Stock Market Integration and International Portfolio Diversification between U.S. and ASEAN Equity Markets

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Msc International Banking and Finance

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Abstract

The paper empirically analyzes stock market integration and the benefit possibilities of international portfolio diversification across the Southeast Asia (ASEAN) and U.S. equity markets. It employs daily sample of 6 ASEAN equity market indices and S&P 500 index as a proxy of U.S. market index from years 2001 to 2010.

The paper examines the stock market return interdependence from three different perspectives which are 'long-term', 'short-term' and 'dynamic' perspectives. In order to investigate the long-run interdependences, the Johansen-Juselius multivariate co-integration test and the bivariate Engle-Granger 2-step method were used. In respect to the short-run interdependences, the Generalized Impulse Response Function (GIRF) and the Generalized Forecast Error Variance Decomposition (GFEVD) are employed. Finally, to assess the dynamic structure of equity market co-movements, the Dynamic Conditional Correlation (DCC) model is engaged.

Results suggest that in the long-run, there are no potential benefits in diversifying investment portfolios across the ASEAN and U.S. market since there are evidences of co-integration among them. However, the potential benefits of international portfolio diversification can be seen throughout the short-run-period. Subsequently, the DCC findings suggest an overall proposition that by the end of 2010, most of the ASEAN markets do not share the U.S. stock price movement.

Keywords: Market Co-integration, International Portfolio Diversification, U.S., ASEAN, 'long-term', 'short-term' and 'dynamic' perspectives, Johansen-Juselius Co-integration, Bivariate Engle-Granger method, GIRF, GFEVD and DCC.

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Therefore the results from this dissertation are for you all!

"Follow Excellence, Success will Chase You Down"

Introduction

1.1 Background of the Topic

The root cause of United States financial crisis started when Federal Reserve bottomed out the intended federal funds rate from 6.5% on May 25th 2000 to 1.0% on June 25th 2003. The adverse effect of this trend made investors pour their funds into other non-governmental sectors, which lead to risky lending practices in U.S. Subsequently, with the housing bubbles event, investment banks began to create Collateralised Debt Obligation (CDO) as pool of bonds while decomposing its risk into different forms and be shared worldwide. Moreover, in the form of housing loans, housing mortgage creditors worsened the situation with the involvement of subprime borrowers and their default later consequently affected financial markets globally. Inevitably, 'Association of Southeast Asian Nations' (ASEAN), as part of the Asian economies, experienced severe downturns on stock market indices, and the initial impact on Asian economies was so rigorous that the output in most of these countries was contracted more than in U.S. (Yoshida, 2011).

The adverse shock on ASEAN stock market indices was substantial. For example, in Vietnam, the Ho Chi Minh index plummeted from its most recent peak of 3861.38 points in 15th October 2007 to 1864.93 points in 30th October 2008, a decrease of 77.59%. In Singapore, the FTSE Straits Times index bottomed up from its latest summit of 3800.01 points on 17th October 2007 to a decrease of 2306.48 points in 12th March 2009, a decline of 60.69%. Moreover, the Jakarta Composite index (Indonesia) decreased 58.2% from its highest level in 14th January 2008 to 1173.86 points in 30th October 2008. Stock Exchange of Thailand index dropped from its apex of 875.59 points in 23th May 2008 to a decline of 56.13% in 29th October 2008. Philippines Stock Exchange index dismounted during the period of 15th October 2007 until 30 October 2008 for 51.7% (3861.38 and 1864.93

respectively). And finally, in Malaysia, the FTSE Bursa Malaysia – Kuala Lumpur Composite index gradually decreased from its recent climax level of 1505.71 points in 15th January 2008 to 829.41 points in 29th October 2008, a plummet of 44.9%. However, from the six countries stated, the negative impact of U.S. financial crisis differs for each nation. For instance, Vietnam and Singapore indices experienced almost two years of a decreasing trend, whilst Thailand index only encountered this for 5 months and later on started to recover from the shock. Philippines witnessed almost a one year plummeting trend, whilst Indonesia and Malaysia indices experienced nine months of a declining stocks movement. Nevertheless, the contagion effect in experiencing the starting date of turmoil period in each country was different between one and another.

The analysis given above implies that there was an indication of strong correlation between ASEAN and U.S. equity market during the recent US financial turmoil. These markets interdependencies have enticed the attention of financial investors around the world. In particular, one aspect that interests them is the benefits of international portfolio investment. The financier invests across international markets in order to distribute the risk whilst keeping the expected return maximum as long as the different markets display low or less than perfect correlation. In other words, if the degree of integration between the international markets is high, the potential returns from these markets will be minimal. Moreover, the studies on the ASEAN stock market integration done by Ibrahim (2000, 2005), Hee (2002) and Azman-Saini *et al.* (2002) indicates that ASEAN markets become more integrated between themselves and U.S. market during the post recent Asian crisis period.

1.2 Objective and Research Questions

A detailed comparative investigation during the tranquil period posts the Asian financial crisis and recent U.S. financial crisis on market interdependencies in selected of interest

ASEAN regions because of the increased economic and trading cooperation in accordance with the ASEAN agreement. Principally, the outcomes of this paper are contributions for investors and investment companies in the international community that globally diversify their investments and make capital budgeting decisions in the ASEAN region. Particularly, this study may benefit international investors and investment companies to invest in ASEAN region and U.S. capital markets, whether it is for portfolio management, risk diversification or even for arbitrage purposes.

Moreover, in April 2010, the 14th ASEAN Finance Ministers meeting (AFMM) in Nha Trang, Vietnam concludes to have commitment to further promote financial stability in the region. Endorsed by the AFMM in Manila 2003, the roadmap for monetary and financial integration of ASEAN consists of steps, timelines, and indicators of activities in four areas: (i) Capital Market Development, (ii) Liberalisation of Financial Services, (iii) Capital Account Liberalisation and (iv) ASEAN currency cooperation, with the ultimate purpose of greater economic integration in ASEAN by 2015 (ASEAN Secretariat, 2009). Therefore, the research can explain whether the roadmap for monetary and financial integration of ASEAN is successful or not based on the linkages degree between the ASEAN stock markets. This study also contributes to partially filling the gap in literature and provides recent empirical evidence on market integration in the ASEAN region, based on longer and more recent sample of time series data and superior model of estimation.

The research questions of this study are therefore to: (a) examine empirically the long-run relationship among the six selected members of ASEAN markets (Indonesia, Malaysia, Philippines, Thailand, Singapore, and Vietnam) and their interdependencies from the U.S. market; (b) explore empirically the short-run dynamic linkages among six ASEAN markets with the U.S. market, and finally (c) assess the dynamic structure of stock returns co-movements between the six ASEAN markets with the U.S. market.

1.3 Outline

The paper is structured into six sections. The second chapter describes the theoretical framework of international portfolio investment and state of the art literatures which investigates stock market linkages with a particular observation across ASEAN and U.S. markets up until the recent period of 2010. The latter part includes ‘long-run’, ‘short run’ and ‘dynamic’ perspectives outcomes from the studied countries. The third chapter describes the data properties which latter being used in the econometric modelling. The next chapter explains the methodology and the empirical methods being used to address the objectives of the study. The results and analysis are presented in chapter five with the strength and weaknesses of this study. Lastly, the final chapter provides conclusions and implications based on the objectives of this research. Additionally, it also explains the research limitations and proposes suggestions for further studies.

Literature Review

Theoretical Framework

2.1 The tenet of International Portfolio Investment

The investment allocation of earning is essential for individuals in order to fulfil their consumption in the future. By the means of distributing their incomes allocation between the current consumption and productive investments leaves the financial investment decision to be defined. The remaining wealth is therefore meant to be allocated to the financial sector investment. In spite of this simplification, the forms in which capitals can be held are ranging from real estate holdings or through gold and commodity futures, all the way to money market securities, savings accounts, stocks, bonds and cash equivalents. Therefore, this research has a foremost interest to investigate their rational investment in the form of equity market indices instead of other financial investment alternatives.

The early theory of International Portfolio Investment was mentioned by Markowitz (1952, 1959) through the portfolio theory. He proved that individual risk can actually be diversified by investing in a market portfolio. Grubel (1968) also supports this finding which suggests that one country's specific risk could be diversified by investing in many countries' security markets. Accordingly, the investor has undoubtedly become more favourable to the International Portfolio Investment (IPI). The concept of IPI comprises investment not only in domestic, but also in foreign market indices. Meanwhile, a notable proposition arises in the measurement of its risk and expected return. In most cases, due to the regulation, local currency is used to calculate return and variance values for security characteristics. This means that foreign market indices need to be adjusted for their currency gains or losses. This should be noted, however, this adjustment is not a matter that needs to be addressed in this research and the explanation for this will be discussed at a later section in the paper.

As mentioned earlier, one of the study aspects in this paper is international portfolio investment across ASEAN and US markets. Undoubtedly based on the 'technical' point of view, US equity markets are known for its best reputation for the way they regulate the markets and how they characterize them in depth, breadth and resilience. The Bartram and Dufey (2001) study shows that there is an increase of 26% in the US investor holdings of foreign market securities from 1998 to 1999, from $2052.9 billion to $2583.4 billion. This implies that the U.S. international portfolio diversification has been quite modest during the studied period. Therefore, in this study it is of interest to describe and explain the possibility of diversifying their investment in the ASEAN markets from the 2001 to 2010 period.

2.2 International Portfolio Diversification

The concept of international portfolio investments attracts investor's attention for its allure. The drawing power of international portfolio investment is based on (a) the possibility of abnormal returns due to market segmentation, (b) the participation in the growth of other foreign markets, (c) hedging of the financier's consumption basket and (d) diversification effect (Bartram & Dufey, 2001). This research is of interest to examine the enticement of the diversification effect from the international portfolio investment fathom. By this means, holding all else equals, an investor will benefit from having a diversified portfolio in other foreign markets. Therefore, the pivotal determinant that influences their gains and losses on the diversified portfolio is the correlation between the returns in one market to the other. In other words, if there is a low correlation as opposed to high correlation between markets then there is lower portfolio risk (favourable diversified portfolio), *ceteris paribus*. Moreover, conditions which may benefit the investor from investing in foreign market is based on the following: (a) the expected return of the foreign market is higher, (b) the variance in the expected return is lower (low volatility), (c) the correlation (interdependence) coefficient in

the expected return is lower and (d) the dividend share is higher than the investor's home market.

Based on the idea above, investors start to make use of the diversified portfolio which displays a low correlation and select the securities based on these indicators. It can be argued that most rational investors are risk averse; therefore they will always prefer less risk to more. Since the case of negative correlation[1] is rare between different markets, the investment decision will be made on the lowest possible correlation. By all means, this is the definition of international portfolio diversification.

Other explanation on the international portfolio diversification is based on the industrial diversification arguments. A study from Gerard, Hillion and Roon (2002) indicates that different countries with different industry composition could offer sufficient diversification benefits. For example, Switzerland market has a higher proportion of banks than the other markets (Roll, 1992). This gives diverse industry proportion across the countries therefore might explain the divergence in volatility as some industry sectors tend to be more volatile than others. Moreover, the country factor such as an increase of real interest rate has also brought impact to the international diversification strategies (Gerard, et al., 2002).

Meanwhile, investing in foreign markets is not always more preferable than investing only in domestic markets. Since there is a possibility that the return from an international diversified portfolio is lesser than domestic portfolio. This can mainly be explained by country specific events. For instance, 'X' government is a type of anti-inflation policy maker; therefore it gives rise to periods of relatively low economic activity which later would limit the gains possibility from investing in that country. Nevertheless, in order to minimize the total risk of

[1] A negative correlation which is displaying the correlation coefficient between 0 and -1 indicates that there are two securities move in the opposite direction. For example: the negative correlation between Gold denominated in USD and USD index from late 1996 to the end of 2011.

a portfolio, the diversified international portfolio is still favourable (Markowitz, 1952, 1959; Grubel, 1968; Odier and Solnik, 1993).

2.3 Risks and Constraints

The fruitful practices of international portfolio diversification also have hindrances, since the international portfolio diversification phenomenon is related to securities investment that held to an international scale. This issue arises particularly when the circumstances of the real world are taken into account. This study classifies the issues into two categories, risks and institutional constraints. Firstly, there are two aspects of risks that may affect the investment decision in overseas markets; these are currency risk and country risk. Secondly, for the institutional investor, there are four constraints that may influence negatively (or even positively) the international portfolio diversification resolution. These are taxation, foreign exchange controls, capital market regulations, transaction costs and familiarity with overseas stock markets. These categories are discussed comprehensively in the next sub-chapter.

2.3.1 Risks

As mentioned above, the unique international risks are currency risk (can also be defined as exchange risk) and country risk (which is related to political circumstances). Exchange risk arises as the foreign securities market is designated in respective to foreign denomination. Since exchange rate's notions vary across different countries, it can be induced that the unanticipated or anticipated changes that can be a source of additional risk to the investor, yet, at the different point of view, it also reduces the total portfolio risk which is in favour for the investor. The positive or negative effect of exchange risk mainly depends on the investor's portfolio distribution. Basically, if the total risk of an overseas stock is decomposed into the movement of currency rate (currency risk) and volatility, which these are denominated in domestic currency, the exchange risk is able to compensate for sufficient

benefits of international portfolio diversification while it can also reduce the overall total portfolio risk (Odier and Solnik, 1993). Especially in the developed market, they also postulate that the currency rate and the stock markets display the same directional trend over a short time horizon. In essence, it can be summarized that currency risk can promote the benefits of diversification purposes. Therefore, by proper hedging strategies the currency risk is in favour to the investor.

The fact that international portfolio diversification engages with foreign security which is issued and traded across different sovereign political jurisdiction; give rise to the country (political) risk. In general, country risk can be characterized as follows: (a) restrictions on capital inflow or outflow, (b) constraints on management and corporate activity and (c) government policies with respect to managerial control (Bartram & Dufey, 2001). Moreover, the country political stability and economic development conditions are also able to influence the default risk of company share price or share dividends. Therefore, it can be implied that the investor requires information related to the country's prospect of economic growth, the dividend share payment trend, political condition and so on. To acquire this type of information is costly; nevertheless the developed and some the developing countries have provided and published it publicly. In addition, another issue still exists which is related to the standard of reporting, since across different countries, especially the developing countries, have different standards of reporting. In spite of these risks, many empirical evidences show that combining securities which display low interdependencies between each other with high and low political risk can bring greater benefits.

2.3.2 Institutional Constraints

Apart from the unique risk that arouse when investor deals with international portfolio diversification, there are other barriers that may hurt the benefit of international portfolio diversification, which is institutional constraints. Institutional constraints are typically

government actions through regulations towards domestic and foreign financial institutions. These institutional constrains consist of taxation, foreign exchange controls, capital market regulations, transaction costs and familiarity with foreign markets (Bartram & Dufey, 2001). Moreover, other factors that may also be included to institutional constraints are weak or negligence ordinance from the authority in respect to the rights of minority stockholders, prevention of insider trading or simply flaws disclosure over material and/or information to the markets. However, these institutional barriers are fairly ambiguous. Since many financial practitioners and/or authority institution, depends on their point of view, can make these issues into profits. For instance, the restraint in one market in foreign exchange controls[2] turns out to be an incentive for another market. Furthermore, each of the institutional constraints is comprehensively discussed as follows.

Taxation

International portfolio diversification inevitably deals with various cross-border activities. The form of taxes can be an obstacle or an incentive to investor. Basically, taxation is made by the government to accumulate revenue generation. However, nowadays the motivation behind the taxation became complex and this paper only presents the context of its tax consideration which affects international diversification.

The form of taxation which becomes the primary obstacle to international portfolio diversification is 'withholding taxes'. Withholding tax is an amount of payment that was deducted from the total payment that one party (in our case is the investor) needs to pay to another payee. This withholding tax is to be paid to the taxation authorities. Based on the nature of the product or services being paid for, the amount of withholding tax may vary.

[2] United Kingdom and United States of America are well known for their stringent regulation in restraining capital flows, whilst for Indonesia in general, there is no foreign exchange control. Accordingly, Indonesia becomes more favourable to be an investment destination in the perspective of less exchange control barriers.

There are many countries jurisdiction which require withholding tax on the transaction payment of dividends interest. The reason for why this tax is being engaged by many countries is to facilitate or accelerate collection, by collecting them through payers instead of the vast number of payees, and by collecting the tax from the payers within the jurisdiction instead of payees who may reside outside the jurisdiction. Moreover, the withholding tax is also seen as the government's act of solution in the respect of tax evasion. The solution to overcome this tax obstacle is 'double taxation agreements'. Double taxation agreements, also known as 'tax treaties', play a crucial role to reduce or eliminate retention tax rate on a bilateral basis[3].

Foreign Exchange Controls

Foreign exchange controls is the regulation of government-imposed to control the capital inflows and outflows within the country. This type of regulation is intended to protect domestic companies from foreign institutional acquisition. Moreover, there is a study on the Swedish capital market that explains the effect of capital flow barriers on portfolio selection and asset pricing. The study shows that there is an existence of capital inflow and outflow constraints during the period of studied (Bergstrom, et al., 1993). The capital inflow controls manifest in the form of a fraction limit that the domestic firm's equity may be held by foreign investors. Accordingly, the foreign investor would expect two different share prices which consist of domestic share price and international asset price. Consequently, in the favour of international portfolio diversification, some of the authority jurisdiction may offer them a foreign asset premium which could raise a home bias in portfolio selection. Meanwhile, the capital outflow controls embody in the form of limitation on the amount of capital domestic which a local investor may expend on the foreign stocks. In essence, the authority intentions'

[3] For example, the 'tax treaties' in UK are being regulated by ' Her Majesty Revenue & Customs' (HMRC), which is stated at the following website link: http://www.hmrc.gov.uk/cnr/withholding-tax.pdf (Her Majesty Revenue & Customs, 2012)

imposing these barriers is in an expectation towards the domestic investor substituting their foreign purchase asset with akin-substitute domestic asset.

Capital Market Regulations

Regulations on capital market are usually underpinned through an examination and regulation from an independent department which reported directly to the government minister of finance. The names of the regulatory bodies in this research are stated as follows.

Table 1. Capital Market Regulator

Country	Capital Market Regulator	Abbreviations
United States of America	Securities and Exchange Commission	SEC
Indonesia	Indonesia Capital Market and Financial Institution Supervisory Agency	BAPEPAM-LK
Malaysia	Suruhanjaya Sekuriti - Securities Commission Malaysia	SCM
Singapore	Monetary Authority of Singapore	MAS
Thailand	Thailand Securities and Exchange Commission	SEC
Philippines	Philippines Securities and Exchange Commission	SEC
Vietnam	State Securities Commission of Vietnam	SSC

The purpose of these capital market authorities in general is to safeguard the interests of investor, therefore maintaining investors' confidence in the market. Moreover, these impartial regulatory bodies are there to ensure that risks are kept to an acceptable level and promote efficient price discovery.

Some of the regulations that the official entities made are manifest in the form of restrictions to the type of financial institution which deals with insurance, pension funds and other fiduciaries. For instance, in the United States, the distribution of insurance company portfolios which plan to be invested outside the country is severely restricted. Therefore, the option to generate profits from international portfolio diversification would not be their decision.

Transaction Costs

In the context of transaction costs, purchasing securities in the foreign markets are prone to be substantially higher compared to purchasing in the domestic markets. Since, investing in foreign markets also bring extra costs for investors that need information related to the market such as prices, market movements, company share profile and so on. Therefore, these costs can be regarded as barrier to the fruitful practice of international portfolio diversification. In addition, time differences between markets and administrative overhead cost (cost of transferring information between local parties to the foreign counterpart) can be costly as well.

However, these costs issues are able to be mitigated by the capital market regulator by providing depth, breadth, and resilient information related to the securities in the market. The level development of this impartial body of capital market regulator is really essential since with their superior quality in conducting efficient transaction at low cost and providing sufficient information would therefore attract more investor's to the markets.

Additionally, if all other factors are equal, the currency value can also be one of the lure factors for the international investor. For instance, Indonesia currency value is far lower than the US currency. This means that whatever the costs there may be in respect to securities procurement within the Indonesian market, these costs are still lower than the transaction costs in US markets.

Familiarity with Foreign Markets

The final risk that may affect investor decision to invest on foreign market is the familiarity with foreign markets. Inevitably, the perceived cultural differences between one country's markets to another represents a psychological barrier to the investor. These differences can be

manifest in the form of trading mechanism, the way business is conducted, financial reporting standard, and other kinds of asymmetric information that may prevail to the investor. A study postulate that the unfamiliarity factor related to foreign markets such as geographic, economic, cultural and industrial proximity play the dominant role in the choice of overseas listing venue (Sarkissian & Schill, 2004). This finding which sampled 44 countries across the world from 1998 to 1999 also implied that familiarity with foreign market is the key determined factor for an investor to choose selected market, in contrast to the notion of low or weak correlation between the markets.

However, over the last decade, multinational companies in ASEAN have progressively published their financial information in English besides their national language, increasing the frequency of disclosure and adapting the style of international financial reporting standard (Solnik, 2000). Accordingly, since this unfamiliarity with the foreign market is a kind of psychological barrier, it is not supposed to undermine the attractions of international portfolio diversification. If the investor invests a reasonable time to study the foreign markets and decides on whether the studied market can be taken advantage or not, can be worthwhile.

Empirical Evidence of International Portfolio Diversification

According to Dunnis and Shannon (2005) during the post 1997 Asian Financial crisis, the level of integration between several emerging markets in Asia and the U.S. has remained steady or declined over the review period. They also documented that all the developing markets have become more closely integrated with the Japanese market. Moreover, Ibrahim (2005, 2008) discovered lack of integration among the ASEAN markets in the long run, although in the short run this was not the case during the observation period from January 1988 to December 2003 (with the perspective of the Indonesian market). This finding implies that benefits of portfolio diversification within the ASEAN equity markets may be understated. Additionally, there were opportunities to benefit from portfolio diversification during the period 1988–1997, for which Hee (2002) found that among the capital markets of ASEAN, there was no long-run co-movement; nevertheless, correlation analysis indicated that the markets were becoming integrated. This finding is being supported by a lack of evidence that ASEAN markets are sharing a common stochastic trend, although there was evidence of co-integration among the ASEAN (Azman-Saini, 2002).

In contrast, Daly (2003) explored the market linkages in South-East Asia over the period 1990–2003 and concluded that after the Asian financial turmoil, there has been a significant increase in the integration among ASEAN markets. Implying also that there were no merits in investing on diversification countries, Palac–McMicken (1997) and Wongbangpo (2000) show that ASEAN equity markets excluding Philippines shared a long-run co-movement over the period of 1985-1996. Furthermore, Ibrahim (2000) conducted a study in exploring the degree of financial integration and return of portfolio diversification among the ASEAN stock markets from the perspective of Malaysia, over the period January 1988 - June 1997. The study discovered that there was evidence of long-run co-movement among the ASEAN and U.S. capital markets, although the short-run linkages among the ASEAN markets were

mostly contemporaneous. Nevertheless, the study concludes that the equity markets in South-East Asia countries were strongly integrated and the U.S. market inflicted a noticeable influence on the ASEAN markets. In line with the Ibrahim (2000) study, Cheng *et al* (2003), Click and Plummer (2005) also supported that the ASEAN-5 equity markets were co-integrated during the period of January 1992 – August 2002, although Cheng *et al* (2003) discovered that the level of integration can only be found before and after the Asian financial crisis, but not during the turmoil period.

Data Description

Data used for this research are the closing prices of selected ASEAN[4] and U.S. stock exchanges. The selected ASEAN stock markets are the Jakarta Composite Index (Indonesia), FTSE Bursa Malaysia KLCI (Malaysia), the FTSE Straits Times Index (Singapore), the Stock of Exchange Thailand Index (Thailand), the Philippines Stock Exchange Index (Philippines), and the Ho Chi Minh Stock Index (Vietnam). The Standard and Poor's 500 (S&P 500) index is being used as a proxy of the United States indices. The S&P 500 index was chosen since it can capture 75% coverage of U.S. equities and includes 500 leading corporations in leading industries of the U.S. economy.

To provide more robust and updated results, this study uses daily data frequency which is collected from the Bloomberg Database. Using daily frequency is of foremost interest since it allows for more suitable explanations in the stock returns co-movements, which often change rapidly as investors shift their portfolio allocation (Kim, *et al.*, 2005). Additionally, daily return data are favoured than the weekly and monthly frequencies because lower frequency data can dim out the response functions towards the innovations (financial shock) which may last for a few days only (Elyasiani, et al., 1998).

The data sample is covering the period from January 2001 to December 2010. The currency of these indices is denominated in their own domestic currency and is stated as follows: Indonesia is Indonesian Rupiah (IDR), Malaysia is Malaysian Ringgit (MYR), Singapore is

[4] Association of Southeast Asian Nations (ASEAN) has ten members including Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Singapore, Thailand, and Vietnam. This study only investigates six members of ASEAN excluding Brunei Darussalam, Cambodia, Lao PDR, and Myanmar because of the following reasons. Until recently, Brunei Darussalam has not seen to have a plan in structuring their owned stock exchange. Laos Stock Exchange has only two listed companies which are EDL Generation-Public Company and Banque Pour Le Commerce Exterieur Lao (BCEL). The Laos capital market began its operations on January 11th 2011 (Lao Security Exchange, 2011). In other words, the data of market index is insufficient for related study. Cambodia Stock Market had not started operating until the early of 2012. Albeit, Han Kyung Tae, managing director of Tong Yang Securities (Cambodia) conduct that it would be fully operated on July or August 2011 (Bunthea, 2011). Contrarily, Myanmar President Thein Sein alleged that the Myanmar is focusing on nurturing the democracy system, whilst economic development is a secondary priority for the country (Suhartono, 2012).

Singapore Dollar (SGD), Thailand is Thai Baht, Philippine is Philippines Peso (PHP), Vietnam is Vietnamese Dong (VND) and United States of America is US Dollar (USD).

3.1. Unbalanced Time Series Data

The extracted daily data from the selected markets display an unbalanced pattern, since they have different numbers of closing market days throughout period of study. These closing market days are affected by the allocation of national holidays, the start/end date of stock markets' year and the impact of financial crises. Consequently, there are missing values when the markets are to be synchronized to one another. To solve this issue, this research employs an assumption that the missing day value is the same as the last day of closing price index. Furthermore, the trading dates of S&P 500 index from January 2001 to December 2010 is the reference date for other market indices. This study combines two excel functions which are *'if errors* and *vlookup'* to execute previous assumptions in order to balance (synchronized) the time series data across the seven studied market indices.

3.2. Time Series Data Transformation

After obtaining the balanced time series data, the next data treatment to be expressed is the market price index into their natural logarithms form. In the form of the natural logarithms, the time series data can be more easily visualized and interpreted, over the usage of raw time series data (untransformed time series). Subsequently, the next treatment for the transformed natural logarithms is the calculation of the daily returns. The daily market returns is calculated as follows:

$$R_{it} = 100 \,.\ln\left(\frac{P_t}{P_{t-1}}\right) \qquad \ldots (1)$$

Where, R_{it} = return of the market i on date t

P_t = market price index at date t

3.3. Descriptive Statistics

Descriptive statistics are used to describe the basic features of the time series data. This paper presents comprehensively the quantitative description of the time series data as follows:

a. Trend graph of the stock market indices in the form of natural logarithms and market returns
b. Statistical properties of stock market returns such as mean, median, standard deviation, skewness, kurtosis and normality assessment using the Jarque-Bera test.
c. Type of distribution for the stock market returns

This research performs descriptive statistics with the usage of Eviews 7.2.

The trend graphs of the equity market indices in the form of lognormal and market returns are presented in *Figure 1* and *Figure 2*.

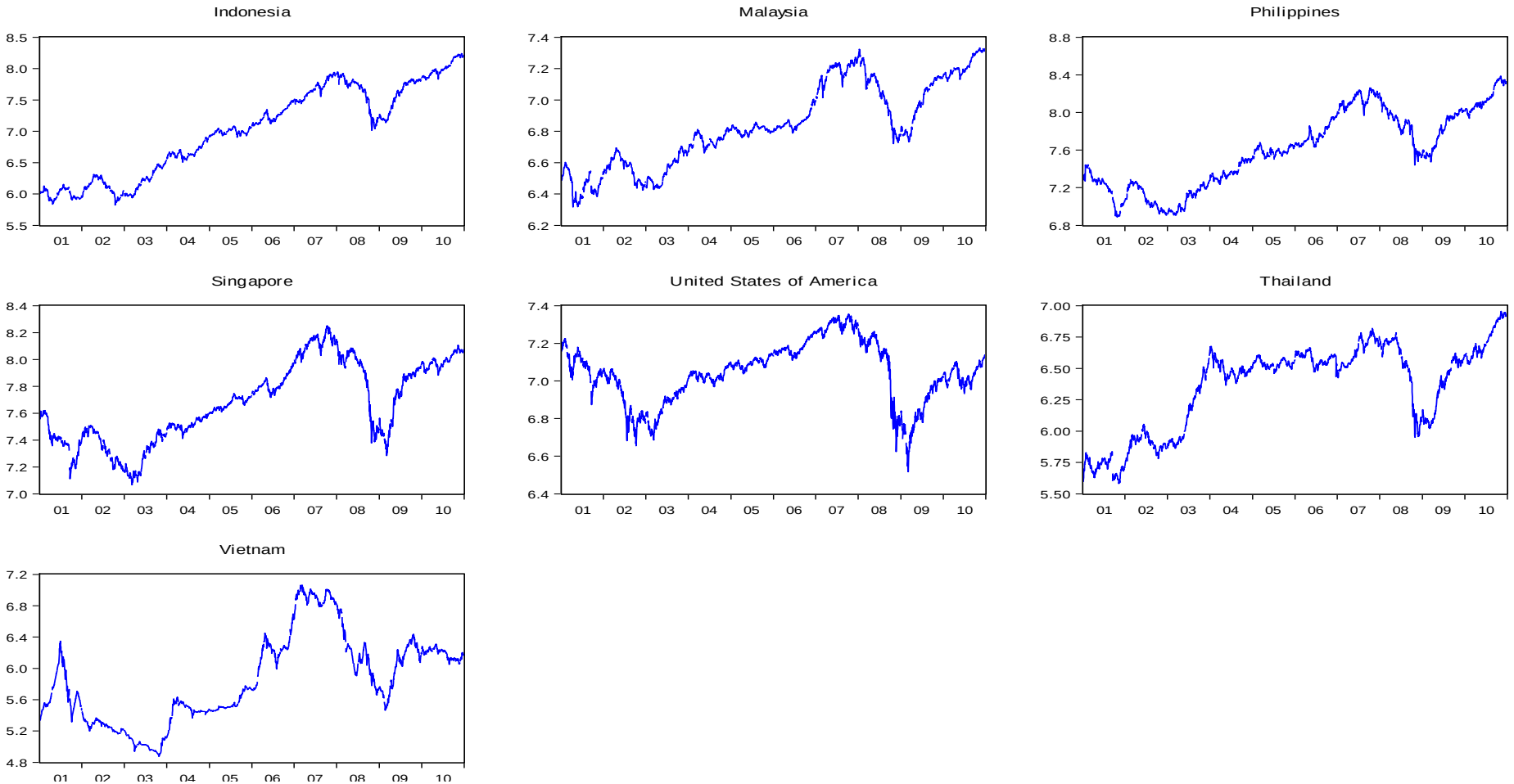

Figure 1. Stock Market Indices during 01/01/2001 – 31/12/2010 (Lognormal)

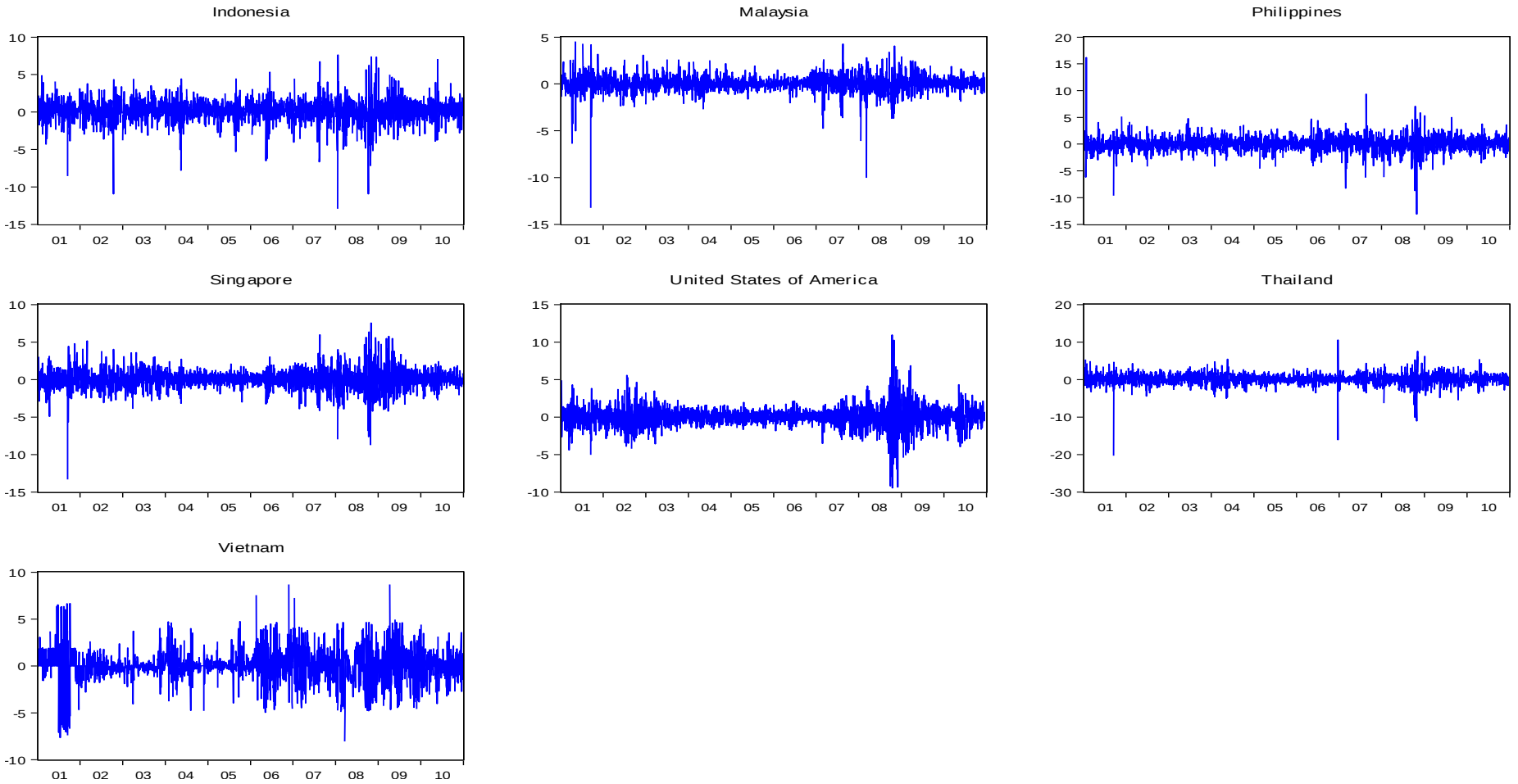

Figure 2. Return of Market Indices during 01/01/2001 – 31/12/2010

The statistical properties of the equity market returns are presented in *Table 2*.

Table 2. Statistical Properties

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Indonesia	0.08753	0.07574	1.51332	-0.83715	11.20222	7340.839*
Malaysia	0.03276	0.02234	0.90926	-2.06946	30.68789	82097.80*
Philippines	0.04236	0.00000	1.40576	0.00265	16.59407	19357.66*
Singapore	0.01965	0.02176	1.32616	-0.53917	11.19292	7153.04*
Thailand	0.05348	0.00000	1.48535	-1.71039	26.60473	59590.73*
Vietnam	0.03387	0.00000	1.75463	-0.14900	6.11186	1023.669*
USA	-0.00080	0.06385	1.37581	-0.12273	11.18770	7028.58*

One asterisk exhibit rejection of the null hypothesis at the 5% level of significance

Interpreting the results presented on *Table 2*, we can see that the statistical properties of each market indicate almost similar patterns. Regarding the measure of skewness[5], Indonesia, Malaysia, Singapore, Thailand, Vietnam and U.S. market indices exhibit a negative skewness whilst Philippines exhibit a positive skewness. Negative skewness implies that the left tail in the market distribution is longer (also known as *skewed to the left*). In this case which relates to the investment returns, the negative skewness also means that the investor is likely to have few extreme losses and frequent small gains. Meanwhile, positive skewness implies that the right tail in the market distribution is longer (also known as *skewed to the right*). Accordingly, in the investment returns perspective, the investor is likely to have a few extreme gains and frequent small losses.

In the aspect of kurtosis[6], the seven markets exhibit the kurtosis is larger than 3. This means that the distribution of these markets is leptokurtic. A leptokurtic distribution implies that the distribution has fatter tails entailing that there are lesser chances of extreme outcomes compared to a normal distribution. In support of the excess kurtosis pattern in the data, the

[5] Skewness is a measurement of asymmetry shape in a time series data distribution.
[6] Kurtosis is a measurement of the degree of peak in a time series data distribution.

Jarque-Bera test shows that the continuous probability distribution for all markets does not have the typical bell-shaped probability density function met in Normally distributed data..

To further analyze the shape of probability density function for each market, this research employs a kernel density estimator which is an adjusted histogram in which the 'boxes' of the histogram are replaced by 'bumps' that are smooth (Silverman, 1986). This definition of 'smoothing' is implemented by putting less weight on observations that lie further from the point being evaluated; in this case, the Epanechnikov weight function is being compared to the estimated theoretical normal (Gaussian) density function. *Figure 3* below shows the comparison between these two density functions on each market returns indices.

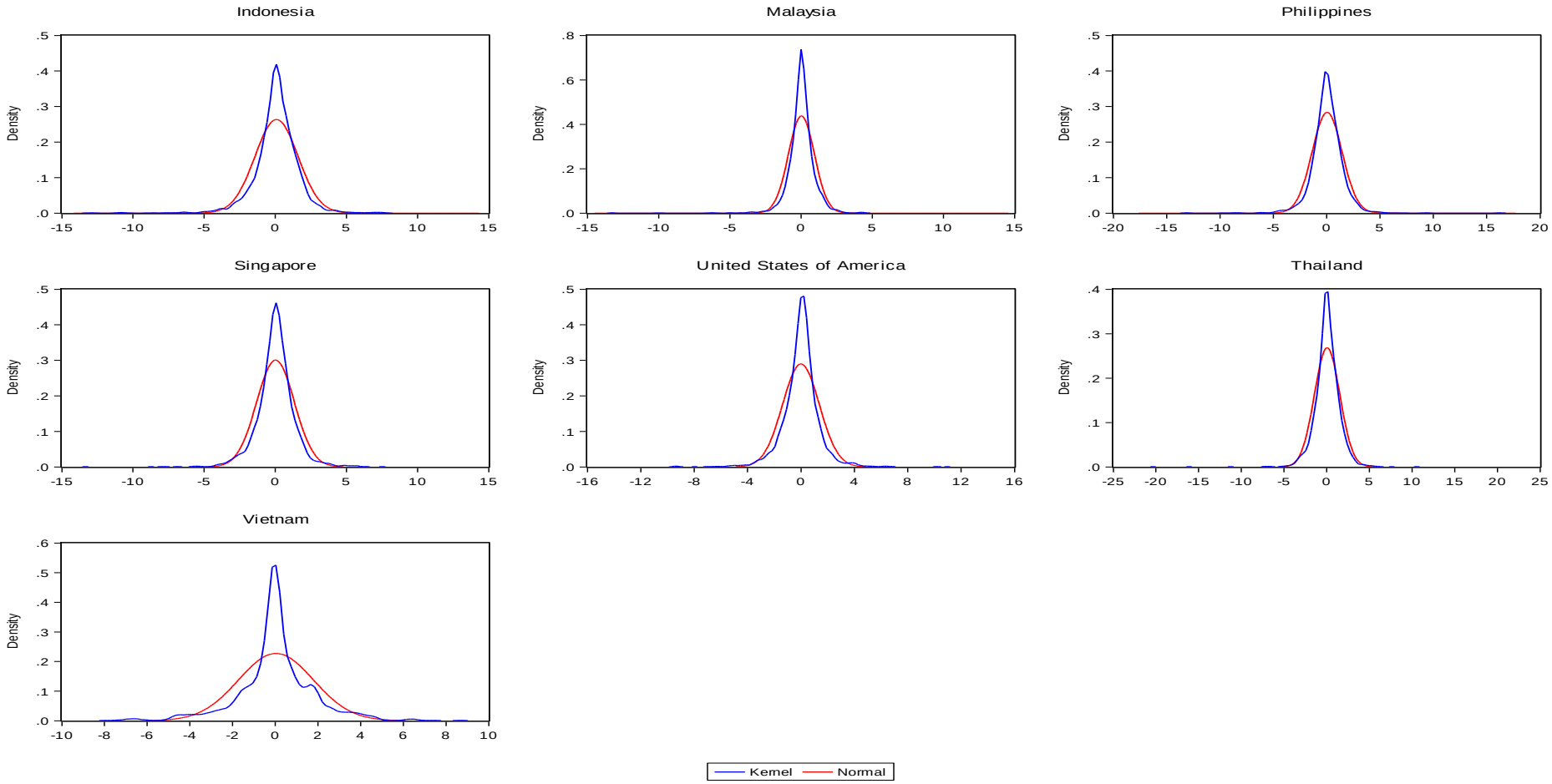

Figure 3. Density Functions of Seven Market Indices (blue line) and the normal density (red line)

Figure 3 above confirms the outcomes from the statistical properties of skewness, kurtosis, and non-normality distribution for each market return. *Figure 3* shows that the distribution for all market returns are leptokurtic meaning that each of them has a lesser chance to have extreme outcomes. Moreover, Philippines and Thailand market returns seem more volatile than the other markets since they have lower degree of peak than the other market indicated[7].

[7] To further analyze, the result on which markets have more probability in extreme upshots are due to difference. Based on the kurtosis statistical property, it is the Vietnam market whilst based on the Epanechnikov weight function it are the Philippines and Thailand markets. The reason for this difference is because of the weight being employed to the point being evaluated. To have a further understanding of the weight distributions see Silverman (1986).

Methodology

4.1. Stationarity Tests

The aim of the stationarity tests is to evaluate whether asset returns can be categorized into a random walk or a mean reverting process. A random walk process, also known as having a unit root, has the characteristic that any disturbance (innovation) to the market price is permanent and significant. This means that there is no propensity to return to equilibrium trend overtime. In contrast, a mean reverting process (also known as stationary process) implies that any shock to the market price will die away overtime and there is tendency for the market price to return to its trend path overtime. In other words, the stationary process is a process which has a series of mean and variance that will not vary over the period of study.

The stationary test can also be used to examine the weak form of market efficiency between ASEAN and U.S. markets. A market efficiency weak form implies that there is no investor who can earn extreme returns by developing investment strategies based on historical prices or other financial data. In respect to this research, for each studied markets indicates that they can be characterized as a weak-form efficient since they are all a non-stationary data in the level form (lognormal).

A non-stationary data series in the level form and a stationary data series in the first differenced form are foremost interest of this research to proceed to the next measurement of long-run and short-run interdependencies between the ASEAN and US markets. In other words, it can be said that the time series data are individually integrated of order 1, I (1). Subsequently, in order to determine stationary properties, this study conducts two different Stationary Tests: the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) tests[8]. The stationary tests are employed also by allowing for an intercept, or an intercept and

[8] See Brooks (2008) for the detail explanation of ADF and PP tests

deterministic trend, or neither, in the test regression. The result of the ADF and PP test can be found in the Appendix 3.

4.2. Measuring the Long-term Relationships

Given that the basic five assumptions of capturing the best estimates of correlation from a linear regression model have been fulfilled[9], the measurement of 'long-term' interdependencies analysis is now being examined. This study employs two approaches, bivariate Engle-Granger (1987) and Johansen-Juselius (1990) approach. This research executes both approaches, yet only the estimates correlation coefficient from the latter approach will be presented whilst the former approach is presented as a validation model to the Johansen-Juselius outcomes.

According to Granger and Newbold (1974), combining at least two non-stationary variables into a linear regression model will lead to an erroneous conclusion, which is also recognized as a spurious regression. However, if the disturbances of the linear regression model display a stationary result, then an inference from two variables in the regression model are said to be cointegrated (Engle & Granger, 1987). This paper is of interest to examine how many bivariate relationships are there across the ASEAN and US markets, whilst the correlation coefficient from this approach is to be neglected since it leads to spurious regression outcomes. The 'long-run' bivariate relationship equation is as follows:

$$y_{it} = \alpha_{1,i} + \beta X_t + \epsilon_{it} \qquad \dots (2)$$

Where, X = natural logarithm of US market

Y = natural logarithm of i^{th} country

ϵ_{it} = white noise process ~ I(0)

[9] See Appendix 1

The Johansen-Juselius (JJ) superiority model over the bivariate Engle-Granger model is stated as follows: (1) JJ model examines the presence of multiple cointegration relations not only limited on assumption of a single cointegrating vector, (2) assuming that all considered variables in the system are endogenous, JJ model has invariant choice of the dependent variable in the cointegration equation, (3) JJ model employs two test statistics in order to estimate the number of cointegrating vectors, (4) the estimation from JJ model would not be biased from small sample input (Agrios, 2006).

The Johansen-Juselius (1990) 'long-run' cointegration is based on the vector autoregressive model with order *p* as follow.

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + B x_t + \varepsilon_t \qquad \dots (3)$$

Where, y_t = *k* –vector of non-stationary I (1) endogenous variable

x_t = d – vector of deterministic variables

ε_t = vector of innovations

The outcome from above equation (unrestricted VAR) is the number of cointegration rank which may exist in the system. Therefore, to have a further analysis whether the number of cointegration rank can be reduced or not, the study employs a restriction on the VAR model by the form of vector error correction model (VECM). The VECM representation is as follows.

$$\Delta y_t = \Pi y_{t-1} + \sum_{t=1}^{p-1} \Gamma_i \Delta y_{t-i} + \cdots + B x_t + \varepsilon_t \qquad \dots (4)$$

Where,

$$\Pi = \sum_{i=1}^{p} A_i - I \qquad \dots (5), \qquad \Gamma_j = -\sum_{j=i+1}^{p} A_j \qquad \dots (6)$$

Granger's representation theorem express that if the coefficient matrix Π can be reduced so that the rank $r < k$, thus the $k \times r$ matrices exist in which then coefficient matrix of $\Pi = \alpha\beta'$ and $\beta' y_t$ is I (0); where the matrices of α and β are multiplied by rank *r*. *r* is the number of cointegrating relationship (the cointegrating rank) and each column of β is the cointegrating vector, whilst α represent the adjustment parameters in the VECM.

The JJ model employs two likelihood ratio test statistics in order to find the number of cointegrating vector by using the trace and the maximum eigenvalue statistics. The trace statistic tests the null hypothesis of *r* cointegrating relations towards the alternative of *k* cointegrating relations, where *k* represents the number of endogenous variables. The alternative *k* cointegration relations appertain to the case where none of the series has a unit root. In other words, the corresponded variable to run the JJ model is the market return variables, whilst to run the VECM is the data series in the lognormal form. The trace statistics for the null hypothesis of *r* cointegrating relations is computed as follows:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^{k} \log (1 - \lambda_i) \qquad \ldots . (7)$$

Where, λ_i = ith largest eigenvalue of the matrix Π

The maximum eigenvalue statistics for the null hypothesis of *r* cointegrating relations towards the alternative of *r+1* cointegrating relations is computed as follows:

$$LR_{max}(r|r+1) = -Tlog(1 - \lambda_{r+1}) \qquad \ldots (8a)$$

Or else can be written as:

$$LR_{max}(r|r+1) = LR_{tr}(r|k) - LR_{tr}(r+1|k) \qquad \ldots (8b)$$

In order to determine the number of cointegrating relations (r), the Johansen cointegration test proceeds sequentially from $r = 0$ to $r = k$-1 until it fails to reject. Moreover, the choice of the lag length is highly crucial, since the JJ model based on the unrestricted VAR (Ibrahim, 2006). This research engages Eviews 7.2 to run the JJ cointegration model and it provides the lag selection criteria function, therefore the number of lag length will be determined from this function. Furthermore, in respect to which type of trend specification that the corresponded data time series have, this research determines it by using Eviews 7.2 function of trend selection which derives based on the Johansen (1995) paper[10].

Finally, the analysis of JJ cointegration test is divided into two sections, the perspective of investor who interested to invest across the ASEAN equity markets only and among the ASEAN and U.S. Equity markets combined.

4.3. Measuring the Short-term Relationships

In order to measure the 'short term' relationship across ASEAN and US markets, this study employs two econometric methods suggested by Pesaran and Shin (1998) and Koop, Pesaran and Potter (1996), namely the Generalized Impulse Response Function (GIRF) and Generalized Forecast Error Variance Decomposition (GFEVD) respectively.

The GIRF model is employed in order to describe the time profile from a shock at one of the stock market index to another in a context of a dynamic system. Whilst, the GFEVD model is used to estimate the speed of market reaction to its equilibrium states if they were hit by financial shocks.

[10] Based on the Eviews function of trend selection, the level data series have no deterministic trends and the cointegrating equations do not have intercepts.

4.3.1 Generalized Impulse Response Function

The root problem from the traditional impulse response function is that the underlying shocks to the VAR model is orthogonalized using the Cholesky decomposition before they are computed to the impulse responses or the forecast error variance decomposition. Therefore, the ordering variable in the VAR becomes very sensitive and in order to address it by a recursive VAR form until it display the maximum likelihood value (Pesaran & Shin, 1998). In contrast, the GIRF overcomes this problem, thus being invariant to the ordering of variables in the VAR.

This research extends the generalized impulse response analysis model of Pesaran and Shin (1998) to the VECM case. The 'short-run' dynamics of stock market integration can be identified through the parameters of Γ_i and α in *equation (4)* and *(5)*. Suppose that the studied countries following the JJ cointegration test displaying cointegrating relationship, this means that there exists *k* x *r* matrix which then the coefficient matrix of $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary.

Denoting the non-linear generalized impulse response function from Koop *et al.* (1996) is defined as:

$$GI_x(n, \delta, \Omega_{t-1}) = E(x_{t+n}|\varepsilon_t = \delta, \Omega_{t-1}) - E(x_{t+n}|\Omega_{t-1}) \qquad \dots (9)$$

Where $GI_x(n, \delta, \Omega_{t-1})$ is the conditional expectation equal to the VAR model in *equation (4)*, Ω_{t-1} is a particular historical realization of the process at time *t*-1 and δ is a *m* x 1 vector of shocks hitting the system at time t.

The choleski decomposition that used in the orthogonalized impulse response function defines the *m* x 1 vector of a unit shock to the *j-th* equation on x_{t+n} as (Sims, 1980):

$$\psi_j^o = A_n P\, e_j\,, \qquad n = 0,1,2, \dots$$

Where $e_j$is *m* x 1 selection vector with its *j-th* element equal to unity and zeros elsewhere.

However, Pesaran and Shin (1998) suggested that instead of shocking all elements of ε_t on the VAR model (see equation (4)), shocking to only one element, say its *j-th* element, and integrate out the effects of other shocks by using the historically observed distribution of the errors. Thus, in this case, the generalized impulse equation can be re-written as:

$$GI_x(n, \delta_j, \Omega_{t-1}) = E(x_{t+n}|\varepsilon_{jt} = \delta_j, \Omega_{t-1}) - E(x_{t+n}|\Omega_{t-1}) \qquad \dots (10)$$

Where ε_t was assumed to have a multivariate normal distribution, therefore it can be shown that

$$E(\varepsilon_t|\varepsilon_{jt} = \delta_j) = \sigma_{1j}, \sigma_{2j}, \dots, \sigma_{mj})' \sigma_{jj}^{-1} \delta_j = \sum e_j \sigma_{jj}^{-1} \delta_j \qquad \dots (11)$$

Thus, the *m* x 1 vector of the generalized impulse response of a shock in the *j-th* equation on x_{t+n} (see *equation (10)*) at time t is shown as:

$$\left(\frac{A_n \sum e_j}{\sqrt{\sigma_{jj}}}\right)\left(\frac{\delta_j}{\sqrt{\delta_{jj}}}\right), \qquad n = 0,1,2, \dots \qquad \dots (12)$$

By setting $\delta_j = \sqrt{\sigma_{jj}}$, this means by measuring the shock to the *j-th* element by one standard deviation, thus the scaled generalized impulse response function is represented as:

$$\psi_j^g(n) = \sigma_{jj}^{-\frac{1}{2}} A_n \sum e_j \,, \qquad n = 0,1,2, \dots \qquad \dots (13)$$

Equation (13) implies the effect measurement of one standard error shock to the *j-th* equation at time *t* on expected value of x at time *t + n*.

The GIRF model in this paper provides insight analysis of the international portfolio diversification possibility across ASEAN countries alone and ASEAN and U.S. markets combined, in the perspective of 'short-run' horizon. The model also can be considered as

measures of how fast the innovation or information transmits from one market to the others and provides the movement direction (positive of negative) between the studied countries in the 'short-run' period. The GIRF model is employed by using Microfit 4.0.

4.3.2 Generalized Forecast Error Variance Decomposition

Similarly to the GIRF, the GFEVD model in this paper provides measure of how fast the innovation or information transmits from one market to the others. Additionally, the GFEVD supplies the information in respect to the variation in one market can be explained by innovation from other market. The GFEVD result is very important to this study because in order to determine which country has the potential benefit from a diversified portfolio, this country should display a weak correlation (isolation) compared to other countries. In addition, since this study examines two block of countries which are ASEAN only and ASEAN and U.S. combined, the GFEVD analysis could provides different perspective on which country is more isolated than the others.

Consider equation (4) of the VECM model can be re-written as an infinite moving average process as follows:

$$\Delta y_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i} \quad , \qquad t = 1,3, \dots, T \qquad \dots (14)$$

Where, A_i = coefficient matrices

The forecast error of predicting Δy_t conditional given at time *t*-1is represented as (Pesaran & Shin, 1998):

$$\xi_{t,n} = \sum_{l=0}^{n} A_l \varepsilon_{t+n-l} \qquad \dots (15)$$

The total forecast error variance-covariance matrix is given by:

$$Cov(\xi_{t,n}) = \sum_{l=0}^{n} A_l \sum A_l' \qquad \ldots(16)$$

According to Pesaran and Shin (1998), the GFEVD considers the *n*-step forecast errors of y_t (see equation (4)) by using non-orthogonalized shocks of ε_{it}, $\varepsilon_{i,t+1}$, …, $\varepsilon_{i,t+n}$ to the proportion of its variance, but explicitly allowing for the contemporaneous correlations between these shocks and the shocks to the other markets in the system. Now assumes that $\varepsilon_{it} \sim N(0, \sum)$, thus conditioning on the information means that:

$$E\left(\varepsilon_{t+n-l} \middle| \varepsilon_{i,t+n-l}\right) = \left(\sigma_{ii}^{-1} \sum e_i\right) \varepsilon_{i,t+n-l} \qquad \text{for } l = 0,1,2,\ldots,n; i = 1,2,\ldots,p \qquad \ldots(17)$$

Subsequently, recall the equation (15) which is the forecast error vector of predicting Δy_t conditional on the information *t*-1becomes:

$$\xi_{t,n}^{(i)} = \sum_{l=0}^{n} A_l(\varepsilon_{t+n-l} - \sigma_{ii}^{-1} \sum e_i \varepsilon_{i,t+n-l}) \qquad \ldots(18)$$

Then, the unconditional expectations yields to:

$$Cov\left(\xi_{t,n}^{(i)}\right) = \sum_{l=0}^{n} A_l \sum A_l' - \sigma_{ii}^{-1} \left[\sum_{l=0}^{n} (A_l \sum e_i e_i' \sum A_l')\right] \qquad \ldots(19)$$

Now by subtracting equation (19) to (16) provides a decline in the *n*-step forecast error variance of z_t which obtained as a result of conditioning on the future shocks to the *i-th* equation is represented as:

$$\Delta_{in} = Cov\left(\xi_{t,n}^{(i)}\right) - Cov(\xi_{t,n}) = \sigma_{ii}^{-1} \left[\sum_{l=0}^{n} (A_l \sum e_i e_i' \sum A_l')\right] \qquad \ldots(20)$$

Finally, by scaling the *j-th* diagonal element of Δ_{in} by the n-step ahead forecast error variance of the *i-th* variable in Δy_t, thus the equation of generalized forecast error variance decomposition is given by:

$$\theta_{ij}^{g}(n) = \frac{\sigma_{ii}^{-1} \sum_{l=0}^{n} (e_i' A_l \sum e_j)^2}{\sum_{l=0}^{n} e_i' A_l \sum A_l' e_i} \quad , \qquad i, j = 1, \dots, p \qquad \dots (21)$$

Where $\theta_{ij}^{g}(n)$ the GFEVD of the n-step ahead is forecast error variance of the *i-th* country which is being hit by innovations in *j-th* country in the VAR system, σ_{ii} is the *i-th* diagonal element of the covariance matrix $\sum$ and A_l is the coefficient matrices in the moving average representation. The GFEVD model is employed by using Microfit 4.0.

4.4. Measuring the Dynamic Conditional Correlation

This study employs the Dynamic Conditional Correlation multivariate GARCH (DCC-GARCH) model in order to avoid biased results from the conventional correlation analysis which gives equal weight to all past observations; see for instance, the Pearson Correlation Coefficient model and the Moving Windows model. The DCC-GARCH model continuously provides correlation adjustment for the time-varying volatility, unlike the volatility-adjusted cross-market correlation employed in Forbes and Rigobon (2002). In other words, the estimated conditional correlation depends on the past realizations of both their correlation and volatility. Therefore, by means of employing the DCC-GARCH model, it is expected to give more weight to the observations in the recent past and less (but nonzero) to long past.

Estimation of the dynamic conditional correlation follows three steps. The first step is determining the demeaning process in which the ARMA model[11] study is employed in order to obtain the residual returns. In the second step, the residual returns are installed into a standard GARCH model, represented as follows:

[11] See Appendix 1

$$\varepsilon_t = D_t v_t \sim N(0, H_t) \quad \ldots(22)$$

Where, ε_t = *k*x1 matrix vector of residual returns

k = the number of the studied countries

v_t= *k*x1 matrix vector of standardized residual returns

H_t = *k*x*k* matrix of time varying variances

$$H_t = D_t R_t D_t \quad \ldots(23)$$

Where, R_t = *k*x*k* matrix of time varying correlations

D_t = *k*x*k* diagonal matrix of time-varying standard deviations of residual returns

The matrix of D_t is obtained by running GARCH (1,1) processes (see *equation 8* in Appendix 1). Subsequently, the log-likelihood function for the DCC model is as follows:

$$l = -0.5 \sum_{t=1}^{T} (n \log(2\pi) + \log(|H_t|) + \varepsilon_t' H_t \varepsilon_t)$$

$$= -0.5 \sum_{t=1}^{T} n \log(2\pi) + \log(|D_t R_t D_t|) + v_t' D_t^{-1} R_t^{-1} D_t^{-1} v_t$$

Since,

$$\varepsilon_t' D_t^{-2} \varepsilon_t = \varepsilon_t' D_t^{-1} D_t^{-1} \varepsilon_t = (D_t^{-1} \varepsilon_t)' D_t^{-1} \varepsilon_t = v_t' v_t$$

$$l = -0.5 \sum_{t=1}^{T} (n \log(2\pi) + 2 \log(|D_t|) + \varepsilon_t' D_t^{-2} \varepsilon_t) - 0.5 \sum_{t=1}^{T} (\log(|R_t|) + \varepsilon_t' R_t^{-1} \varepsilon_t - v_t' v_t)$$

$$= l_1 + l_2 \quad \ldots(24)$$

Where,

$$l_1 = -0.5 \sum_{t=1}^{T} (n \log(2\pi) + 2 \log(|D_t|) + \varepsilon_t' D_t^{-2} \varepsilon_t) \quad \ldots (25)$$

$$l_2 = -0.5 \sum_{t=1}^{T} (\log(|R_t|) + \varepsilon_t' R_t^{-1} \varepsilon_t - v_t' v_t) \quad \ldots (26)$$

The equations of l_1 and l_2 represent the volatility (variances) and the correlation part respectively. In which, the parameters for time varying volatility are obtained by maximizing the log-likelihood function l_1.

Finally, the last step involves the correlation coefficients to be estimated. The correlation coefficient equation is as follows:

$$\rho_{ijt} = \frac{E_{t-1}[\varepsilon_{it}\varepsilon_{jt}]}{\sqrt{E_{t-1}[\epsilon_{it}^2]}\sqrt{E_{t-1}[\epsilon_{jt}^2]}} = \frac{E_{t-1}[\sqrt{h_{it}}v_{it}\sqrt{h_{jt}}v_{jt}]}{\sqrt{E_{t-1}[h_{it}v_{it}^2]}\sqrt{E_{t-1}[h_{jt}v_{jt}^2]}} = -\frac{E_{t-1}[v_{it}v_{jt}]}{\sqrt{E_{t-1}[v_{it}^2]}\sqrt{E_{t-1}[v_{jt}^2]}} = E_{t-1}[v_{it}v_{jt}]$$

Where:

$$E_{t-1}[v_{it}^2] = E_{t-1}[h_{it}^{-1}\varepsilon_{it}^2] = h_{it}^{-1}E_{t-1}[\varepsilon_{it}^2] = 1$$

The correlation of ρ_{ijt} justify the correlation matrix R_t of which diagonal elements are unity.

Let, $Q_1 = E_{t-1}[v_t v_t']$

Therefore matrix R_t is presented as:

$$R_t = \{diag(Q_1)\}^{-\frac{1}{2}} Q_1 \{diag(Q_1)\}^{-\frac{1}{2}} \quad \ldots (27)$$

It is assumed that Q_1 follows an autoregressive process and $\bar{Q}$ is an unconditional correlation coefficient matrix (Engle, 2002). Thus, Q_1 can also be written as:

$$Q_1 = \bar{Q}(1 - \alpha - \beta) + \alpha v_{t-1} v_{t-1}' + \beta Q_{t-1} \quad \ldots (28)$$

The unconditional correlation that had been determined from the second step becomes the predetermined values in this third step[12]. The parameters from time-varying correlations are obtained by maximizing the log-likelihood function l_2. However, because the $v_t' v_t$ does not involve determining the parameters on equation (28), the log-likelihood function of l_2 can be re-written as:

$$l_2 = -0.5 \sum_{t=1}^{T} (\log(|R_t|) + \varepsilon_t' R_t^{-1} \varepsilon_t) \qquad \dots (29)$$

This paper implements the correlation model in equation (28) between the contagion source and the targeted country to allow the parameters α and β become divergent for each considered pair. The methodology of DCC-GARCH engaged in this paper is different from the Argyropoulos (2006) and Agrios (2006) papers which used constant parameters from RiskMetrics ($\lambda = 0.94$) for all country pairs. The author employed the DCC-GARCH model by using R Statistical software and the author designs the coding programme for DCC-GARCH in it[13].

[12] See Engle and Sheppard (2001, p.5)
[13] The full coding programme of DCC-GARCH on R statistical software is available upon request

Empirical Results

5.1. The Application of Domestic Currency Denominated

The market price indices across the ASEAN and U.S. countries are denominated in their own domestic currency. Using similar assumptions as this paper, the study from Yoshida (2011) conducted research using local domestic currencies instead of converting them into one single currency such as U.S. Dollar. For instances, the study from Ibrahim (2008), Click and Plummer (2005) and Daly (2003) use one single currency denominated in U.S. Dollar for their studied countries.

Explanations for this research to employ market indices price in domestic currency denominated are given as follows:

1. The currency rate in selected ASEAN countries are far too small compared to the U.S. dollar currency rate.

   For example: The price of one lot of Indonesian market index dated at 31/12/2010 was 0.4 USD[14] and U.S. S&P 500 market index dated at the same date was 1.3 USD.
2. One of the research's aims is to examine the correlation between the ASEAN and U.S. markets. In essence, this paper tries to capture the market price movement between them. In other words, the local currency denominated is considered to explain more about their price movement thus these financial phenomenons can be captured by employed econometric models.
3. From a technical point of view, if this study uses currency in US denomination, the first data transformation which is the natural logarithm, would display negative values for the whole sample during the period of study. In this case, the trend graph would therefore look peculiar since the market price indices are negatives values.

[14] Based on the data collected from the Bloomberg Database

The above reasons justifies why this research employs the local currency denomination across the markets instead of using one single currency.

5.2. Long-run Cointegration Tests Results

In order to examine potential benefits of international portfolio diversification across the studied markets in the 'long-run' horizon, long-run cointegration tests are analyzed by comparing the results from the Johansen multivariate cointegration and the Engle-Granger bivariate cointegration tests. As discussed in section 1.2, the ASEAN Finance Ministers meeting (AFMM) in Manila are determined to have a greater financial integration in ASEAN, thus it is expected that the ASEAN markets are to be co-integrated. Therefore, the outcomes from the 'long-run' cointegration tests are able to explain whether in the period of 2001 to 2010 of the ASEAN markets have been integrated or not.

As discussed earlier, the Johansen test is divided into two sections, the perspective of investors who are interested to invest across the ASEAN stock markets alone and the ASEAN and U.S. stock markets combined. *Table 3* and *4* are presented to display the outcomes of the Johansen test. Two types of statistics are reported as well, the trace and maximum eigenvalue statistics. The critical values of Osterwald-Lenum (1992) are employed for the test statistics. The maximum number of cointegration (interdependence) relations for the six considered ASEAN markets is five, whereas for the seven markets from ASEAN and U.S. combined is six. The null hypothesis is that there is no cointegrating vector (rank/ relation) which is presented as $r = 0$. If this null is not rejected, then there is no cointegration relation and the hypothesis testing would be completed. However, if the first null of $r = 0$ is rejected, then the null of one cointegrating rank (H_0: $r = 1$) would be tested and so on. Therefore, the number of

interdependences between the considered markets is continually increased until the null is no longer rejected.

Table 3. Johansen Cointegration Test on ASEAN markets

		Test Statistics		Critical Values			
		Trace Statistics	Max-Eigen Statistics	Trace		Max-Eigen	
H_0	H_1			5%	1%	5%	1%
r = 0	r > 0	2496.972**	591.3767**	82.49	90.45	36.36	41.00
r ≤ 1	r > 1	1905.595**	552.2536**	59.46	66.52	30.04	35.17
r ≤ 2	r > 2	1353.341**	542.2228**	39.89	45.58	23.80	28.82
r ≤ 3	r > 3	811.1185**	485.7381**	24.31	29.75	17.89	22.99
r ≤ 4	r > 4	325.3804**	321.7030**	12.53	16.31	11.44	15.69
r ≤ 5	r > 5	3.677401	3.677401	3.84	6.51	3.84	6.51

***** and * denote significance at 5% and 1% level respectively. The optimal lag length in the VAR model is chosen by AIC and SBIC.

Table 4. Johansen Cointegration Test on ASEAN and U.S. markets

		Test Statistics		Critical Values			
		Trace Statistics	Max-Eigen Statistics	Trace		Max-Eigen	
H_0	H_1			5%	1%	5%	1%
r = 0	r > 0	3025.069**	620.1357**	109.99	119.80	41.51	47.15
r ≤ 1	r > 1	2404.933**	580.7994**	82.49	90.45	36.36	41.00
r ≤ 2	r > 2	1824.134**	550.2663**	59.46	66.52	30.04	35.17
r ≤ 3	r > 3	1273.868**	511.1481**	39.89	45.58	23.80	28.82
r ≤ 4	r > 4	762.7196**	455.3567**	24.31	29.75	17.89	22.99
r ≤ 5	r > 5	307.3629**	304.2944**	12.53	16.31	11.44	15.69
r ≤ 6	r > 6	3.068522	3.068522	3.84	6.51	3.84	6.51

***** and * denote significance at 5% and 1% level respectively. The optimal lag length in the VAR model is chosen by AIC and SBIC.

The Johansen multivariate cointegration results for investors who are interested in investing across ASEAN markets are presented in *Table 3*. The trace and maximum eigen-value statistics indicate the existence of five cointegrating relations at the 1% level of significance. In particular, if the trace statistics or the maximum eigen-values statistics are greater than the Osterwald-Lenum critical values, then the contemplated null hypothesis would be rejected.

This process is to be repeated until the null of $r \leq 5$ is not rejected, indicating that there is an existence of five cointegrating vectors across the ASEAN markets. Therefore, from an investment perspective, this means there are no potential benefits of international portfolio diversification across the ASEAN markets for those investors with long-run investment horizons.

Table 4 which combined U.S. market with ASEAN markets also indicates that there are no potential benefits of international portfolio diversification. This is due to the fact that the trace and maximum eigen-values test statistics cannot be rejected on the null of $r \leq 6$, which means that there are six cointegrating relations in the system.

This study is of interest to gain further insight on the cointegrating relations between ASEAN and U.S. markets; therefore *Table 5* presented displays the outcomes of Engle-Granger bivariate cointegration tests.

Table 5. Bivariate Engle-Granger Approach

Bivariate Relationship	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	U.S.
Indonesia	*N/A*	*Coint.*	*Coint.*	*Coint.*	*Coint.*	*Coint.*	*Coint.*
Malaysia	*Coint.*	*N/A*	*Coint.*	*Coint.*	*Coint.*	*Coint.*	*Coint.*
Philippines	*Coint.*	*Coint.*	*N/A*	*Coint.*	*Coint.*	*Coint.*	*Coint.*
Singapore	*Coint.*	*Coint.*	*Coint.*	*N/A*	*Coint.*	*Coint.*	*Coint.*
Thailand	*Coint.*	*Coint.*	*Coint.*	*Coint.*	*N/A*	*Coint.*	*Coint.*
Vietnam	*Coint.*	*Coint.*	*Coint.*	*Coint.*	*Coint.*	*N/A*	*Coint.*

Coint. = Cointegrated,

Table 5 displays interesting results since for each pair of countries in the relationship moves along together for the period of 2001 to 2010. The vertical side of *table 5*, which exhibits the name of country, omits the U.S market from the relationship. The reason behind this is since the ASEAN markets are considered not to have any influence in the U.S. stock market movement whilst not the other way around. The bivariate Engle-Granger results therefore confirm the results from the Johansen-Juselius model such that there are no potential benefits

of international portfolio diversification across the ASEAN market and ASEAN and U.S. markets combined for those investors with long-run investment horizons.

The findings from this paper are in favour by the studies from Ibrahim (2000), Cheng *et al*. (2003), Click and Plummer (2005) albeit their period of study is ranging from 1992 to 2002. However, according to Ibrahim (2008) with the studied period from 1988 to 2003, there is no evidence suggesting long-run co-movements across the ASEAN markets. Nevertheless, the outcomes from this paper can be argued that although the Southeast Asia markets and Southeast Asia and U.S. markets combined are moving together in the long-term horizons, the benefits of diversifying portfolio will vanish. Further investigation is needed because although they were moving together it does not mean that all stock markets are expected to react identically to these trends. Therefore, the short-term of market co-movements is addressed below.

5.3. Generalized Impulse Response Function Results

The Generalized Impulse Response Function analysis is conducted by imposing a one standard deviation shock to the innovation of a specific variable of interest. Subsequently, this unexpected shock in the innovation will not only affect the variable itself but also it will be transmitted to other endogenous variables in the system. Furthermore, the impulse response function also informs the importance of each market in handling unexpected shocks, the magnitude by which it would affect the other markets and also how well the targeted market responds to the shock from the struck market.

This paper analyzes the short-term interdependence across the ASEAN and U.S. markets combined and ASEAN markets. This brings an implication for those investors who are interested to invest across the ASEAN and U.S markets, whilst the other part is to entertain

those who are interested to invest across the ASEAN markets only. In other words, on the first analysis section, this research includes U.S. market into the GIRF model, whilst excluding it on the second analysis section.

GIRF's analysis results are presented in *Table 6* and *Table 7*. In order to save space, the tables present 6 days responses which started from period 0 to period 5[15]. Each entry displays impulse responses of targeted markets due to shocks in the struck market listed on top of the periods.

Table 6. GIRF results for ASEAN and U.S. markets combined

Period	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	U.S.
				U.S.			
0	0.01174	-0.00907	-0.03490	0.02534	0.01734	0.00257	0.42066
1	0.01388	0.00903	0.02634	0.02460	0.01429	0.02849	-0.00362
2	0.02225	0.01956	0.03866	0.01855	0.01329	0.01219	0.02454
3	0.01718	-0.00291	0.00938	0.02742	0.01580	-0.00509	0.03637
4	0.03811	0.01605	0.01119	0.02245	0.02326	-0.01554	0.02061
5	0.01276	0.00223	0.01560	0.02209	0.02033	0.03892	0.03907
				Indonesia			
0	0.39398	0.04667	0.02479	0.04067	0.03746	0.01620	0.01253
1	0.03851	0.01360	0.04280	0.01297	0.01344	0.01638	0.00366
2	0.02432	0.01468	0.01307	0.01219	0.02095	0.02002	0.00059
3	-0.00100	0.00413	0.01435	0.01496	0.01638	0.01818	0.00861
4	0.03505	0.01508	0.03080	0.02444	0.02367	0.01004	0.01770
5	0.02909	0.02771	0.02207	0.01800	0.02862	0.03049	0.01224
				Malaysia			
0	0.05323	0.34539	0.03789	0.02953	0.02980	0.02201	-0.01105
1	0.02271	0.02315	0.03032	0.00185	0.00368	0.01534	-0.00615
2	0.01428	0.00587	-0.00345	-0.00060	0.00453	-0.00525	-0.01633
3	0.00353	0.01173	0.00346	0.01138	0.00644	0.02761	0.00151
4	0.01040	0.00405	0.01936	0.00519	0.00634	0.01272	-0.00895
5	-0.00056	0.01424	0.01115	0.00698	0.00946	0.01069	0.00109
				Philippines			
0	0.02170	0.02908	0.45006	0.02452	0.01953	-0.00624	-0.03262
1	0.00678	0.00938	0.03996	0.00928	0.00924	0.00919	-0.00967
2	0.00776	0.00403	0.00971	-0.00083	0.00185	0.00006	-0.01016
3	0.00951	0.00677	0.00162	0.00996	0.01368	-0.00503	0.00433
4	0.00369	-0.00270	-0.00414	-0.00037	0.00712	0.00992	-0.00895

[15] The full results of one month or more days of horizon are available upon request.

5	-0.00231	0.01197	0.00669	0.00353	0.00183	0.01615	-0.00357
	Singapore						
0	0.06372	0.04057	0.04389	0.25145	0.05534	0.02643	0.04240
1	0.04895	0.03565	0.05673	0.02675	0.01438	0.02596	0.00922
2	0.03129	0.02412	0.02153	0.03629	0.02409	0.01146	0.01122
3	0.03346	0.02853	0.02957	0.02773	0.02113	0.02160	0.03012
4	0.03747	0.02011	0.03241	0.02932	0.03408	0.01504	0.02501
5	0.02905	0.02706	0.02366	0.03389	0.03353	0.03124	0.03373
	Thailand						
0	0.06096	0.04252	0.03631	0.05748	0.24209	0.01887	0.03013
1	0.05152	0.03777	0.05456	0.02178	0.03259	0.02431	0.01685
2	0.03410	0.02352	0.02787	0.03354	0.03774	0.03621	-0.00095
3	0.03596	0.03408	0.03675	0.03111	0.04018	0.00675	0.02896
4	0.04520	0.01798	0.03680	0.03799	0.04684	0.04465	0.02285
5	0.03857	0.02435	0.04354	0.03334	0.04385	0.01568	0.02215
	Vietnam						
0	0.00994	0.01184	-0.00438	0.01036	0.00712	0.64174	0.00168
1	-0.00642	0.00543	0.01772	-0.00392	0.00382	0.08395	-0.00360
2	-0.00095	0.00155	0.01052	-0.00502	0.00614	0.08372	-0.00558
3	0.00686	0.01156	0.00845	0.01520	0.00973	0.03869	-0.00581
4	0.00678	0.00649	-0.00131	0.00117	0.01658	0.07329	-0.00434
5	-0.00176	0.00459	0.00642	0.00429	0.01411	0.08251	0.00902

Based on *Table 6*, there is an indication that the innovation which occurred in the U.S market was not transmitted to the ASEAN markets. This means that there are potential benefits for investors who are interested to invest across these markets. In particular, at the same date when the shock hit the U.S market (period 0); Philippines became the least affected market from the shock compared to other ASEAN markets for -0.0349, followed by Malaysia for -0.009. At day 3, Vietnam and Malaysia emerged to offer the potential benefit of international portfolio diversification counted at -0.005 and -0.003 respectively. Finally, at the 12 period, U.S. market returned into its' equilibrium level with an insignificant and persistent change of 0.018 from its equilibrium level.

On the other hand, *Table 6* also confirms the previous assumption being used in the bivariate Engle-Granger cointegration test in a statement of 'for each markets being shocked in

ASEAN; they would not affect the U.S. stock price movement'. Moreover, when the Indonesia market was being shocked at zero periods, Malaysia and Singapore markets respond most with 0.046 and 0.0406 respectively. This informs an indication that when there are unexpected changes in Indonesia market; Malaysia and Singapore are the countries which respond the most from those impacts. With respect to Malaysia market innovations at zero periods, Indonesia market acts in response for changes of 0.053 which is followed by Philippines for 0.037. Moreover, in connection with Singapore market innovations at zero periods, Indonesia and Thailand respond the most in which their changes counted as 0.0637 and 0.0567 respectively. The interesting finding is related to Thailand market innovations, where Indonesia becomes the most sensitive market to changes in Thailand compared to other ASEAN markets. Lastly, the unexpected shocks which happened to Philippines and Vietnam markets indicates that those innovations do not transmit to other markets. In other words, Philippines and Vietnam market display isolated situations which imply that both markets are the inferior markets in the terms of their influence to the other markets.

This study entertains the next question as to whether the potential benefits of international portfolio diversification exist when the U.S market is excluded from the system. This means that the investors diversify their investment portfolio across ASEAN markets only. *Table 7* presents the results for this particular consideration.

Table 7. GIRF results for ASEAN markets

Period	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
			Indonesia			
0	0.40504	0.04841	0.02712	0.04139	0.03746	0.01805
1	0.04047	0.01291	0.04363	0.01316	0.01307	0.01720
2	0.02297	0.01413	0.01204	0.01330	0.02110	0.01895
3	-0.00029	0.00416	0.01477	0.01524	0.01617	0.01924
4	0.03931	0.01529	0.03231	0.02616	0.02370	0.01191
5	0.03338	0.02883	0.02341	0.01964	0.02907	0.03072
			Malaysia			
0	0.05671	0.34573	0.03951	0.02973	0.03009	0.02236
1	0.02428	0.02277	0.03120	0.00187	0.00332	0.01628
2	0.01425	0.00597	-0.00366	-0.00019	0.00457	-0.00744
3	0.00669	0.01154	0.00359	0.01134	0.00637	0.02812
4	0.01172	0.00405	0.01984	0.00605	0.00630	0.01330
5	0.00130	0.01447	0.01171	0.00787	0.00959	0.01126
			Philippines			
0	0.02436	0.03029	0.45101	0.02614	0.02050	-0.00400
1	0.00843	0.00952	0.04168	0.01052	0.00952	0.00900
2	0.01010	0.00395	0.00956	0.00075	0.00268	-0.00205
3	0.01391	0.00730	0.00252	0.01139	0.01470	-0.00410
4	0.00735	-0.00228	-0.00265	0.00202	0.00811	0.01265
5	0.00142	0.01310	0.00836	0.00612	0.00322	0.01766
			Singapore			
0	0.06595	0.04043	0.04638	0.25422	0.05801	0.02805
1	0.05228	0.03687	0.06010	0.03070	0.01699	0.02562
2	0.03548	0.02386	0.02339	0.04190	0.02731	0.01337
3	0.04005	0.03078	0.03243	0.03354	0.02480	0.02288
4	0.03922	0.02131	0.03618	0.03480	0.03768	0.02005
5	0.03166	0.02939	0.02782	0.04131	0.03814	0.03400
			Thailand			
0	0.06242	0.04280	0.03804	0.06067	0.24307	0.01962
1	0.05621	0.03861	0.05714	0.02504	0.03456	0.02574
2	0.03835	0.02418	0.03002	0.03800	0.04031	0.03768
3	0.04380	0.03600	0.03964	0.03576	0.04307	0.00889
4	0.04830	0.01937	0.04037	0.04316	0.05030	0.04793
5	0.04923	0.02724	0.04810	0.04036	0.04840	0.01961
			Vietnam			
0	0.01137	0.01203	-0.00281	0.01109	0.00742	0.64297
1	-0.00774	0.00601	0.01893	-0.00318	0.00363	0.08313
2	-0.00091	0.00118	0.01040	-0.00483	0.00625	0.08216
3	0.00910	0.01187	0.00869	0.01567	0.01008	0.03777
4	0.01033	0.00660	-0.00053	0.00222	0.01704	0.07471
5	-0.00135	0.00484	0.00685	0.00506	0.01412	0.08238

Table 7 shows an interesting result in respect of the market's influence characteristics among the ASEAN markets. Malaysia market emerges as the fastest market recovery from the shocks by the end of day 2. Meanwhile, Thailand becomes the most influential market; since at period zero, innovations in Thailand would affect Indonesia, Singapore, Malaysia and Philippines markets accordingly (0.0624, 0.0606, 0.043 and 0.038 respectively). Singapore comes into second as the most influential market as it is responsible for market changes in Indonesia, Thailand, Philippines and Malaysia for 0.0659, 0.058, 0.0464 and 0.404 accordingly. The same results occur in which suggest that Vietnam and Philippines are isolated compared to the other ASEAN markets. Whilst, Indonesia market tends to transmit its innovation to Malaysia, Singapore and Thailand at period zero for 0.0484, 0.0414 and 0.0374 respectively. Indonesia market also indicates to return to its equilibrium state by the end of day 8 in which the shock still remains insignificant and in persistence for 0.025.

5.4. Generalized Forecast Error Variance Decomposition Results

The GFEVD is analyzed in order to have a deeper understanding and confirmation related to the potential benefit of international portfolio diversification in the short-term horizon. Moreover, GFEVD provides the answers to the degree of linkage amongst the ASEAN market in the short-term perspective by means of examining the degree of responsiveness from one market to the other. Therefore, if the variance decomposition in one market is mainly explained by its own innovation, then that market is considered to be unresponsive and becomes a potential candidate to offer the fruitful practices of international portfolio diversification. On the other hand, if the variance decomposition of an equity market is generally explained by innovations from other markets, then those markets are considered to be co-integrated.

Table 8 and *9* exhibit the results of GFEVD for ASEAN and U.S markets combined and ASEAN markets. In order to save space, the tables present the variance decomposition in a sequence of array for 1, 5, 10, 15 and 20 days[16]. Each entry displays the variance decomposition of a particular market due to innovations from a market listed on top of the periods.

Table 8. GFEVD results for ASEAN and U.S.

Period	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	U.S.
				U.S.			
1	0.001	0.001	0.007	0.011	0.007	0.000	0.997
5	0.004	0.003	0.007	0.025	0.016	0.001	0.975
10	0.013	0.004	0.008	0.043	0.048	0.001	0.934
15	0.021	0.005	0.008	0.058	0.074	0.002	0.900
20	0.029	0.006	0.008	0.072	0.098	0.003	0.868
				Indonesia			
1	0.978	0.021	0.003	0.040	0.040	0.001	0.002
5	0.926	0.021	0.004	0.063	0.072	0.001	0.016
10	0.866	0.021	0.004	0.085	0.119	0.004	0.027
15	0.820	0.022	0.005	0.104	0.153	0.005	0.037
20	0.779	0.022	0.005	0.121	0.182	0.007	0.047
				Malaysia			
1	0.019	0.984	0.008	0.024	0.027	0.001	0.001
5	0.028	0.943	0.009	0.043	0.046	0.003	0.006
10	0.041	0.878	0.009	0.060	0.090	0.005	0.016
15	0.050	0.830	0.009	0.078	0.120	0.007	0.025
20	0.057	0.787	0.009	0.093	0.146	0.009	0.033
				Philippines			
1	0.012	0.011	0.971	0.024	0.020	0.002	0.009
5	0.019	0.013	0.929	0.037	0.044	0.003	0.018
10	0.035	0.015	0.871	0.056	0.078	0.005	0.026
15	0.044	0.015	0.823	0.073	0.108	0.007	0.034
20	0.051	0.016	0.781	0.088	0.134	0.008	0.042
				Singapore			
1	0.028	0.014	0.011	0.987	0.058	0.002	0.019
5	0.042	0.015	0.011	0.918	0.114	0.005	0.045
10	0.066	0.018	0.010	0.830	0.186	0.007	0.073
15	0.082	0.019	0.010	0.771	0.240	0.010	0.088
20	0.095	0.020	0.010	0.725	0.282	0.012	0.099
				Thailand			

[16] The full results of GFEVD are available upon request.

1	0.026	0.015	0.008	0.055	0.995	0.001	0.008
5	0.052	0.015	0.010	0.093	0.944	0.009	0.027
10	0.082	0.020	0.011	0.142	0.884	0.013	0.050
15	0.099	0.021	0.011	0.176	0.842	0.016	0.069
20	0.112	0.022	0.011	0.202	0.811	0.018	0.084
				Vietnam			
1	0.001	0.002	0.000	0.003	0.002	0.996	0.002
5	0.005	0.004	0.001	0.007	0.010	0.979	0.006
10	0.008	0.005	0.001	0.019	0.024	0.956	0.010
15	0.013	0.006	0.002	0.030	0.039	0.930	0.015
20	0.018	0.007	0.002	0.040	0.056	0.904	0.020

Given the results from 'long-run' co-integration tests which suggest that there is no potential benefit across the ASEAN and U.S markets, the results from GFEVD imply that in short-term horizons, the whole markets are considered not to be co-integrated. This means that there are potential benefits in diversifying portfolio investment across these markets. According to the first part of *Table 8*, innovations which happened in U.S. do not explain any variations in the ASEAN markets. However, Thailand and Singapore indicate a small level of integration with U.S by the end of the period (9.8% and 7.2% respectively).

Furthermore, *Table 8* also implies that there is a diminutive indication degree of linkage across the five founders of ASEAN which are Indonesia, Malaysia, Philippines, Singapore and Thailand; although, the level of integration amongst these countries are only responsible to explain the variation of each other at an average level of 17%. Indonesia explains their variance in the market price for 77.9% whereas Thailand and Singapore are responsible to explain the rest of Indonesia's variation for 12.1% and 18.1% accordingly by the end of day 20. Based on the GFEVD analysis, the dominancy of Thailand market emerges again. Thailand is able to express the market price variance in Singapore for 28.2%, in Malaysia for 14.6% and in Philippines for 13.4% by the end of day 20; whereas, Singapore, Malaysia, and Philippines explain their variation due to its own innovations for 72.5%, 78.7% and 78.1% respectively. Moreover, there is a small degree of linkage between Thailand and Singapore.

Thailand's level of responsiveness by the end of the period is counted as 81.1%, whereas Singapore market explains the rest of Thailand's market variation.

Furthermore, the GFEVD results also confirm the GIRF findings for the Vietnam market with respect to its unresponsiveness to the other markets. In other words, Vietnam is the only market in ASEAN which can be classified as a relative isolated market compared to the other ASEAN markets. Vietnam is responsible to express its own innovation for 90.4% by the end of day 20.

Table 9. GFEVD results for ASEAN markets

Period	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
			Indonesia			
1	0.976	0.022	0.004	0.042	0.042	0.001
5	0.923	0.023	0.006	0.068	0.083	0.002
10	0.853	0.023	0.007	0.099	0.144	0.005
15	0.801	0.024	0.008	0.125	0.189	0.007
20	0.756	0.025	0.008	0.147	0.226	0.009
			Malaysia			
1	0.021	0.983	0.008	0.025	0.027	0.001
5	0.030	0.942	0.010	0.046	0.049	0.003
10	0.043	0.873	0.010	0.069	0.102	0.006
15	0.053	0.819	0.011	0.091	0.140	0.008
20	0.061	0.772	0.011	0.111	0.173	0.009
			Philippines			
1	0.012	0.012	0.971	0.027	0.022	0.002
5	0.021	0.014	0.930	0.043	0.050	0.003
10	0.037	0.016	0.866	0.068	0.093	0.005
15	0.047	0.017	0.814	0.089	0.130	0.007
20	0.055	0.018	0.768	0.109	0.163	0.009
			Singapore			
1	0.029	0.013	0.012	0.993	0.065	0.002
5	0.044	0.015	0.013	0.932	0.137	0.006
10	0.070	0.019	0.013	0.851	0.229	0.008
15	0.087	0.021	0.014	0.793	0.293	0.011
20	0.099	0.023	0.014	0.750	0.250	0.014
			Thailand			
1	0.026	0.015	0.008	0.060	0.997	0.001
5	0.051	0.015	0.011	0.109	0.952	0.010
10	0.082	0.021	0.014	0.170	0.902	0.014
15	0.100	0.023	0.015	0.212	0.868	0.017

20	0.113	0.024	0.015	0.156	0.844	0.020
			Vietnam			
1	0.001	0.002	0.000	0.003	0.002	0.998
5	0.005	0.004	0.001	0.008	0.012	0.982
10	0.009	0.006	0.002	0.024	0.029	0.956
15	0.015	0.007	0.002	0.038	0.050	0.928
20	0.020	0.008	0.003	0.051	0.071	0.898

In order to entertain those investors who are interested in investing in ASEAN markets, *Table 9* above shows a deeper understanding of the cointegrating relations across the five founders of ASEAN community plus the Vietnam market. GFEVD results confirm the GIRF findings which assert that Thailand and Singapore markets are the most influential market in Southeast Asia markets. Thailand explains 22.6% and Singapore explains 14.7% in respect to the market price variance in Indonesia by the end of day 20. Thailand describes the variation of stock market price in Malaysia and in Philippines which is counted for 17.3% and 16.3% respectively at the end of period 20; whereas, Singapore can explain 11.1% and 10.9% for previous respective countries accordingly. Lastly, Singapore and Thailand market seem to be co-integrated to such an extent. The stock market innovations on both countries explain to one another the market variation. For instance, Singapore expresses 15.6% of market variation in Thailand whereas Thailand explains 84.4% due to its own innovations by the end of day 20. Thailand on the other hand describes 25% of Singapore market variation, whilst Singapore explains 75% for its variance decomposition.

In contrast, Vietnam market is relatively isolated compared to other ASEAN markets. It can be argued, there is no evidence that Vietnam market is moving towards ASEAN market integration. In other words, it offers a suggestion that the five founders of ASEAN market, excluding the Vietnam market, show an indication that they are heading to a single block of cointegrated financial market. To sum it up, even though there is a diminutive degree of

linkage indication, the research argues that this would not undermine the potential benefits of diversifying portfolio investment.

5.5. Dynamic Conditional Correlation Results

In this section, the paper presents the dynamic correlation of a stock market to the other markets in order to analyse the market interdependencies during the period of 2001 to 2010. The dynamic correlation between the studied markets is a legit indicator to explain whether the market price is moving along together and therefore be considered as co-integrated. In other words, this means that the global event which may happen becomes the driving forces for co-integrated market to experience a significant impact from it. On the other hand, if a market exhibits a low correlation with the other market, this means that the market price movement is mainly being explained by its own internal events and not from the global events. In the latter case, this is what makes the diversified investment portfolio looks promising. In respect to ASEAN markets, since most of the markets are considered as an emerging market, then, according to Argyropoulos (2006), their domestic events mostly explain their market returns.

This section is divided into two parts of analysis. The first part explains the comparison between each ASEAN market to U.S. market. In this part, the period of study is decomposed into two periods which are from January 2001 to August 2008 and September 2008 to December 2010. In the first period, the paper serves the analysis of dynamic correlation before the U.S financial crisis occurred. In the second period, starting from the bankruptcy of the Lehman Brothers on September 2008, consideration is given to bring substantial impact to the ASEAN markets (Kim and Kim, 2011). The second part of the analysis asserts the

comparison between each ASEAN market to one another. Therefore, the paper also entertains those investors who are interested in investing on ASEAN market only.

The form of correlations between each pair of countries has invertible relationships. This means that on each pair of countries that will be discussed on the following paragraph has the same analysis interpretation as if the inverse relationship was explained, *vice versa*.

Figure 4 in Appendix 4 exhibits the DCC of Indonesia market with U.S. market from 01/2001 to 08/2008. It suggests that there are no high correlations between Indonesia and U.S. markets. In most of the cases, the correlation is not much higher than 0.3 except on 09/2001 for 0.32. This research suggests that the reason behind this exceptional correlation point is because the Federal Reserve bottomed out their official interest rate into a level of 1%. However, this proposition needs to be addressed for a further investigation. Nevertheless, Indonesia market reacts inversely with a substantial decrease to 0.01 on February 2002. Moreover, until the end of period 1, Indonesia displayed a fluctuate correlation in a range of 0.01 to 0.15. On the other hand, *Figure 5* suggests that the impact from U.S. financial crisis to Indonesia market only lasted for two months (starting from September 2008 to October 2008). The proceeding period displays a modest relationship between these markets on which by end of December 2010; Indonesia has a correlation of 0.15 with U.S. market.

Figure 6 in the Appendix 4 shows the dynamic correlation of Malaysia with U.S. market during period 1. The graph suggests that Malaysia market has a lower correlation compared to the relationship of Indonesia and U.S. In other words, during the period of 01/2001 to 08/2008, Malaysia market becomes a more promising country to be invested in rather than Indonesia for those investors who are proposed to invest in ASEAN and U.S. Moreover, based on *Figure 7*, the Malaysia market appears to be less correlated to the U.S. during the U.S. financial crisis. These results indicate that the Malaysia stock market has not shared the

same market price movement with U.S. during this period 2. This makes sense because Malaysia is considered to be an emerging market which is expected to have low interdependencies with the developed market such as U.S.

Figure 8 in the Appendix 4 displays the DCC of Singapore and U.S. equity markets during the period of 2001 to 2008. The figure contends the same results as Indonesia, Malaysia, Thailand and Philippines when a substantial correlation peak happened on September 2001. In the case of Singapore, the correlation at that time was 0.44 which was the highest correlation compared to what happened to Indonesia, Malaysia, Thailand and Philippines. This finding asserts a support postulation from the GIRF and GFEVD outcomes which concludes that Singapore is the most responsive market to the internal events which occurred in U.S. compared to other ASEAN markets. Furthermore, from *Figure 9*, it concurs that the previous finding which shows that, during the period of U.S. financial crisis, Singapore had a relative high correlation with U.S. compared to other ASEAN markets with a range of 0.2 to 0.3.

The dynamic correlation between Thailand and U.S markets in period 1 is presented in *Figure 10* in the Appendix 4. The graph shows that the overall returns of Thailand market does not share the same market movement with U.S. market which concurred the characterization of Thailand market as one of the emerging markets in Southeast Asia countries. Overall, during the period of 2001 to 2008, Thailand stock market exhibits a low correlation, of not more than 0.2, to U.S. stock market. Interestingly, during the second period, shown in *Figure 11*, there was a relative increase in the correlation ranging from 0.15 to 0.25 from September 2008 to September 2009; whereas, the dynamic correlation in proceeding year was relatively decrease to the range of 0.1 to 0.15 by the end of October 2010.

Figure 12 in the Appendix 4 presents the DCC of the Philippines market with a comparison to U.S. market from the period before the recent U.S. financial crisis. It suggests that in general, there are low correlations between the Philippines market and the U.S. market. During most of the studied period, the dynamic correlations do not exceed the level of 0.15. This result concludes that the Philippine returns are highly independent from the returns in the U.S. market. This finding confirms the result from the GIRF and GFEVD analysis, showing that the Philippines stock market is relatively isolated to U.S. stock market. In favour of this, the results from *Figure 13* strengthen the previous finding. Although during the recent U.S. financial crisis, the Philippines stock market exhibits a lower trend of correlations which does not exceed the level of 0.1 with some of them being negatively correlated with a maximum level of -0.05 from November 2009 to December 2009 and repeated from February 2010 to March 2010.

The DCC results between the Vietnam and the U.S. markets from 2001 to 2008 are presented on *Figure 14* in Appendix 4. Accordingly with the outcomes from GIRF and GFEVD, Vietnam market exhibits very low correlations to U.S. market compared to other ASEAN members. During the studied period in general, a considerable number of negative correlations appeared which can be seen from January 2001 to July 2001, February 2004 to August 2004, December 2005 to October 2006 and February 2008 to August 2008 with a range of correlations between -0.01 and -0.13. Furthermore, *Figure 15* shows that the recent U.S. financial crisis brings only a small increase trends with a maximum rise of correlations level to 0.11 from February 2009 to November 2009. Nevertheless, it can be concluded that Vietnam market is the most relatively isolated stock market in the Southeast Asia stock markets.

The first part of the analysis in this section can be concluded that the Vietnam and Philippines equity markets are relatively isolated market to the movement of U.S. equity market. This

means that their returns appeared to be influenced internally and not by the U.S. local events. Moreover, Indonesia, Malaysia, Singapore and Thailand equity markets position can be considered to have emerging market characteristics which explained their stock price movement to be influenced by their own internal events. Nevertheless, these summaries can be argued since it has not considered the correlations within the ASEAN markets. Therefore, further analysis of correlations amongst ASEAN members needs to be investigated in the second part of the analysis. The following analysis interpretation on conditional correlations across ASEAN members is explained based on the *Figure 16* to *Figure 30* and *Table 15* in Appendix 4.

In general the analysis interpretations from *Figure 16* to *Figure 30* can be categorized into four clusters. Firstly, the pair of dynamic correlations among the four founders of ASEAN which are Indonesia, Malaysia, Singapore and Thailand are to be described. For those four members, in general the range of dynamic correlation among them is from 0.3 to 0.6. In other words, it can be implied that across these four nations, they are positively correlated one to another during the period of study from January 2001 to December 2010. From the investors' perspective, this can be interpreted as a risk of diversifying their portfolio across these countries since with a range of correlation from 0.3 to 0.6; one stock market movement sometimes is influenced by other stock market co-movements. Furthermore, in respect to the AFMM treaty which has an interest of ASEAN market integration, this study provides a legit suggestion that Indonesia, Malaysia, Singapore and Thailand can be considered to have initial markets level of integration among them. Although, this postulation can be argued since the study is not considering other influential factors such as political situation, indicator of economic variables, currency rate and so on. Therefore, further investigation of the integration level across these four countries which have considered the previous factors need to be addressed.

The second analysis cluster is explaining the relationship from the four founders of ASEAN to Philippines market (*vice versa*) and Vietnam to Philippines market. In general from the period of January 2001 to December 2010, Indonesia, Malaysia, Singapore and Thailand has the same positive dynamic conditional correlation to Philippines market which range from 0.2 to 0.5. Whilst, the pair relationship between Vietnam and Philippines markets is highly independent to one another. In particular, this highly independency between these two markets happened on January 2002, November 2003, February 2006, May 2006 and July 2008. The study postulates a second indication that the Philippines market can be recognized as the second level of integration compared to the level of integration on Indonesia, Malaysia, Singapore and Thailand markets.

Thirdly, this paragraph explains the dynamic correlations among the four founders of ASEAN including Philippines to Vietnam market. Interesting results emerge based on this pair relationship and at the same time confirm the results from GIRF and GFEVD analyses. In particular, the Vietnam market seems to have an isolated (unresponsive) stock market co-movement to other ASEAN members. In fact, Thailand market emerges as the first prominent discrepancy towards Vietnam equity market with correlation series from -0.09 to 0.2. This means that Thailand market movement is most likely to have a contrary movement towards the Vietnam stock market movement. The relationship of Singapore and Vietnam comes into second with correlations ranging from -0.07 to 0.16. Malaysia and Indonesia market contact towards Vietnam are to be followed accordingly with correlation series from -0.06 to 0.2 and -0.05 to 0.2 respectively. Meanwhile, Philippines and Vietnam markets are moving independently from one to another.

Lastly, the following analysis of DCC-GARCH model is based on the average correlation on *Table 15* in the Appendix 4. In favour of the concluding suggestion on the first analysis cluster, *Table 15* shows that Indonesia, Malaysia, Singapore and Thailand are positively correlated. In particular, the ranks of pair relationships among them can be listed as follows: (1) Malaysia with Singapore, (2) Indonesia with Singapore, (3) Singapore with Thailand, (4) Indonesia with Malaysia, (5) Indonesia with Thailand and (6) Malaysia with Thailand (with 0.474, 0.473, 0.446, 0.428, 0.393 and 0.387 respectively). Moreover, it can also be concluded that Indonesia, Malaysia, Singapore and Thailand has a second degree of integration towards Philippines market. The orders of pair relationship between them are stated as follows: (1) Malaysia with Philippines, (2) Singapore with Philippines and (3) Thailand with Philippines (with 0.323, 0.311, and 0.27 respectively). Finally, based on the average correlation results suggest that Vietnam market is moving independently towards other ASEAN members. In implication, this means that the level of stock market co-movement of Vietnam towards ASEAN members is appeared to be influenced by internal and not regional events. The degree of market integration on other ASEAN members towards Vietnam market is accordingly presented as follows: (1) Vietnam with Philippines, (2) Vietnam with Malaysia, (3) Vietnam with Indonesia, (4) Vietnam with Singapore and (5) Vietnam with Thailand (with 0.1, 0.066, 0.06, 0.055, and 0.035 respectively).

To sum up, the above analysis might be a sign that the ASEAN members have made some development towards market integration, although this sign is only clear for the relationships among Indonesia, Malaysia, Singapore and Thailand. The empirical evidence also shows that the interdependencies of Philippines with Indonesia, Malaysia, Singapore and Thailand can be considered as a second level of market integration. Lastly, the findings also propose that the Vietnamese market is not correlated with other ASEAN members or in other words, Vietnam does not share a common stock market trend with any of them.

Conclusion, Research Limitation and Further Research

6.1 Conclusion

This study investigates the selected six members of ASEAN and the U.S. markets level of integration and the benefit possibilities in diversifying investments portfolios across these studied stock markets. Moreover, based on the AFMM meeting in Manila 2003, this research is also of interest to supply the empirical evidence of the degree of integration among the ASEAN nations in the terms of their financial market. This research also aims to partially filling the gap in the literature and provides empirical evidences on the level of market integration based on the daily time series data and the superiority of the estimation model. The distinctive features that this thesis offers, unlike previous studies, are the comprehensive investigation of market linkages and the potential benefits of international portfolio diversification across ASEAN and U.S markets in three different time perspectives which are 'long-run', 'short-run' and 'dynamic' horizon perspectives.

The time series data engaged in this research is the closing price of the selected ASEAN and U.S. stock market indices. The study uses daily data frequency which is collected from the Bloomberg Database spanning the period of January 2001 to December 2010. The currency of these market indices is denominated in their local currency. The analysis of three different time perspectives is divided into two categories; First category is for those investors who are interested in diversifying their portfolios across U.S. and ASEAN markets, Second category is for those investors who are interested in investing their portfolios among the ASEAN markets only.

This research employs the bivariate Engle-Granger (1987) and the Johansen-Juselius (1990) multivariate approach. The findings from both models indicate that there are five cointegrating vectors across the ASEAN markets and six cointegrating vectors across the

ASEAN and U.S. markets combined. These outcomes suggest that for those investors who are interested in diversifying their investment portfolio across ASEAN markets only and ASEAN and U.S. markets combined, is there is no potential benefits of international portfolio diversification in the perspective of long-term investment horizons.

In order to investigate the 'short-term' linkages across the ASEAN and U.S. markets, this research employs the Generalized Impulse Response Function (GIRF) and the Generalized Forecast Error Variance Decomposition (GFEVD) models. The results from both models postulate that innovations that occurred in the U.S. are not transmitted to the ASEAN market (at least not in the 'short-term' horizons). Additionally, the models also confirm that for any individual ASEAN stock markets, the innovations that shocked them do not affect U.S. stock price movements. Accordingly, both models suggest that for four founders of ASEAN; Indonesia, Malaysia, Singapore and Thailand; have an indication of initial market co-integration in the short-run horizon. Although, the magnitudes of the correlation among them are still moderately low. Subsequently, the Philippines market appears to be less co-integrated with the large four markets. On the other hand, Vietnam is the only market in ASEAN that is relatively isolated towards other ASEAN equity markets.

To have further investigation on the market interdependencies across ASEAN and U.S. financial markets, the Dynamic Conditional Correlation GARCH (1,1) model is engaged. In respect to the first analysis part which considered ASEAN and U.S. stock markets, this paper divides the analysis into two periods; before the recent U.S. financial crisis and the starting period of Lehman Brothers bankruptcy on September 2008. During the first period, Indonesia, Malaysia and Thailand have low correlation in the terms of overall market returns with the U.S. market index. However, Malaysia appears to be the more promising market to invest in than Indonesia and Thailand during the first period. And also interestingly, Singapore market emerges to become the most responsive market due to innovations in U.S.

compared to other ASEAN markets. With on the other hand, Philippines and Vietnam markets appear to have a considerable low correlation with U.S. market in the course of period 1. Meanwhile, proceeding to the next period, the impact of Lehman Brothers bankruptcy had slight influence in general for ASEAN market return movements. This finding is somewhat in contrast to what Kim and Kim (2011) suggested. The impact of U.S. recent financial crisis towards Indonesia only appeared in September to October 2008 with a slight rise of correlation between them. Thailand market also exhibits a slight increase in correlation with a percentage of 25% from period 1 to period 2 (in particular the rises can only be seen on September 2008 to September 2009). Accordingly, Malaysia market did not share the same market returns movement with U.S. during the second period. Additionally, during the second period, Philippines and Vietnam markets exhibit lower trend of relation compared to the first period with some of them are negatively correlated.

In respect to the second part of DCC-GARCH analysis which investigated across the ASEAN markets alone, these following conclusions can be inferred. There is an indication that the ASEAN members have made some development in its degree of market integration, however the sign is only clear for the relationships among Indonesia, Malaysia, Singapore and Thailand. The empirical evidence also shows that the interdependencies of Philippines market towards Indonesia, Malaysia, Singapore and Thailand markets can be considered as a second level of market integration. Finally, the findings also propose that the Vietnam market does not share a common stock market trend with any of the ASEAN market members. As a result, this research suggests that the attempts to promote a financial market integration in ASEAN region which was started by the AFMM meeting in Manila 2003 is still far from reality.

The implication of this research for investors interested to invest in both ASEAN and U.S markets combined or in ASEAN markets only remarks that there are still huge potential benefits of international portfolio diversification across these countries. In the terms of their

correlation coefficient, Philippines and Vietnam markets emerge to have considerable investment opportunities for them. Nevertheless, Indonesia, Malaysia, Singapore and Thailand also cannot be undermined for their attractiveness to be candidates of international portfolio diversification. In respect to ASEAN finance ministers, low tendency of market integration across the ASEAN market means that their efforts to stabilize and promote the economic growth in the Southeast Asia region are still far from reality. Nevertheless, the implication of these findings also imply that if there were any unexpected financial shocks in one market, then the impact would be less affected to all ASEAN members who are in favour of stabilizing the ASEAN financial markets system.

6.2 Research Limitation and Further Research

The whole postulation that this paper asserts has its limitation in explaining the market integration and the potential benefits of international portfolio diversification across the ASEAN and U.S. markets. The author realizes the scepticism of the Heisenberg and Goodhart's Law in these findings. Therefore the limitation of this research is addressed in the following:

1. In generating the new time series data which no longer has heteroskedasticity, (recall the section of GARCH (1,1) model) in Appendix 1, the division of the initial time series data with the volatility estimation from GARCH yields a number of missing values due to the rooting process. In order to solve this issue, this research calculates average value from the new time series data then installs its average into every missing value in the new time series data. This is not merely a fault, although more appropriate estimation of the missing value can be addressed such as using the Bootstrap estimation. Moreover, in order to remove heteroskedasticity there are ways to solve this, for instance is by adding vectors of dummies into the VAR model.

2. The implication of this research in respect to the explanation of ASEAN market integration can still be argued since this study has not considered other pivotal factors such as political situation in one country to another, currency rate, official interest rate, money supply, GDP, and other macroeconomic variables.

The author of this paper suggests that the latter research limitation can be an interesting topic to do further research on. As this research focuses on the market price indices across the studied countries, further research can explore more deeply into other macroeconomic variables in order to assess the degree of market integration among the ASEAN. Moreover, in the same spirit as this thesis, Japan market also has an indication to be an influential market in driving the stock market co-movements in ASEAN. Therefore, a detailed comparison between ASEAN and Japan market can be another interesting topic to be researched. Finally, the particular assessment in the extreme volatile period across the ASEAN and U.S. markets correlations can be assessed since there is a possibility of market structural break which dramatically differs from the case of the tranquil period.

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APPENDIX 1

Diagnostic Tests

There are five assumptions derived to underlie the classical linear regression model (Brooks, 2008).

1. The error terms have zero mean
$$E(u_t) = 0$$
2. The variance of the errors is constant and finite over all values of X_t (homoskedasticity)
$$var(u_t) = \sigma^2 < \infty$$
3. The errors are linearly independent of one another (no-autocorrelation)
$$cov(u_i, u_j) = 0$$
4. There is no relationship between the error and corresponding *X* variable
$$cov(u_t, X_t) = 0$$
5. The disturbances (error) term is normally distributed.
$$u_t \sim N(0, \sigma^2)$$

From the five assumptions mentioned, this research has foremost interest to examine the assumption of no-autocorrelation and homoskedasticity (assumption 2 and 3 respectively). Therefore, these two examinations are presented in this paper and if there is an existence of both autocorrelation and heteroskedasticity then these assumptions will be comprehensively addressed in order to salve them.

Nevertheless, the rest of the assumptions are addressed and discussed as follows. According to Brooks (2008), the first assumption can be satisfied if a constant term is included in the regression equation. The regression models being used in research have constant term in its equation; therefore the first assumption was satisfied. Additionally, if assumption 1 holds, assumption 4 can be equivalently written as $E(u_t, X_t) = 0$. Thus, both assumptions (1 and 4) indicate that the explanatory variable is *orthogonal* (unrelated to) the error term (Brooks,

2008). Finally, the assumption 5 is satisfied by an assumption from this paper to relax the requirement of the error term to be normally distributed. Since many econometrician postulate that relaxing the assumption 5 is not going to hurt much the inferences that are may be made from the regression model.

1. Autocorrelation Test

A common case that appears in a time series of stock market price indices is that the data series are correlated with their own lagged values. Inevitably, this is occurring for this study as well. This means that the autocorrelation issue violates the standard assumption 3 above which postulates that error term is not correlated to other error term. The issue of autocorrelation brings consequences into the outcomes of the regression models. These consequences are as follows (Brooks, 2008):

a. The outcomes of the estimated coefficients derived using any linear regression model is no longer efficient. This means that they are not the best linear unbiased estimation (BLUE). Nevertheless, although not efficient anymore the estimated coefficients are still unbiased and consistent.
b. The outcome of the standard errors could be wrong and lead to raise the probability of type 1 error.
c. The residual autocorrelation leads to an underestimation/overestimation of the true error variance.

This study employs the autocorrelation function to examine the existence of autocorrelation on two variables; which are market price indices (lognormal) and market returns. The autocorrelation function (ACF) of a series X country at lag k is estimated by following equation:

$$\tau_k = \frac{\sum_{t=k+1}^{T}(X_t-\bar{X})(X_{t-k}-\bar{X})/(T-K)}{\sum_{t=1}^{T}(X_t-\bar{X})^2/\,T} \quad \ldots (1)$$

Where $\bar{X}$ = the mean of *X* country

T = the total number of period (days)

K = the lag days

The partial autocorrelation (PAC) equation is then employed since it measures the correlation of *X* values that are k periods apart after removing the correlation from the interceding lags. The equation of partial autocorrelation is as follow (Box and Jenkins, 1976):

$$\emptyset_k \begin{cases} \tau_1 & \text{for } k = 1 \\ \frac{\tau_k - \sum_{j=1}^{k-1} \emptyset_{k-1,j} \cdot \tau_{k-j}}{1 - \sum_{j=1}^{k-1} \emptyset_{k-1,j} \cdot \tau_{k-j}} & \text{for } k > 1 \end{cases} \quad \ldots (2)$$

Where τ_k is the estimated autocorrelation at lag *k* and where,

$$\emptyset_{k,j} = \emptyset_{k-1,j} - \emptyset_k \emptyset_{k-1,k-j}$$

In order to obtain $\emptyset_k$ variable, then execute following regression:

$$X_t = \beta_0 + \beta_1 X_{t-1} + \cdots + \beta_{k-1} X_{t-(k-1)} + \emptyset_k X_{t-k} + \varepsilon_t \quad \ldots (3)$$

The dotted lines in the above regression are the approximate two standard error bounds computed as $\pm 2/(\sqrt{T})$. Thus, if PAC is within these bounds, it is insignificant from zero at the 5% level of significance.

In order to save space, the results of the autocorrelation function are not presented in the paper[17] instead the summary of the result is presented as follows.

[17] The autocorrelation test results are available upon request.

Table 10. Autocorrelation Tests

	Variables	
	Market Price Indices (Lognormal)	**Market Returns**
Indonesia	Autocorrelated*	Autocorrelated*
Malaysia	Autocorrelated*	Autocorrelated*
Philippines	Autocorrelated*	Autocorrelated*
Singapore	Autocorrelated*	No Autocorrelation
Thailand	Autocorrelated*	No Autocorrelation
Vietnam	Autocorrelated*	Autocorrelated*
U.S.	Autocorrelated*	Autocorrelated*

* implies that there are autocorrelation within the time series data markets. All the ACF coefficients are highly significant under the standard error bounds computed as $\pm 2/(\sqrt{T})$. This implies that Ljung-Box joint test statistics rejects the null hypothesis of no autocorrelation at the 5% level of significance for all the number of lags considered.

Since both variables (market price indices and market returns) are autocorrelated for all studied markets except for Singapore and Thailand for market returns variable. Nevertheless, the next treatment was to remove the autocorrelation from the time series data.

1.1. ARMA Processes

ARMA model is a combination model of Autoregressive (AR) and Moving Average model (MA). By using ARMA model, the current value of a time series data that depends linearly on its own previous values plus a combination of current and previous values of a white noise error term can be asserted (Brooks, 2008). In other words, ARMA model is employed to remove the autocorrelation from the time series data.

The ARMA model is written as:

$$\emptyset(L)y_t = \mu + \theta(L)\mu_t$$

Where,

$$\emptyset(L) = 1 - \emptyset_1 L - \emptyset_2 L^2 - \cdots - \emptyset_p L^p \text{ and}$$

$$\theta(L) = 1 + \theta_1 L + \theta_2 L^2 + \cdots + \theta_q L^q$$

Or also could be written as

$$y_t = \mu + \emptyset_1 y_{t-1} + \emptyset_2 y_{t-2} + \cdots + \emptyset_p y_{t-p} + \theta_1 \mu_{t-1} + \theta_2 \mu_{t-2} + \cdots + \theta_q \mu_{t-q} + \mu_t \quad \ldots (4)$$

With $E(\mu_t) = 0; E(\mu_t^2) = \sigma^2; E(\mu_t \mu_s) = 0, t \neq s$

The variable of y_t is the time series data at time t, the array variables written in orange colour is the autoregressive part model (also known as the lag series of the time series y_t) and the array variables are written in blue colour as the moving average part model.

In order to select which ARMA model best fits the time series data. These studies execute the combination order of ARMA (1, 1) to ARMA (5, 5) which is counted as 36 times running the ARMA regression model for each listed country. The EViews 7.2 software has been employed to do the regression and subsequently the selection on which model fits the time series data the most; this study uses Akaike's (1974) information criterion (AIC) and Schwarz's Bayesian information criterion (SBIC).

$$AIC = \ln(\hat{\sigma}^2) + \frac{2k}{T} \quad \ldots (5)$$

$$SBIC = \ln(\hat{\sigma}^2) + \frac{k}{T}(ln\, T) \quad \ldots (6)$$

Where, $\hat{\sigma}^2$ = estimator of variance of regression error terms μ_t

k = p + q + 1 (total number parameters)

T = total number of periods (days)

The decision rule based on estimated standard errors is the ARMA model with the lowest value of AIC and SBIC. Moreover, in order to cherish the objective of a parsimonious model, this study chooses the best ARMA model, which has least parameters possible and the criterion between AIC and SBIC is able to remove the autocorrelation from the data series. The result of the chosen ARMA model for each of the listed countries is as follows[18]:

Table 11. Summary of the selected ARMA model

	Variables	
	Market Price Indices (Lognormal)	**Market Returns**
Indonesia	ARMA (1,1)	ARMA (0,1)
Malaysia	ARMA (5,4)	ARMA (1,1)
Philippines	ARMA (4,2)	ARMA (0,1)
Singapore	ARMA (1,0)	ARMA (0,0)
Thailand	ARMA (1,0)	ARMA (0,0)
Vietnam	ARMA (4,5)	ARMA (5,3)
U.S.	ARMA (5,2)	ARMA (5,2)

After this, the best selected ARMA model for each listed country was sufficient to be tested again for the presence of autocorrelation. Moreover, the previous results indicated that Singapore and Thailand market returns do not have the autocorrelation issue; therefore the selected ARMA model for both countries is ARMA (0,0) which is also what has been selected for the AIC and SBIC lowest values. *Table 12* below exhibits the summary of the autocorrelation for each listed market which has been treated by using the ARMA model.

[18] Results from AIC and SBIC can be found at Appendix 2

Table 12. Summary of the treated markets on Autocorrelation Tests

	Variables	
	Market Price Indices (Lognormal)	**Market Returns**
Indonesia	No Autocorrelation	No Autocorrelation
Malaysia	No Autocorrelation	No Autocorrelation
Singapore	No Autocorrelation	No Autocorrelation
Philippines	No Autocorrelation	No Autocorrelation
Thailand	No Autocorrelation	No Autocorrelation
Vietnam	No Autocorrelation	No Autocorrelation
U.S.	No Autocorrelation	No Autocorrelation

* implies that there are autocorrelation within the time series data markets.

After the ARMA model treatment, each listed market exhibited no autocorrelation between their lagged values for the two variables being studied. This means that the market data series was now ready to proceed into the next evaluation of the presence of heteroskedasticity.

2. Heteroskedasticity Tests

Heteroskedasticity test is based on *assumption 2* which is that the variance of the errors is constant and finite over all values of X_t. Otherwise, if the error terms do not have a constant variance then it is said to be heteroskedasticity. In fact, if this issue is ignored by researcher and proceeded to capture the estimate coefficient and postulate inference, the outcomes would be somewhat misleading. Any linear regression model being used by ignoring the existence of heteroskedasticity will give unbiased and consistent coefficient estimates, but they are no longer *BLUE*. Moreover, the standard errors could be wrong in which latter inferences made could be misleading.

In order to evaluate the existence of heteroskedasticity, this research engaged the Autoregressive Conditional Heteroskedasticity – Lagrange Multiplier (ARCH-LM) test in the residuals (Engle, 1982). Recalling *equation (4)* from the ARMA model, the residual presented in μ_t is the input variable for the ARCH-LM test. This means that residual from

selected ARMA model of each market was taken to be analysed for the presence of heteroskedasticity.

The ARCH-LM tests statistics with a null hypothesis of no ARCH up to the order q in the residuals is executed by using following regression:

$$e_t^2 = \beta_0 + \left(\sum_{s=1}^{q} \beta_s e_{t-s}^2\right) + v_t \qquad \ldots (7)$$

where e is the residual of selected ARMA model from the previous data treatment (the removal of autocorrelation). Eviews 7.2 is employed to run the heteroskedasticity test. The result of the Obs*R-squared statistics is computed as the number of observation multiplied by R^2 from the regression (4). The Obs*R-squared is also known as the Engle's LM test statistics which is asymptotically distributed as a chi-squared distribution. Additionally, this study executes the ARCH-LM test for the lag period of 5 days. The reason for this is that there are 5 working days in a week and this research tries to capture the heteroskedasticity effect during the period of one week. The result of heteroskedasticity test for the studied market on market price indices (lognormal) and market returns is as follows:

Table 13. Heteroskedasticity Tests

Obs*R-squared	Market Price Indices (lognormal)	Market Returns
Indonesia	174.568**	174.7501**
Malaysia	41.63912**	39.83219**
Philippines	84.69496**	82.09031**
Singapore	269.2566**	270.1072**
Thailand	65.16785**	66.15714**
Vietnam	487.4853**	491.2662**
U.S.	664.3031**	648.1995**

* And ** denote rejection of the null hypothesis at the 5% and 1% level of significance

Table 13 shows that for both variables (price indices and returns) in each market have the presence of heteroskedasticity, therefore further data treatment was needed. In order to

address this issue, the research employs the model of GARCH (1,1) (which is discussed in the following section).

2.1. GARCH (1,1) model

Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model was developed by Bollerslev (1986) and Taylor (1986). GARCH model can be regarded as the extension of the ARMA model but which in addition allows the conditional variance to be dependent upon previous own lags. In other words, the ARMA model from previous section become the mean equation of the GARCH model and the variance equation is the extension of the residual in which the error term of ARMA model is presented (recall equation 5). This study employs the GARCH (1,1). Compared to other lags, the GARCH (1,1) is better and far more widely used by many econometrician, as well as it is more parsimonious and able to avoid over fitting problem[19]. The variance equation for GARCH (1,1) model is as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad \dots (8)$$

Where, σ_t^2 = conditional variance at time t

μ_{t-1}^2 = residual at time t-1 squared

σ_{t-1}^2 = conditional variance at time t-1

In order to remove the heteroskedasticity from the selected equity markets, the following procedures were employed.

1. The ARMA (for example: ARMA (1,1)) model which becomes the mean equation of the GARCH model has the properties as follows:

$$y_t = \mu + \emptyset_1 y_{t-1} + \theta_1 \mu_{t-1} + \mu_t \qquad \sim \quad N\,(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \beta \sigma_{t-1}^2$$

[19] To have deeper understanding why GARCH (1,1) is better than any other GARCH forms see (Hansen & Lunde, 2005)

2. This study executes the GARCH (1, 1) model by using Eviews 7.2 and the results of the estimated coefficient $\widehat{\alpha_0}$, $\widehat{\alpha_1}$, $\hat{\beta}$ and the volatility $\widehat{\sigma_t^2}$ obtained.
3. In order to remove the heteroskedasticity, the standardized variable is now favourable.

$$\frac{y_t}{\sigma_t} \sim N(0,1)$$

Since normal distribution holds if we divide a variable by its standard deviation, then this new variable is standardized to have variance 1. In this case, the variable of σ_t is replaced with the estimation from the GARCH model on point 1 above. This means that $\sigma_t = \sqrt{\widehat{\sigma_t^2}}$, the new subsequent variable (without heteroskedasticity) is defined as:

$$\dot{y_t} = \frac{y_t}{\sqrt{\widehat{\sigma_t^2}}}$$

4. Consequently, the new variable without heteroskedasticity gives rise to another issue which generates missing values because of the rooting process. In order to solve this problem, an average value from the new variable is calculated and then installed into every missing value within the new variable.

In order to check whether heteroskedasticity is still intact within the time series data, the autocorrelation test using the ARCH-LM test is employed. Following table summarises the new condition of the time series data in heteroskedasticity occurrence.

Table 14. Summary of the treated markets on Heteroscedasticity Tests

Obs*R-squared	Market Price Indices (lognormal)	Market Returns
Indonesia	3.922159	3.929701
Malaysia	0.784853	0.673794
Philippines	1.309471	10.85801
Singapore	2.876793	2.883893
Thailand	0.681503	0.651829
Vietnam	3.917776	3.707592
U.S.	10.45378	11.06306

* and ** denote rejection of the null hypothesis at the 5% and 1% level of significance

Given that the condition of the time series data no longer has heteroskedasticity. The new standardized variable (homoskedasticity) of market price indices and market returns on every country here and after replaces the former time series data (with heteroskedasticity).

APPENDIX 2

AIC and BIC results for ARMA model selection

Market Price Indices (Lognormal)

I. Indonesia

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	2.149652	0.791413	-0.418215	-1.371804	-2.097238	-2.65142
1	-5.542664	-5.555141	-5.554425	-5.553983	-5.553207	-5.552707
2	-5.55509	-5.554301	-5.55351	-5.553091	-5.552297	-5.552206
3	-5.554077	-5.553797	-5.552992	-5.552386	-5.555035	-5.557033
4	-5.553795	-5.553188	-5.558733	-5.55794	-5.557142	-5.55657
5	-5.55297	-5.552826	-5.554532	-5.557074	-5.555576	-5.559521

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	2.151971	0.796049	-0.411261	-1.362532	-2.085647	-2.637512
1	-5.538026	-5.548184	-5.54515	-5.542389	-5.539294	-5.536475
2	-5.548132	-5.545023	-5.541912	-5.539173	-5.536059	-5.533649
3	-5.544796	-5.542195	-5.539069	-5.536144	-5.536472	-5.536149
4	-5.542189	-5.539261	-5.542485	-5.539371	-5.536252	-5.533359
5	-5.539039	-5.536573	-5.535957	-5.536177	-5.532356	-5.533979

II. Malaysia

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	0.195039	-1.161935	-2.306956	-3.181897	-3.805801	-4.294816
1	-6.561562	-6.578034	-6.57894	-6.58402	-6.583141	-6.582421
2	-6.577213	-6.583055	-6.582868	-6.581116	-6.58373	-6.583633
3	-6.578001	-6.582784	-6.584538	-6.583787	-6.582949	-6.58571
4	-6.584065	-6.582984	-6.583718	-6.584178	-6.583936	-6.589204
5	-6.58315	-6.583735	-6.583084	-6.582902	-6.589319	-6.588875

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	0.197357	-1.157298	-2.300002	-3.172625	-3.794211	-4.280908
1	-6.556924	-6.571078	-6.569665	-6.572425	-6.569228	-6.566189
2	-6.570254	-6.573776	-6.57127	-6.567198	-6.567493	-6.565076
3	-6.568719	-6.571182	-6.570616	-6.567544	-6.564386	-6.564827
4	-6.572459	-6.569057	-6.56747	-6.565608	-6.563046	-6.565992
5	-6.569219	-6.567481	-6.564509	-6.562005	-6.566099	-6.563334

III. Philippines

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	1.028403	-0.316966	-1.459198	-2.326655	-2.96353	-3.424879
1	-5.690124	-5.70461	-5.703885	-5.704083	-5.703518	-5.703762
2	-5.704116	-5.703465	-5.703461	-5.703967	-5.702494	-5.702213
3	-5.703657	-5.702814	-5.702965	-5.707671	-5.706903	-5.702301
4	-5.703664	-5.70433	-5.716073	-5.715427	-5.714903	-5.715476
5	-5.703345	-5.706627	-5.707202	-5.71791	-5.716654	-5.716231

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	1.030721	-0.31233	-1.452244	-2.317382	-2.95194	-3.410971
1	-5.685486	-5.697654	-5.694609	-5.692489	-5.689605	-5.68753
2	-5.697157	-5.694187	-5.691863	-5.690049	-5.686257	-5.683656
3	-5.694376	-5.691212	-5.689042	-5.691428	-5.68834	-5.681417
4	-5.692058	-5.690403	-5.699825	-5.696858	-5.694013	-5.692264
5	-5.689414	-5.690373	-5.688627	-5.697013	-5.693434	-5.69069

IV. Singapore

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	0.392381	-0.937422	-1.982677	-2.831408	-3.357129	-3.807819
1	-5.806925	-5.806414	-5.805717	-5.805143	-5.805557	-5.804792
2	-5.806627	-5.806205	-5.805622	-5.804891	-5.805214	-5.806216
3	-5.807557	-5.807317	-5.809663	-5.808923	-5.808868	-5.811789
4	-5.808263	-5.807724	-5.808931	-5.808231	-5.809145	-5.811875
5	-5.808571	-5.807781	-5.80884	-5.808664	-5.813783	-5.818555

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	0.394699	-0.932785	-1.975722	-2.822135	-3.345539	-3.793911
1	-5.802288	-5.799457	-5.796442	-5.793549	-5.791644	-5.78856
2	-5.799669	-5.796926	-5.794024	-5.790973	-5.788977	-5.787659
3	-5.798275	-5.795715	-5.795741	-5.79268	-5.790304	-5.790905
4	-5.796657	-5.793797	-5.792682	-5.789662	-5.788254	-5.788664
5	-5.794639	-5.791527	-5.790264	-5.787767	-5.790564	-5.793014

V. Thailand

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	0.725025	-0.606957	-1.681869	-2.518538	-3.071228	-3.520477
1	-5.580933	-5.580184	-5.581682	-5.581519	-5.580751	-5.579987
2	-5.579934	-5.583307	-5.58309	-5.584829	-5.584289	-5.58351
3	-5.581951	-5.582862	-5.58261	-5.585193	-5.58625	-5.584271
4	-5.582502	-5.586945	-5.586232	-5.586101	-5.5856	-5.592299
5	-5.582908	-5.586452	-5.586173	-5.586763	-5.587375	-5.587435

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	0.727343	-0.602321	-1.674915	-2.509265	-3.059637	-3.506568
1	-5.576296	-5.573227	-5.572406	-5.569925	-5.566838	-5.563755
2	-5.572975	-5.574029	-5.571492	-5.570912	-5.568052	-5.564953
3	-5.572669	-5.57126	-5.568687	-5.56895	-5.567686	-5.563387
4	-5.570897	-5.573018	-5.569984	-5.567531	-5.564709	-5.569087
5	-5.568977	-5.570199	-5.567598	-5.565866	-5.564156	-5.561894

VI. Vietnam

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	1.661579	0.309051	-0.871856	-1.78375	-2.455792	-2.958365
1	-5.247117	-5.292794	-5.301207	-5.302271	-5.308058	-5.310106
2	-5.299187	-5.299733	-5.304636	-5.300349	-5.317541	-5.318165
3	-5.299448	-5.302358	-5.303534	-5.303043	-5.317631	-5.317761
4	-5.29915	-5.302349	-5.305196	-5.31743	-5.316985	-5.325889
5	-5.31244	-5.314942	-5.31629	-5.316482	-5.325562	-5.324952

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	1.663897	0.313687	-0.864902	-1.774478	-2.444202	-2.944456
1	-5.24248	-5.285837	-5.291932	-5.290676	-5.294144	-5.293874
2	-5.292228	-5.290455	-5.293038	-5.286431	-5.301304	-5.299608
3	-5.290167	-5.290756	-5.289611	-5.286801	-5.299068	-5.296877
4	-5.287545	-5.288422	-5.288948	-5.298861	-5.296095	-5.302677
5	-5.298508	-5.298688	-5.297715	-5.295584	-5.302343	-5.299411

VII. United States of America

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	-0.82021	-2.075736	-3.018365	-3.619642	-4.08864	-4.345345
1	-5.735063	-5.743629	-5.746706	-5.748384	-5.748074	-5.74847
2	-5.747002	-5.748135	-5.751682	-5.752096	-5.751482	-5.752159
3	-5.752101	-5.753082	-5.753461	-5.752739	-5.765382	-5.75542
4	-5.754021	-5.753255	-5.763628	-5.751947	-5.752218	-5.764922
5	-5.753208	-5.752853	-5.766807	-5.768226	-5.758882	-5.766893

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	-0.817892	-2.0711	-3.01141	-3.61037	-4.07705	-4.331437
1	-5.730425	-5.736672	-5.737431	-5.736789	-5.734161	-5.732238
2	-5.740043	-5.738857	-5.740083	-5.738178	-5.735244	-5.733602
3	-5.742819	-5.74148	-5.739538	-5.736496	-5.746819	-5.734536
4	-5.742415	-5.739328	-5.74738	-5.733378	-5.731328	-5.74171
5	-5.739277	-5.7366	-5.748232	-5.747329	-5.735662	-5.741352

Market Returns

I. Indonesia

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	3.666886	3.654421	3.655139	3.655584	3.65636	3.656833
1	3.654478	3.655267	3.656057	3.65648	3.657274	3.65735
2	3.655487	3.656051	3.65684	3.652762	3.653538	3.654322
3	3.655766	3.656374	3.650973	3.651722	3.653736	3.654474
4	3.656591	3.65673	3.650654	3.651867	3.655395	3.6502
5	3.657319	3.65766	3.651723	3.652515	3.651711	3.653372

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	3.669205	3.659059	3.662095	3.66486	3.667954	3.670746
1	3.659118	3.662226	3.665336	3.668078	3.671192	3.673588
2	3.662449	3.665332	3.668442	3.666684	3.66978	3.672885
3	3.665051	3.66798	3.6649	3.66797	3.672306	3.675364
4	3.668201	3.670661	3.666908	3.670443	3.676292	3.673419
5	3.671255	3.673919	3.670305	3.673419	3.674938	3.678922

II. Malaysia

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	2.648033	2.631617	2.630691	2.625653	2.6264	2.62712
1	2.632461	2.626579	2.626676	2.625653	2.625952	2.626068
2	2.631637	2.626861	2.625157	2.626314	2.626686	2.627408
3	2.625615	2.626402	2.625981	2.625459	2.62571	2.62047
4	2.626516	2.625018	2.626588	2.626765	2.627561	2.626122
5	2.62768	2.626666	2.626229	2.620764	2.627808	2.62111

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	2.650352	2.636255	2.637647	2.634928	2.637994	2.641033
1	2.6371	2.633538	2.635954	2.637252	2.639869	2.642305
2	2.638598	2.636143	2.636759	2.640237	2.642929	2.645971
3	2.634899	2.638008	2.639908	2.641707	2.644279	2.641361
4	2.638125	2.63895	2.642841	2.645341	2.648459	2.649342
5	2.641617	2.642925	2.64481	2.641668	2.651035	2.646659

III. Philippines

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	3.519425	3.504967	3.505695	3.505484	3.506044	3.505792
1	3.505466	3.506113	3.506119	3.505295	3.506088	3.506431
2	3.505914	3.504986	3.506605	3.506056	3.506707	3.500142
3	3.505899	3.505216	3.506077	3.502965	3.50233	3.50178
4	3.50621	3.50562	3.501362	3.501458	3.501902	3.49352
5	3.504893	3.505532	3.494841	3.492817	3.490089	3.489543

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	3.521744	3.509604	3.512652	3.514759	3.517639	3.519705
1	3.510105	3.513072	3.515398	3.516893	3.520005	3.522669
2	3.512876	3.514268	3.518207	3.519979	3.52295	3.518706
3	3.515183	3.516822	3.520004	3.519213	3.520899	3.52267
4	3.517819	3.519552	3.517616	3.520033	3.5228	3.516739
5	3.518829	3.521791	3.513422	3.513721	3.513316	3.515093

IV. Singapore

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	3.402848	3.403375	3.404081	3.404669	3.404291	3.405062
1	3.403167	3.403583	3.404179	3.404917	3.404636	3.403658
2	3.402238	3.401872	3.401842	3.402244	3.400938	3.398039
3	3.401537	3.402068	3.40084	3.401566	3.400688	3.397947
4	3.401267	3.402055	3.400958	3.401163	3.39599	3.401722
5	3.402173	3.400299	3.397016	3.397773	3.396952	3.397459

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	3.405167	3.408013	3.411037	3.413944	3.415885	3.418975
1	3.407807	3.410542	3.413457	3.416515	3.418554	3.419895
2	3.409199	3.411153	3.413444	3.416167	3.41718	3.416602
3	3.410822	3.413674	3.414767	3.417814	3.419258	3.418837
4	3.412876	3.415987	3.417211	3.419738	3.416888	3.424941
5	3.416109	3.416558	3.415598	3.418677	3.420179	3.423009

V. Thailand

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	3.629577	3.630332	3.628873	3.629063	3.629825	3.630581
1	3.630547	3.626331	3.627002	3.626528	3.626892	3.627652
2	3.628485	3.62724	3.625828	3.627295	3.623812	3.624462
3	3.627861	3.627169	3.626199	3.624824	3.624499	3.620464
4	3.627358	3.627669	3.625756	3.623585	3.622985	3.623758
5	3.628454	3.628504	3.626635	3.621911	3.623135	3.622743

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	3.631896	3.634969	3.63583	3.638338	3.641419	3.644494
1	3.635187	3.63329	3.636281	3.638126	3.64081	3.643889
2	3.635446	3.636521	3.63743	3.641218	3.640055	3.643025
3	3.637146	3.638775	3.640126	3.641072	3.643068	3.641355
4	3.638968	3.641601	3.642009	3.64216	3.643882	3.646977
5	3.64239	3.644763	3.645217	3.642816	3.646362	3.648293

VI. Vietnam

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	3.962792	3.917207	3.90886	3.907769	3.902028	3.900015
1	3.910846	3.910334	3.905396	3.906166	3.893012	3.892447
2	3.910619	3.907702	3.906486	3.895169	3.892953	3.892855
3	3.910882	3.907683	3.904821	3.893183	3.893781	3.893916
4	3.897681	3.895323	3.894247	3.894102	3.894858	3.894936
5	3.897234	3.892824	3.893538	3.884095	3.884637	3.893193

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	3.96511	3.921845	3.915816	3.917044	3.913622	3.913928
1	3.915485	3.917293	3.914675	3.917765	3.90693	3.908685
2	3.91758	3.916984	3.918088	3.909091	3.909196	3.911419
3	3.920167	3.919289	3.918748	3.909431	3.91235	3.914806
4	3.909291	3.909255	3.9105	3.912678	3.915755	3.918155
5	3.91117	3.909083	3.91212	3.904999	3.907864	3.918743

VII. United States of America

AR (p)/ MA (q)	AIC					
	0	1	2	3	4	5
0	3.476352	3.467417	3.464172	3.462636	3.462877	3.462394
1	3.4642	3.462914	3.459285	3.45899	3.459565	3.458787
2	3.458858	3.457938	3.457619	3.45831	3.457501	3.458297
3	3.457015	3.457778	3.458572	3.458998	3.454953	3.446196
4	3.457765	3.45805	3.458143	3.458869	3.459613	3.444093
5	3.458255	3.458808	3.443374	3.446081	3.443045	3.442718

AR (p)/ MA (q)	SBIC					
	0	1	2	3	4	5
0	3.478671	3.472055	3.471128	3.471911	3.474471	3.476308
1	3.468839	3.469873	3.468564	3.470588	3.473483	3.475025
2	3.465819	3.46722	3.469221	3.472232	3.473744	3.47686
3	3.466299	3.469384	3.472499	3.475246	3.473522	3.467086
4	3.469375	3.471981	3.474396	3.477444	3.48051	3.467313
5	3.472192	3.475066	3.461956	3.466985	3.466272	3.468268

APPENDIX 3

ADF and PP tests

1. Augmented Dickey Fuller Test

a. Market Price Indices (Lognormal)

Countries	Model 1	Model 2	Model 3
	(Drift)	(Trend and Drift)	(No Trend, No Drift)
Indonesia	-0.247002	-2.026244	2.554553
Malaysia	-0.582351	-2.179925	1.483047
Philippines	-0.306409	-2.130388	1.314106
Singapore	-0.758598	-2.03173	0.713357
Thailand	-1.558045	-1.817605	1.717654
Vietnam	-1.202903	-1.426663	0.508216
U.S.	-1.884164	-2.002345	-0.140349

Critical values are from MacKinnon (1996). *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The optimal lag length is selected using the Bayesian Information Criteria.

b. Market Returns

Countries	Model 1	Model 2	Model 3
	(Drift)	(Trend and Drift)	(No Trend, No Drift)
Indonesia	-44.63872 ***	-44.63292 ***	-44.5127 ***
Malaysia	-26.07103 ***	-26.07164 ***	-26.02086 ***
Philippines	-44.29977 ***	-44.30705 ***	-44.2729 ***
Singapore	-49.29914 ***	-49.29934 ***	-49.29758 ***
Thailand	-49.77844 ***	-49.77186 ***	-49.7253 ***
Vietnam	-20.71343 ***	-20.70981 ***	-20.70654 ***
U.S.	-40.1071 ***	-40.11019 ***	-40.11491 ***

Critical values are from MacKinnon (1996). *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The optimal lag length is selected using the Bayesian Information Criteria.

2. Phillips Perron Test

a. Market Price Indices (Lognormal)

Countries	Model 1	Model 2	Model 3
	(Drift)	(Trend and Drift)	(No Trend, No Drift)
Indonesia	-0.200132	-1.999076	2.617186
Malaysia	-0.560452	-2.137969	1.536431
Philippines	-0.179463	-1.998889	1.435158
Singapore	-0.815237	-2.087152	0.683095
Thailand	-1.578607	-1.873157	1.681534
Vietnam	-1.372188	-1.58742	0.472261
U.S.	-1.927134	-2.024887	-0.076653

Critical values are from MacKinnon (1996). *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The optimal lag length is selected using the Bayesian Information Criteria.

b. Market Returns

Countries	Model 1	Model 2	Model 3
	(Drift)	(Trend and Drift)	(No Trend, No Drift)
Indonesia	-44.53031 ***	-44.52327 ***	-44.49288 ***
Malaysia	-44.32899 ***	-44.32256 ***	-44.33336 ***
Philippines	-44.04299 ***	-44.0455 ***	-44.0455 ***
Singapore	-49.32348 ***	-49.32324 ***	-49.33635 ***
Thailand	-49.78901 ***	-49.78253 ***	-49.75604 ***
Vietnam	-42.77521 ***	-42.76882 ***	-42.78925 ***
U.S.	-55.41523 ***	-55.41913 ***	-55.42656 ***

Critical values are from MacKinnon (1996). *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The optimal lag length is selected using the Bayesian Information Criteria.

APPENDIX 4

Dynamic Conditional Correlation Results

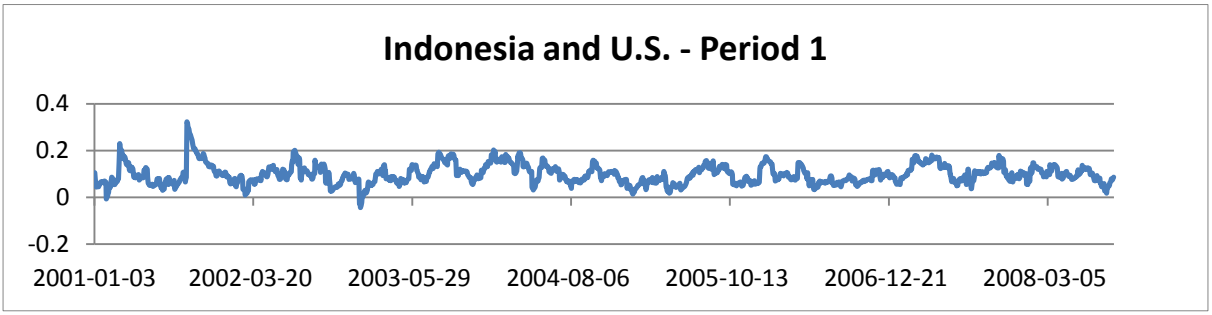

Figure 4. Dynamic Correlation between Indonesia and U.S. – Period 1

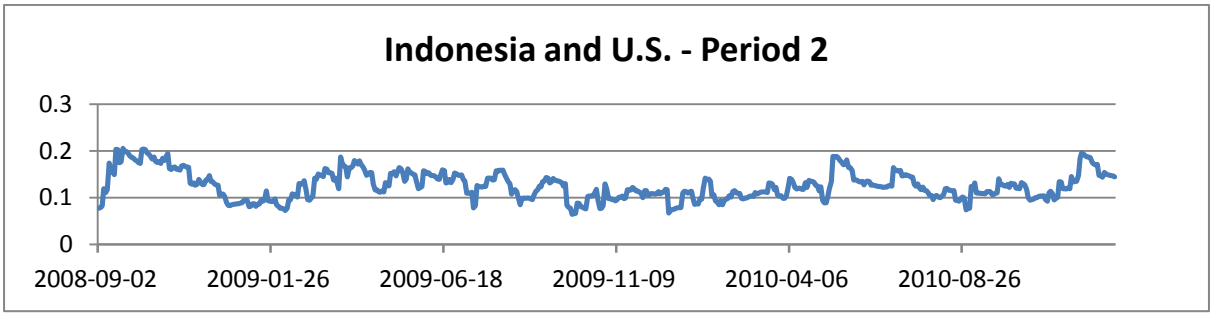

Figure 5. Dynamic Correlation between Indonesia and U.S – Period 2

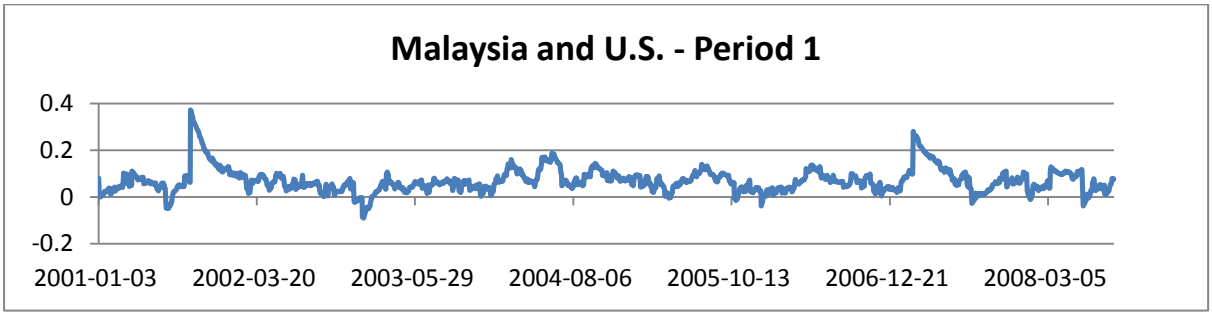

Figure 6. Dynamic Correlation between Malaysia and U.S. – Period 1

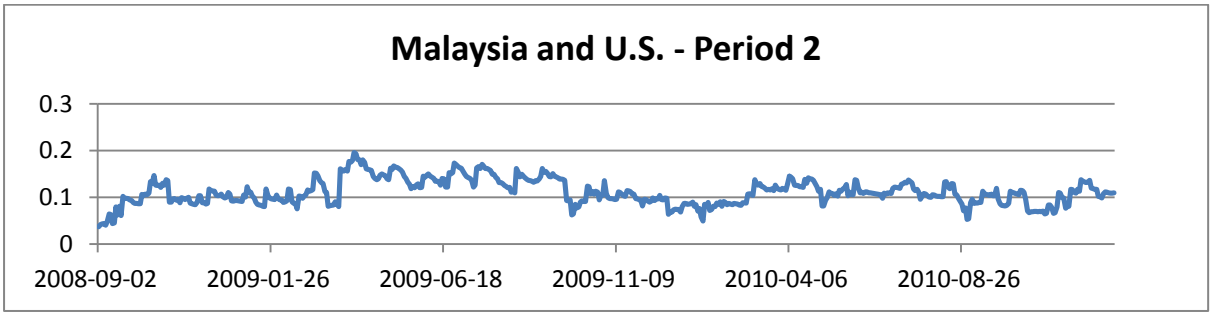

Figure 7. Dynamic Correlation between Malaysia and U.S. – Period 2

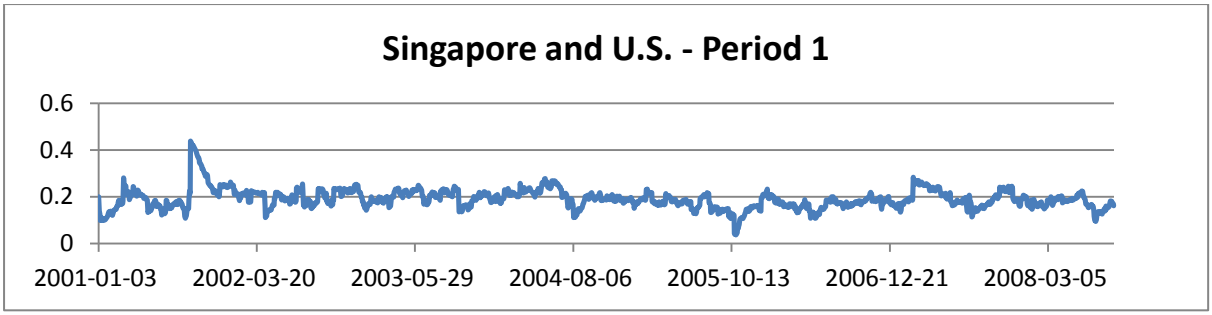

Figure 8. Dynamic Correlation between Singapore and U.S. – Period 1

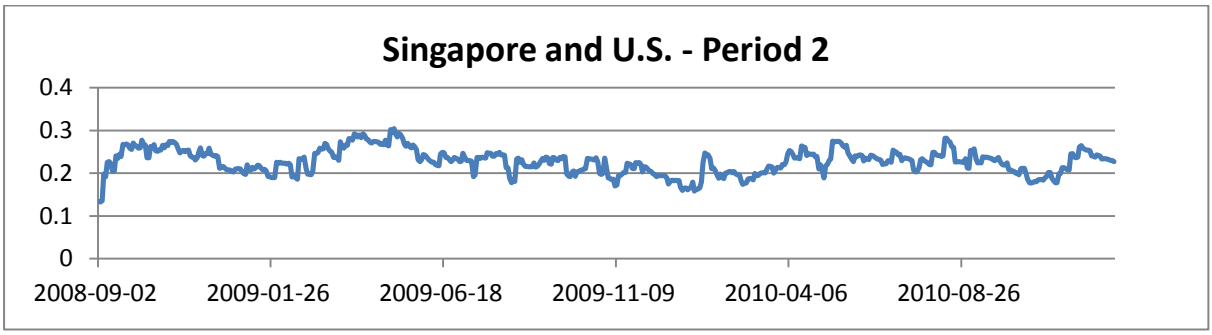

Figure 9. Dynamic Correlation between Singapore and U.S. – Period 2

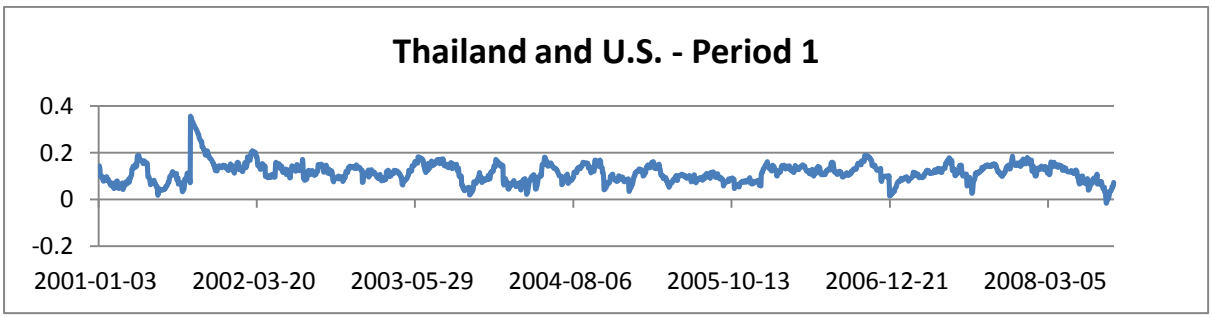

Figure 10. Dynamic Correlation between Thailand and U.S. – Period 1

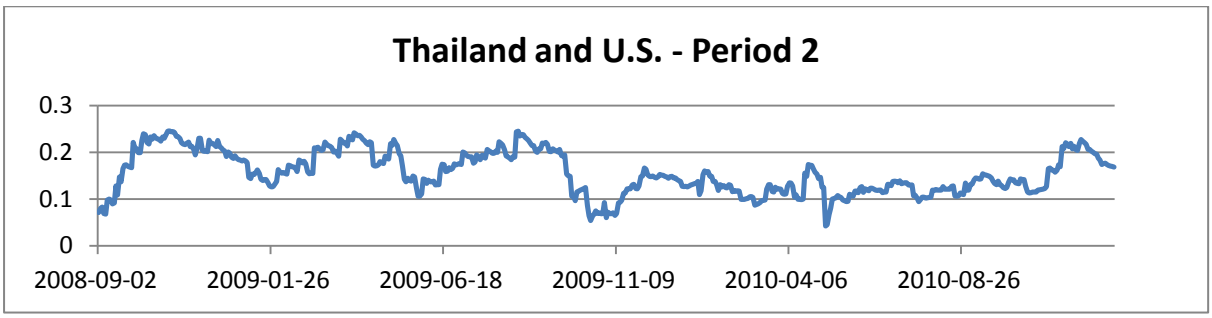

Figure 11. Dynamic Correlation between Thailand and U.S. – Period 2

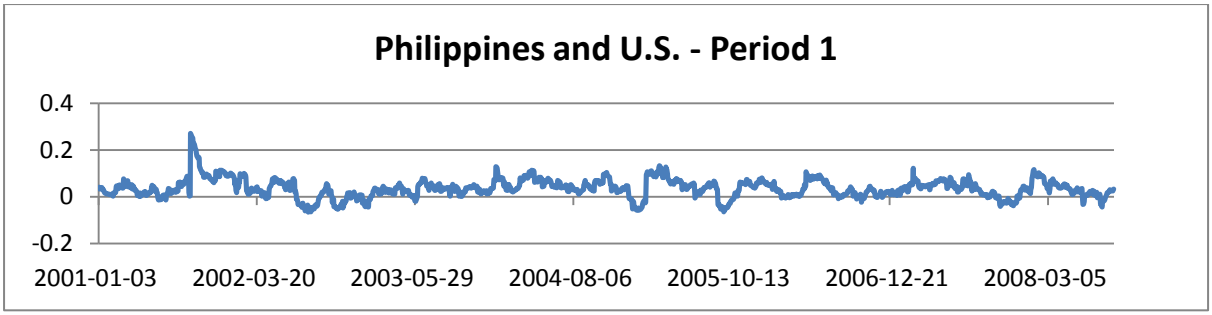

Figure 12. Dynamic Correlation between Philippines and U.S. – Period 1

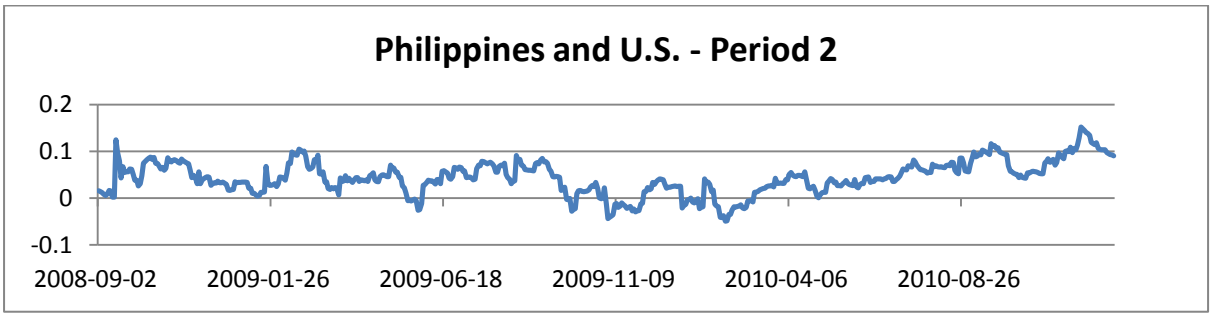

Figure 13. Dynamic Correlation between Philippines and U.S. – Period 2

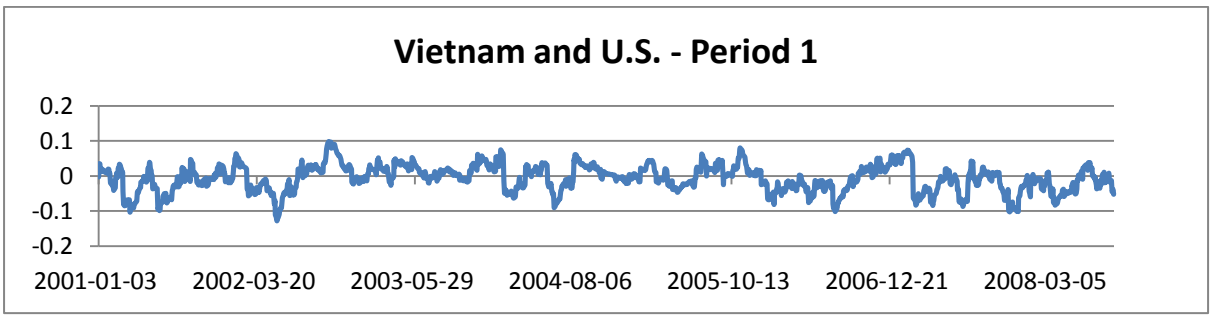

Figure 14. Dynamic Correlation between Vietnam and U.S. – Period 1

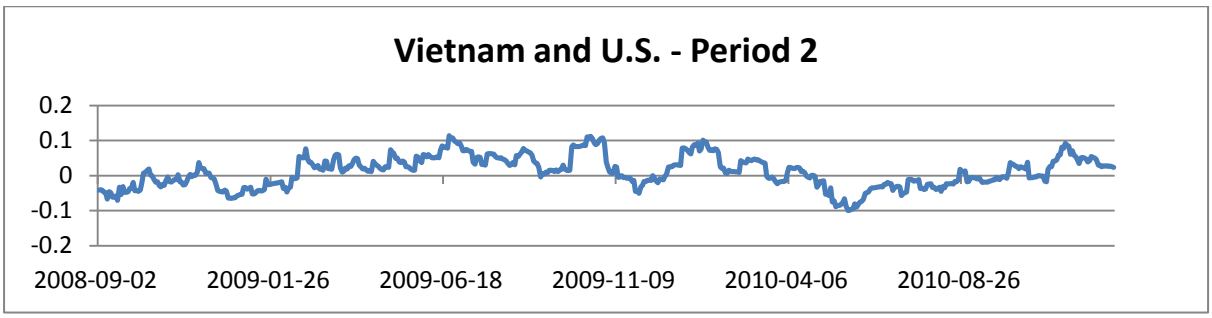

Figure 15. Dynamic Correlation between Vietnam and U.S. – Period 2

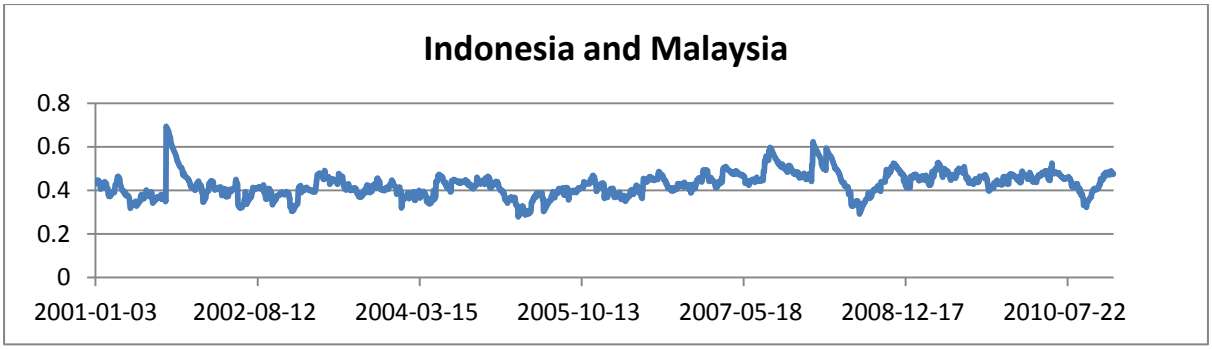

Figure 16. Dynamic Correlation between Indonesia and Malaysia

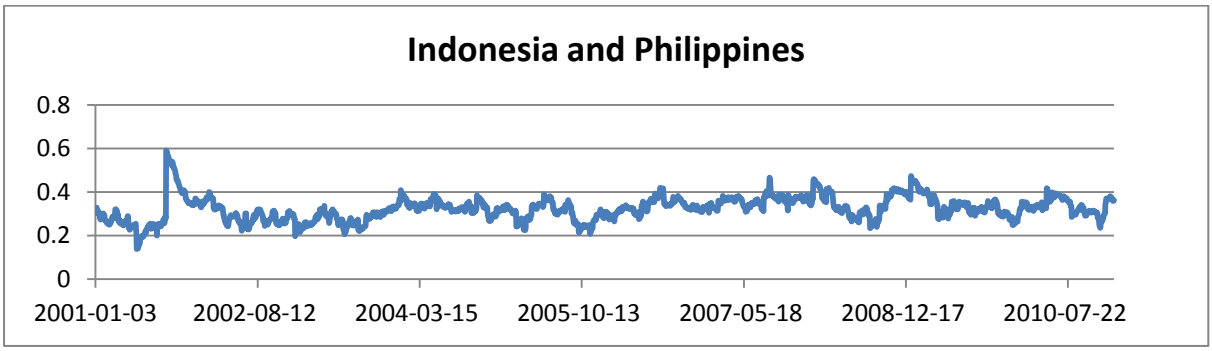

Figure 17. Dynamic Correlation between Indonesia and Philippines

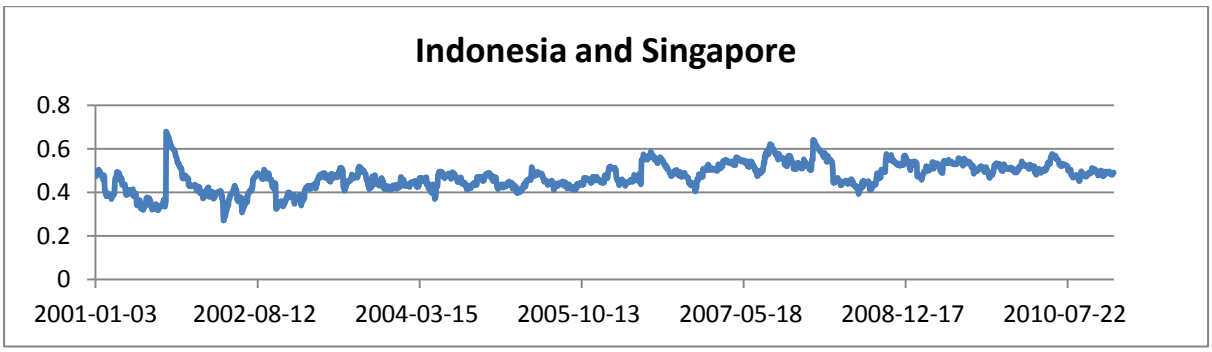

Figure 18. Dynamic Correlation between Indonesia and Singapore

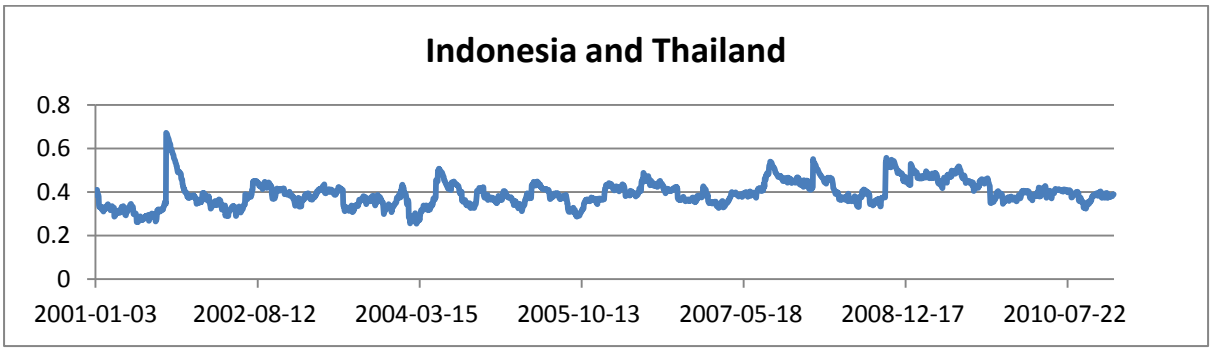

Figure 19. Dynamic Correlation between Indonesia and Thailand

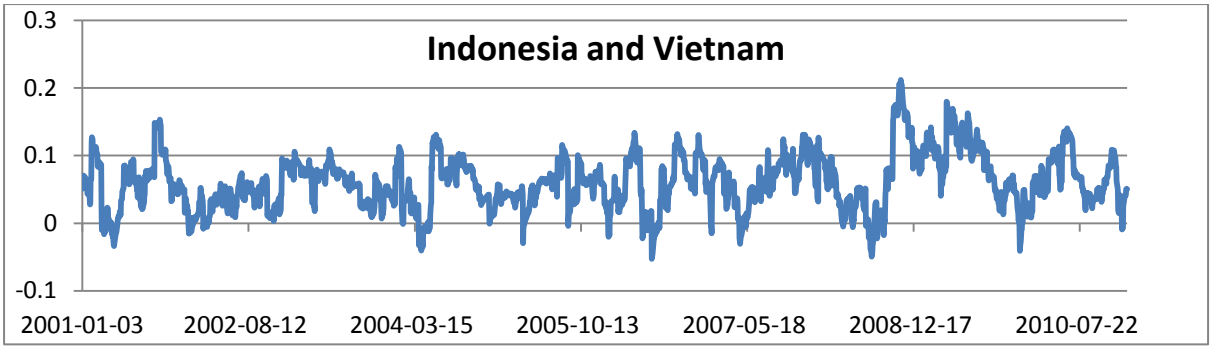

Figure 20. Dynamic Correlation between Indonesia and Vietnam

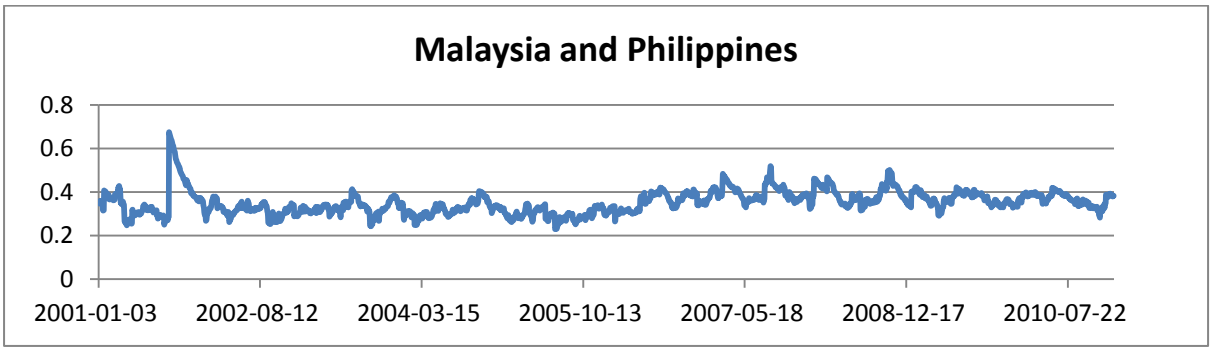

Figure 21. Dynamic Correlation between Malaysia and Philippines

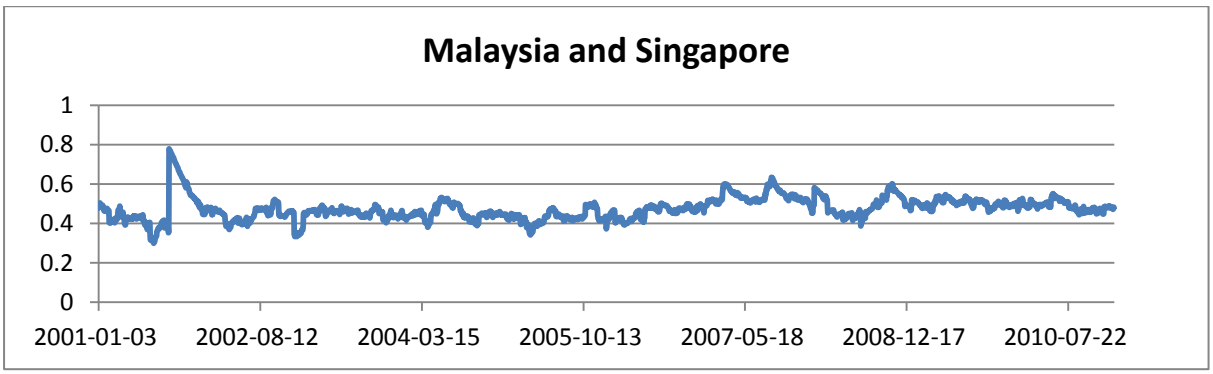

Figure 22. Dynamic Correlation between Malaysia and Singapore

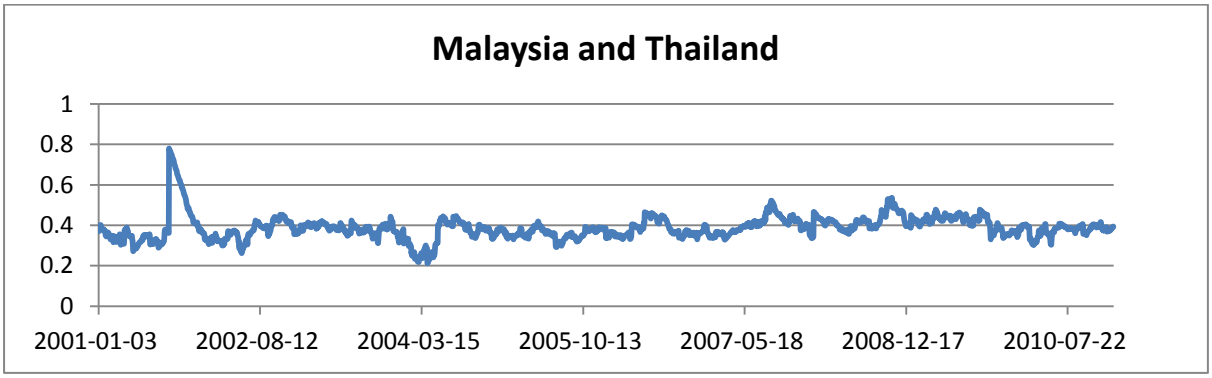

Figure 23. Dynamic Correlation between Malaysia and Thailand

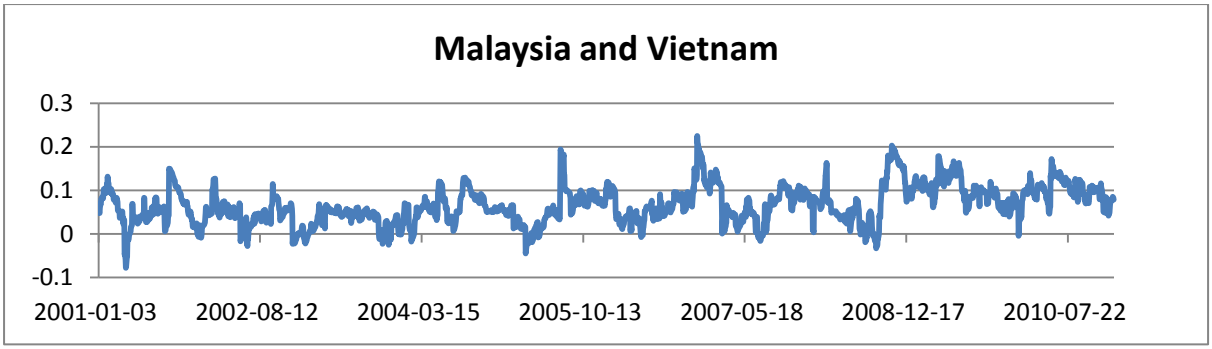

Figure 24. Dynamic Correlation between Malaysia and Vietnam

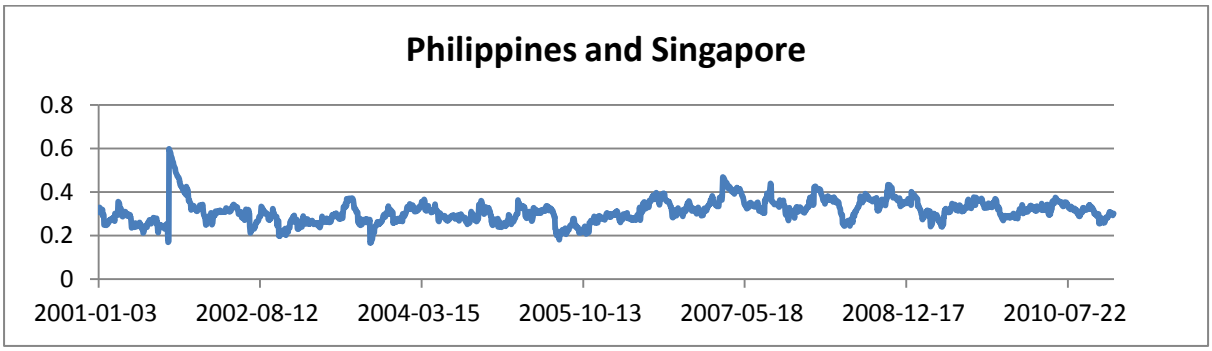

Figure 25. Dynamic Correlation between Philippines and Singapore

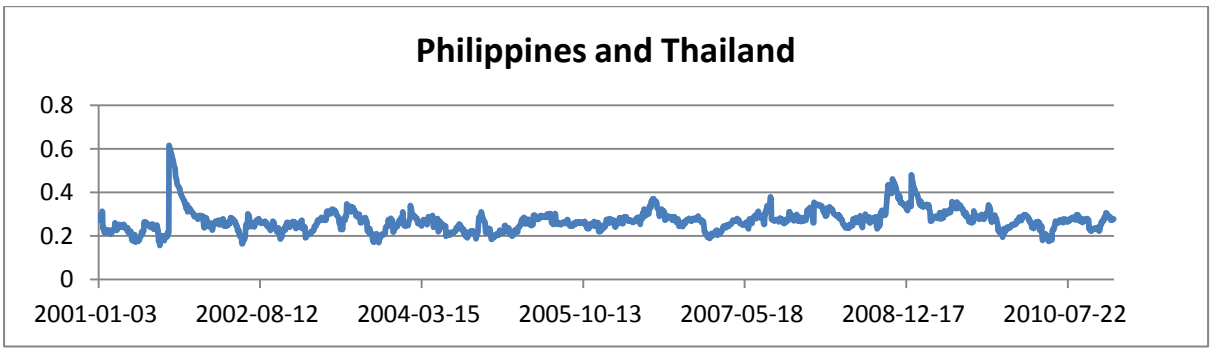

Figure 26. Dynamic Correlation between Philippines and Thailand

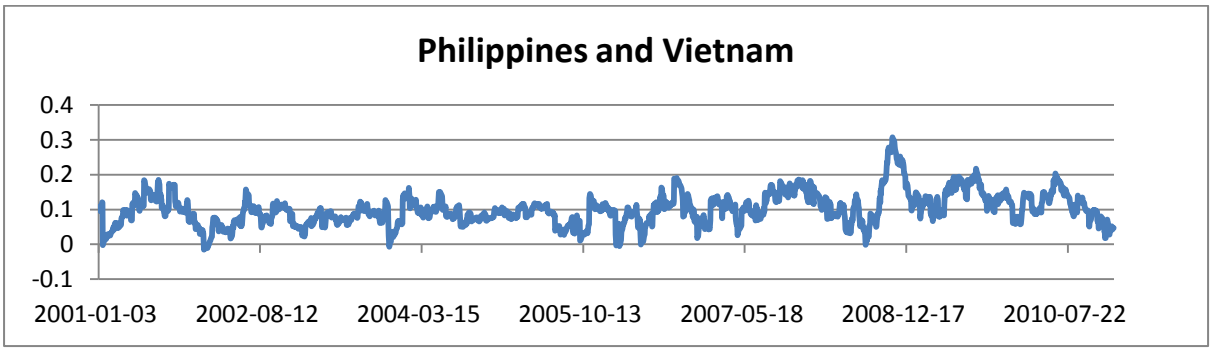

Figure 27. Dynamic Correlation between Philippines and Vietnam

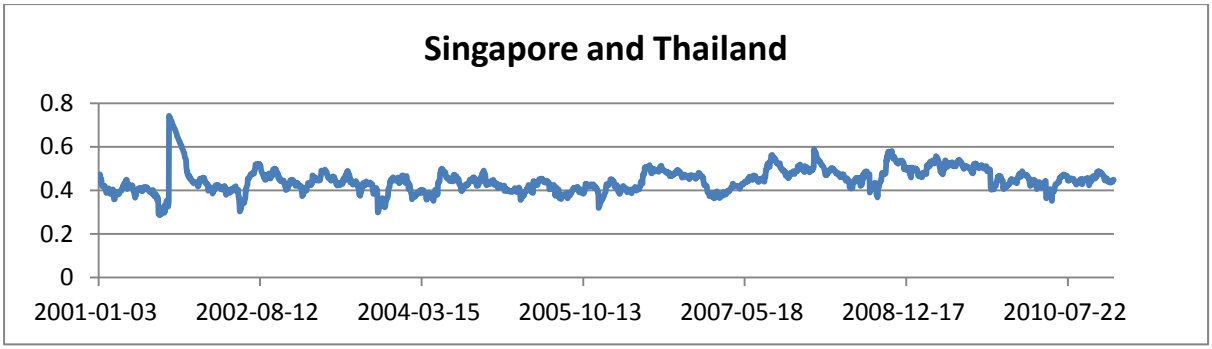

Figure 28. Dynamic Correlation between Singapore and Thailand

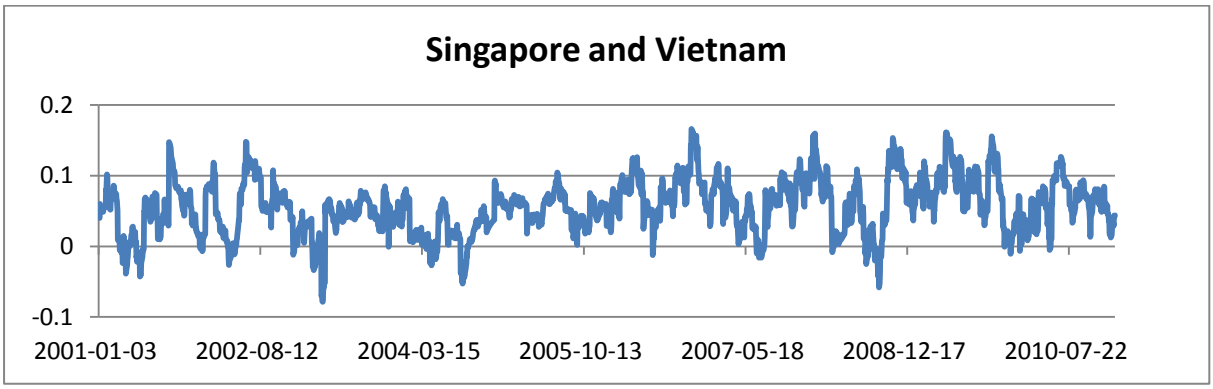

Figure 29. Dynamic Correlation between Singapore and Vietnam

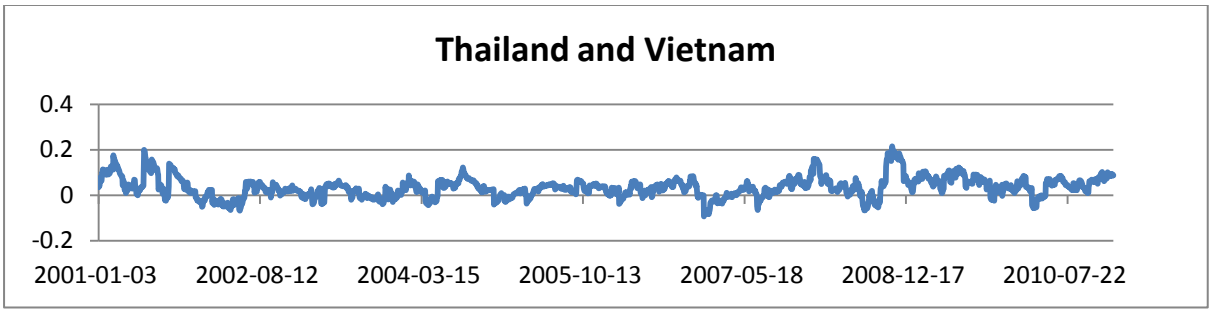

Figure 30. Dynamic Correlation between Thailand and Vietnam

Table 15. Average Conditional Correlation

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	U.S.
Indonesia	1.000	0.428	0.323	0.473	0.393	0.060	0.105
Malaysia		1.000	0.351	0.474	0.387	0.066	0.079
Philippines			1.000	0.311	0.270	0.100	0.037
Singapore				1.000	0.446	0.055	0.199
Thailand					1.000	0.035	0.124
Vietnam						1.000	-0.003
U.S.							1.000