Volatility transmissions and spillover effects: An empirical study of Vietnam's stock market and other Asian stock markets.

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Attestation of Authorship:

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Phu Vu.

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Phu C. N. Vu

Abstract/Summary

In this study, I examine the transmissions of volatility spillovers during the subprime crisis in the U.S between Vietnam and other Asian financial markets (Japan, Korea, China, Hong Kong, and Taiwan). I attempt to explore the level and magnitude of volatility spillover effects of other Asian markets on the Vietnam stock market by applying a multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) model. It is found that the level of the volatility effect of the selected financial markets on the Vietnamese stock market's return from 2006 to August - 2009 increases over time. Particularly, the level of volatility transmissions and spillover effect of two developed markets, Hong Kong and Japan onto the Vietnamese market are relatively higher and more consistent than other markets during the 2006-2009 period. Also, the Vietnamese financial market seems to perform better than other markets during my 2006-2009 sample, including the financial crisis period in 2007.

Chapter 1: Introduction

Background

Since it was established in July- 2000, the Vietnamese stock market has strengthened and expanded the financial system, as it serves trade, hedge, and diversify and pool risks. It has become a critical channel in terms of producing an efficient allocation of capital, short and long-term investments, which contribute to the expansion of business operations to become more diversified and effective for an overall domestic economy. Besides, Vietnam has a become member of such as the Association of Southeast Asian Nations (ASEAN), World Trade Organization (WTO), Asia-Pacific Economic Cooperation (APEC), which has provided a great opportunity for the country to globalize its economy and become more integrated to the world economy.

In Vietnam, we had an average GDP growth rate of above 6% annually from 2005-2009 and we have a very stable economic and political system. (See below)

Year	GDP - real growth rate	Rank	Percent Change	Date of Information
2003	6.00%	22		2002 est.
2004	7.20%	23	20.00%	2003 est.
2005	7.70%	27	6.94%	2004 est.
2006	8.50%	23	10.39%	2005 est.
2007	8.20%	29	-3.53%	2006 est.
2008	8.50%	28	3.66%	2007 est.
2009	6.20%	55	-27.06%	2008 est.
2010	5.30%	20	-14.52%	2009 est.

(source www.indexmundi.com)

However, the financial market crisis in the U.S capital market caused by the subprime mortgages crisis in summer 2007 has transmitted to the European capital market, Asian markets and then become a global crisis. It has been raised as a great concern that the stronger integration of financial markets, especially the linkages between those emerging markets and advanced markets, has accounted for this global financial crisis. In 2007, the VNI (Vietnamese stock index) hit the recorded high at

1170 points in March 2007, after that the VNI recorded the loss of approximately 80% to 235 points index in February 2009. This continuous loss of market index happened simultaneously with other Asian stock indices such as: the Hang Seng index (Hong Kong) and Nikkei 225 (Japan) and others during the subprime crisis in the U.S.

There is a strong belief in modern finance that movements in the price of assets in one particular market followed by another would possibly establish contemporaneously between markets. Those co-movements could be caused by the similarity of market reactions to an important financial event, news or changes in the macroeconomic background in the region.

Over the last few decades, it has been found that the higher the level of global financial integration, the more likely it is that the financial market will be affected by volatility spillover effects from other financial markets, especially from the mature markets (such as U.S, Japan, Hong Kong) to the emerging market economies (EMEs). The level of transmission volatility and spillover effects is more likely to be established during turbulent periods and either increase market volatility or market illiquidity and funding illiquidity (Frank, Gonzalez-Hermosillo and Heese 2008). Those factors either directly or indirectly impact on both daily returns and conditional volatility of asset prices, the markets' returns. The relative consequences are empirically analysed in my paper across selected financial markets. Even though EMEs like China or Vietnam have been observed to have a long run-up in asset prices including equities, they were experiencing a very strong domestic consumption confidence and a very competitive export advantage during over several years before the crisis in 2007. However, the 2007 financial crisis hit to these EMEs hard because these economies had to suffer a very slow world export demand, a substantial decrease in FDIs (foreign direct investments) as well as FIIs (financial institution investments) from overseas into their countries and other factors involved in the volatility spillover effects from other leading financial markets. Volatility during crisis time can be transmitted through different mechanisms influencing various markets, such as liquidity shocks, investors' behaviour toward the financial crisis and the correlations level between markets.

The cross-country equity volatility transmissions levels are very important factors and have become a debate for both researchers and professionals over the years. Firstly, understanding the level of volatility transmissions could possibly assist investors taking into consideration the management of their hedging strategy for domestic and international diversified portfolios optimization. Furthermore, the estimations of volatilities and spillover effects are important for financial management tasks such as asset allocation and risk assessment in stock selection in order to minimize loss and maximize return. Lastly, by understanding the behaviours of markets, investors can diversify their international portfolios to different markets depending on the level of correlations between markets, to receive optimal returns at the lowest risk level.

The most recent global financial crisis provides a very good opportunity for me to readdress the degree of interdependencies among Asian stock market returns. Inspired by that motivation, my paper aims to investigate the level of volatility transmission and spillover effects on the Vietnamese stock market's returns during the 2006-2009 period from other selected Asian stock markets (which are traded contemporaneously: same trading day within 2-3 hours in difference).

As far as I know, this paper is one of the first attempts to model empirically the transmissions of volatility across the Vietnamese and other Asian markets during the latest financial crisis by using time-series based examination. This paper also provides the degree of responses of the Vietnamese stock market to the 2007 financial crisis, and reflects the different level of financial openness and integrations of the Vietnamese market and other Asian markets. More importantly, the paper's findings would provide the transmission mechanisms that would tell us about Vietnam's market efficiency.

There is an advantage in my paper compared to previous studies in that I also evaluate the power of the econometric model used and calculate the realized return by applying the certainty equivalent rates of return (CER) model to evaluate the economic health for each pair of correlations examined.

The empirical results in this research may be found helpful for academics, domestic policy makers and professionals to understand the magnitude of volatility spillover effects of other Asian markets on the Vietnamese stock market. Moreover, this study will contribute to the growing literature about Asian spillover effects and volatility transmission of equity returns during the period 2007-2009, especially between Asian financial markets during the financial crisis period which will be examined.

The paper is organised as follows: Chapter 2 provides the literature, and Chapter 3 gives details about the financial model for estimating volatility transmissions and spillover effects and discusses estimation procedure. Chapter 4 describes how data is constructed and provides empirical results for the econometric models applied. In Chapter 5, I compare the results of the DCC forecasting model used and the economic benefit performance for the use of the DCC-MGARCH model using out-of-sample data. Finally, in the last chapter, I briefly conclude the paper's findings and outline the paper's limitations for future research possibilities.

Chapter 2: Literature Review

2.1. Literature review

One of the most phenomenal topics in the contemporary financial world is financial integration in the form of spillover effects and transmissions of volatility across markets. There has been a great concern about interdependence of financial markets globally, especially in South East Asia, where stock markets have been growing significantly during the last decade. The underlying fundamental explanation for this region's growth is because the Asian region is influenced by similar economic expectations, technological innovations, financial regulations or trading conditions. These factors are likely to lead to a long-run positive correlation between markets. (Soenen& Johnson, 1998).

The dominance of the U.S and Japanese markets has been established for the last few decades, and has led to the spillover effects level of these two markets to other markets, especially to emerging markets, which has increased over time. There are a substantial number of empirical studies that have addressed the transmissions volatility and spillover effects spread across countries such as the U.S and the UK, the U.S and other markets. The level of correlations and co-integrations between countries' stock markets is normally used to evaluate the magnitude of volatility transmissions across markets. (Ng, 2000, Soenen & Johnson, 1998, and Worthington &Higgs, 2004).

The spillover effects of the U.S and Japanese markets to other markets have been studied many times in both empirical and theoretical analysis. As an example, Soenen & Johnson (1998) found that the equity markets of China, Singapore, Hong Kong, and Malaysia are highly integrated with the stock market in Japan. In their paper, one of the main reasons cited is that an increase in export share into Japan by Asian countries and greater FDI from Japan to other Asian countries led to a greater co-movement. Also, Ng (2000) studied how and to what extent Asian financial markets' volatility is influenced by foreign shocks from other financial markets by using the GARCH model. His results show that other than the impact of world factors, there are significant spillover effects of the U.S and Japanese market to his studied Asian financial markets. However, world factors seem to have greater impact along with countries' significant liberalization policies commonly shared by the Asian countries, such as reducing restrictions for FDI or ownership of company shares.

The paper of Worthington & Higgs (2004) investigates the transmission of equity returns and volatility in the Asian market between two groups: one group consists of more developed financial markets (Hong Kong, Japan, Singapore) than the other group (markets such as Korea, Thailand, and Taiwan). The MGARCH model was adapted to examine the source and magnitude of spillover effects. Their results from the model applied indicate all Asian markets studied in the paper are highly integrated based on the estimated coefficients from conditional mean return equations. On the other hand, they found the spillover effects are not homogenous across all the emerging markets in their paper. Both the studies of Ng (2000) and Worthington & Higgs (2004) suggest that there is evidence of the U.S and Japanese influence on the volatility of equity returns in the Pacific-Asia region emerging countries. Miyakoshi (2003) used a different approach to investigate the same impact of the U.S and Japan on Pacific-Asia (similar to Ng's (2000) paper). However, by applying the bivariate EGARCH model, he found only the U.S has more important influence on the Asian markets returns, while Japan has an impact on the Asian market's volatility. Secondly, he found there is a causal interaction between the Japanese and Asian markets as there is an established fact that Japan and other Asian countries have a strong economic relationship through Japan's investment' portfolios from the 1990s until now.

More recent papers, such as Johanson & Ljungwalls (2008), examined interesting spillover effects among the Greater of China stock markets, including Taiwan, Hong Kong and China. Their empirical findings suggest that there is a non-existing long-run relationship between these markets. Both Chinese and Hong Kong markets are influenced by mean spillover effects from Taiwan. Their results determine that volatility from the Hong Kong market spills over to the Taiwanese market, which in turn will impact on China Mainland's market' volatility. Their paper indicates that there are significant interdependencies between these markets.

2.2. Volatility transmissions and spillover effects in the financial crisis 2007

The latest financial turmoil began in the summer of 2007, and started to downgrade the quality of the U.S. subprime mortgages, credit risk, and financial institutions. It started to spread to Asian markets in the beginning of 2008, which largely impacted on EU markets at first and Japanese and Hong Kong financial markets soon after as they are both international financial centres (IFC) in Asia. After that, other Asian financial markets became highly volatile and started to fall significantly during this time (see analysis throughout this paper). Even though Asian markets have been growing rapidly through foreign direct investments (FDIs), financial institution investments (FIIs), and fundamental economic growth (GDP), they still cannot avoid the effect of the 2007 financial crisis.

These issues have been examined in working papers of the IMF published recently, which were studied by Frank, Gonzalez-Hermosillo & Hesse (2008). Their study examines the empirical linkages between market and funding liquidity pressures during the 2007 subprime financial crisis in the U.S by applying the dynamic conditional correlations MGARCH (DCC-MGARCH) model. They found the financial crisis triggered market' liquidity shocks that soon led to funding illiquidity shocks transmitted across different asset classes and markets. The interaction between market and funding liquidity significantly increase in the U.S markets; this interaction is hardly to be found before the financial turmoil in 2007. The spillovers of U.S subprime financial turmoil to Asian markets such as the Hong Kong and Chinese markets also increase sharply due to the level of economic openness between nations. Sun & Zhang (2009) found both Chinese and Hong Kong markets are not immune to the 2007 financial crisis in their study of price and volatility spillovers from the U.S to China and Hong Kong. Their study suggests the conditional correlations between the U.S and Hong Kong markets are higher than correlations between the U.S and China due to the limited openness of China to the U.S. They also found that the level of financial integration between China and Hong Kong is increasing due to the high cross-volatility level effects between them.

Both papers are found to be very useful for investigating the spillover effects of the U.S. subprime crisis to other markets in the form of liquidity transmissions as well as the cause of stock price volatility.

Referring to previous studies of the financial crisis in 2007, both empirical and theoretical analysis review the co-movements between financial markets, there are some possible spillover channels from developed markets to developing markets like Vietnamese market as follows:

- Loss of confidence in investors' behaviour: The Vietnam-index was still moving up at its peak (above 1100 points index). However, with the increasing number of news releases of credit crunch in the U.S spreading over the entire world, the collapse of those giant financial institutions has brought a substantial impact on Vietnam.
- Uncertainty of source of capital flows: Capital inflows to Vietnam through FDIs, FIIs, even ODAs were reduced significantly during the financial turmoil. It generated the substantial loss for financial market liquidity and funding liquidity. The capital withdrawal of foreign investments from listed companies, caused domino effects to other investors in markets, which made them decide to leave the stock market.
- Slower export sector growth: The reduction of possible export markets over the world especially to developed markets, due to the consequent reduction of world demand has led to lower expectations for the export sector.

In general, the changes of asset market prices occurring in dominated markets (such as Japan and Hong Kong), will be transmitted to other markets as shocks to investors. It will lead to investors (including intermediates and banks) adjusting their international portfolios; their actions are explained as playing an important role in generating and spreading financial fragility. These effects will soon become systemic crises and liquidity crises and cause a series of rapid falls in asset prices in other stock markets (Allen & Gale, 2007). My paper focuses on investigating the equity market transmission of volatility and spillover effects caused by this particular set of circumstances.

Chapter 3: Econometric methodology and evaluation model

3.1 Econometrics model: Dynamic conditional correlation - Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models (DCC-MGARCH model)

The importance of modelling the volatility effect in financial markets during the financial turmoil has increased significantly and there has been a correspondingly large amount of literature over time to address the issue. Currently, the ARCH/GARCH models are amongst the most popular econometric models being used in academic studies.

There are a number of MGARCH models available in econometric study for financial time series in order to estimate volatility spillover effects. There have been some developments applied for the MGARCH model which have increased accuracy for model users in estimating their results, regarding the parameterization of conditional cross-moments (Tse & Tsui, 2002, and Bae, Karolyi, & Stulz, 2003).

In my study, I decided to choose the DCC-MGARCH model as a main model to estimate my finding results throughout this paper. Engle (2002)[1] developed the DCC-MGARCH model, which can be viewed as a generalization of the Constant Conditional Correlation (CCC) model introduced by Bollerslev (1990), to estimate the correlation model for the set of financial market returns during 2006-2009. This model proposed by Engle (2002) has the flexibility of the univariate GARCH model but does not include the complexity of the conventional multivariate GARCH. The model also has the ability to analyse the performance of the model for large covariance matrices.

The model allows us to model the volatility transmission spillovers between markets, with the data generating processes for the time-varying covariances across markets, rather than an unconditional consistent shock. This model has the flexibility of univariate GARCH models coupled with parsimonious parametric models for the correlations.

[1] *Engle (2002) develops DCC-MGARCH to estimate conditional correlations between DJ and NASDAQ, stock and bonds, Exchange rate by using US data at the length of 10 years period. His findings conclude the DCC model is more accurate than other MGARCH models, whether the criterion is mean absolute error, diagnostic tests, or tests based on value at risk calculations.*

They are not linear but can often be estimated very simply with univariate or two-step methods based on the likelihood function. It is shown that they perform well in a variety of situations and give sensible empirical results.

The multivariate GARCH model proposed assumes that returns from *n* assets are conditionally multivariate normal with zero expected value and covariance matrix H_t the returns can be either mean zero or the residuals from a filtered time series. Where r_t is return of asset defined: $r_t = 100\ x\ ln\left(\frac{p_t}{p_{t-1}}\right)$, (p is the price of asset), F is the set of information.

$$r_t |\ F_{t-1}\ \sim \text{N}\ (0, H_t) \qquad (1)$$

where

$$H_t\ \equiv\ D_t R_t D_t \qquad (2)$$

here, $R_{t,}$ is the time varying correlation matrix containing the conditional correlations, is made up from the time dependent correlations; it is called the time varying correlation matrix. Where D_t is defined as a diagonal matrix of time varying standard deviations n x n implied by the estimations from univariate GARCH model, which are computed separately:

$$r_t\ |\ F_{t-1}\ \sim N\ \left(0, D_{t,} R_{t,} D_t\right) \qquad \textit{(3)}$$

where $D_t\ = diag\ \left\{\sqrt{h_{it}}\right\}$

whereby the i[th] element is denoted as $\sqrt{h_{it}}$, exhibiting a mean of zero and the following time-varying covariance:

So that, the proposed the elements of D_t can be written as univariate GARCH model as:

$$h_{it}\ =\ w_i\ +\ \sum_{p=1}^{Pi} \alpha_{ip}\, r_{it-p}^2\ +\ \sum_{q=1}^{Qi} \beta_{iq}\, h_{it-q} \qquad (4)$$

for *i* = 1*, 2, 3…, n with* the usual GARCH restrictions for non-negativity and stationarity being imposed, such as non-negativity of variances and $\sum_{p=1}^{Pi} \alpha_{ip}\ +\ \sum_{q=1}^{Qi} \beta_{iq}\ < 1$. The set *P* and *Q* for each series indicates the lag lengths chosen need not be the same in GARCH (p, q) model (I use GARCH (1, 1) in my DCC-MGARCH to estimate my result). The specification of the univariate GARCH models is not limited to the standard GARCH (p, q), but can include any GARCH process with normally distributed errors that satisfies appropriate stationarity conditions and non-negativity constraints.

The log likelihood for this estimator can be expressed as

$$r_t \mid F_{t-1} \sim N\left(0, D_{t,} R_{t,} D_t\right)$$

$$L = -\frac{1}{2}\sum_t (n log(2\pi) + \log|H_t| + r_t' H_t^{-1} r_t) \qquad (5)$$

$$L = -\frac{1}{2}\sum_t (n log(2\pi) + log|D_t R_t D_t| + r_t' D_t^{-1} R_t^{-1} D_t^{-1} r_t)$$

$$L = -\frac{1}{2}\sum_t (n log(2\pi) + 2 log|D_t| + log|R_t| + \varepsilon_t' R_t^{-1} \varepsilon_t)$$

Where $\varepsilon_t \sim N(0, R_t)$ are residuals standardized.

The estimation presented below is conducted within a multivariate GARCH framework, which takes the heteroskedasticity exhibited by the data into account. In addition to providing the natural interpretation of the conditional variance as a time-varying risk measure, the proposed dynamic correlation structure:

$$Q_t = (1 - \sum_{m=1}^{M} \alpha_m - \sum_{n=1}^{N} \beta_n)\bar{Q} + \sum_{m=1}^{M} \alpha_m (\epsilon_{t-m} \epsilon_{t-m}') + \sum_{n=1}^{N} \beta_n Q_{t-n} \qquad (6)$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1}$$

Where m, n = 1, 2, α is the news coefficients and β is the decay coefficient. To ensure a conditional correlation between -1 and +1, the model is mean reverting provided α + β < 1.

Where $\bar{Q}$ is the unconditional covariance of the standardized residuals resulting from the first stage estimation. Q_t^* is a diagonal matrix composed of the square root of diagonal elements of Q_t. This specification of time-varying correlations was studied extensively by Engle and Sheppard (2001), the model referred as DCC (1, 1) for dynamic conditional correlation with lags equal to one.

3.2 Model evaluation test

In this section, I evaluate the out-of-sample forecast performance of the MGARCH models. In order to access the model performance, I apply the dynamic quantile (DQ) test proposed by Engle and Manganelli (2004). This test is designed to test the models' prediction of Value-at-Risk (VaR). The VaR (of a portfolio) is known as the maximum loss occurring during a specific time with a given probability (5% in this research).

I first calculate the Hit which is expressed as:

$$Hit_t = (r_t < -VaR_t) \qquad (7)$$

where $\mathbb{I}$ is an indicator function. This indicates that if the portfolio return is less than the portfolio VaR, the Hit is equal to 1 otherwise it is zero. Then I further calculate the hit percentage via using sum of the Hit divided by the sample size. Next, I carry out the DQ test by running an artificial regression, which is constructed as

$$Hit_t - q = \lambda_0 + \sum_{i=1}^{p} \lambda_i Hit_{t-1} + \lambda_{p+1} VaR_t + u_t \qquad (8)$$

$$= \mathbf{X}\boldsymbol{\lambda} + \boldsymbol{u}$$

where *q* is quantile and **X** is a vector notation.

The null hypothesis of the test is H_0: $\lambda_i = 0$, i = 1, 2,…, p+1. In other words, under the null of a correctly specified MVGARCH model for the forecasted VaR, the Hits should have mean *q* and must be independent of lagged Hits and the VaR.

Engle & Manganelli (2004) deduce the out-of-sample test statistic as:

$$DQ_{OOS} = \frac{\hat{\boldsymbol{\lambda}}'\mathbf{X}'\mathbf{X}\boldsymbol{\lambda}}{q(1-q)} \sim \chi^2_{p+2} \qquad (9)$$

Therefore, if the DQ_{OOS} is greater than the critical value then we reject the null.

3.3 The certainty equivalent rates of return (CER) model

In order to evaluate the potential ability for portfolio diversification between Vietnam and other markets, I calculate the realized return for the CER model for my MGARCH models using actual out-of-sample data. The CER model is proposed by Aslanidis, Osborn & Sensier (2009) to calculate the optimal portfolio weights to evaluate the economic value of the DCC-MGARCH model. In particular, by using given in-sample coefficients estimated, I compute the equally-weighted portfolio weighted for the out-of-sample period for the DCC-MGARCH model.

The one-step-ahead wealth is calculated:

$$W_{t+1} = w_t^x (1 + y_{t+1}^x) + (1 - w_t^x)(1 + w_{t+1}^y) \qquad (10)$$

where:

$$w_t^x = \frac{\left(\hat{\mu}^x - \hat{\mu}^y + \lambda h_{t+1}^x - \lambda \hat{\rho}_{t+1}\sqrt{h_{t+1}^x h_{t+1}^y}\right)}{\lambda\left(h_{t+1}^x + h_{t+1}^y - 2\hat{\rho}_{t+1}\sqrt{h_{t+1}^x h_{t+1}^y}\right)} \qquad (11)$$

where $\hat{\mu}^x$ and $\hat{\mu}^y$ are the estimated constants from respective mean equation, $\hat{\rho}$ is the conditional correlation for the out- of- sample data and h_t is the conditional variances for the out-of-sample data (the out-of-sample data includes two market returns time-series x, y).

As w_t^x is one-step-ahead wealth in which is the proportion of the portfolio invested in x market and (1- w_t^x) is the rest of the proportion invested in y market. The λ is interpreted as the coefficient of risk aversion that trades off predicted mean and variance of the one-step ahead wealth; the larger the λ the more risk averse the investor.

The CER model is simply designed by using equation (11), as follows:

$$CER = \sum_{t=1}^{n} \frac{W_{t-1}}{k} - 0.5\lambda \sum_{t=1}^{n} \frac{(W_{t-1} - \bar{W})^2}{k} \qquad (12)$$

k is the number of out-of-sample observations.

Chapter 4: Data and empirical results

4.1 Data

For my empirical analysis, I am using the daily closing Vietnamese stock market index (Vietnam-index) as well as other Asian market closing indices such as Hang Seng (Hong Kong), Nikkei225 (Japan), Shanghai Composite (China), SE Weighted (Taiwan), and Seoul Composite KOSPI (Korea). The daily data (in USD from November-2006 to August- 2009) are mainly downloaded from DataStream. (The data length is at the maximum that I can request from DataStream for VN-index in USD.)

Each compounded daily return series of each index is generated as follows:

$$r_t = 100\ x\ ln\left(\frac{p_t}{p_{t-1}}\right)$$

where r_t is the return for period t; p_t and p_{t-1} are closing price index on days t and t-1 and ln is the natural logarithm.

The research data is designed as follows: I split the whole data sample into two different sub-periods which contain the 2007 financial crisis event: the in-sample period: 30/11/2006 to 30/11/2008 (500 observations) and the out-of-sample period 3/12/2008 to 30/07/2009 (195 observations). My sample period includes the financial crisis which occurred from the end of 2007 to mid-2009 which affects all market' returns examined in my study.

In this research, I study the volatility spillover effects between the Vietnamese stock market and other Asian stock markets. I apply Dynamic Conditional Correlation - Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models (DCC-MGARCH) for my data sample.

4.2 Summary of descriptive statistics

Figures in Table 1 (Appendix 1) summarize the descriptive statistics of market' returns for both the full sample and sub-periods sample. Along with the summary of statistics,

Table 2 (Appendix 1) provides the cross-correlations between the Vietnamese market and other markets. As can be seen, these markets exhibit a positive correlation with the Vietnamese market over the entire sample, but their correlations are not very strong. The correlations are stronger during the out-of-sample period than the in-sample period, with the exception of the China and Vietnam correlation.

From Table 1 (Appendix 1), the summary descriptive statistic results suggests that the all market' return movements are limited at a constant fluctuation level: 10% in the Chinese market, 11% in Hong Kong, 11% in Japan, 8% for Taiwan, 5% for Vietnam except for the Korean stock market which is highly volatile and where its stock market can fluctuate in the margin of 28%. We can see in the Table 1, from the full sample to the out-of-sample statistics summary, all markets performed better in the out-of-sample than in-sample period by comparing mean value of all markets' returns between the two samples. All financial markets generate positive returns on average during the out-of sample, on the other hand during the in-sample period the mean value of all market returns is negative.

Secondly, from the skewness, standard errors, kurtosis, according to these figures, the Vietnamese stock market seems to perform better than other markets monitored (Hong Kong, Taiwan, Japan, Korea, China). The standard errors, skewness and kurtosis show that the Vietnamese market has consistent results in the all-sample summaries (less volatile than most of the markets). Particularly, in all of my samples the Vietnamese market has positive skewness, it tends to increase over time (0.075 to 0.125, the series has long tails to the right), and meaning that the Vietnamese market provides positive returns over time and the consistent standard errors are at around 2.5. The kurtosis figure suggests the Vietnamese stock market has much less volatility than other markets. Its kurtosis is at about 2.3-2.6 compared to the highest volatile market, Korea is (21.00) or the second lowest kurtosis figures market China (5.04) and Taiwan (5.27) (using the in-sample kurtosis result) . For most of the markets (except the Vietnamese market) the sample kurtosis for all series is greater than 3.0, implying that their market daily returns are more peaked about mean and have fatter tails than normal distribution.

In general, from the in-sample to the out-of-sample period, all markets become more stable over time as we can observe the kurtosis figure reduces significantly.

4.3 DCC-MGARCH model statistical analysis and discussion

As discussed above, I adopt the DCC-MGARCH model that allows for time-varying volatility to investigate the volatility spillover effects between markets during the in-sample period which is shown in Table 3 (Appendix 1). In order to explore the reliability of the MGARCH models, I evaluate the model fittings with some evaluation tests; by comparing the DCC-MGARCH model result to the CCC-MGARCH model result, applying the QC and Hit test and the CER model as shown in Tables 4 and 5.

In the GARCH set of parameters, most of the estimated coefficients are significant (Table 3). From these empirical results, these estimated conditional correlations for the in-sample period (from 30 November 2006 to 31 November 2008) present the different level of volatility spillover effects of other markets onto Vietnam market examined. One highlight in these sets of correlations is the correlation between the Japanese-Vietnamese markets and it is consistently higher than other correlations over time. This conditional correlation is consistent through my result in the cross- correlations test which is shown in Table 2 .This finding suggests that the Japanese market has stronger and more consistent volatility spillover effect to the Vietnamese market than other markets; this result is consistent with other literature mentioned above, in the paper of Worthington & Higgs (2004).

The results from the DCC-MGARCH model suggest the Vietnam-index is more positively correlated to developed markets (Hong Kong and Japan) than other emerging markets (China, Korea and Taiwan). In my observations, the correlations between Vietnam and other markets were increasing after mid-August 2008 to October 2008. Especially, from 2007 to mid-August 2008 those correlations fluctuated widely when the financial crisis spread all over the Asian region.

I describe each pair of market correlations for empirical analysis results from the DCC-MGARCH model as below. (For more about extended figures refer to Appendix 2.)

4.4 In-sample DCC-MGARCH conditional correlations estimated

Shanghai Composite index and Vietnam–index:

The conditional correlation between two markets is examined by DCC-MGARCH during the in-sample period as shown in Figure 1.

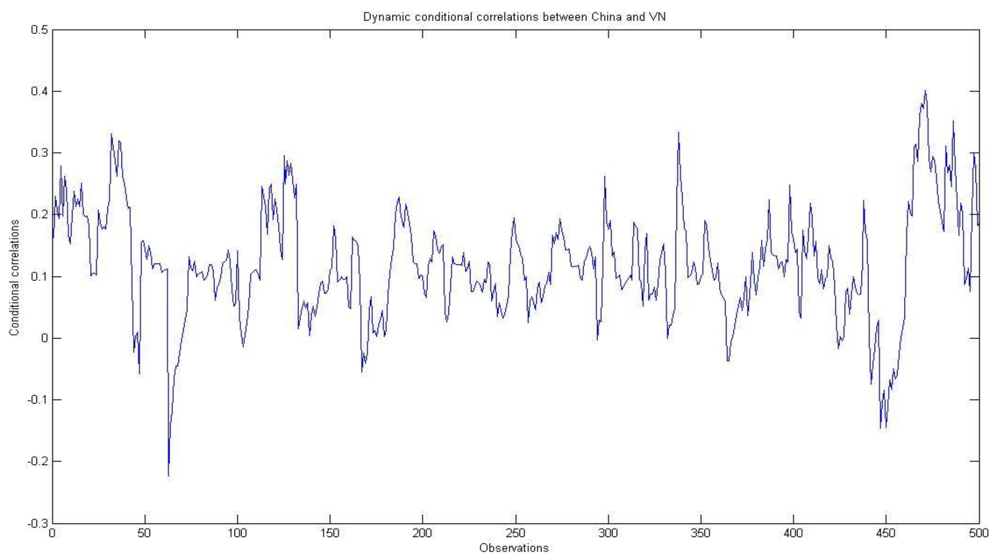

Figure 1: In-sample period of Shanghai Composite and Vietnam-index correlations.

The conditional correlations between these two markets are on average between positive 0 and 0.2 during observed data. The correlation varied widely between -0.2 and approximately 0.4. On more than four occasions the correlations climbed above 0.3 in January 2007, March 2008 and September 2008. On the other hand, there were more than five times when the correlations fell below 0. Two of them were distinctive drops; in February 2007 the correlations dropped below -0.2 and in September 2008 it was below -0.1.

Hang Seng index and Vietnam-index:

The conditional correlation between two markets is examined by DCC-MGARCH during the in-sample period as shown in Figure 2:

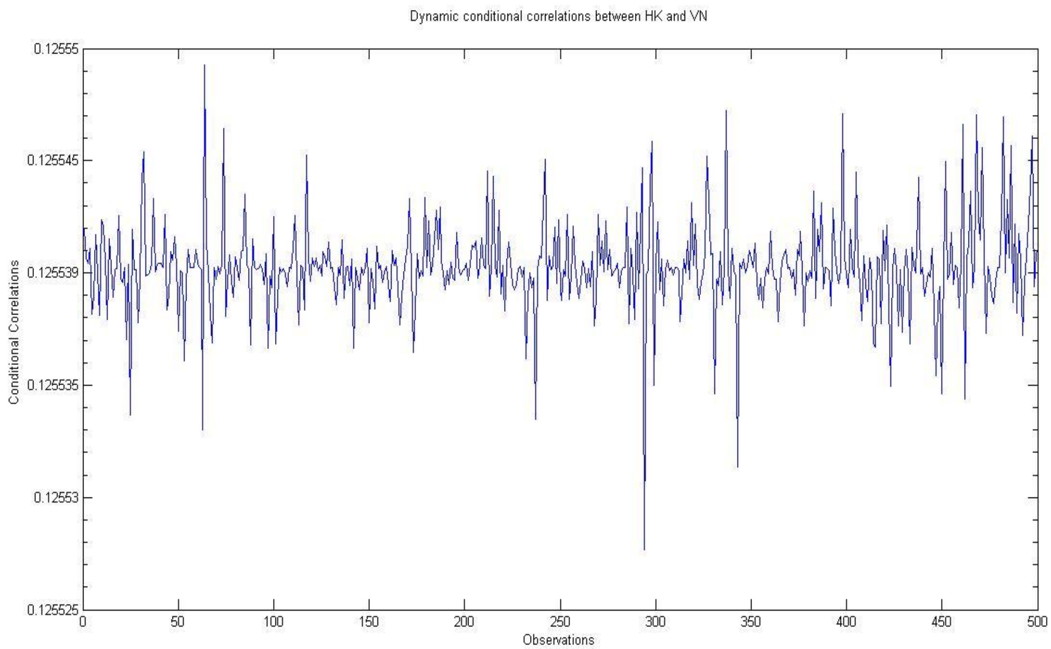

Figure 2: In -sample period of Hang Seng index and Vietnam-index correlations.

The conditional correlations between the two markets monitored appear to give an interesting result, as the two markets' returns are positively correlated during the observed period. The correlations were around 0.1255, with a very small change from 0.125525 to 0.125555 (in range of 0.00003); there was no significant change.

Nikkei 225 and Vietnam-index:

The conditional correlation between the two markets is examined by DCC-MGARCH during the in-sample period as shown in Figure 3:

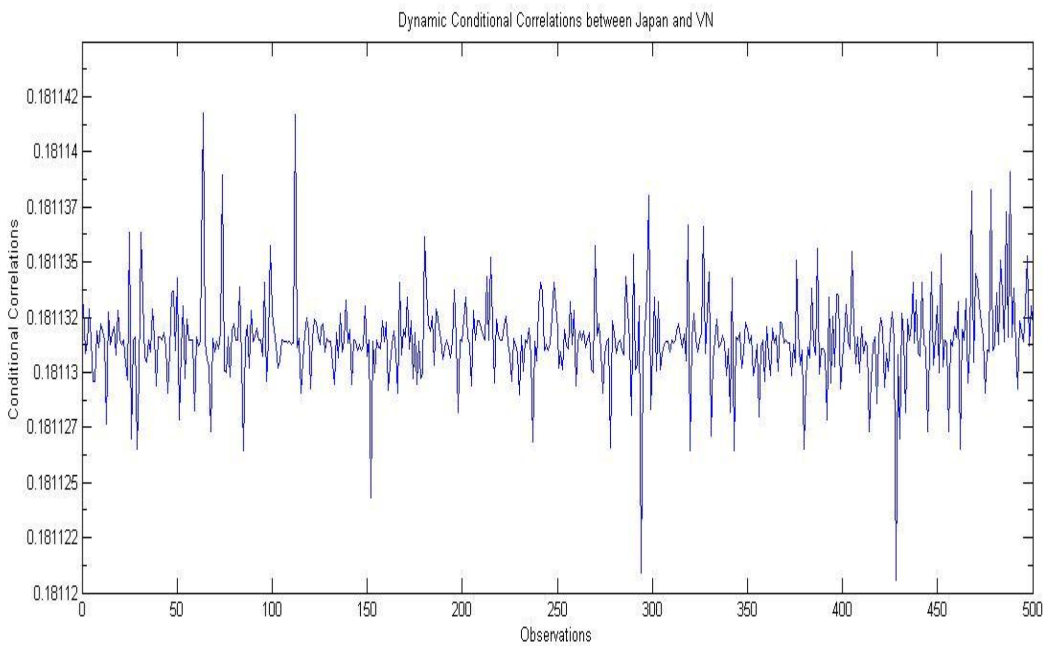

Figure 3: In-sample period of Nikkei 225 and Vietnam-index correlations.

The conditional correlations between the two markets monitored again provide an interesting result, as the two markets' returns are positively correlated during the observed period. The correlations were around 0.1811 with a very slight change from 0.18112 to 0.181142 (range of 0.00002); there was no significant drop.

KOSPI-index and Vietnam-index:

The conditional correlation between the two markets is examined by DCC-MGARCH during the in-sample period is as shown in Figure 4:

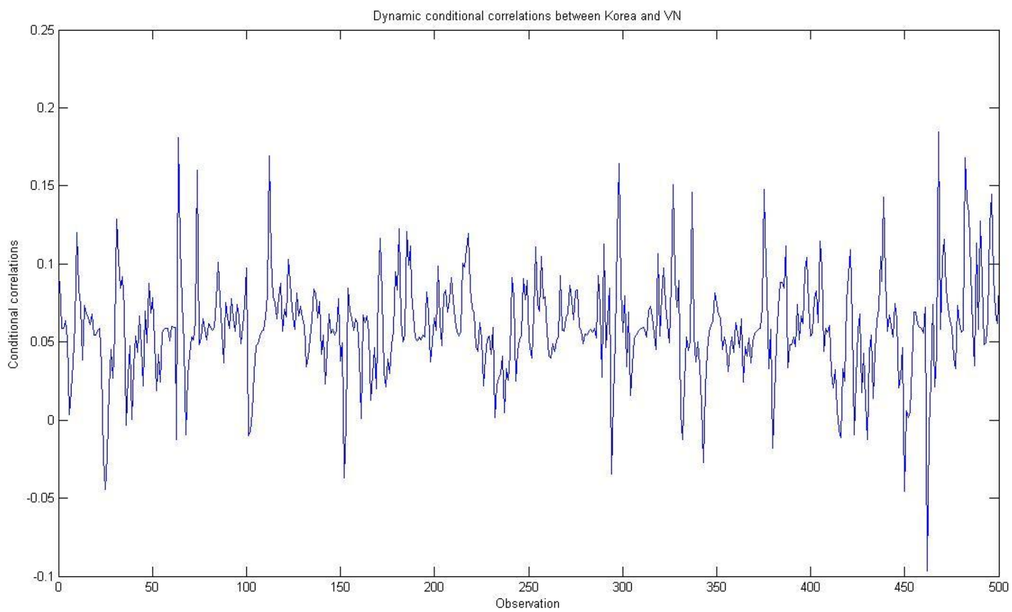

Figure 4: In-sample period of KOSPI and Vietnam-index correlations.

The conditional correlations between these two markets are between positive 0 and 0.1 during the period of observed data. There were many times when the correlations fell below 0 significantly; they were around -0.05. There were notable correlations in August 2008 and September 2008 when the correlations dropped to around -0.1 and rose approximately to 0.2 respectively.

SE-Weighted and Vietnam-index:

The conditional correlation between the two markets is examined by DCC-MGARCH during the in-sample period as shown in Figure 5:

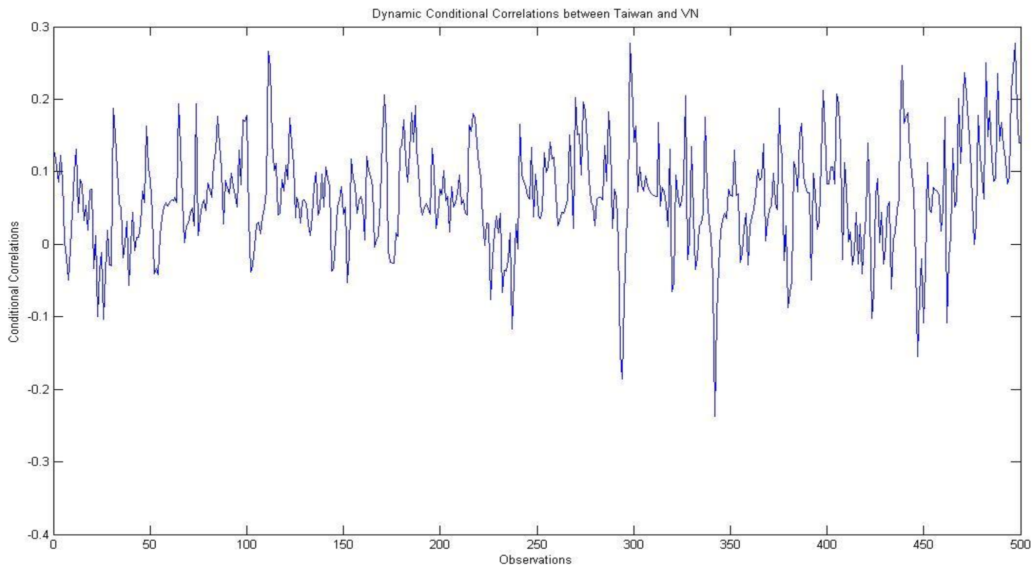

Figure 5: In-sample period of SE-Weighted and Vietnam-index correlations.

The conditional correlations between these two markets average between positive 0 and 0.2 during the period of observed data. The correlation varied widely between under -0.2 to approximately 0.3. There were many times when the correlations fell below 0. There were distinctive drops below -0.1 in January 2008, the correlation fell significantly to below -0.2 in March 2008, and in August 2008 the correlations again dropped below -0.1. After August 2008, the two markets became more positively correlated as the correlations were around 0.1 to 0.2.

In summary, according to the above conditional correlation analysis, this paper's findings provide opportunities for investors to hedge against the Vietnamese, Korean, Taiwanese, and Chinese markets based on the in-sample period. Also, these conditional correlations are quite significant and they are good indicators to show how each of these markets perform during the financial crisis period.

Furthermore, the high positive and the consistent correlations between the Japanese and Vietnamese stock markets over the observed period can be explained by the level of financial integration and the openness between the Vietnamese and Japanese economies through the Japan-Vietnam Economic Partnership Agreement. Since October-2006, when the Agreement was established, the level of integration between the two economies has been increased through import-export sectors as well as Japan's FDI to Vietnam's infrastructure (roads, airports, power stations, etc), and it is also called Official Development Assistance (ODA). This ODA promotes liberalization of trade in goods and services and facilitation of investment between Japan and Vietnam, and enhances economic partnership between the two countries, as well as strengthening cooperation in various areas including the movement of natural people and intellectual property. Japan has committed more than US$13 billion in ODA, including $12 billion in soft loans for Vietnam from November 1992 to March 2007. In 2007 alone, it committed to grant Vietnam $1.1 billion in ODA, $800 million in 2008 and then $700 million in 2009 to the Vietnamese economy. (source: Vietnam Investment Review Journal, www.virj.com).

A large amount of ODA goes directly to medium-sized companies to enhance their capacity and upgrade facilities in the context of an economic downturn. Japan's ODA for Vietnam will help increase FDI inflows from Japan into Vietnam as well as bilateral trade relations of both nations. Moreover, Japanese firms will also have many other opportunities to approach the Vietnamese market by becoming contractors in ODA projects, which are granted by the Vietnamese Government's authorities.

Chapter 5: Evaluating volatility and spillover effect models

5.1 Forecasting result for CCC and DCC-MGARCH

My out-of-sample period of 3/11/2008 to 27/08/2009 (including 195 observations) contains a distinct period when Asian markets started to recover from financial crisis, which can be defined as the bull market, with rising returns for all markets studied and relatively low volatility. I apply the DCC-MGARCH model, comparing it with the CCC-MGARCH model to test the power of the models which are used to estimate the correlations of markets examined in this study. I particularly focus on investigating the forecasting ability of both the CCC and the DCC-MGARCH model used in this paper. In my out-of-sample period, I use the same set of parameters as for the in-sample DCC-MGARCH results, in order to see how well the model can perform with a new set of data.

Table 4 (Appendix 1) summarizes both CCC and DCC model test' results for the out-of-sample period. Both the Hit test and QC test are applied to examine the reliability of the MGARCH models' results. They suggest that the CCC model is successful for forecasting volatility spillover for all markets observed in my paper at the 5% significant level. In test results for the DCC model, in both Hit test and QC test, the p-values suggest the model could be used to forecast volatility between markets over the period with the exception of correlations between the Hang Seng index and Vietnam-index. The test rejects the ability of forecasting volatility spillover effects by the DCC model between the Hong Kong financial market and the Vietnamese market at 5% significance level. This rejected result is due to the insignificant DCC-MGARCH correlation estimated at β figure in the test (0.000002 at standard errors of 1.979965). The DCC-MGARCH model is unsuccessful in performing this correlation for the out-of-sample period because of the availability of the high frequency data itself between the two markets during this period. It reduces the reliability of volatility forecasting performance of the MGARCH model.

5.2 CER: Investors' wealth evaluation model

Table 5 (Appendix 1) provides the summary reports of portfolio weights of mean values over the out-of-sample period given by the DCC-MGARCH model with a different level of risk aversion parameter from 0.2, 0.5 and 1. Interestingly, the results from the CER model suggest there is very little demand for assets in other markets rather than the Vietnamese stock market during the out-of-sample period. According to the CER test result, when I compare the proportional portfolio invested in two markets, the Vietnamese market always accounts for a larger proportion of investment (at around 80% of the portfolio) in all comparisons. The higher the risk aversion level, the more investors tend to increase their portfolio weight to the Vietnamese market. This finding supports my other findings in the summary of descriptive statistics, throughout this paper that the Vietnamese stock market had a better performance than other examined markets during financial crisis time. According to the Vietnamese market returns, the Vietnamese stock market was impacted strongly by the financial recession at an early stage which caused the Vietnam-index to crash to the lowest point of its index; it was at about 287.00 point index on 12 March 2009 before other markets. When the Vietnam economy had signs of moving out of the recession (with the prospect of FDIs, GDP, Government funding programme) the Vietnamese stock index started to rise from March-2009 through to the end of my out-of-sample period on the 31 July 2009 (the index rose above 500), and the market has increased around 90% compared to the lowest index point on March 2009.

Chapter 6: Conclusion

This paper provides some interesting findings which contribute to the understanding of the time-varying nature of volatility spilliover effects between Vietnamese stock returns and other Asian markets. First, the DCC-MGARCH model is found to be useful in determining results statistically in my out-of-sample performance. Second, my findings suggest that during the financial crisis period (first 500 observations), market volatility increases significantly as the correlations between markets are widely varied with a very large margin. These correlations led to an opportunity for investors to apply hedging strategy as well as diversifying their investment portfolio for better returns particularly where these correlations are found to be negative between markets. However, when most economies started to recover from the crisis (from quarter 2-2009 onwards) , the correlations between Vietnam and markets it was compared to become more positive, which reduces substantially the opportunities for investors dealing with their portfolio diversification across two markets. Third, all correlation statistics (CCC, DCC-MGARCH and descriptive statistics) suggest Japan has a consistently strong correlation with the Vietnamese stock market. This result also consolidates existing literature about the impact of developed markets on developing markets, especially in Asian region.

From the statistical perspective, both the CCC and DCC-MGARCH models are suitable for modelling volatility spillover effects in my study. The DCC-MGARCH model seems to be more robust for estimating the volatility spillover effects that include the time-varying and varying co-variances across markets, rather than an unconditional consistent shock, especially in my sample period which includes the financial crisis period. The main advantage of this model is that the dynamic correlation between these markets can be fully investigated.

Furthermore, in this analysis, I apply the CER model for the out-of-sample period for investors with a portfolio across Vietnam and other markets at different levels of risk aversion. These returns are analysed over the out-of-sample period where there is no-short-selling allowance in the test; the DCC model demonstrates the best economic health performance over all levels of risk aversion considered. The CER mean-variance portfolio weight indicates there is a very high demand for Vietnamese stocks in most of my comparisons. The results from the CER model imply the Vietnamese market has the best performance compared with other markets during the studied period.

Paper's limitations

This paper only focuses on investigating the transmission volatility and spillover effects of selected Asian financial markets to the Vietnamese market by exploring the level of conditional correlations between markets. It mainly focuses on estimating and evaluating results for all the particular market correlations above during the financial crisis and the post-crisis period ending 31 July 2009 by applying the DCC-MGARCH model. A different length of sample, period selected or econometric model applied for the sample period may give different correlation levels and testing results which could differ from my findings. Other methods or factors other than equity indices taken into consideration will give different results about the Vietnamese financial market.

Further research is necessary for determining a broader and clearer understanding of the Vietnamese market's volatility during the 2007 financial crisis, such as the effects of the Vietnamese stock market corporate governance system, its country deregulations and the level of financial freedom, the financial support of Government funding programmes, and also the trading activities of foreign investors or foreign fund management.

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Appendices

APPENDIX 1:

Table 1: Summary of statistics for samples:

			Full sample			
	China	**Hong Kong**	**Japan**	**Korea**	**Taiwan**	**Vietnam**
Subject	Statistics	Statistics	Statistics	Statistics	Statistics	Statistics
Length	695	695	695	695	695	695
Maximum	9.998308	10.34739	11.907904	28.301372	8.505085	5.354605
Minimum	-9.680955	-10.906914	-8.736856	-18.55498	-6.899676	-5.226761
Mean	0.03286	0.036755	-0.03076	0.016007	-0.001165	0.002978
Std	2.663573	2.091194	1.816078	2.838371	1.911524	2.404038
Skewness	-0.176593	-0.045214	0.145122	0.667978	-0.057058	0.097366
Kurtosis	5.073799	6.395342	7.767192	21.266108	4.958001	2.560351
Jarque_Bera(5.9915(chi2(2)%5))	128.151699	334.078614	660.550052	9713.652939	111.396674	6.695486

Table 1.1: Summary of descriptive statistics of the Full-sample

			In-sample			
	China	**Hong Kong**	**Japan**	**Korea**	**Taiwan**	**Vietnam**
Subject	Statistics	Statistics	Statistics	Statistics	Statistics	Statistics
Length	500	500	500	500	500	500
Maximum	9.998308	10.34739	11.907904	28.301372	8.003347	5.354605
Minimum	-9.680955	-10.906914	-8.736856	-18.55498	-6.899676	-5.226761
Mean	-0.150983	-0.057328	-0.076615	-0.075021	-0.086089	-0.041544
Std	2.813171	2.0574	1.7266	2.660082	1.784143	2.351682
Skewness	-0.128391	-0.071255	0.142046	1.351791	-0.076357	0.074822
Kurtosis	5.037322	7.854643	10.713644	34.803227	5.265716	2.672945
Jarque_Bera(5.9915(chi2(2)%5))	87.846205	491.413917	1241.27117	21224.05476	107.433132	2.694962

Table 1.2: Summary of descriptive statistics of the In-sample data

	China	Hong Kong	Japan	Korea	Taiwan	Vietnam
			Out-of- sample			
Subject	Statistics	Statistics	Statistics	Statistics	Statistics	Statistics
Length	195	195	195	195	195	195
Maximum	6.942935	7.592051	6.434388	9.947973	8.505085	4.964128
Minimum	-6.723194	-6.269555	-5.173952	-12.106521	-5.892004	-4.902279
Mean	0.504251	0.277992	0.086818	0.249412	0.21659	0.11714
Std	2.171019	2.162159	2.027603	3.247043	2.194854	2.536024
Skewness	-0.01099	-0.020411	0.100051	-0.386637	-0.130867	0.124873
Kurtosis	3.925078	3.357708	3.384314	4.422043	4.270289	2.295773
Jarque_Bera(5.9915(chi2(2)%5))	6.957057	1.053176	1.525375	21.288786	13.667386	4.536251

Table 1.3: Summary of descriptive statistics of the Out-of-sample

Notes: Each Table shows the summary descriptive statistics of the sample which includes six markets' returns recorded daily.

Table 2: Summary of cross-correlation between VN stock market and other Asian stock markets

Pearson-rho	**Full sample**	**In sample**	**Out-of-sample**
	Vietnam	**Vietnam**	**Vietnam**
China	**0.1557**	**0.1558**	**0.1526**
P-value	3.75E-05	4.72E-04	0.0327
Hong Kong	**0.1497**	**0.1458**	**0.1531**
P-value	7.4535E-05	0.0011	0.0327
Japan	**0.2474**	**0.2137**	**0.314**
P-value	3.7241E-11	1.425E-06	7.8398E-06
Korea	**0.1321**	**0.0993**	**0.1932**
P-value	0.00047811	0.0264	0.0068
Taiwan	**0.1299**	**0.1037**	**0.1763**
P-value	0.000597	0.0203	0.0137

Notes: Table 2 reports the Pearson correlation between VN return index and other markets, also including p-value for each of the correlation, significance level at 5%.

Table 3: Summary of DCC-MGARCH model

	China and VN	HK and VN	Japan and VN	Korea and VN	Taiwan and VN
a1	**2.030676**	**0.153758**	**0.05489**	**0.109727**	**0.07277**
	(0.446456)	(0.004632)	(0.001031)	(0.00545)	(0.002026)
b1	**0.173738**	**0.20767**	**0.180585**	**0.188245**	**0.175098**
	(0.017838)	(0.001519)	(0.001426)	(0.00078)	(0.002039)
c1	**0.574908**	**0.767991**	**0.818749**	**0.811753**	**0.820792**
	(0.248896)	(0.001544)	(0.001199)	(0.001038)	(0.001876)
a2	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**
	(0.021427)	(0.021427)	(0.021427)	(0.021427)	(0.021427)
b2	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**
	(0.003662)	(0.003662)	(0.003662)	(0.003662)	(0.003662)
c2	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**
	(0.006272)	(0.006272)	(0.006272)	(0.006272)	(0.006272)
a	**0.049196**	**0.000002**	**0.000002**	**0.031997**	**0.065487**
	(0.000663)	(0.000002)	(0.001264)	(0.002791)	(0.00216)
b	**0.784357**	*0.000002*	*0.000006*	**0.398801**	**0.513587**
	(0.014879)	*(1.979965)*	*(9.568292)*	(0.044926)	(0.037699)
Loglik	-2290.339965	-2050.30065	-1953.046836	-2108.757082	-2021.400834
Rho (CCC-MGARCH)	**0.113588**	**0.125387**	**0.182055**	**0.061737**	**0.067159**
	(0.002358)	(0.00196)	(0.00188)	(0.001851)	(0.00193)

Note: Table 3 reports the empirical results for the DCC model using in-sample data, estimated parameters result, log-likelihood, correlations between markets. Figures presented in brackets are standard error for each coefficient. The last row shows the Rho: correlation estimated by the CCC model.

Table 4: Summary of model testing: Hit Test and QC Test

	China and VN		HK and VN		Japan and VN		Korea and VN		Taiwan and VN	
M-Garch	**CCC**	**DCC**	**CCC**	**DCC**	**CCC**	**DCC**	**CCC**	**DCC**	**CCC**	**DCC**
HIT %	0.0256	0.0256	0.0359	0.0564	0.0256	0.041	0.0667	0.0564	0.0462	0.0513
Fhat	**1.1021**	**1.1021**	**0.5811**	**2.1775**	**1.767**	**0.8012**	**0.7854**	**1.1654**	**0.4692**	**0.5135**
QC -Test	**5.7289**	**5.7262**	**3.277**	*14.426*	**7.7525**	**4.2718**	**6.4802**	**7.1797**	**2.6905**	**3.2435**
p-value	0.4542	0.4546	0.7734	*0.0252*	0.2568	0.6399	0.3716	0.3045	0.8466	0.7777

Note: Table 4 shows the results of F test and QC test for both CCC and DCC models, with significance level of 5%.

Table 5: Summary for mean-variance portfolio weights

			No short selling							
	Investing in China	Investing in VN	Investing in HK	Investing in VN	Investing in Japan	Investing in VN	Investing in Korea	Investing in VN	Investing in Taiwan	Investing in VN
λ = 0.2										
DCC	0.2784	**0.7216**	0.2004	**0.7996**	0.1780	**0.8220**	0.1867	**0.8133**	0.1344	**0.8656**
CER	1.2248		1.1494		1.1117		1.1418		1.1305	
λ = 0.5										
DCC	0.1659	**0.8341**	0.1398	**0.8602**	0.1917	**0.8083**	0.1526	**0.8474**	0.1003	**0.8997**
CER	1.1812		1.1396		1.1113		1.1373		1.1271	
λ = 1										
DCC	0.1285	**0.8715**	0.1196	**0.8804**	0.1963	**0.8037**	0.1413	**0.8587**	0.0891	**0.9109**
CER	1.1667		1.1364		1.1112		1.1358		1.1260	

Note: Table 5 presents the summary for mean-variance portfolio weights w (t/VN) and (1-wt(market)) associated with investing in VN and other markets, respectively, calculated over the out-of-sample period 2008m11-2009m7. λ is the level of risk aversion investors.

Table 6: Statistics summary of DCC and CCC-MGARCH models:

	China and VN		HK and VN		Japan and VN		Korea and VN		Taiwan and VN	
	CCC Coefficient	**DCC Coefficient**	**CCC Coefficient**	**DCC Coefficient**	**CCC Coefficient**	**DCC Coefficient**	**CCC Coefficient**	**DCC Coefficient**	**CCC Coefficient**	**DCC Coefficient**
a1	**2.030676**	**2.030676**	**0.153758**	**0.153758**	**0.05489**	**0.05489**	**0.109727**	**0.109727**	**0.07277**	**0.07277**
	(0.454695)	(0.446456)	(0.004636)	(0.004632)	(0.001031)	(0.001031)	(0.005456)	(0.00545)	(0.002026)	(0.002026)
b1	**0.173738**	**0.173738**	**0.20767**	**0.20767**	**0.180585**	**0.180585**	**0.188245**	**0.188245**	**0.175098**	**0.175098**
	(0.017837)	(0.017838)	(0.001519)	(0.001519)	(0.001424)	(0.001426)	(0.00078)	(0.00078)	(0.002041)	(0.002039)
c1	**0.574908**	**0.574908**	**0.767991**	**0.767991**	**0.818749**	**0.818749**	**0.811753**	**0.811753**	**0.820792**	**0.820792**
	(0.248965)	(0.248896)	(0.001545)	(0.001544)	(0.001199)	(0.001199)	(0.001039)	(0.001038)	(0.001877)	(0.001876)
a2	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**	**0.276475**
	(0.021511)	(0.021427)	(0.021519)	(0.021427)	(0.02158)	(0.021427)	(0.021494)	(0.021427)	(0.021515)	(0.021427)
b2	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**	**0.215892**
	(0.003662)	(0.003662)	(0.003676)	(0.003662)	(0.003669)	(0.003662)	(0.003671)	(0.003662)	(0.003688)	(0.003662)
c2	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**	**0.735572**
	(0.006274)	(0.006272)	(0.006293)	(0.006272)	(0.006293)	(0.006272)	(0.006291)	(0.006272)	(0.006304)	(0.006272)
rho	**0.113588**		**0.125387**		**0.182055**		**0.061737**		**0.067159**	
	(0.002358)		(0.00196)		(0.00188)		(0.001851)		(0.00193)	
a		**0.049196**		*0.000002*		*0.000002*		**0.031997**		**0.065487**
		(0.000663)		*(0.000002)*		*(0.001264)*		(0.002791)		(0.00216)
b		**0.784357**		*0.000002*		*0.000006*		**0.398801**		**0.513587**
		(0.014879)		*(1.979965)*		*(9.568292)*		(0.044926)		(0.037699)
Loglik	-2293.025541	-2290.339965	-2050.3008	-2050.3007	-1953.04539	-1953.04684	-2109.09226	-2108.75708	-2022.73206	-2021.40083

Notes: Table 6 reports the empirical results for the DCC vs CCC model using the in-sample data, estimated parameters result, log-likelihood, and correlations between markets. Figures presented in brackets are standard error for each coefficient.

APPENDIX 2:

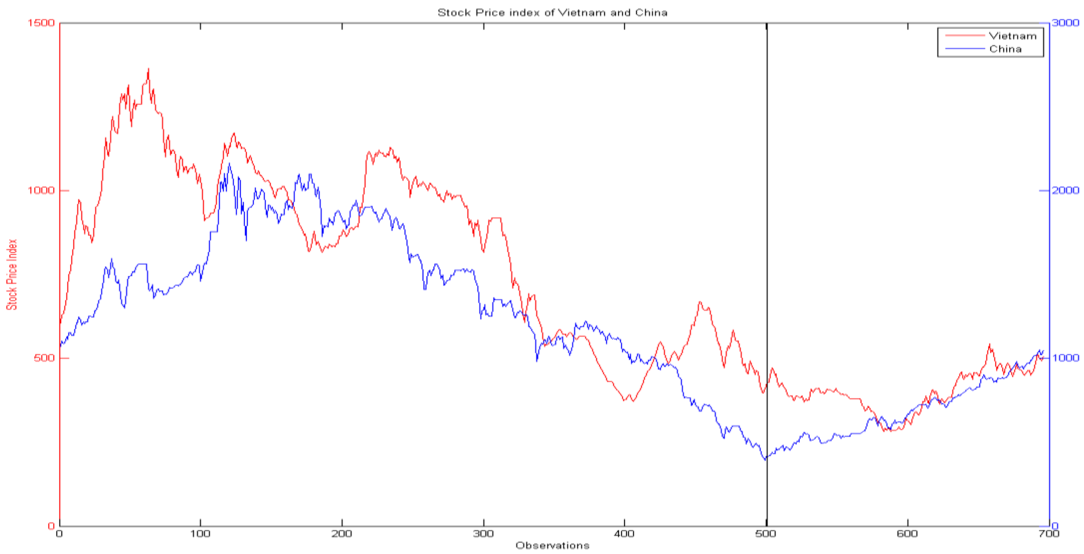

Figure 1.1: Stock market index of Vietnam and China

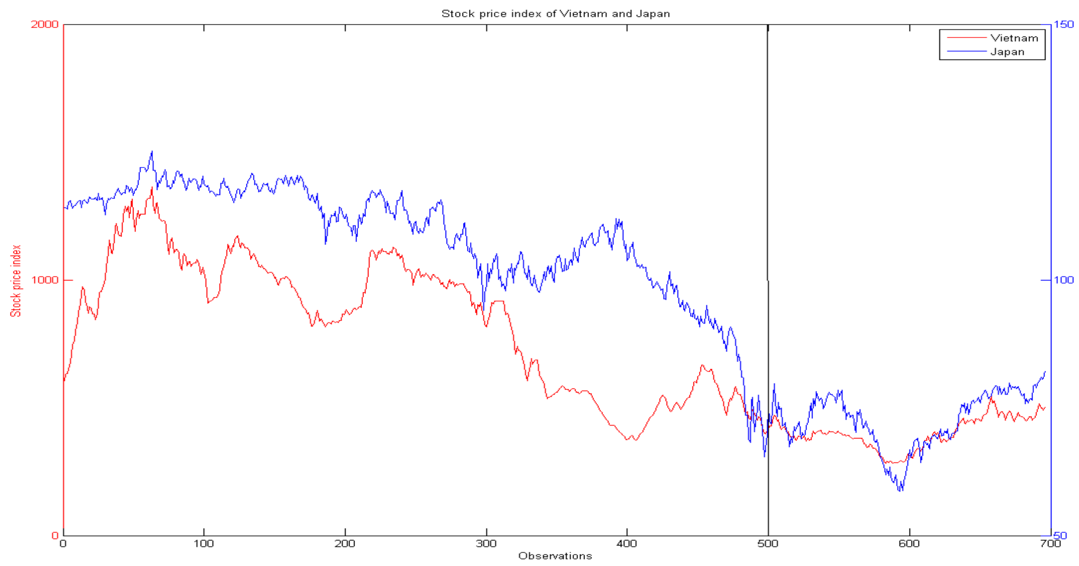

Figure 2.1: Stock market index of Vietnam and Japan

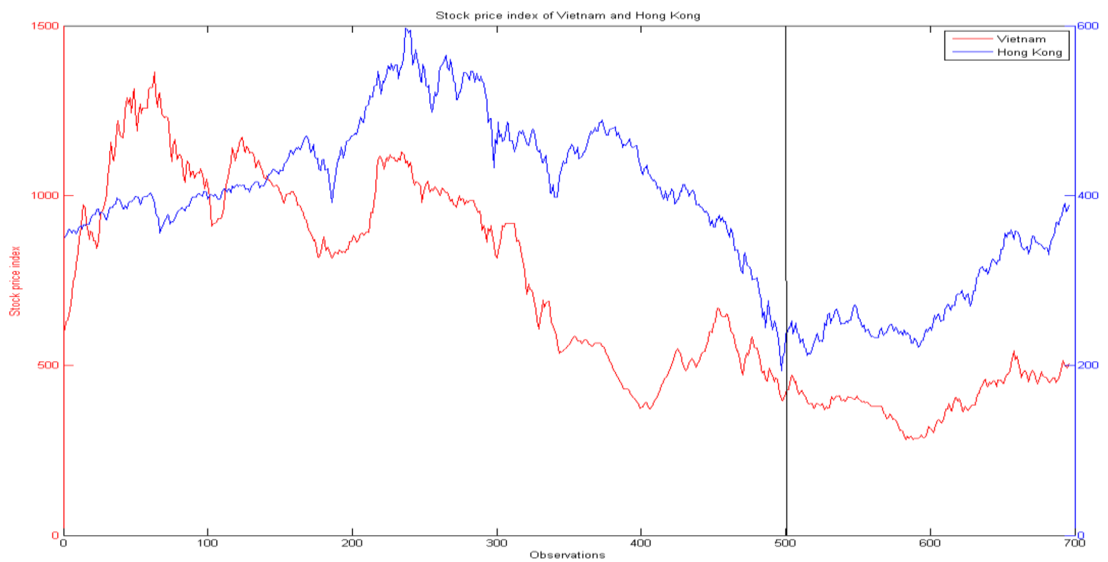

Figure 3.1: Stock market index of Vietnam and Hong Kong

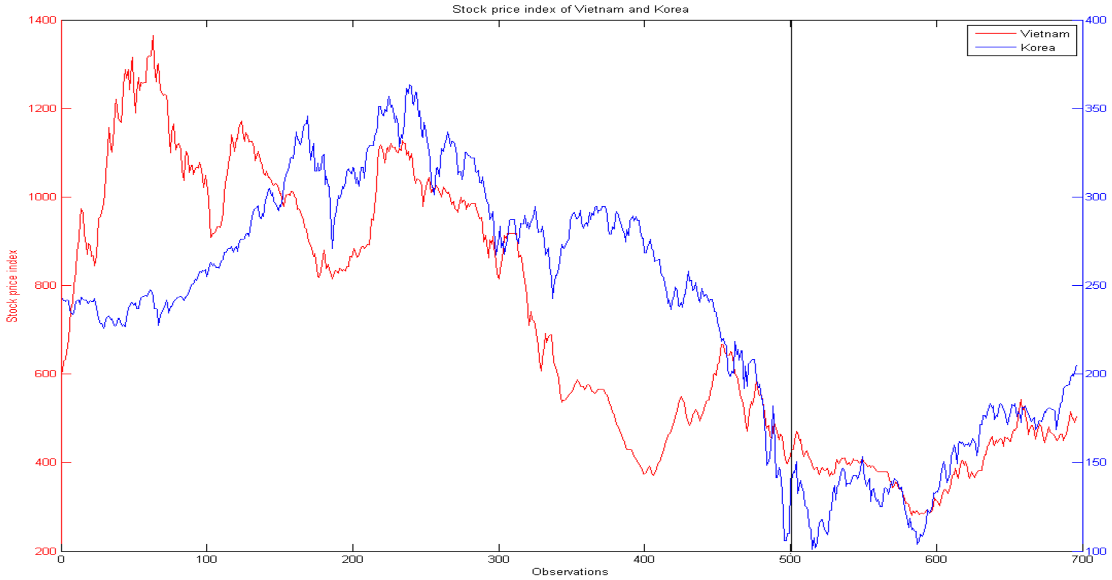

Figure 4.1: Stock market index of Vietnam and Korea

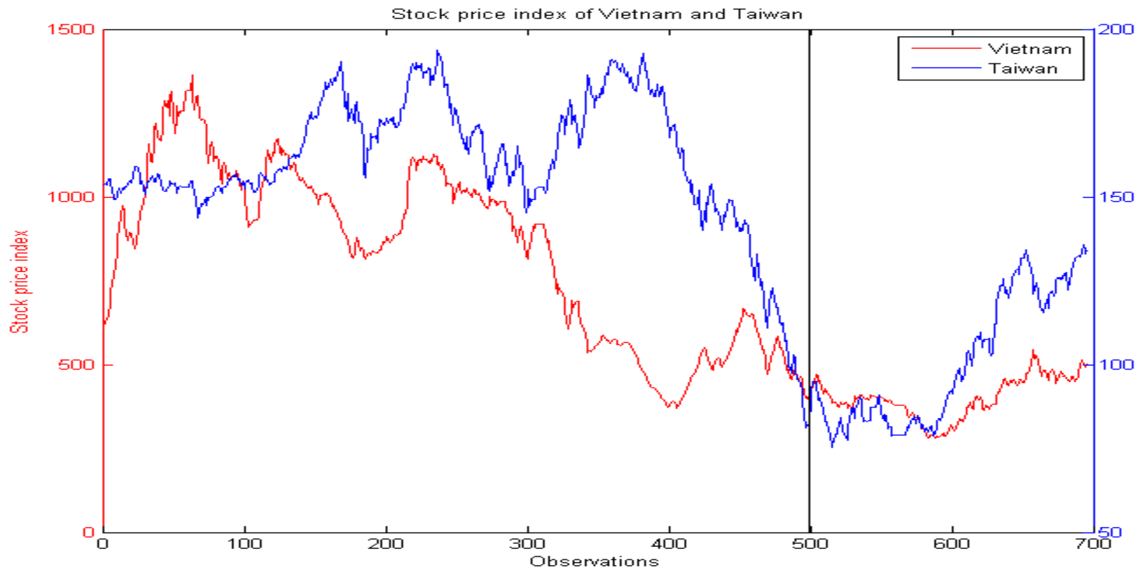

Figure 5.1: Stock market index of Vietnam and Taiwan

Note: These are the five graphs used to support the DCC-MGARCH graphs in Chapter 4.
The line in each graph determines the boundary between in-sample (500 observations) and out-of-sample (200 observations).