
	(1.67)	(59.12)	(-0.24)			(2.75)	(95.44)	(-0.71)	
hk-sg	0.0261**	0.9489***	0.0036	-2415.44	**uk-us**	0.0143	0.6599*	0.1112	-2538.68
	(2.44)	(38.19)	(0.38)			(0.55)	(1.65)	(0.95)	
hk-aus	0.0106*	0.9837***	-0.0023	-2525.21	**uk-us2**	0.0153	0.7109***	0.0911	-2535.80
	(1.77)	(67.37)	(-0.42)			(0.59)	(2.91)	(1.23)	
hk-uk	0.0143	0.9723***	0.0041	-2556.84	**fra-ger**	0.0203***	0.9766***	0.0012	-2445.52
	(1.10)	(36.33)	(0.68)			(3.00)	(116.19)	(0.18)	
hk-fra	0.0173**	0.9725***	0.0013	-2591.25	**fra-neth**	0.0397***	0.9441***	0.0169	-2280.60
	(1.92)	(52.33)	(0.20)			(3.12)	(48.07)	(1.10)	
hk-ger	0.0167**	0.9803***	0.0011	-2584.86	**fra-us**	0.0444*	0.8662***	0.0225	-2571.42
	(2.32)	(83.03)	(0.25)			(1.83)	(9.41)	(0.75)	
hk-neth	0.0276**	0.9538***	0.0086	-2587.79	**fra-us2**	0.0413**	0.8206***	0.0545	-2567.10
	(2.02)	(33.89)	(0.86)			(2.14)	(8.39)	(1.39)	
hk-us	0.0245*	0.9550	-0.0012	-2566.61	**ger-neth**	0.0318***	0.9655***	-0.0090	-2437.68
	(1.65)	(34.78)	(-0.11)			(3.47)	(88.72)	(-0.97)	
hk-us2	0.0314***	0.9105***	-0.0067	-2563.49	**ger-us**	0.0783***	0.7715***	0.0778	-2557.41
	(61.56)	(26.62)	(-0.59)			(2.88)	(7.77)	(1.57)	
sg-aus	0.0363***	0.9243***	-0.0020	-2534.43	**ger-us2**	0.0763***	0.7678***	0.0733	-2558.60
	(5.29)	(97.83)	(-0.16)			(2.96)	(7.20)	(1.35)	
sg-uk	0.0110*	0.9818***	0.0008	-2549.72	**neth-us**	0.0093*	0.9856***	0.0051	-2573.39
	(1.90)	(82.32)	(0.18)			(1.94)	129.1	(1.03)	
sg-fra	0.0152***	0.9808***	-0.0018	-2564.13	**neth-us2**	0.0086*	0.9861***	0.0047	-2569.78
	(2.87)	(123.74)	(-0.35)			(1.81)	(142.05)	(1.19)	
sg-ger	0.0142***	0.9843***	-0.0011	-2570.16	**us-us2**	0.0582***	0.8922***	-0.1209***	-1016.56
	(3.09)	(161.01)	(-0.28)			(3.69)	(30.24)	(-4.31)	
sg-neth	0.0186***	0.9769***	-0.0044	-2564.22					
	(2.99)	(105.22)	(-0.76)						
sg-us	0.0110*	0.9704***	0.0129	-2573.97					
	(1.64)	(48.71)	(1.04)						
sg-us2	0.0104*	0.9759***	0.0055	-2568.56					
	(1.65)	(55.05)	(0.71)						

Notes:1.This is the estimation result for equation (10), the threshold isdefined as equation (11). 2.The values in the parentheses are t-statistics. LL indicate the log likelihood.

Table5.6 Asymmetric Threshold Coefficient (Jul.1992 - Mar. 2010)

	50%	75%	90%	95%		50%	75%	90%	95%
jp-hk	-0.0028	0.0033	-0.0025	0.0266***	aus-uk	-0.0003	-0.0004	0.0220***	0.0526***
	(-0.23)	(0.67)	(-0.56)	(4.27)		(-0.07)	(-0.08)	(303.78)	(2.70)
jp-sg	-0.0022	-0.0023	-0.0028	-0.0032	aus-fra	0.0046	0.0014	-0.0018	-0.0088
	(-0.71)	(-0.78)	(-0.66)	(-0.67)		(0.65)	(0.15)	(-0.12)	(-0.39)
jp-aus	-0.0134	-0.0096***	-0.0118**	0.3961*	aus-ger	-0.0053	-0.0037	0.0054	0.0197
	(-0.85)	(-2.62)	(-2.11)	(1.73)		(-0.90)	(-0.51)	(0.33)	(0.62)
jp-uk	0.0351*	0.2030*	-0.0093	-0.0156*	aus-neth	0.0034	-0.0013	-0.0100	-0.0216
	(9.48)	(1.86)	(-1.63)	(-1.71)		(0.46)	(-0.16)	(-0.90)	(-1.17)
jp-fra	0.0003	-0.0003	-0.0056	-0.0149	aus-us	0.1224*	0.1928	0.0390**	0.0951*
	(0.07)	(-0.08)	(-0.65)	(-1.08)		(1.85)	(1.61)	(2.03)	(1.65)
jp-ger	-0.0046	-0.0071*	-0.0136*	-0.0200**	aus-us2	0.1738**	0.0129**	0.0634**	0.1368**
	(-1.05)	(-.71)	(-1.95)	(-1.99)		(2.32)	(2.31)	(2.57)	(2.08)
jp-neth	0.0692	0.0971*	0.0773	0.0690	uk-fra	-0.0022	-0.0069	0.0019	0.0154
	(1.08)	(1.68)	(1.29)	(1.09)		(-0.35)	(-0.93)	(0.09)	(0.47)
jp-us	-0.0034	-0.0052	-0.0239***	-0.0203***	uk-ger	-0.0126	-0.0111	0.0058	0.0272
	(-0.49)	(-1.11)	(-2.58)	(-12.82)		(-1.28)	(-0.95)	(0.17)	(0.59)
jp-us2	-0.0013	0.0185**	-0.0115*	-0.0173	uk-neth	-0.0058	-0.0061	0.0033	0.0135
	(-0.24)	(2.27)	(-1.66)	(-0.53)		(-0.71)	(-0.66)	(0.17)	(0.46)
hk-sg	0.0036	0.0063	0.0312	0.0403	uk-us	0.1112	0.0484***	0.0554*	0.0284***
	(0.38)	(0.63)	(1.01)	(1.11)		(0.95)	(2.58)	(1.65)	(9.92)
hk-aus	-0.0023	-0.0025	-0.0020	-0.0025	uk-us2	0.0911	0.0414***	0.1563	0.0238
	(-0.42)	(-0.41)	(-0.26)	(-0.23)		(1.23)	(4.57)	(0.80)	(0.43)
hk-uk	0.0041	-0.0014	-0.0068	-0.0080	fra-ger	0.0012	0.0059	0.0389	0.0484
	(0.68)	(-0.16)	(-0.75)	(-0.71)		(0.18)	(0.54)	(0.76)	(0.86)
hk-fra	0.0013	0.0013***	0.0058	0.0022	fra-neth	0.0169	0.0305	0.0877*	0.0814*
	(0.20)	(35.78)	(0.45)	(0.18)		(1.10)	(1.21)	(1.89)	(1.77)
hk-ger	0.0011	0.0009	0.0003	0.0092**	fra-us	0.0225	0.1322*	0.1066*	0.0852***
	(0.25)	(0.19)	(0.06)	(2.00)		(0.75)	(1.75)	(1.71)	(22.32)
hk-neth	0.0086	0.0115	0.0146	0.0084	fra-us2	0.0545	0.0802	0.1232*	0.0460
	(0.86)	(0.70)	(0.68)	(0.55)		(1.39)	(1.21)	(1.75)	(0.86)
hk-us	-0.0012	-0.0005	-0.0054	-0.0079	ger-neth	-0.0090	-0.0115	-0.0130	0.0023
	(-0.11)	(-0.06)	(-0.54)	(-0.73)		(-0.97)	(-1.10)	(-0.58)	(0.06)
hk-us2	-0.0067	0.0078	-0.0014	-0.0025	ger-us	0.0778	0.0953*	0.2736*	0.2032*
	(-0.59)	(0.87)	(-0.15)	(-0.19)		(1.57)	(1.69)	(1.95)	(1.84)
sg-aus	-0.0020	-0.0060	-0.0055	-0.0057	ger-us2	0.0733	0.0673	0.2507	0.1952*
	(-0.16)	(-1.64)	(-1.17)	(-0.85)		(1.35)	(1.46)	(1.88)	(1.67)
sg-uk	0.0008	-0.0018	-0.0083	-0.0126*	neth-us	0.0051	0.0121	-0.0015	0.0332***
	(0.18)	(-0.36)	(-1.16)	(1.79)		(1.03)	(1.02)	(-0.08)	(3.00)
sg-fra	-0.0018	-0.0037	-0.0037	-0.0040	neth-us2	0.0047	0.0170***	0.0171	-0.0012
	(-0.35)	(-0.82)	(-0.68)	(-0.56)		(1.19)	(1.82)	(0.35)	(-0.05)
sg-ger	-0.0011	-0.0015	-0.0004	-0.0001	us-us2	-0.1209***	-0.1159***	-0.0249	-0.0435
	(-0.28)	(-0.45)	(-0.09)	(-0.01)		(-4.31)	(-3.74)	(-0.45)	(-0.62)
sg-neth	-0.0044	-0.0069	-0.0079	-0.0096					
	(-0.76)	(-1.35)	(-1.24)	(-1.21)					
sg-us	0.0129	0.0730	-0.0002	-0.0029					
	(1.04)	(1.15)	(-0.04)	(-0.37)					
sg-us2	0.0055	0.0485	0.0006	-0.0021					
	(0.71)	(0.98)	(0.09)	(-0.25)					

Notes: 1.This is the estimation result for equation (10), the threshold is defined as equation (11). 2.The values in the parentheses are t-statistics. The values with underlines are the ones with negative value. The values in bold indicate insignificant coefficient g.
3.Only the γ coefficient is reported, α and β are reported in previous tables

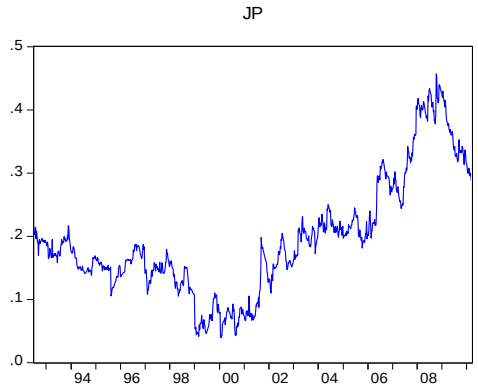
5.3.3 Correlation Analysis – mean value

To show how the markets correlated with other markets briefly, we calculate the average value for all the nine correlation pairs of each country in our sample. Figure 5.1 shows the plot of the average correlation and the dynamic volatility for each country. The plot of volatility series could show the basic market condition with time changes. The peak in volatility indicate financial crisis. There is not quite significant peak in Asian market correlations in Asian Financial Crisis period, while there s significant high volatilities that period. This would be the result of the correlations with European markets are not influenced in that period. Also, the effect for Asian Financial Crisis is weaker than the World-wide one. After Asian Financial Crisis, almost all the correlations have stable increased, suggesting global markets integration. This is particular significant in Asian markets and Netherland, indicating their roles in world market become more important. The international markets became more integrated. The correlation performances after 2007 indicate the influence of current global financial crisis. This financial crisis starts from US and have direct influence on all the markets. In post financial crisis period, the co-movement in these countries began to fall gradually.

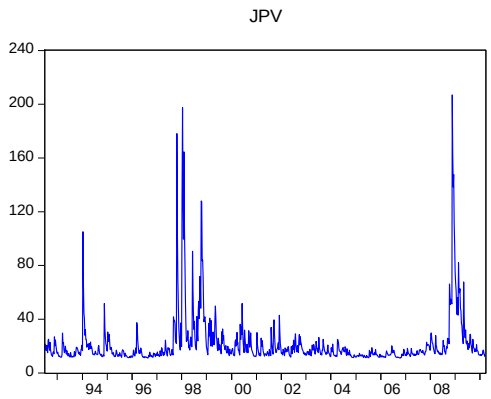
Figure 5.1 Mean value of dynamic conditional correlation and dynamic volatility for international real estate securities markets. (July,1992 – March, 2010)

Japan

Dynamic Correlation

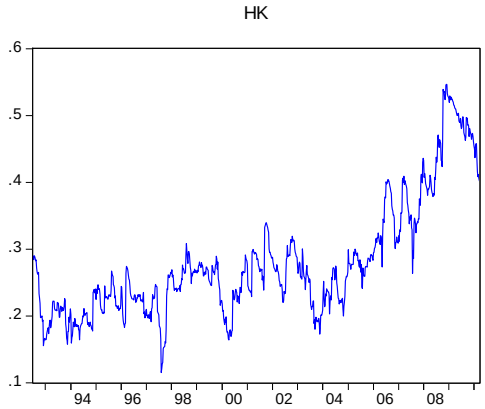


Dynamic Volatility

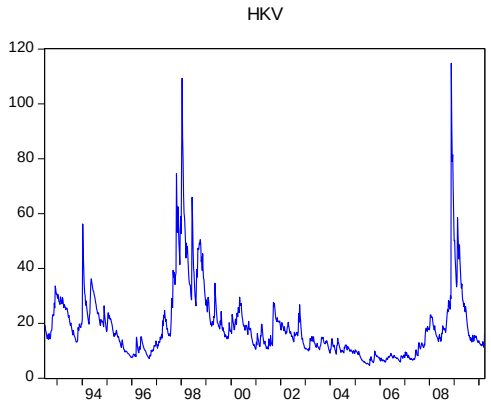


Hong Kong

Dynamic Correlation

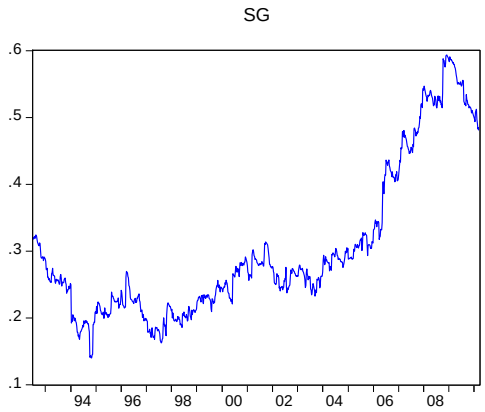


Dynamic Volatility

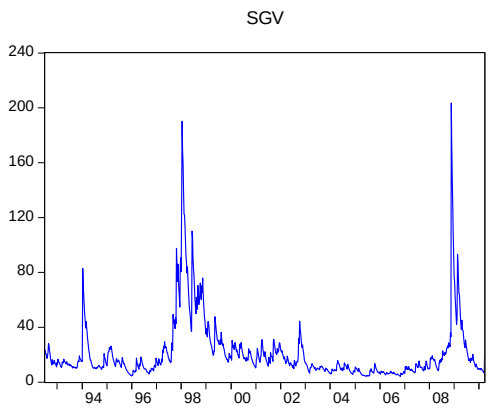


Singapore

Dynamic Correlation

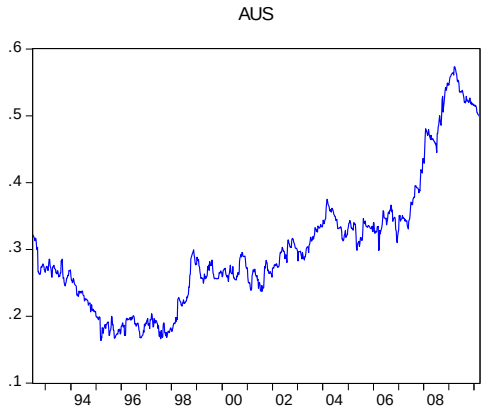


Dynamic Volatility

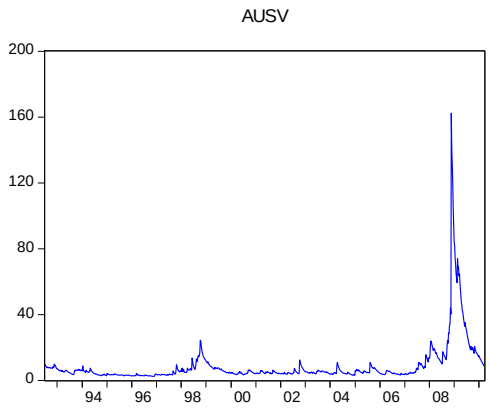


Australia

Dynamic Correlation

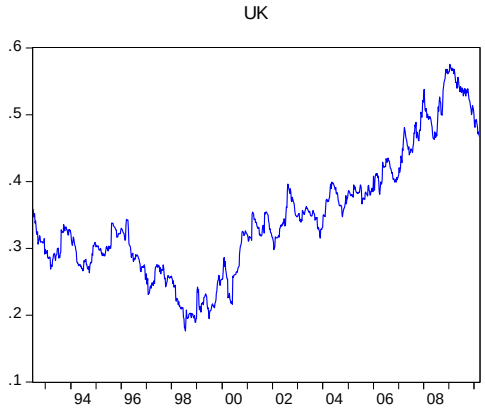


Dynamic Volatility

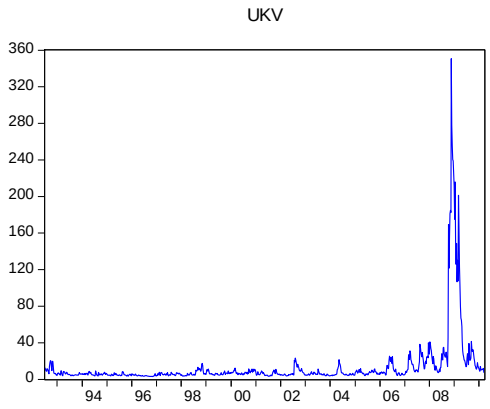


United Kingdom

Dynamic Correlation

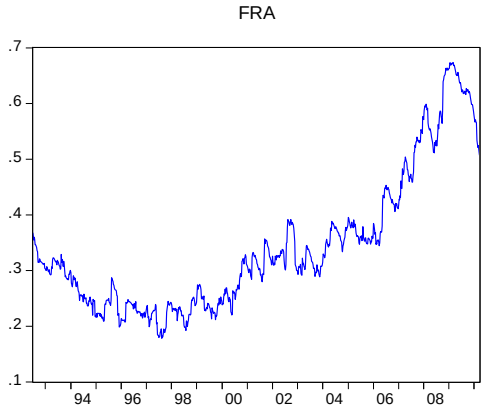


Dynamic Volatility

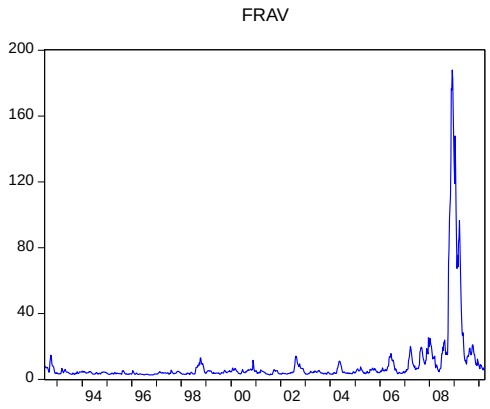


France

Dynamic Correlation

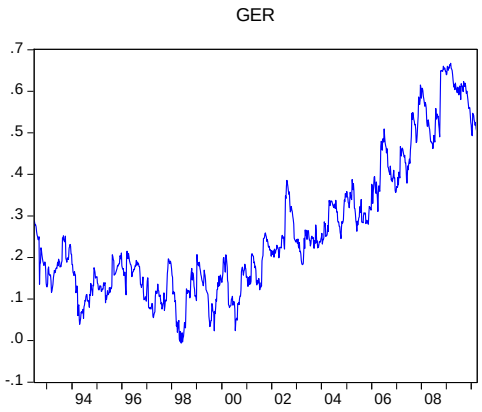


Dynamic Volatility

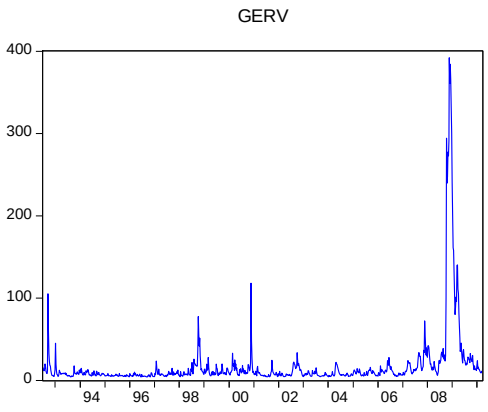


Germany

Dynamic Correlation

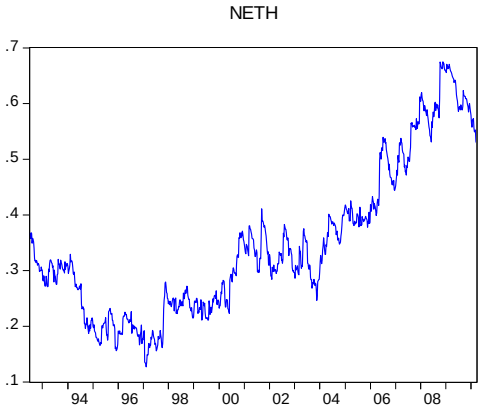


Dynamic Volatility

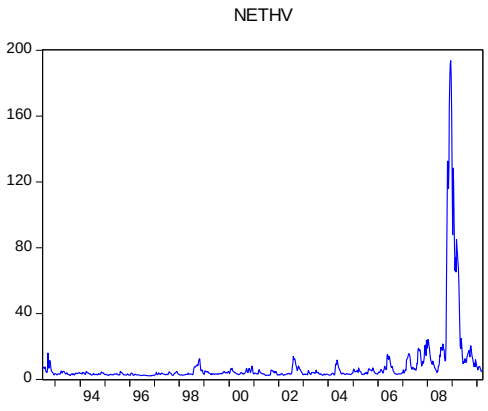


Netherland

Dynamic Correlation

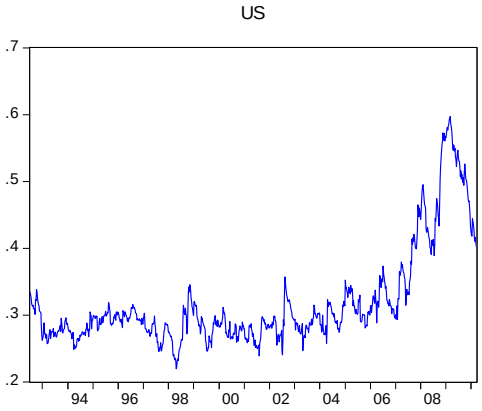


Dynamic Volatility

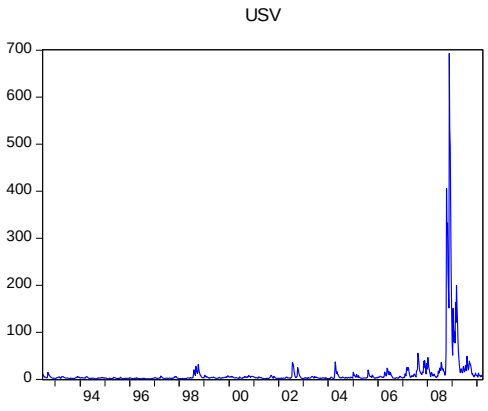


United States

Dynamic Correlation



Dynamic Volatility



5.3.4 Correlation Analysis – BP test

The BP test results for evidence of structural changes in the correlation series and volatility series are reported in Table 5.6. Both double maximum values ($UD\max$ and $WD\max$) support rejecting the null hypothesis of no structural breaks in all time series. UD max and WD max statistics are statistically significant at the 5% level only in Hong Kong, Australia and United Kingdom volatility series. The $SupF_{i,T}(l+1|l)$ statistics which could determine the number of breaks for each return and volatility series is investigated followed. The number of structural breaks suggests that, there are more multiple breaks in correlation including Asian markets. This indicates that in long period, the co-movements in different markets are more constant in European markets. Asian markets are easy to be changed. On the other side, the volatility series are more stable, there are significant structural breaks in Hong Kong, Australia and United Kingdom based on the results.

Tables 5.6 reports the estimated end dates for structural breaks. With this clear evidence of multiple changes in volatilities, it indicates that 8th , Aug. 2007 is a significant changing date. Hong Kong and Singapore suffered the influence of Asian financial crisis more than other markets.

Table 5.7 Bai and Peron results for dynamic correlations and volatilities

Panel A: Dynamic Conditional Correlation							
Series	**UDMAX[a]**	**WDMAX[b]**	**SupF(2|1)[d]**	**SupF(3|2)[e]**	**SupF(4|3)[f]**	**SupF(5|4)[g]**	**Breaks**
jp-hk	43.56***	68.58***	19.64***	5.65	2.21	2.32	2
jp-sg	38.03***	60.71***	17.33***	0.55	10.04*		4
jp-aus	30.38***	60.31***	0.09	35.28***	1.23		3
jp-uk	8.33*	20.83***	2.82	5.47	0.31		1
jp-fra	108.09***	174.79***	0.80	35.79***	3.79	0.02	3
jp-ger	32.05***	51.83***	0.9	15.43***	0.32		3
jp-neth	11.64**	11.64**	0.61	4.94	0.3		1
jp-us	7.46*	8.90*	7.11	0.61			1
jp-us2	13.42***	26.98***	3.58	3.71	4.38		1
hk-sg	4.62	6.22	2.27	6.38	3.21		0
hk-aus	70.68***	70.68***	0.01	0.88	0.01		1
hk-uk	21.92***	37.50***	3.68	3.84	3.02		1
hk-fra	23.18***	26.31***	0.68	2.45	8.05		1
hk-ger	25.64***	25.64***	10.66**	1.13	0.04		2
hk-neth	23.89***	30.52***	3.36	7.87	1.95	0.01	1
hk-us	13.66***	34.19***	3.37	22.35***	1.03		3
hk-us2	13.15***	23.04***	3	26.97***	1		3
sg-aus	271.03***	429.85***	6.28	9.63*	8.18		3
sg-uk	37.50***	64.36***	2.04	32.09***			3
sg-fra	66.87***	82.64***	1.74	0.55	2.07		1
sg-ger	159.55***	351.55	3.33	5.40	3.04		0
sg-neth	63.68***	63.68***	3.90	0.32	0.33		1
sg-us	50.42***	97.61***	2.57	0.46	1.22		1
sg-us2	40.27***	90.56***	1.15	4.25	0.6		1
aus-uk	69.15***	70.07***	26.82***	7.35	2.22		2
aus-fra	75.51***	155.22***	32.54***	7.89	3.35		2
aus-ger	55.35***	138.54***	38.97***	3.41	0.24		2
aus-neth	150.40***	376.45***	16.60***	15.86***	6.08	5.51	3
aus-us	3.68	9.11	1.25	2.56	8.72		0
aus-us2	7.97*	10.77**	1.32	2.61	0.43	6.5	1
uk-fra	156.15***	390.84***	28.78***	2.82	9.35		2
uk-ger	57.10***	113.38***	14.91***	2.83			2
uk-neth	87.16***	177.72***	11.96**	7.63	7.63		2
uk-us	4.39	8.336.04	1.62				0
uk-us2	5.62	5.75	1.65	1.02	0.73		0
fra-ger	128.51***	275.90***	32.71***	5.39	6.43	0.42	2
fra-neth	34.50***	65.18***	17.28***	2.63	0.44		2
fra-us	8.51*	8.51*	2.53	1.58	2.85		1
fra-us2	7.48*	7.73	2.11	1.35	4.11		1
ger-neth	201.29***	325.51***	70.43***	5.06			2
ger-us	8.51*	8.51*	3.06	0.87	0.58		1
ger-us2	5.5	5.5	3.46	0.86			0
neth-us	95.11***	163.26***	17.07***	11.02**	13.89**		4
neth-us2	51.50***	97.38***	17.70***	3.54	27.79***		4
us-us2	9.53**	12.43**	9.55**	2.28			2

Panel B: Mean Correlation for each market							
JP	49.70***	111.98***	18.31***	3.03	6.35		2
HK	31.67***	51.21***	12.02***	0.71	0.42		2
SG	53.66***	92.07***	10.98**	0.95	0.94		2
AUS	81.87***	191.63***	20.12***	10.66**	9.11		3
UK	29.76***	59.09***	14.32***	10.30**	13.74**		4
FRA	29.83***	62.52***	23.43***	6.29	6.71		2
GER	60.32***	97.54***	33.78***	3.78	4.10		2
NETH	74.77***	187.16***	21.12***	3.27	2.08	36.34***	5
US1	24.19***	29.84***	21.44***	2	4.16		2
US2	18.34***	24.20***	22.55***	1	2.09		2
Panel C: Conditional Volatility for each market							
JP	6.18	7.47	1.94	1.31	4.58	2.11	0
HK	9.96**	9.96**	2.91	6.79	1.10		1
SG	4.18	5.71	2.95	1.75	1.38		0
AUS	11.81**	11.81**	2.57	5.91	0.22		1
UK	10.62**	10.62**	2.34	2.91	0.14		1
FRA	7.34	7.34	3.19	6.38	0.67		0
GER	5.01	7.25	8.65*	1.89	2.36	0.35	0
NETH	5.63	3.85	2.17	2.65	1.00	0.94	0
US1	6.21	8.15	9.09	0.65	6.05	0.3	0
US2	3.27	4.29	3.16	0.27	0.05	0.17	0

Note:

The double maximum statistics (UDmax and WDmax) are highly significant, indicating that there is at least on structural break in the time series. The number of breaks are decided by examining the SupFi,T(l +1|l) statistics, choosing the , (1|) i T SupF 1 + 1 statistic that rejects for the largest value of 1 .

[a]One-sided (upper-tail) test of the null hypothesis of 0 breaks against the alternative hypothesis of an unknown number of breaks given an upper bound of 5; 10%, 5%, and 1% critical values equal 7.46, 8.88, and 12.37,resp

[b]One-sided (upper-tail) test of the null hypothesis of 0 breaks against the alternative hypothesis of an unknown number of breaks given an upper bound of 5; critical value equals 13.83.

[c]One-sided (upper-tail) test of the null hypothesis of 1 break against the alternative hypothesis of 2 breaks; 10%, 5%, and 1% critical values equal 8.51, 10.13, and 13.89, respectively.

[d]One-sided (upper-tail) test of the null hypothesis of 2 breaks against the alternative hypothesis of 3 breaks; 10%, 5%, and 1% critical values equal 9.41, 11.14, and 14.80, respectively.

[e]One-sided (upper-tail) test of the null hypothesis of 3 breaks against the alternative hypothesis of 4 breaks; 10%, 5%, and 1% critical values equal 10.04, 11.83, and 15.28, respectively.

[f]One-sided (upper-tail) test of the null hypothesis of 4 breaks against the alternative hypothesis of 5 breaks; 10%, 5%, and 1% critical values equal 10.58, 12.25, and 15.76, respectively.

*** Significant at the 1% level; ** Significant at the 5% level. * Significant at the 10% level.

Table 5.8 Breaks dates for BP test on dynamic correlations and volatilities

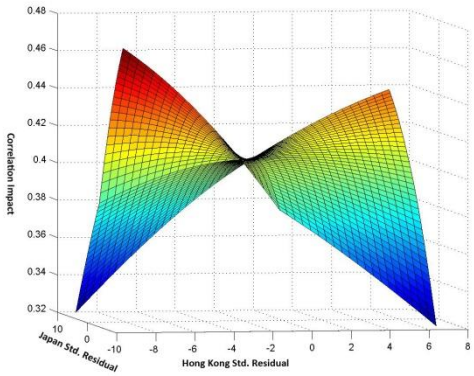
Series	Break 1	Break 2	Break 3	Break 4	Series	Break 1	Break 2	Break 3	Break 4
Panel A: Dynamic Conditional Correlation									
jp-hk	07-Jan-1998	17-Sep-2003			aus-uk	04-Nov-1998	08-Aug-2007		
jp-sg	08-Mar-1995	10-Jun-1998	01-Jan-2003	05-Jul-2006	aus-fra	02-Jun-1999	08-Aug-2007		
jp-aus	28-Oct-1998	12-Sep-2001	10-Aug-2005		aus-ger	02-Jan-2002	08-Aug-2007		
jp-uk	07-Dec-2005				aus-neth	22-Feb-1995	13-May-1998	19-Feb-2003	
jp-fra	06-May-1998	12-Sep-2001	08-Aug-2007		aus-us				
jp-ger	06-May-1998	07-Nov-2001	17-May-2006		aus-us2	08-Aug-2007			
jp-neth	08-Aug-2007				uk-fra	13-Feb-2002	10-Jan-2007		
jp-us	08-Aug-2001				uk-ger	14-Mar-2001	04-Jan-2006		
jp-us2	03-Sep-2003				uk-neth	18-Oct-2000	01-Dec-2004		
hk-sg					uk-us				
hk-aus	13-Jun-2007				uk-us2				
hk-uk	24-May-2000				fra-ger	05-Sep-2001	28-Mar-2007		
hk-fra	24-May-2006				fra-neth	26-Jan-2000	12-Apr-2006		
hk-ger	14-Mar-2001	14-Jun-2006			fra-us	08-Aug-2007			
hk-neth	24-May-2006				fra-us2	08-Aug-2007			
hk-us	22-Feb-1995	23-Sep-1998	05-Jan-2005		ger-neth	31-Jan-2001	10-May-2006		
hk-us2	22-Feb-1995	23-Sep-1998	05-Jan-2005		ger-us	25-Jul-2007			
sg-aus	16-Aug-2000	15-Dec-2004	08-Aug-2007		ger-us2				
sg-uk	08-Oct-1997	07-Jun-2000	10-Jan-2007		neth-us	08-Mar-1995	24-Nov-1999	01-Dec-2004	08-Aug-2007
sg-fra	04-Jan-2006				neth-us2	22-Feb-1995	29-Sep-1999	12-May-2004	08-Aug-2007
sg-ger	19-Oct-2005				us-us2	06-Mar-2002	07-Sep-2005		
sg-neth	10-May-2006								
sg-us	07-Feb-2007								
sg-us2	07-Feb-2007								
Panel B: Mean Correlation for each market					Panel C: Conditional Volatility for each market				
JP	12-Mar-2003	04-Jul-2007			JP				
HK	29-Oct-1997	24-May-2006			HK	29-Nov-1995			
SG	07-Jun-2000	14-Jun-2006			SG				
AUS	23-Sep-1998	18-Jun-2003	08-Aug-2007		AUS	11-Oct-1995			
UK	11-Dec-1996	13-Sep-2000	18-Feb-2004	14-Mar-2007	UK	04-Oct-1995			
FRA	18-Oct-2000	28-Feb-2007			FRA				
GER	20-Sep-2000	17-May-2006			GER				
NETH	07-Feb-1996	22-Oct-1997	19-Jul-2000	24-Nov-2004	NETH				
US1	24-Nov-2004	08-Aug-2007			US1				
US2	24-Nov-2004	08-Aug-2007			US2				

5.3.5 News Impact Surface

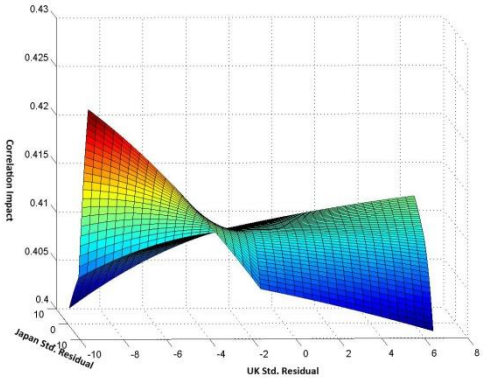
The asymmetric effect in correlation to joint bad and joint good news is clearly in all cases. The correlation news impact surface reveals a much larger response to bad news than good news in all market pairs. The asymmetric effect is more significant when concerning cross-region market pairs.

Figure5.2 Correlation News Impact Surfaces in Real Estate Securities Markets (July, 1992 – March, 2010)

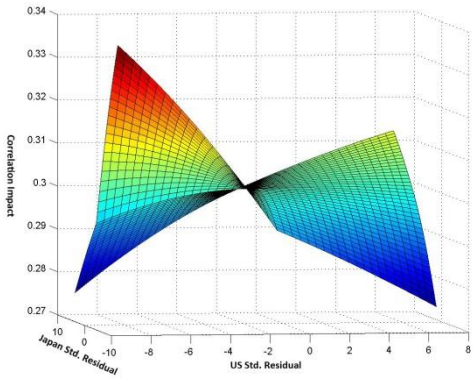
JP-HK



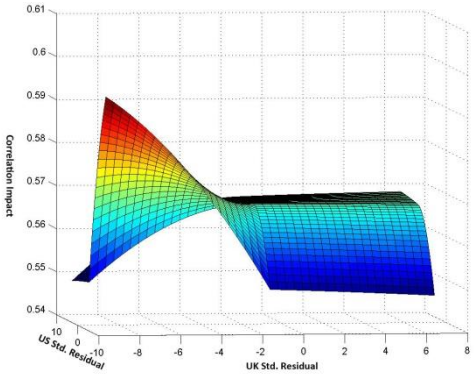
JP-UK



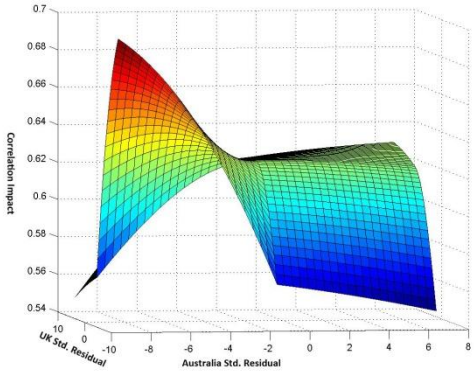
JP-US



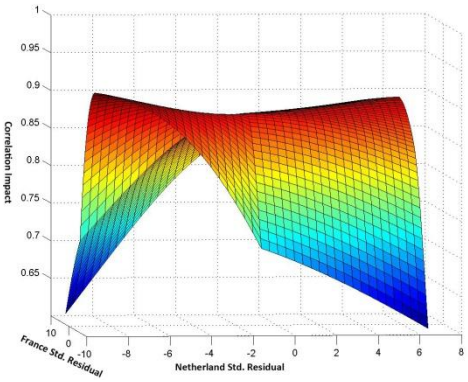
UK-US



AUS-UK



FRA-NETH



5.4 Summary

This chapter examines the dynamic conditional correlations in the international real estate securities markets. This is an important aspect to investigate market integration. Dynamic correlations are analyzed in two steps. First, to highlight the effect of crisis or extreme high volatilities, VTADCC model is employed to examine the dynamic correlation with volatility threshold and asymmetric effect. Then, Based on the correlations generated from VTADCC model, we use BP test to investigate the structural breaks in correlations in a long period. The combination of these two methods reveals the direct change in correlation under different market environment. Hence, this chapter is important to help local and international real estate securities investors understand the markets co-movement and arrange portfolio to reduce risk. Especially the research on correlation performance in crisis period would guide investors on the current market pictures, and recognize new information to adjust asset allocation under new environment in post-crisis period. The main findings in this chapter are:

There is ordinary positive relationship between time-varying correlation and common volatility, which is consistent with previous research and expectation.In extremely high volatility period, the correlations of cross-region market pairs

tend to be lower compared to normal period; the correlations of within-region markets pairs would be strengthened. This suggests in crisis period, the markets in different regions have less co-movement. The high volatility – correlation effect is more sensitive when volatility threshold is defined higher. Crisis period would change correlations more.The degree of real estate securities market integration of a specific region increased in high volatility period.

Asian financial crisis doesn't influence correlations too much except for Hong Kong and Singapore securitized property market. The global financial crisis leads to relevant high correlations in all the market pairs. This is a worldwide market contagion with response speed not synchronized. The difference in reaction speed to crisis and high volatilities lead to the downgrade of market integration degree in certain cross-region pairs. The world market began to recover and the correlation began to fall after June, 2009. bIn long period, the co-movements in different markets is more constant in European markets. Asian markets are easy to be changed. Aug. 2007 is a key point for correlation changing under the global financial crisis. European markets have synchronized break point on correlations.

Chapter 6 Conclusion

In the recent 20 years, the real estate market with the relevant securities market especially REITs have gone through a huge boom with rapid growth and increasing market capitalization. More and more institutional and personal investors choose real estate securities market as an important part of total investment portfolio. However, under the economic environment that world markets became more tightly connected, information could be rapidly transmitted in multiple channel, the real estate securities markets in different countries have transmission on each other either. Thus, to reduce risk and organize optimal asset allocation, it is necessary to investigate the dynamic connection between real estate securities markets in domain developed economics. The aim of the thesis is to examine the volatility transmission of securitized real estate market returns and the dynamic conditional correlation in these markets under the influence of volatility spillovers especially the extreme high volatility in global financial crisis period.

6.1 Summary of main findings

As an important international investment asset, the real estate securities market requires investors to understand the integration of securitized property

markets in developed countries to understand potential diversification portfolio including these assets. In this research, market integration is analyzed from two prospective: volatility transmission and dynamic correlation.

The empirical results on volatility transmission suggest that US is still the major world-wide volatility producer in long period. European markets are highly integrated; real estate securities markets have volatility transmission to each other. In Asian markets, Japan plays a more paramount role in volatility spillover effect. Australia is more independent although it is counted in Pacific-Asia region. However, the transmission between different regions is not significant as with the specific region. The information spillover and volatility influence are still affected by location and real economic market. In the situation that market condition is bad, volatility transmission would be strengthened the market is more active. Before global financial crisis, the world real estate securities market is more integrated, the transmission is bi-directional. With the break out of crisis, US stills plays the role as world volatility producer, both European markets and Asian market received strong volatility spillover from US. European markets also have volatility transmission to Asian market. But the connection between European and Asian securitized property market is weakened after financial crisis. As such Asian securitized real estate markets would be a hedging asset for European assets. The globalization and worldwide

market integration are undermined. This analysis on market transmission situation would help investors to allocate their international portfolios and achieve diversification benefit in the future.

The second chapter of the study connected the dynamic conditional correlation with the previous volatility transmission effect. The direct investigation on the time-varying correlation between markets would guide investors to optimize portfolio, achieve low risk without return decreased. The results supported the correlation would change with dynamic volatility positively in tradition period. In special high volatility period, the correlation of cross-region pairs would be undermined; they don't have strong synchronized movements. However, the correlations of within-region pairs climb higher when facing extreme high volatility. When crisis comes, the markets in a specific region would become closer. In long period, the correlations including European markets and US market are more stable, while Asian markets are more volatile with high risk but potential high return. The transmission of financial crisis to Asian markets is delayed compared to European markets. Hence, the worldwide market integration is the long-term trend. On the other hand, when global financial crisis happens, market integration in region level is enhanced; the integration in world level is weakened. This would offer guide on investment risk management in extremely high volatility period. When facing financial crisis,

markets share more fundamental macroeconomics would become closer and influence each other, hence destroy diversification effect. Conversely, investors would choose markets in different regions, in bad markets; they would become less correlated to reduce risk.

6.2 Research Implication

There are several implications coming from this study. The first implication is on the issue of international real estate portfolio diversification. Strong evidence of market integration in long-term is detected in international real estate securities markets. Therefore, the global investment diversification effect could be undermined from the increased co-movement. In this situation, the investigation on major international real estate securities markets reveals there are different market integration degrees within a specific region and across different regions. As market connection in different regions would be weakened especially in high volatility or crisis period, we could take advantage of this and establish appropriate asset allocation strategy in order to avoid more risk and achieve diversification effect from investment in international real estate securities markets.

The second implication is that international and domestic real estate

securities investors could improve their investment performance by risk management and volatility forecast. The analysis on relationship between international securitized real estate markets could help to understand the relationship in these markets. Hence, when there is sudden shock happening in one market, the influence and transmission could be estimated, the change in correlation could also be forecasted. Upon understanding this, the investors could react on these shocks analyze a safer hedging market, rearrange their investment to avoid loss and gain returns safely.

Least but not last, government policy and decision makers could also apply the results in this research. The investigation on real estate securities market integration could help to understand the national situation in region and world level, the relationship with other countries. This is also based on the macroeconomic environment of its county or region. Under this precondition, the economic and finance policy could be more appropriate and positive for utilizing other markets and further development.

6.3 Contribution

This research applies several econometric techniques in order to investigate the degree of international real estate securities markets integration. Market

integration is expressed in two prospects: volatility transmission and dynamic correlation especially in crisis period.

This research work has several major contributions on literature:

First, it applies five-variant asymmetric VAR-BEKK-GJR model in securitized property market. This model could examine the return and volatility transmission together in five markets. This helps to organize research sample into two groups – Asian and European real estate securities markets. In previous research this model is estimated in bi-variant format. The five-variant model could investigate the region real estate markets as an entirety.

Second, this study investigates 9 major international real estate securities markets, both within-region and cross-region relationship have been examined and contrasted to provide guide on world-wide portfolio management. The group analysis would contrast the different volatility transmission performance and dynamic correlation in different regions and derive different integration degrees within a specific region and across regions. Hence, international investors could benefit from the integration analysis and arrange optimistic portfolio.

Third, a newly developed VTADCC model is employed to investigate

relationship between time-varying correlation and volatility under volatility threshold framework. The threshold hold part could help to detect correlation sensitivity in different volatility periods, especially under the influence of extreme high risk period which means crisis. This is an improvement on investigation of relationship between correlation and volatility.

6.4 Limitation and recommendation

This study has achieved the objective in Chapter 1, and got the inspiring results to guide investors allocate assets including real estate securities under crisis period and post-crisis period. As a study on dynamic performance for securities market returns and volatilities, on limitation of this research is the sample size. Based on the available, we incorporate 9 markets in 3 regions. More markets should be included even emerging markets to generate more profound results and give more direction on further investment.

The markets sample in this research focus in three regions. In one particular region, the real estate securities markets would be fundamentally connected from different paths; the potential endogenous problem is considered and analyzed in

the theoretical part but not completely eliminated in the empirical portion.

This study concentrates only in real estate securities markets. This is the indirect real estate markets. However, the direct property market and the common stock market should be investigated either as a contrast.

What is more, based on the results, the performance switching under different regimes would be another contribution if it could be investigated in the future as a deeper explore for dynamic volatility spillover and correlation research.

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