STOCK MARKET INTEGRATION: A CASE STUDY OF ASEAN COUNTRIES

BY

MISS PHENPIMOL BOONBANDANRIT

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
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(INTERNATIONAL PROGRAM)
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ENTITLED

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was approved as partial fulfillment of the requirements for the degree of Master of Economics (International Program)

on August 5, 2016

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ABSTRACT

This study contributes to investigate the mechanism of ASEAN stock market integration through ASEAN trading link which included Singapore, Malaysia and Thailand. The study is starting from the simple hypothesis about the two way causality between others by applying VAR and SVAR model to test whether the completely stock market integration is occurred in our region. DCC-GARCH model is added in the next step to increase the efficiency of the model and to estimate the integrated level to show how much interdependent relationship we have. The last technique is used to estimate the long-run component which is the weak of DCC-GARCH. The results suggest that the completely stock market integration is not occurred in our regional cooperation. The obvious instruments we created like ASEAN trading link does not have more power to increase our interdependence dramatically. Increasing market development of the lower is the important booster for stock market integration.

Keywords: Stock market integration, VAR, DCC, DCC-MIDAS

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CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

The ASEAN Economic community (AEC) Blueprint 2015 aim to transform ASEAN into single market and product base that includes free flow of investment and capital. The main motivation of this cooperation is to improve the competitiveness of ASEAN financial market in global market stage. The capital experts and regulators from 10 countries generated the implementation plan to promote our financial integration in ASEAN capital market forum. After this achievement, the ASEAN exchange will move into top 10 ranking of market capital among world federation of Exchange (WFE) member. Although this goal seems to be positive, many issues still have to be dealt with, especially financial deregulation, which was the cause of the 1997 Asian financial crisis. As we need to be careful about the side effect of all derestricted policies, the complete capital market integration has been postponed to 2025.

Do we need to integrate? How do countries benefit from this project? These questions are directed toward all players in the economy, not only toward the financial sector. The answer is related to the bargaining power of each country. How can the bargaining power of each emerging country be increased? One answer is cooperation among countries. Many countries seek cooperation with other countries through bilateral cooperation, which escalates to multilateral cooperation in the region. The more countries cooperate, the more strength they have.

The benefits from the increased integration level are the reduction of the duplicated and complicated procedure of buying and selling financial products in international trading, transaction cost, and cost of capital for domestic firms, the improvement of the allocative efficiency of the portfolio, and the expanded investor base (Bae & Zhang, 2015; Bekaert, Harvey, & Lundblad, 2000). In addition, the correlation between stock's return is the important instrument for generating optimal portfolios. Therefore, the fluctuation of correlation affects their portfolios. The greater the understanding is, the more risks that can be diversified.

Nevertheless, stock market integration also provides an opposite result in the crisis period, but the effect depends on the integration level (Forbes & Rigobón, 2002). The more different they are, the more segmentation they have. ASEAN financial integration in the earlier stage has many differences and obstacles. A small mistake may affect the whole economy. Thus, moving to the global arena is a great challenge for ASEAN countries.

At present, although the stock market integration has not been completed yet, the market has been linked to other countries at different levels as evidenced by the Asian financial crisis and the great subprime crisis in 2007. The highest level of stock market integration occurred in the European Union (EU). The EU's single market has been used as the regional integration model. Although they can steadily increase their power in the global market, the EU lost some instruments for economic stability, such as their local currency. We cannot look at one only side of the coin. Risk sharing may be the opposite side in a crisis situation. Currently, crisis in other countries may be transmitted through regional integration. This extensive crisis effect is called the "contagion effect."

Most studies in the field of financial economics have shown the interesting result that contagion effect level increases in a crisis situation. This condition requires policy makers to be careful about their decisions on the integration level and the instrument to protect and recover their countries from the crisis. Increased integration in a normal period may be caused by the loss of policy autonomy. Therefore, we may have few solutions to stabilize the economy, such as those of Greece and other Eurozone members.

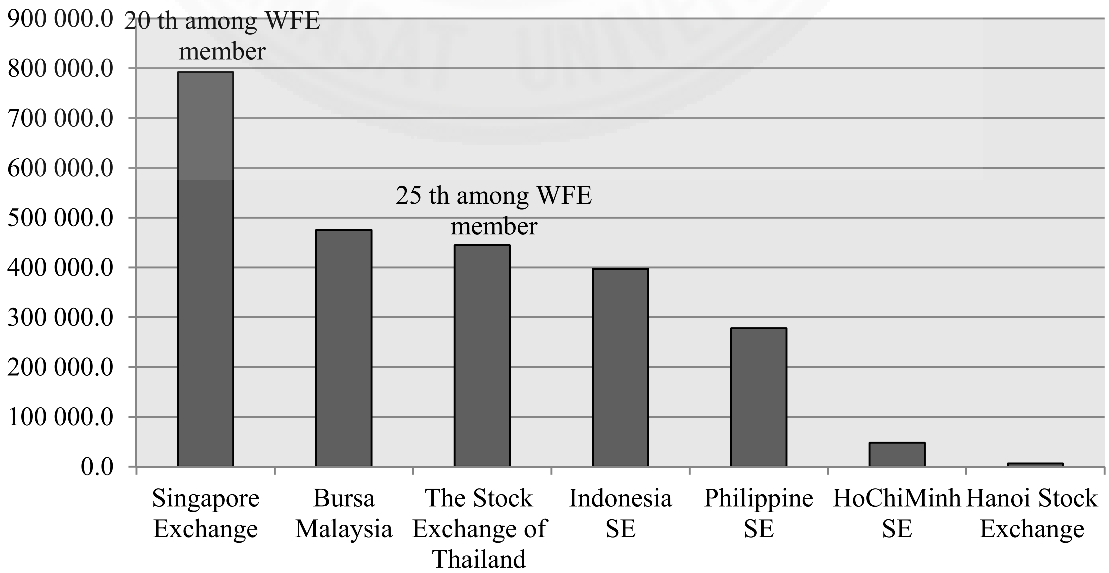
Did the stock market experience integration before the crisis occurred? This question is an interesting one. Some integration levels were reported prior to the crisis, and the integration level dramatically increased during the crisis period (Yang, J., et al, 2003 and Kim et al, 2005). These increases in integration levels support the asymmetric response of the stock market to different types of information, such as those in normal and crisis periods.

The ASEAN capital market integration is part of a single market and product base target. Despite having 10 ASEAN countries (i.e., Thailand, Singapore, Malaysia, Vietnam, Indonesia, the Philippines, Lao PDR, Myanmar, Cambodia, and Brunei), only seven stock markets from six countries are included in the integrated plan. The great challenge in this part of regional cooperation is the different characteristics and regulations of each stock market. The ASEAN financial integration has many differences and obstacles in the earlier stage. How long does the ASEAN financial integration take?

The main difference among the seven stock markets in the ASEAN exchange plan is shown in Figure 1.1. Singapore has the highest market capitalization and ranks 20th in the world market capitalization among WFE members. This world market capitalization level is higher than 1,449 percent of the sum of the two lowest market values from Lao PDR although the numbers of listed companies from Lao PDR and Singapore are not quite different. Differences can be found not only in market capitalization but also in the main sectors in each country. This difference creates benefits for others because strong countries need to help weak countries in increasing their financial development to achieve regional economic stability.

Figure 1.1

ASEAN market capitalization(USD millions) in May 2015

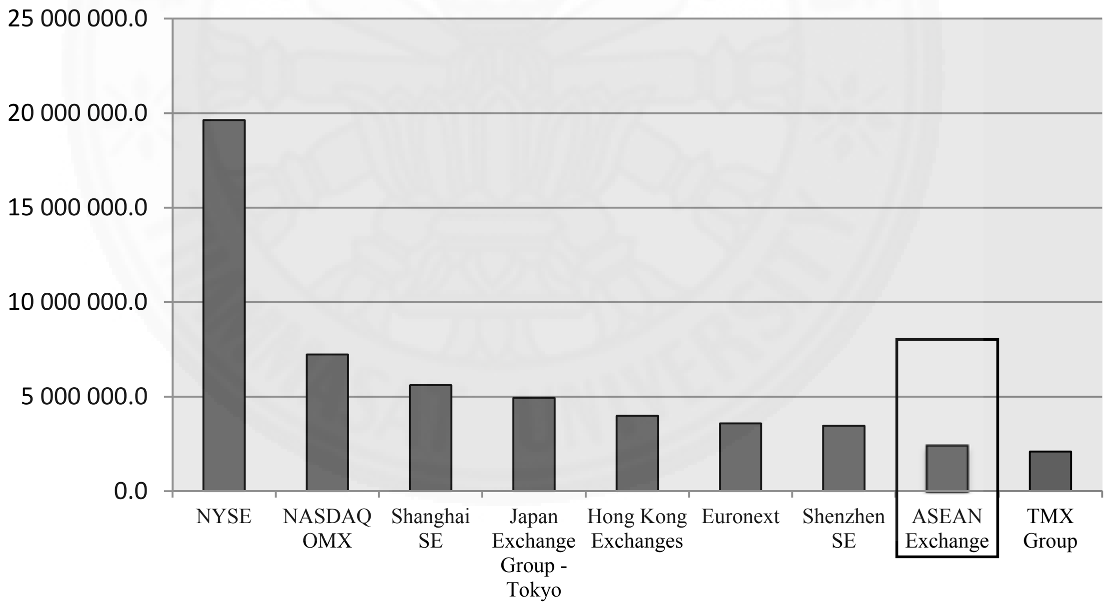


Source: World Federation of Exchanges (WFE)

After the complete integration, the ASEAN stock market will move into the top 10 ranking of market capital among WFE members. Accordingly, the role of Southeast Asia in the global financial market will increase. The ASEAN stock market's ranking will soar by leaps and bounds as shown in Figure 1.2. Stock market integration increases not only the role of the region in the global economy but also the economic growth and financial development of each country (Prasald et al, 2003). Before achieving the objective of the ASEAN economic community blueprint, all ASEAN countries need to adapt themselves in various dimensions, such as restructuring the limited foreign investment law and the requirements for listed companies to enter the stock market.

Figure 1.2

World market capitalization (USD millions) in May 2015



Source: World Federation of Exchanges (WFE)

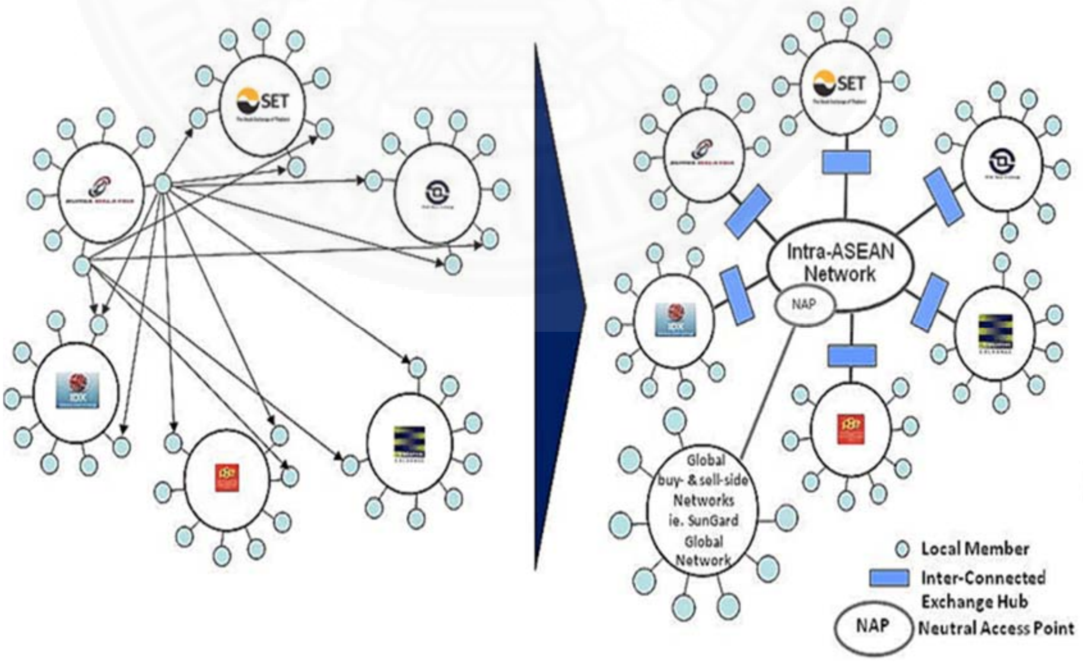
In the first stage of the ASEAN exchange, only the stock exchanges of Singapore and Malaysia were included the ASEAN exchange project in the first stage. Thailand joined this project in the fourth quarter of 2012 probably because of the different stages of its financial development (Sukcharoensin, 2013). Stock market integration seems to be concrete. Three stock markets (i.e., Singapore, Malaysia, and

Thailand) allow foreign investors to trade their domestic stocks through the ASEAN trading link, but such trading has not been developed nowadays.

Not only do policy makers need to be concerned about all the steps, but international traders must also understand the additional risks from outside, such as country risk and exchange rate risk. Moreover, complete information is required to support this cooperation. Although this project occurred three years ago, the ASEAN exchange project is still fresh among ASEAN traders at present. Did the project work? This question is the main issue of my study. The answer may be the incomplete information obtained from countries on outside investors (Arouri & Foulquier, 2012), or the increase in integration level being less than what was expected. Several instruments were created to support information on all investors, such as the blue-chip stock index called "ASEAN stars," "Invest ASEAN," which is a sharing information activity, and "ASEAN trading link," which is an easy trading gateway as shown in Figure 1.3.

Figure 1.3

The old system of cross-border trading and the new gateway of ASEAN trading link



Source: Stock exchange of Thailand (SET)

Table 1.1

Different Characteristices of Singapore, Malaysia and Thailand

Indicator	Country's name		
	Singapore	Malaysia	Thailand
Basic information[1]			
Population (million)	5.47	29.9	67.73
GDP (current billion US$)	307.9	326.9	373.8
Market information[2]			
Market capitalization (USD million)	613,005.20	347,397.20	358,437.10
Number of listed company	772	903	631
Domestic owners	484	893	631
Foreign owners	288	10	0
Dividend yield	4.470	3.430	3.220
Price per Earning ratio	12.24	12.56	17.76
Financial development[3]			
Stock market return (%, year-on-year)	8.40	8.75	20.91
Stock price volatility	11.62	8.58	16.85
Credit rating[4]			
S&P	AAA	A-	BBB+
Moody	Aaa	A3	Baa1
Fitch	AAA	A-	BBB+

Source: CEIC data, Global financial development data, World exchange forum

[1] Basic information from World bank database in 2013

[2] Market information : Market Capitalization, Number of listed company from WEF monthly database in September 2015, Dividend yield and P/E ratio from CEIC database in September 2015

[3] Financial development from World bank database in 2013

[4] Credit rating : http://www.tradingeconomics.com/

To support ASEAN economic blueprint, we need to make this project being famous extensively. This means that the efficient level of this project is depend on the ability to access domestic and foreign securities of both domestic and international investors. How to increase investor's accessibility? We need to understand more about this integration. Because of the difference in country's characteristics (as shown in table 1.1), the level of integration between each countries will not be equal (Dumas, Harvey and Ruiz, 2003). There are a lot of empirical researches in this field but most of them scope in of Eurozone and global integration. I study the relationship of stock market integration by employing vector autoregressive model (VAR), using Structural vector autoregressive model (SVAR) to test more about the real mechanism and put some dummy variable to test the contagion in stock market integration by testing the relationship between crisis dummy and residual from VAR model which made by Favero and Giavazzi (2002).

This study aims to investigate the mechanism of integration using the VAR model. I use daily data from three stock markets that joined the ASEAN trading link, compare the result before and after integration, and test whether or not the ASEAN trading link project is efficient. If the project works, how does it work? Which stock market leads the others? What benefits do we receive? For an in-depth analysis, I examine the factor we need to consider to understand this mechanism. If our instruments for economic stability are the important integrated factors, we need to be concerned about loss of policy autonomy. The result of the investigation can help us understand the current stock market integration in the ASEAN exchange.

1.2 Objective of the Study

The purpose of this study is to investigate the mechanism of stock market integration in the ASEAN exchange project by

1. Testing the co-movement of all stock markets in the ASEAN trading link to elucidate the current state of the ASEAN stock market integration,

2. Comparing the before and after situations of the ASEAN trading link that occurred, and

3. Investigating the determinants of stock market integration.

1.3 Scope of the Study

This study focuses on the mechanism of the ASEAN stock market integration. The ASEAN has six countries, but only three countries entered the ASEAN trading link. Therefore, I test the co-movement of the return among Singapore Exchange, Bursa Malaysia, and Stock Exchange of Thailand, which joined the project to examine the mechanism of integration. High-frequency data are used in this model to analyze the movement and reaction of the return for each stock exchange. I obtain the daily data of the three stock markets from Datastream. Daily data are observed from December 31, 1999 to September 21, 2015. This model includes not only a mechanism of integration but also the contagion effect. Dummy variables are used as proxy for the subprime crisis (mortgage crisis), Eurozone crisis (debt crisis), and China's Black Monday. I consider the crisis affecting the global financial market because of the complexity of integration. The measurement of integration requires the inclusion of all properties of financial data. I use the VAR and SVAR models to analyze the current state of the financial integration in our project. For an in-depth study, I add a conditional model, namely, GARCH, to check for robustness. Aside from using system equation, such as VAR and SVAR, I also use advance techniques, such as DCC–GARCH and DCC–MIDAS, to measure the integration level through conditional correlation.

1.4 Organization of the Study

The study comprises five chapters. The first chapter gives a brief overview of the statement of the problem, objective, research question, scope, and organization of the study. Chapter 2 presents the literature review of both empirical studies and theoretical framework, and it supports the methodology in the next chapter. The conclusion and policy implications are shown in the last chapter.

CHAPTER 2

LITERATURE REVIEW AND ANALYTICAL FRAMEWORK

"A new direction for research on stock market co-movements. Focusing on how international propagation mechanisms change after a shock may not be the most productive approach. Instead, research should focus on why markets are so highly integrated during periods of relative stability, as well as during periods of crisis."

Forbes and Rigobon (2001)

Stock market integration has been an interesting topic in financial development for 20 years. Most studies in this field focused on the mechanism of stock price in crisis periods called "contagion effect" (Caporale, Schulze-Ghattas, & Beirne, 2008; Favero & Giavazzi, 2002; Forbes & Rigobón, 2002; Stulz, Bae, Karolyi, & National Bureau of Economic Research., 2000). The results generally show that the correlation among international stock markets seems to dramatically increase during crisis periods. How about in normal period? Does inter-country correlation increase? If the correlation increases, what are the determinants that affect it? This study attempts to fill this gap by considering the normal period of the ASEAN stock market integration. As the contagion and integration of stock markets are complicated issues, we may not be able to clearly separate these two topics, especially during crisis periods. An important instrument that many papers use is definition. Previous authors defined stock market integration to separate it from the contagion effect. The definitions of both stock market integration and the contagion effect are also important to classify their actual effects. After distinguishing these concepts, we develop a measurement that can evaluate our market integration and test how it changes.

Market integration has many definitions. In the present study, market integration can occur through empirical evidence, such as cooperation policy, and the co-movement among stock markets. Policy makers use market integration to increase the global market's competitiveness. Both emerging and developed countries should improve the competitiveness of the global market. For example, the Shanghai–Hong

Kong Stock Connect was established in 2014. Euronext integrated five stock markets, namely, Paris, Amsterdam, Brussels, London, and Lisbon. To obtain the actual result of this regional cooperation, we need to examine fluctuation (e.g., the contagion effect), which occurs according to investors' sentiment. Therefore, measuring the actual effect of fluctuation is difficult. The contagion level depends on the type and magnitude of sentiments investors have.

2.1 Analytical Framework

In this sub-section, I present the analytical framework, which begins with a definition of complete stock market integration by assuming the law of one price theory. Law of one price proposes that prices in different countries should be the same. However, the international market has complex conditions, such as exchange rates. This condition creates an unequal return index for the international market. International market efficiency is the second analytical framework I use.

2.1.1 Law of one price

The law of one price is used to define complete stock market integration. Most papers in this field use this law to assume complete stock market integration (Bentes, 2015; Click & Plummer, 2005; Dorodnykh, 2013; Korajczyk, 1996). The law of one price implies that prices of homogeneous goods in different locations should be the same if they have the same conditions. The stock price may not be used as a proxy when applied to the stock market because of the differences in capital and structure of each company in each country. Thus, using the rate of return is more suitable than stock price.

According to Sharpe (1964), the CAPM formula shows that the same rate of return cannot occur when risk level is different. This finding supports the fact that complete stock market integration can occur among stock markets that are not different. Some studies have defined complete market integration as a characteristic of stock markets that have no restrictions for investors to buy or sell assets. The qualitative indicator, which shows complete stock market integration, is the same as the law of one price assumption.

Lamont and Thaler (2003) explained that the law of one price refers to the market equilibrium, which has no arbitrage opportunity. Thus, if all markets have one price for each of their goods, no market can make more profit than the other. There are four assumptions to make this law existed; perfect information, homogenous commodities, no transportation and transaction cost, and no trading barrier.

From these assumptions, we can imply that the law of one price is usable in an efficient market. We can adapt this law as a condition of complete stock market integration. In the stock market, we use returns instead of goods or commodities. Complete stock market integration occurs when the return in one market is equal to those of other markets that have the same constraints, such as risk.

According to these assumptions, the law of one price seems to be unrealistic in the real world. Several markets, especially those of developing countries and undeveloped countries, have trade barriers to protect themselves from others. This empirical finding supports the fact that we do not have complete stock market integration in the real world. Despite the incomplete integration, we still have some level of financial integration in the real world though such factors as economic integration, financial development, and capital flow.

2.1.2 Definition of stock market integration

Different studies provide different definitions of stock market integration. In this paper. We base our definition of stock market integration on the law of one price. Complete stock market integration refers to the situation in which returns in different geographies should be equal with the same fundamentals. That is, the change of return in one should affect other countries at the same level. Incomplete stock market integration involves the co-movement of stock returns.

2.1.3 International market efficiency

Solnik (1996) argued that efficiency and complete stock market integration have a causal relationship. The greater the efficiency is, the higher the integration level. Solnik (1996) identified five factors as barriers that increase the segmentation level among markets.

2.1.3.1. Psychological barrier is considered by some as “home bias” because investors in a host country know news and information first before outsiders do. The barrier for some outside investors is not only information but also other characteristics, such as language and time.

2.1.3.2. Lessons from previous crises are the factor that makes all policy makers aware of the legal restriction, which can stabilize and protect their economy from international speculators, such as the 1997 ASEAN financial crisis.

2.1.3.3. Transaction cost and discriminatory taxation are the two factors that policy makers can easily control and use as instruments to attract fund flow. Host people not only pay for lower transaction costs of trading but also for lower taxes than outsiders because of double taxation, which outsiders need to pay at their home countries.

2.1.3.4 Investors need to be aware of *Exchange risk* because they need to hold the equity at some time. This risk is included as a holding cost. Some investors can reduce this risk by hedging their currency in future markets.

2.1.3.5. *Political risk* is an unexpected factor, and its side effect is not known. For instance, we do not know when terrorism may occur.

The greater these factors are, the more uncertainty that international investors bear. These barriers can make all international investors aware of their investment decisions and be wary of investing outside of their home.

2.2 Literature Review

In this section, I briefly review the related work on stock market integration. How can we call stock markets integrated with one another? We need to understand the definition of stock market integration first. Most studies have used the return index of each stock market. After determining the definition and the indicator, I review the methodology to measure the integration level to understand the mechanism. Then, I review the empirical result of inter-regional and intra-regional stock market integrations. Lastly, I explain the cause and transmission mechanism as the contagion effect.

2.2.1 The measurement of the integrated level

Numerous methods are used to measure the level of stock market integration starting from basic statistics to advanced econometric models. Errunza and Losq (1984) generated the integrated index, which is considered an extreme case of the relationship similar to integration and segmentation. A zero value of the E–L index shows the complete stock market integration that these stock markets had. An insignificant variable, such as correlation between the world and conditional variance, is the main indicator of both results. This integration level applies to international asset pricing models. Most empirical evidence shows that complete integration or segmentation cannot occur in the real world. Therefore, the index may not be suitable to our study.

Most properties are added to fulfill the gap of previous works. The basic indicator is the unconditional correlation in returns across countries. Baltzer et al. (2008) examined financial integration in new EU member states. Twelve countries joined the EU on different dates. The present paper uses different techniques to explain the integration in that area. Cross-sectional dispersion in the benchmark is the basic indicator. The result from this standard deviation shows that new EU members are integrated in their groups more than in the states. This method seems to have a descriptive result.

The next basic indicator is R-square. Pukthuanthog and Roll (2009) generated their model using a multi-factor model and used global factors as explanatory variables in the model through simple linear regression. R-square from ordinary least squares (OLS) is the integrated indicator in the present paper. The result shows that European countries are integrated through the global stock market. Malaysia seems to be less integrated than others. Several empirical studies have adapted this method as their methodology. Bae (2011) examined the regional stock market integration of 31 countries from three regions by adding the regional fundamental factors using OLS to estimate the adjusted R-square similar to Pukthuanthong and Roll. These additions distinguish the global from regional integration. Estimating pure regional integration is the difference in the adjusted R-square between regional and global integrations. According to the result, Thailand has the lowest pure regional integration but the highest global integration, whereas Singapore has the highest pure regional integration.

All previous methodology considered the relationship between country and country, regions, and world. Previous literature did not show more than two groups of relationships, which could be systematic relationships among countries, regions, and world. The system equation is added to show this correlation. The VAR model and the vector error correction model (VECM) (AuYong, Gan, & Treepongkaruna, 2004; Sheng & Tu, 2000; Yutaka & Eiji, 2006) are the most popular models in this field. These models can show the system relationship for all dimensions of cooperation. The difference in both estimations is the data properties. Non-stationary variables, such as price index, are suitable for the VECM (Choudhry, 1996; Hassan & Naka, 1996; Masih & Masih, 1999; Maysami & Koh, 2000). The co-integration test is used in this model. Although this model shows short-run and long-run relationships through coefficients and tests, it can only present the ordinal scale of integration. Its estimated result is different and more difficult to understand than that in the VAR model.

The VAR model (Brailsford, Neill, & Penm, 2007; Huang, Yang, & Hu, 2000) model requires a stationary variable. It cannot show short-run and long-run results similar to the VECM. The Granger causality test is the integrated indicator of this model. Some papers added more conditions to increase the explanatory ability of the model. According to Brailsford et al. (2008), the VAR model with and without disregarding the factor is the measurement of integration. The authors used the new data weighting process to include human behavior, such as the "forgetting factor," which considers the current period more than earlier data. The result from VAR is different. The forgetting vector remains more consistent with the real world more than without it. The Thailand, Singapore, and Philippine exchanges are highly integrated with the ASEAN and the Asia-Pacific region. The returns of the stock market in the real world have high volatility all the time. Thus, the basic method may not be practical to be used as an indicator.

Advanced properties (e.g., time-varying volatility) have been added to studies. This significant condition in this real world is supported by using the GARCH model. Bekaert and Harvey (1995) used the regime switch model to analyze the world stock market integration. The authors generated the model by assuming the switching between two regimes based on the information they have at that time. This model is correlated with the investor behavior that investors respond differently to different types of news. Bad news may affect investors' decision more than good news; this situation is referred to as the "bad news principle."

Kim et al. (2005) used descriptive statics to analyze the relationship between the developed national and EU, as well as the bivariate ARMA-EGARCH model. The authors adopted the same integrated indicator, such as Bekaert and Harvey's (1995) conditional correlation, with different assumptions. This method assumes constant correlation, which may be impossible in the real world. The DCC model is applied to fulfill this dynamic conditional correlation.

2.2.2 Cause and Transmission Mechanisms of stock market contagion

Different studies have provided different definitions of market contagion. Vester (2006) defined pure contagion as follows: "A form of pure contagion does not involve any macroeconomic fundamentals but take into consideration liquidity, incentive problems, asymmetric information and coordination problems, multiple equilibria and the changes in the rule of game." This definition supports the contagion effect being a situation based on investors' sentiment. In the present paper, the definition of contagion is based on Favero and Giavazzi (2002). The authors defined the contagion as "the nonlinearity of propagation of financial shocks across countries."

2.2.3 Fundamental factor

Most reviews in this field focused on the European equity market integration, which has the strongest regional cooperation in the financial world. The estimated result in these studies showed doubtful results. Hardouvelis et al. (2006) examined stock market integration in individual Eurozone countries from 1995 to 1998. The authors estimated the model using the IAPMs model with time-varying volatility. After the EMU, the trend of the integration level between individual countries and Eurozone seems to be the same, except for the United Kingdom. Ten of the eleven countries in their study showed an upward trend, but only the United Kingdom showed a downward trend after 1994. Thus, a single currency can increase the integration level in these regions. Different estimated results were presented by Kim et al. (2005) and Bekaert et al. (2010). Their studies showed that the integration level between EMU and non-EMU, such as the United Kingdom and Denmark, followed the low-level integration of the other Eurozone countries (countries that do not have Euro as their local currency), which consist of only developed countries. Kalemli-Ozcan et al. (2010) also considered the effect of currency on their market integration using data on banks' cross-border bilateral stocks of assets and liabilities. The result shows that a single currency is the main force that increases their financial integration.

Kim et al. (2005) and Wang and Moore (2008) examined the factors that increase the integration level in the Eurozone. Kim et al. (2005) used the seemingly unrelated estimation to explain the effect of stock market integration on other markers. The authors used the exchange rate volatility, interest rate, log of turnover by value, financial development, and the seasonal dummy. Wang and Moore (2008) used the linear regression model with a different data set. These results of previous works all show that financial development is a significant factor for increasing the integration level. The insignificant variable is the exchange rate volatility. This variable may be significant in the case of the ASEAN because we do not use a single currency like the EU does.

Hooy and Goh (2007) used panel data to analyze the determinants of stock market integration based on three groups of variables, namely, market attributes, economic fundamentals, and world information, from 26 countries. The result shows that financial development also affects the integration level. More variables also affect the integration level, such as trade openness, different dividend yield, and market volatility, although the exchange remains insignificant. Table 2.1 presents the fundamental factors that each paper used to explain stock market integration.

Previous literature showed that some economic factors, such as exchange rate volatility, could affect equity market integration although a high correlation exists similar to the Eurozone. How about in our ASEAN countries? We have several differences not only in stock markets but also in our economies.

Table 2.1

Determinants of stock market integration

Main variable	Proxy	reference	Economic implication on stock market integration
Stock market development	Ratio of stock market capitalization to GDP	Bekaert and Harvey (1995), Bekaet et al(2002) and Kim et al(2005)	With the increases in stock market development, we create more financial depth in their market (more size and more liquidity). These procedures attract a considerable amount of fund flow to our investment, especially in emerging countries.
Market Openness	Total trade divided by nominal GDP	Bhattacharya and Daouk (2002), Carrieri et al. (2007) and Kim et al(2005)	This factor is from real sectors. The more we open these sectors, the more foreign investments will be created, especially in emerging countries. However, financial openness and economic openness should be created at different levels because we need to be careful with financial integration, which can move faster than economic activity. The more openness we create, the more barriers are reduced for outside investors to increase the integration level.

Table 2.1 (continued)

Main variable	Proxy	reference	Economic implication on stock market integration
Economic indicator	Differential inflation rate Spread of interest	Bekaert et al(2002) , Harvey(1995)and Narayan et al.(2014)	According to the law of one price, the more differences we have, the more segmentations are created. In the case of interest, this variable can be seen from both sides. More differences in interest rates attract international investors to invest in their countries, not only in the stock market. This activity leads the market to equilibrium at zero difference and further increase the integration level.
	Exchange rate volatility	Bekaert et al(2002)	The first step to invest outside is to understand international currency. We need to be concerned when to buy some international assets and when to hold them for long periods. The fluctuation of this currency is viewed as an exchange rate risk. More volatility will bring more uncertainty to international investors. Although traders and institutions can be reduced by using a hedging activity, individual investors, such as the big group in SET in Thailand, may not understand this circumstance, thereby causing losses in the market. This shock can lead them to withdraw their money, which reduces our integration level.

Table 2.1 (continued)

Main variable	Proxy	Reference	Economic implication on stock market integration
Expected return	Differential dividend yield	Bekaert et al(2002), Bekaert and Harvey (1995), Hardouvelis et al. (2006) and Teulon et al. (2014)	Dividend yield is used in several financial theories to estimate the current price of the value asset. The difference in dividend yield gives different expected values. This difference leads the investors to invest those assets differently. Flow of investment moves to a higher dividend yield. The more investments are made in those assets, the more the price increases and the mechanism moves to equilibrium. This condition can induce both an increase and a decrease in stock market integration. Not only will international investors move to our countries if we have more returns for them, but domestic investors that invest abroad may also move their capital back home. This circumstance may create either side of the stock market integration depending on the power we have, such as in the cause of US investors after the QE policy's implementation. The US stock market attracted a considerable amount of investors.

Table 2.1 (continued)

Source: Author's reviews

Main variable	Proxy	Reference	Economic implication on stock market integration
Expected return	P/E Ratio	Narayan et al.(2014)	Most investors use the P/E ratio as a proxy of stock market risk. The higher the P/E ratio is, the more risk we have as price increases more than we can earn. As the law of one price indicates, we need to have the same condition to attain complete stock market integration. Thus, creating different conditions increases segmentation.

CHAPTER 3

RESEARCH METHODOLOGY

This paper tried to study about capital market integration which was in some parts of ASEAN economic blueprint. For understanding clearly, I separate my research methodology in six parts. First part is the set of variables. This part shows all variables I apply in this study; Price index, dummy variables and Fundamental factors. Next five parts show all important technique I use to understand the mechanism of our regional stock market integration.

For model parts, I start with simple the famous model in this field like VAR model. Vector autoregressive model (VAR) which can show the lagged effect from other markets is used in this study. The first hypothesis is created to understand more on the co-movement of the stock market integration in intra-regional countries. Not only the hypothesis, but I also create some dummy variable which help to separate some complexity of market integration, called "contagion effect". Those procedure will help to answer some parts of first objective. For more understanding, I separate my analysis in two sub periods as before and after ASEAN trading link and also consider the whole period. Next step is testing the required property of VAR model such as stability testing through Eigenvalue. The Granger causality is required to answer the first hypothesis we created. After VAR model, I will consider Structural vector autoregressive model (SVAR) to analyze the simultaneous effect of each market by assuming some restriction and test whether the result change.

Because of Globalization, the trading activity can occur easily by only one check though we are in other sides of the world. This easiness make the fluctuation occurred all the time. This support that time-varying occurs in high frequency data link stock market nowadays. I add this property to my analysis by using VAR with trivariate generalized autoregressive conditional heteroskedasticity (GARCH) model. Not only the fitted result we get but we also get the proxy of integrated level from additional GARCH model. Dynamic conditional correlation GARCH (DCC-GARCH) model is the best fit for being the additional GARCH model in our estimation. The estimated result we want from DCC-GARCH model is conditional correlation. Although this multivariate GARCH model is more useful, the long-run constant conditional correlation is assume in this model. To deeper understand, we need to check the long-run relationship between all of us. DCC-MIDAS is the next advance technique we use for more understanding. After getting the integrated level, we use this to explain and compare the efficiency of the cooperative policy we had.

Because our relationship exists through real linkage and financial linkage, they might have some factor which can also create and change the integrated level we have. Fundamental factor in the countries might be the interesting factor in those analysis and this might help to create some policy implementation for increase our stock market development. For these reason, I will test the intra-regional determinant factor which might affect our stock market integration at the end of my research.

3.1 The Set of All Variables

In this study, I use three set of variables. First set is the daily aggregate index series of Stock exchange of Thailand, Singapore exchange and Bursa Malaysia from Thomson Reuters-Datastream.

The formula of market capitalization-weighted price index

$$P_{it} = \frac{mkt.capitalization_{it}}{mkt.capitalization_{i0}}$$

Where

P_{it} is aggregate stock price index at period t of country i.

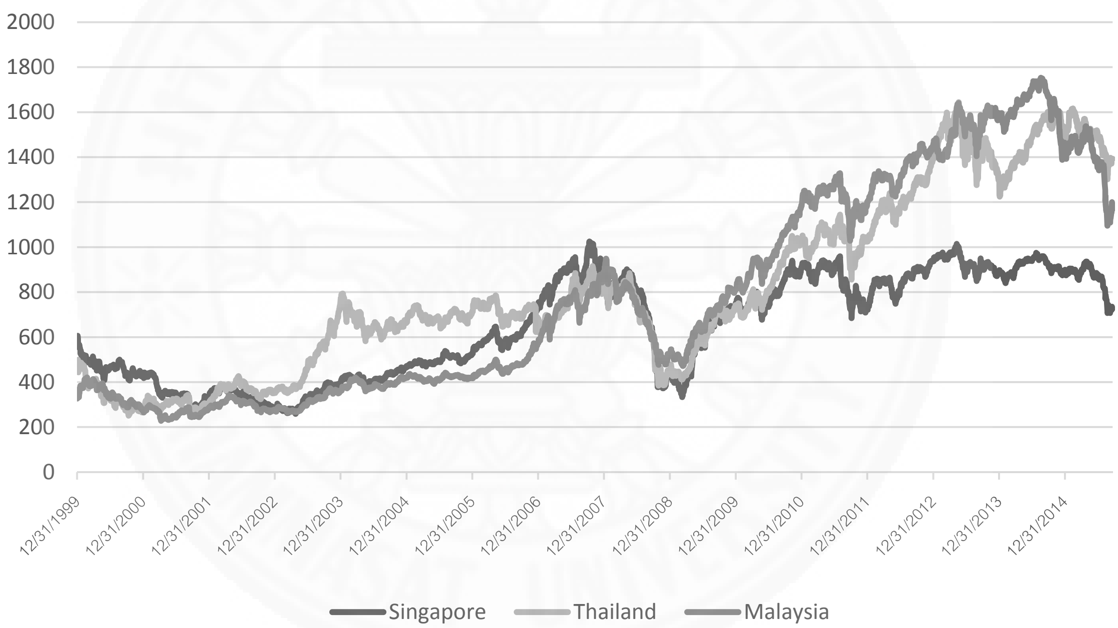
$mkt.capitalization_{it}$ is market capitalization at period t of country i

$mkt.capitalization_{i0}$ is market capitalization at based period of country i

The end of 1999 is the based date we use as the based period.

Although all aggregate analysis is be prepared already, the difference based index we have might be the disturbance for our analysis (as shown in figure 3.1). We cannot compare the taste of the food in different source and date without control some information like you are the taster of those food. The difference people might give the biased result for the study. For our analysis, December 31, 1999 is the based date we fix it like Malaysia's aggregate price index. Figure 3.2 present the descriptive statistics of the new-based index in our study and the comparison between both forms show in table 3.1.

Figure 3.1
Aggregate Stock market index (Original)
31/12/1999-22/9/2015



Source: Thomson Reuters-Datastream and Author's calculation

The formula of new based index.

$$P_{it^*} = \frac{P_{it}}{P_{i0}} \bullet \frac{P_{i0}}{P_{is}} = \frac{P_{it}}{P_{is}}$$

Where

P_{it^*} is the new based aggregate stock price index at period t of country i.

P_{is} is the aggregate stock price index at December 31,1999 of country i

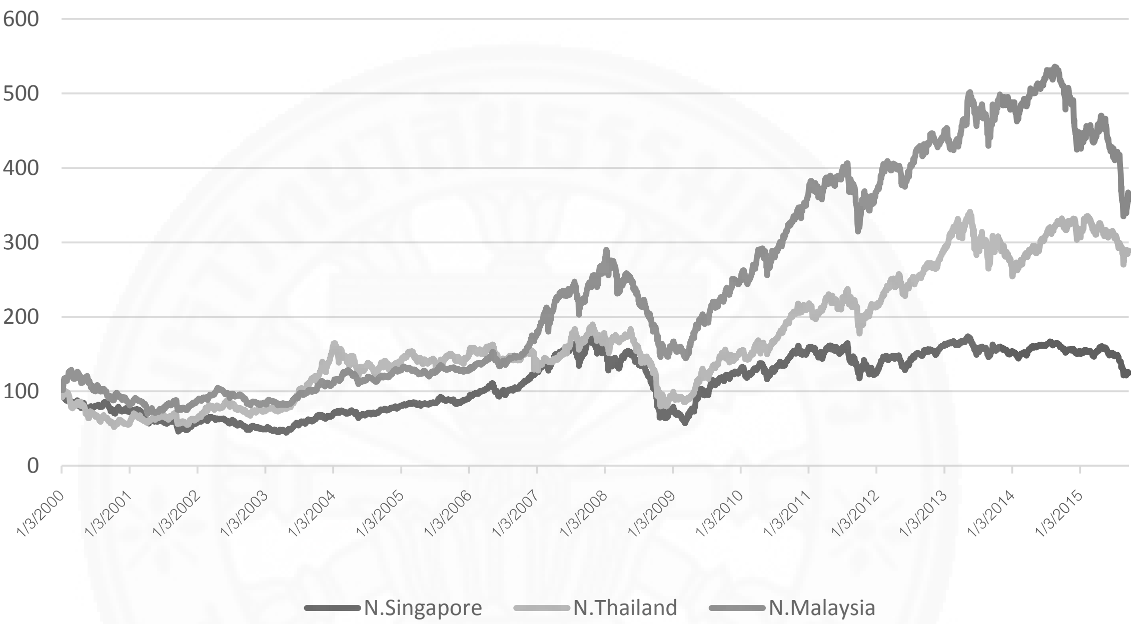
P_{is} is the aggregate stock price index at time t on old base of country i

P_{i0} is the aggregate stock price index at based period of country i

Figure 3.2

The new based aggregate Stock market index

3/1/2000-22/9/2015



Source: Author's calculation

Table 3.1

Definition price index series for aggregate analysis

Variable	Name	Previous Based date	New Based Date	New Based Value
P_{set}	SET index	30/04/1975	12/31/1999	100
P_{sin}	FTSE ST all share index	5/10/2007	12/31/1999	100
P_{ma}	Generating new aggregate index by using market capitalization-weighted price index	-	12/31/1999	100

Source: Thomson Reuters-Datastream and Author's calculation

Because VAR model required the stationary variables, we need to test unit root for all index variable in the model. If the index variables are stationary, we need not do anything about the data. But if not, we need to solve this problem before using VAR model. After unit root testing, this support our hypothesis that there are non-stationary index. First difference is a basic way for solving this problem but some significant characteristic of index variables might be changed then we need to find other form to solve. Continuously compounded return might be the best solved form for financial, economic and statistic studies (Campbell, Lo and Mackinlay, 1997). Table 3.2 present the descriptive statistic of price and return index.

The formula of continuously compounded rate of return is:

$$R_{it} = \ln\left(\frac{P_{it}}{P_{it-1}}\right) = (p_{it} - p_{it-1})$$

Where

R_{it} is continuously compounded return at period t of country i.

$p_{it} = \ln(\mathrm{P}_{it})$ is log-form of stock price index (P_{it}) at period t of country i.

Table 3.2

Descriptive statistics of all stock index series

Variable	Obs	Mean	Std. Dev.	Min	Max
Price Index Variable					
Singapore	4102	110.633	39.39549	44.41642	175.7562
Malaysia	4102	239.0478	239.0478	69.66102	535.9484
Thailand	4102	167.5393	81.0398	52.00033	341.0172
Return Index Variable					
Singapore	4101	0.00005	0.01256	-0.08915	0.09532
Malaysia	4101	0.00031	0.00976	-0.10448	0.05278
Thailand	4101	0.00026	0.01358	-0.16063	0.10577

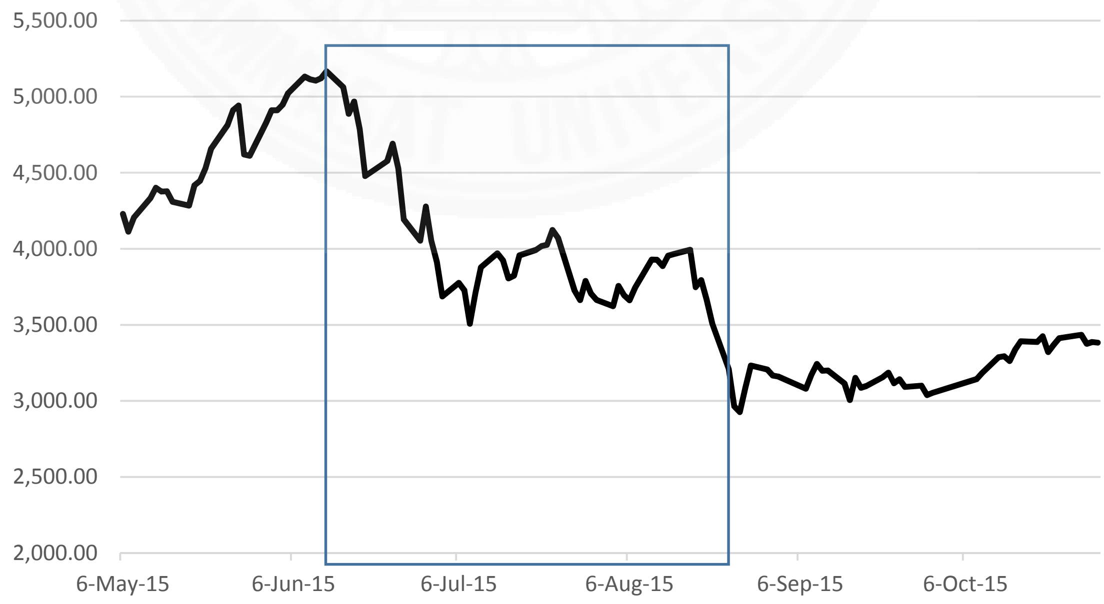
Source: Author’s calculation

Second group of variables is dummy variable which include the crisis proxy and the period of ASEAN trading link. For crisis dummy variable, we use this to separate contagion effect which is the impact from other's crisis. In this study, I use the big economic cries from global market which occurred in 20th century. Subprime crisis is the first crisis dummy I use in my study. I generate dummy variable by using US business cycle from the national bureau of economic research (NBER). NBER separate the US business cycle by using peak and trough of their economic indicator. Eurozone crisis is the next crisis dummy we use. Centre for Economic Policy research (CEPR) is the second source of crisis I use. CEPR and NBER use the same analysis to separate the stage of business cycle. In CEPR, this data is called Euro Area business cycle. CEPR separate two business cycle in Eurozone crisis as shown in table 3.3. Lastly is the black Monday crisis which occurred in Chinese stock market at the previous year. I use the period that price index decreased dramatically. Fifty day of Chinese stock market index's reduction is shown on figure 3.3. All descriptive statistic of crisis dummy and ASEAN cooperative period is shown on table 3.3 and 3.4.

Figure 3.3

Shanghai Stock Exchange Composite Index

(6/5/2015-31/10/15)



Source: Bloomberg

Table 3.3
Definition of all dummy variables

Variable	Information	Time period
US crisis	Subprime crisis in USA	December 2007-June 2009
Eurozone	Eurozone crisis	1st quarter of 2008 to – 2nd quarter of 2009 3rd quarter of 2011 to – 1st quarter of 2013
Bmonday	China's Black Monday	12/06/2015-25/08/2015
Asean trading link	Active date for Thailand in ASEAN Trading link	15/10/2012-Present

Source: NBER, CBER, SET and Bloomberg

Table 3.4
Descriptive statistics of dummy variables

Variable	Total observation	Number of zero value (variable=0)	Number of one (Mean each crisis occurred in that period)
US crisis	4101	3689	412
Eurozone	4101	3250	846
Bmonday	4101	4048	53
Asean trading link	4101	3336	765

Source: Author's Calculation

Fundamental Factor which affect the integrated level is the last group (as shown in table 3.5). Because of the estimation method with the mixed sampling data, we decide use monthly fundamental data from January 2010 to September 2015. Last table in this part (table 3.6) show the descriptive statistics of this group. All of these fundamental data is from CEIC database.

Table 3.5

Definition of fundamental factor

Fundamental factor	
Main variable	Proxy
Stock market development	Growth of Market capitalization
Turnover volume	Ln(turnover volume)
Economic indicator	Differential inflation rate
	Exchange rate volatility
	Spread of interest
Expected return	Differential dividend yield
	Differential Price per Earning Ratio

Source: Author's Calculation

Table 3.6

Descriptive statistics of fundamental factor

Country	Number of observation	Mean	Std. Dev.	Min	Max
Panel A: ln(Market capitalization)					
Singapore	69	6.5267	0.1492232	6.137	6.7098
Malaysia	69	7.2666	0.166555	6.9095	7.4864
Thailand	69	9.2467	0.2712053	8.6254	9.6067
Panel B: Turnover volume					
Singapore	69	29161	11645.64	12073	74968
Malaysia	69	31834	11398.3	11842	74902
Thailand	69	156647	101461.9	36873	515777
Panel C: Inflation rate					
Singapore	69	0.2204	0.5169191	-1.4828	1.632
Malaysia	69	0.1985	0.2948276	-1.0733	0.9099
Thailand	69	0.1739	0.296125	-0.5907	1.3795
Panel D: Interest rate					
Singapore	69	1.6758	0.423142	0.573	2.552
Malaysia	69	0.1699	0.115614	0.048	0.658
Thailand	69	0.468	0.2971748	0.017	1.271
Panel E: Exchange rate volatility GARCH(1,1)					
Baht/ Sing. Dollar	69	1.1474	1.076811	0.128	4.253
Ringgit/ Sing. Dollar	69	0.0657	0.0730605	0.0011	0.4191
Baht/Ringgit	69	0.1907	0.3833039	0.0109	1.7955
Panel F: Dividend yield					
Singapore	69	13.959	2.627061	10.32	20.15
Malaysia	69	15.757	1.343063	12.45	19.73
Thailand	69	16.252	2.720857	10.95	24.22
Panel E: Price per Earning ratio					
Singapore	69	4.1283	0.7451726	2.98	5.96
Malaysia	69	3.1133	0.2431936	2.58	3.8
Thailand	69	3.2649	0.405396	2.58	4.26

Source: Author's Calculation

3.2 VAR and SVAR Model

Vector autoregressive model (VAR) is the multivariate time series model which is used to study the systematic equation. In this model, we use the lagged variable of the endogenous variable as the exogenous in the model. Not only lagged variable but we can also other exogenous variables to increase the fitted result (Lutkepohl, 2005).

The basic form of VAR (p) model with exogenous variables:

$$R_t = A_1 R_{t-1} + A_2 R_{t-2} + A_3 R_{t-3} + \ldots + A_p R_{t-p} + BX_t + e_t \quad (3.2.1)$$

Defined in Matrix form:

$$\begin{bmatrix} R_{\sin,t} \\ R_{malay,t} \\ R_{thai,t} \end{bmatrix} = \begin{bmatrix} a_{ss} & a_{ms} & a_{ts} \\ a_{sm} & a_{mm} & a_{tm} \\ a_{st} & a_{mt} & a_{tt} \end{bmatrix} \begin{bmatrix} R_{\sin,t-1} \\ R_{malay,t-1} \\ R_{thai,t-1} \end{bmatrix} + .. + A_p \begin{bmatrix} R_{\sin,t-p} \\ R_{malay,t-p} \\ R_{thai,t-p} \end{bmatrix} + BX_t + e_t \quad (3.2.2)$$

Where R_t is the k x 1 vector of return index variables.

A is the k x kp coefficient matrix.

B is the k x m coefficient matrix of exogenous variables.

X_t is the m x 1 vector of exogenous variables.

e_t is the k x 1 vector of residual terms.

R_{t-1} is the kp x 1 vector of lagged variables.

p is a number of lagged period

m is a number of exogenous variables in the model

k is a number of endogenous variables in the model

Assuming $e_t \sim IID(0, \Sigma)$ which show time invariant mean and variance-covariance matrix. Maximum likelihood estimator is the method for solving this model.

The log-likelihood for VAR(p) is

$$LL = -\left(\frac{T}{2}\right)\left[\ln(|\hat{\Sigma}|) + \mathrm{K}\ln(2\pi) + \mathrm{K}\right]$$

Where

K is the number of equation

$\hat{\Sigma}$ is the estimated unconditional variance-covariance matrix of the disturbance term.

T is the number of observation

After calculating the maximum log-likelihood, we will get the formula to estimate all coefficients of the VAR model easily. That formula is given by

$$\hat{\Pi} = [\mathrm{YZ'}][\mathrm{ZZ'}]^{-1} \tag{3.2.6}$$

Where

Y is the vector of endogenous variables

Z is the vector of lagged and exogenous variables

According to equation 3.2.1, we see that p is in the model then before estimate the model we need to know which optimal lag length is. Not only optimal lag length we want but also the stability condition for the best result in VAR model. Both of this will be explain next.

Because we cannot show directly the relationship between all endogenous variable at the same period by using VAR model. The simultaneous relationship we can explain is only the simultaneous residual effect. Although the result from VAR model can answer whether we correlate, the magnitude cannot be estimated by using only VAR model. The restricted VAR model is generated to solve this weakness, called "Structural Vector Autoregressive (SVAR) model". This method to estimate this model will be explained in section 3.2.3.

3.2.1 Optimal lag length

The process to estimate VARs model started from finding the optimal lag by using the indicators which depended on your target. There are three indicators to find the optimal lag: Log likelihood ratio test which test all coefficient in the model whether it significant or not, information criteria which use for finding the best fit of the data and forecasting predicted error which the target is the best forecasting model. In this study, I decide to use information criteria as the indicator. Lowest information criteria will give the best fit of the data. First information criteria introduced by Akaike (1973, 1974), called "Akaike information criterion (AIC)". Bayesian information criterion (BIC) is generated by Schwarz (1978). Hannan-quinn (1979) created the last information criterion I use in my study called "hannan-quinn information criterion(HQIC)".

There are three information criteria indicator:

$$AIC(p) = \log(\det(\hat{\Sigma}_p)) + \frac{2\,\mathrm{pm}^2}{n}$$

$$SBIC(p) = \log(\det(\hat{\Sigma}_p)) + \log(n)\frac{2\,\mathrm{pm}^2}{n}$$

$$HQIC(p) = \log(\det(\hat{\Sigma}_p)) + 2\log(\log(n))\frac{2\,\mathrm{pm}^2}{n}$$

Where

P is lag length for VAR model

n is number of observation

$\hat{\Sigma}_p$ is conditional variance and covariance matrix of disturbance

All types of information criteria have the different properties but AIC and SBIC is most useful in economic studies.

3.2.2 Stability testing

The next step is the stability test of VAR model which can separate into two parts. First is stationary test for all variables by testing eigenvalue of all coefficient matrix. The requirement of stationary test is means, variances and co-variances are needed to be constant. Hamilton (1994) show if we write VAR(p) as VAR(1) we will get

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + \ldots + A_p y_{t-p} + e_t \qquad (3.2.3)$$

If variable y are stationary then mean of y need to be constant all the time.

$$\mu = A_1\mu + A_2\mu + A_3\mu + \ldots + A_p\mu \qquad (3.2.4)$$

(3.2.3) – (3.2.4), we get that

$$y_t - \mu = A_1(y_{t-1} - \mu) + A_2(y_{t-2} - \mu) + \ldots + A_p(y_{t-p} - \mu) + e_t \qquad (3.2.5)$$

Writing (3.2.5) in matrix forms:

$$\xi_t = \alpha\xi_{t-1} + v_t$$

Where ξ_t is the vector of $y_t - \mu$

$$\alpha = \begin{bmatrix} A_1 & A_2 & . & . & . & A_p \\ I & 0 & . & . & 0 & 0 \\ 0 & I & 0 & . & 0 & 0 \\ 0 & 0 & . & . & . & . \\ . & . & . & I & . & . \\ 0 & 0 & . & 0 & I & 0 \end{bmatrix}$$

VAR (p) model is stationary as long as $|A_i| < 1$ for all value of A. This support that A is in unit circle. After finding the optimal lags and testing stability condition, VAR model will be satisfy.

3.2.3 Structural VAR model

The basic form of VAR model is called reduce from. By using this original form, we cannot imply whether the current period affect, or not? How do they affect? The structural form of the model can show solve this problem.

$$\begin{bmatrix} aa_{ss} & aa_{ms} & aa_{ts} \\ aa_{sm} & aa_{mm} & aa_{tm} \\ aa_{st} & aa_{mt} & aa_{tt} \end{bmatrix} \begin{bmatrix} R_{\text{sin,t}} \\ R_{malay,t} \\ R_{thai,t} \end{bmatrix} = \begin{bmatrix} a_{ss} & a_{ms} & a_{ts} \\ a_{sm} & a_{mm} & a_{tm} \\ a_{st} & a_{mt} & a_{tt} \end{bmatrix} \begin{bmatrix} R_{\text{sin,t}-1} \\ R_{malay,t-1} \\ R_{thai,t-1} \end{bmatrix} + \ldots + u_t$$

$$Ay_t = \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \Gamma_3 y_{t-3} + \ldots + \Gamma_p y_{t-p} + u_t$$

$$y_t = A^{-1}\Gamma_1 y_{t-1} + A^{-1}\Gamma_2 y_{t-2} + A^{-1}\Gamma_3 y_{t-3} + \ldots + A^{-1}\Gamma_p y_{t-p} + A^{-1}u_t \qquad (3.2.7)$$

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + \ldots + A_p y_{t-p} + e_t \qquad (3.2.8)$$

Equation (3.2.7) is equal to (3.2.2) that is the reduced form model. From original solution, separating A^{-1} from Γ is too hard.

SVARs model can separate that relationship by assuming some restriction of matrix A in the VAR model.

Writing (3.2.8) in Lag-operator form

$$y_t = A_1 L y_t + A_2 L^2 y_t + A_3 L^3 y_t + \ldots + A_p L^p y_t + e_t$$
$$y_t - A_1 L y_t - A_2 L^2 yt - A_3 L^3 y_t - \ldots - A_p L^p y_t = e_t$$
$$(\mathrm{I} - A_1 L - A_2 L^2 - A_3 L^3 - \ldots - A_p L^p) y_t = e_t$$
$$\mathrm{A}(\mathrm{I} - A_1 L - A_2 L^2 - A_3 L^3 - \ldots - A_p L^p) y_t = A e_t = B\varepsilon_t \qquad (3.2.9)$$

Where

ε_t is Kx1 vector of orthogonalized disturbance with $N(0, \mathrm{I}_K)$

Set of A and B are imposed by Cholesky restriction by using A as a lower triangular matrix with ones on diagonal and B as a diagonal matrix.

$$A^s = \begin{bmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} \quad , \quad B^s = \begin{bmatrix} . & 0 & 0 \\ 0 & . & 0 \\ 0 & 0 & . \end{bmatrix}$$

If all a_{ij} o in restricted matrix A is not equal to this meant just-identified SVAR model. If some a_{ij} is equal to zero this meant over-identified SVAR model. The cholesky decomposition of variance-covariance matrix is $A^{-1}BB^{'}(A^{-1})'$. The estimation of SVAR model is based on Score method and Maximum-log likelihood method.

The log-likelihood function for SVAR model is

$$LL = -\left(\frac{T}{2}\right)[\ln(\left|\tilde{W}\right|^2) + K\ln(2\pi) + tr(\tilde{W}'\tilde{W}\hat{\Sigma})]$$

Where $\tilde{W} = B^{-1}A$

In this study, I set matrix A^s by assuming some hypothesis. From table 3.7, we can imply that Singapore investors hold 20.63 percent of total foreign holding on Thai assets. This is the second rank of largest foreign holding Thailand's asset. Therefore the change of Singapore's investment affect Stock exchange of Thailand exactly. Hence, our restriction is assumed that Singapore effect all countries at period t and Thailand cannot affect other stock market in our cooperation. The restricted matrix A^s we have will be just-identified SVAR model.

Table 3.7

Shares of foreign holding on Thailand's stock by country

Country	2013	2014	2015
ASEAN			
Singapore	22.09	21.65	20.63
Malaysia	1.39	1.25	0.96
Others	0.05	0.04	0.42
Total	23.54	22.94	22.01
Inter-regional			
UK	38.78	37.20	37.37
US	12.78	12.12	10.51
Hongkong	4.05	4.92	7.21
Japan	1.69	5.59	6.47
Others	19.16	17.23	16.43
Total	76.46	77.06	77.99

Source: Stock exchange of Thailand

3.2.4 Implication of VAR model: Granger Causality

Because of the transformed effect from other variables can change the estimated result, it is important to consider the effect in the system model. Estimating by using simple model give the bias result. Granger (1969) concern about this systematic properties and proposed the method to test the causality among the variables. Simple two-variable models are the initial model for causality test. F test and t test can be used to analyze the causality between lag variables.

Separating the matrix form in equation 3.2.1 to simple equation VAR(p) , we will get that

$$R_{\text{sgx},t} = c_1 + \sum_{i=1}^{p} a_{11,i} R_{\text{sgx},t-p} + \sum_{i=1}^{p} a_{12} R_{\text{mal},t-p} + \sum_{i=1}^{p} a_{13} R_{\text{thai},t-p} + u_{\text{sgx},t} \quad (3.5.1.1)$$

$$R_{\text{mal},t} = c_1 + \sum_{i=1}^{p} a_{21,i} R_{\text{sgx},t-p} + \sum_{i=1}^{p} a_{22} R_{\text{mal},t-p} + \sum_{i=1}^{p} a_{23} R_{\text{thai},t-p} + u_{\text{mal},t} \quad (3.5.1.2)$$

$$R_{\text{thai},t} = c_1 + \sum_{i=1}^{p} a_{31,i} R_{\text{sgx},t-p} + \sum_{i=1}^{p} a_{32} R_{\text{mal},t-p} + \sum_{i=1}^{p} a_{33} R_{\text{thai},t-p} + u_{\text{thai},t} \quad (3.5.1.3)$$

Let $R_{\text{sin},t}$, $R_{\text{mal},t}$ and $R_{\text{thai},t}$ are stationary variables.

We need to pair our stock market. Then we will get three couple to check the causality. The causality test is based on the hypothesis that all coefficient equal to zero, or not. For causality, we required to reject the null hypothesis for supporting that one variable can affect other. For example

Equation 3.5.1.1, if some a_{j1} are not equal to zero (Reject null hypothesis), it can imply that " R_{sgx} granger cause R_j ", j = 2 if Malaysia or 3 if Thailand. (Change in Singapore affect Thailand or Malaysia or Both)

Equation 3.5.1.2, if some a_{j2} are not equal to zero (Reject null hypothesis), it can imply that " R_{mal} granger cause R_j ", j = 1 if Singapore or 3 if Thailand.
(Change in Malaysia affect Singapore or Thailand or Both)

Equation 3.5.1.3, if some a_{j3} are not equal to zero (Reject null hypothesis), it can imply that " R_{thai} granger cause R_j ", j = 1 if Singapore of 2 if Malaysia.
(Change in Malaysia affect Singapore or Thailand or Both)

3.3 Testing for Non-Linearity (contagion effect)

Favero and Giavazzi (2002) investigate the contagion effect by controlling the interdependence of the spreads between three countries and applying full information maximize technique. The methodology started from VAR model with dummy and lagged variable for testing the distribution of the residual term.

$$\begin{pmatrix} S_{21,t} \\ S_{31,t} \end{pmatrix} = \begin{pmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{pmatrix} \begin{pmatrix} S_{21,t-1} \\ S_{31,t-1} \end{pmatrix} + \begin{pmatrix} u_{1,t} \\ u_{2,t} \end{pmatrix}$$

After predicting the residual from reduced VAR model, we will check the heteroskedasticity and distribution of the disturbance.

$$\begin{pmatrix} u_{1,t} \\ u_{2,t} \end{pmatrix} | I_{t-1} \sim \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{1t}^2 & \sigma_{12t} \\ \sigma_{21t} & \sigma_{2t}^2 \end{pmatrix} \right]$$

If the residual is not normal, we need to specify the model though SVAR model to check the contagion effect thought the relationship between the error term and dummy variables. On the other hand, residual from a reduced VAR model is normal, it will not show the contagion effect.

$$\begin{pmatrix} S_{21,t} \\ S_{31,t} \end{pmatrix} = \begin{pmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{pmatrix} \begin{pmatrix} S_{21,t-1} \\ S_{31,t-1} \end{pmatrix} + B^{-1} \begin{pmatrix} e_{1,t} \\ e_{2,t} \end{pmatrix}$$

$$\begin{pmatrix} e_{1,t} \\ e_{2,t} \end{pmatrix} = \left(I + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} d_{1,t} & 0 \\ 0 & d_{2,t} \end{pmatrix} \right) \begin{pmatrix} e^1{}_{1,t} \\ e^1{}_{2,t} \end{pmatrix}$$

$$\begin{pmatrix} e^1_{1,t} \\ e^1_{2,t} \end{pmatrix} | I_{t-1} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{1t}^2 & \sigma_{12t} \\ \sigma_{21t} & \sigma_{2t}^2 \end{pmatrix} \right]$$

Where $e_{1,t}$ and $e_{2,t}$ are the structural shocks

B is the contemporaneous relationship matrix between the spreads

$d_{1,t}$ and $d_{2,t}$ are the crisis dummies.

Although basic testing of this non-linearity is checking the significant test of a_{12} and a_{21}, we do not know matrix B then the residual test from only VAR might not give the actual result of normality testing[1]. This paper support to use just-identification SVAR model instead.

$$\begin{pmatrix} S_{21,t} \\ S_{31,t} \end{pmatrix} = \begin{pmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{pmatrix} \begin{pmatrix} S_{21,t-1} \\ S_{31,t-1} \end{pmatrix} + B^{-1} \left(I + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} d_{1,t} & 0 \\ 0 & d_{2,t} \end{pmatrix} \right) \begin{pmatrix} e^1{}_{1,t} \\ e^1{}_{2,t} \end{pmatrix}$$

$$\begin{bmatrix} 1 & -\beta_{12} \\ -\beta_{21} & 1 \end{bmatrix} \begin{pmatrix} S_{21,t} \\ S_{31,t} \end{pmatrix} = \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{pmatrix} \begin{pmatrix} S_{21,t-1} \\ S_{31,t-1} \end{pmatrix} + \left(I + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} d_{1,t} & 0 \\ 0 & d_{2,t} \end{pmatrix} \right) \begin{pmatrix} e^1{}_{1,t} \\ e^1{}_{2,t} \end{pmatrix}$$

---

[1] Favero and Giavazzi (2002) said: The test could not be implemented in the reduced form since it required the identification of the parameters in B matrix.

Where β_{12} and β_{21} determine the contemporaneous effect

Assuming $\gamma_{12} = \gamma_{21} = 0$

For deeper analysis, they suggest to restrict some insignificantly simultaneous variable. Then the final model is over-identification SVAR model. Contagion effect refer to the significant dummy variable in this model which imply that the non-normality occurred.

If a_{ij} is not equal to zero, this mean that contagion effect occurs.

3.4 VAR with Trivariate GARCH model (Dynamic conditional correlation GARCH model (DCC model))

In this paper, the estimation started from the conditional first moment (means) of the stock return index for each countries by VAR model and use the dynamic conditional correlation garch model which estabished by Engle (2002) to explain the time-varying of the return index. This model can estimate by using maximize likelihood estimation method (MLE).

A trivariate GARCH in mean:

$$Y_t = AX_t + \varepsilon_t \tag{3.4.1}$$

$$\varepsilon_t = H_t^{1/2} v_t \quad \text{and} \quad H_t = D_t^{1/2} R_t D_t^{1/2}$$

$$R_t = diag(Q_t)^{-1/2} Q_t diag(Q_t)^{-1/2}$$

$$Q = (1 - \lambda_1 - \lambda_2)R + \lambda_1 \tilde{\varepsilon}_{t-1} \tilde{\varepsilon}_{t-1}^{'} + \lambda_1 Q_{t-1}$$

where Y_t is the mx1 vector of dependent variables

X_t is the kx1 vector of independent variables

A is the mxk matrix parameters

H_t is the time-varing conditional variance matrix

v_t is the mx1 vector of normal, independent and identically distributed innovations.

D_t is the diagonal matrix of conditional variance

R_t is matrix of conditional quasicorrelations of standardized residuals

$\tilde{\varepsilon}_t$ is mx1 vector of standardized residuals

λ_1 and λ_2 are parameters of dynamic conditional quasicorrelations, and nonnegative parameters with $0 \leq \lambda_1 + \lambda_2 < 1$

$$D_t = \begin{bmatrix} \sigma_{1t}^2 & 0 & \dots & 0 \\ 0 & \sigma_{1t}^2 & \cdots & 0 \\ \vdots & \ddots & \ddots & \vdots \\ 0 & \vdots & 0 & \sigma_{1t}^2 \end{bmatrix} \text{ and } R_t = \begin{bmatrix} 1 & \rho_{12t} & \cdots & \rho_{1mt} \\ \rho_{21t} & 1 & \cdots & \rho_{2mt} \\ \vdots & \ddots & \ddots & \vdots \\ \rho_{m1t} & \rho_{m2t} & \cdots & 1 \end{bmatrix}$$

Each variance is written by using univariate GARCH model:

$$\sigma_{it}^2 = c_i + \sum_{j=1}^{q} \alpha_j \varepsilon_{it-j}^2 + \sum_{j=1}^{q} \gamma_j \sigma_{it-j}^2$$

And in heteroscedasticity case

$$\sigma_{it}^2 = \exp(\delta_t z_{it}) + \sum_{j=1}^{q} \alpha_j \varepsilon_{it-j}^2 + \sum_{j=1}^{q} \gamma_j \sigma_{it-j}^2$$

Where

z_{it} is the px1 vector of independent variables included constant term

δ_t is the 1xp matrix parameters

α_j are parameters of ARCH

β_j are parameters of GARCH

Maximum likelihood is the estimated method in this model. Log-likelihood function for DCC-GARCH model is

$$LL = -\left(\frac{1}{2}\right)\text{mlog}(2\pi) - 0.5\log\left\{\det(R_t)\right\} - \log\left\{\det(\text{D}_t^{1/2})\right\} - 0.5\tilde{\varepsilon}_t R_t^{-1}\tilde{\varepsilon}_t'$$

Where

$\tilde{\varepsilon}_t = D_t^{-1/2}\varepsilon_t$ is an mx1 vector of standardized residuals

Not only the efficient we increase from using GARCH model but we also estimate the integrated level in quantitative form. Conditional correlation is the estimated result we use to be the proxy of ASEAN stock market integration. After estimated DCC model, we will predict the conditional variance and covariance matrix for calculating conditional correlation.

The formula to calculation the proxy of time-varying conditional correlation is

$$\rho_t = \frac{h_{ij,t}}{\sqrt{h_{jj,t} * h_{ii,t}}} \quad , \ i \neq j$$

Where

$h_{ij,t}$ is the conditional covariance between country i and j at time t

$h_{jj,t}$ is the conditional variance of country j at time t

$h_{ii,t}$ is the conditional variance of country i at time t

3.5 DCC-MIDAS (Dynamic conditional correlation with mixed data sampling)

Colacito et al (2011) introduced the new model which can separate the short -run and long-run component in dynamic conditional correlation model. This model was applied from combining DCC model (Engle, 2002), Component specification model (Engle and Lee, 1999) and GARCH-MIDAS (Engle at el, 2006). The main difference between original DCC model and DCC-MIDAS model is the long-run conditional correlation assumption. From DCC model, we assumed that it is constant term. The short-run component in DCC model is given by

$$Q = (1 - \lambda_1 - \lambda_2)R + \lambda_1 \tilde{\varepsilon}_{t-1} \tilde{\varepsilon}_{t-1}^{'} + \lambda_1 Q_{t-1} \qquad (3.4.1)$$

As we can see from equation 3.4.1 that R which show quasi-correlation is constant term. But this R term will not be assume as constant in DCC-MIDAS model. In DCC-MIDAS, they used GARCH-MIDAS to allow the volatility by assuming MIDAS polynomial. Not only long-run component they can separated but GARCH-

MIDAS can help to estimate the model with the different unit size such as monthly, quarterly and yearly data.

Colacito et al followed Engle (2002)'s procedure to estimate DCC-MIDAS. As DCC model, univariate GARCH-MIDAS will be estimated at the first stage. Instead of using univariate GARCH model at the first stage. They used univariate GARCH-MIDAS model from Engle et al (2006).

Mean equation is

$$r_{i,t} = \mu_i + \sqrt{m_{i,\tau} * g_{i,t}}\,\xi_{i,t}, \forall t = \tau N_v^i, ..., (\tau+1)N_v^i$$

GARCH-MIDAS model we use to estimate the conditional variance is given by

$$g_{i,t} = (1-\alpha_i-\beta_i) + \alpha_i \frac{(r_{i,t-1}-\mu_i)^2}{m_{i,\tau}} + \beta_i g_{i,t-1}$$

$$m_{i,\tau} = \bar{m} + \theta_i \sum_{i=1}^{K_v^i} \varphi_l(\omega_v^i) RV_{i,\tau-1}$$

$$RV_{i,\tau-1} = \sum_{j=(\tau-2)N_v^i+1}^{\tau N_v^i} (r_{i,j})^2$$

$$\varphi_l(\omega_v^i) = \frac{\left(1-\frac{l}{K_v^i}\right)^{\omega_v^i-1}}{\sum_{j=1}^{K_v^i}\left(1-\frac{j}{K_v^i}\right)^{\omega_v^i-1}}$$

Where

$g_{i,t}$ is short-run component

$m_{i,t}$ is MIDAS component (long-run component) which calculated by weight sum of K_v^i lag of realized variance (RV).

N_v^i is Total number of observation

$\varphi_l(\omega_v^i)$ is weighted polynomial in GARCH-MIDAS model

There are two popular weighted polynomial. First is Exponential lag which use exponential Almon. Second is Beta lag by Ghysels et al (2007). They found that beta lag is the best choice for the high frequency data. In set of variables, most of data is the daily 7data then Beta lag is the better choice for this study. The beta lag is given by

$$B(k;\theta_1,\theta_2)=\frac{f(\frac{k}{K}\theta_1;\theta_2)}{\sum_{k=1}^{K} f(\frac{k}{K}\theta_1;\theta_2)}$$

Where $f(x,a,b)=\dfrac{x^{a-1}(1-x)^{b-1}\Gamma(a+b)}{\Gamma(a)\Gamma(b)}$ and $\Gamma(a)=\int_0^{\infty} e^{-x}x^{a-1}dx$

After getting the conditional variance from GARCH-MIDAS, they used this to estimate the conditional correlation in the second step. This step result called "DCC-MIDAS model". The DCC-MIDAS is presented by

$$q_{i,\mathrm{j,t}}=\overline{\rho}_{i,j,t}(1-a-b)+a\xi_{i,t-1}\xi_{i,t-1}+bq_{i,\mathrm{j,t-1}}$$

$$\overline{\rho}_{i,j,t}=\theta_i\sum_{l=1}^{K_v^i}\varphi_l(\omega_v^{ij})c_{\mathrm{i,j,t-1}}$$

Where

$q_{i,\mathrm{j,t}}$ is short-run correlation between i and j at time t

$\overline{\rho}_{i,\mathrm{j,t}}$ is long-run correlation between i and j at time t

Log likelihood for DCC-MIDAS is

$$LL=-\sum_{t=1}^{T}\ (\mathrm{mlog}(2\pi)-2\log\{\det(R_t)\}+r_t^{'}\,\mathrm{D}_t^{-1}\,r_t^{'}+\log|\,R_t\,|+\tilde{\varepsilon}_t R_t^{-1}\tilde{\varepsilon}_t^{'}+\tilde{\varepsilon}_t\tilde{\varepsilon}_t^{'}$$

After getting all parameter, we will use them to estimate the conditional correlation by using the same formula as in DCC model part.

3.6 Panel Fixed Effect Model

According to the hypothesis, there is some integrated level which can be affected from fundamental factors. We will our estimated result from time series to panel data by using three pair cases as panel id. Because of the difference in each investor's behaviors, they might have some fixed effect for each countries which can

Consider the normal case when we have unobservable variables in the model. The classical linear regression model is given by

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + \beta_2 x_{2,it} + e_{it} \tag{3.5.1}$$

for i = 1, 2, …, N and t = 1, 2, …, T

Where y_{it} is dependent variable; $x_{1,it}$ and $x_{2,it}$ are the explanatory variable, and e_{it} is the composite error [$e_{it} = a_i + u_i, a_i$ is unobserved fixed effect variable for each panel id].

Including unobserved variable in the model might violate BLUE assumption and give the bias and inconsistent estimation if that $E(x'a) \neq 0$ then $E(x'e)$ will not equal to zero. The endogeneity problem is existed.

Panel fixed effect model is applied in this study to get rid of this problem. This model use least square dummy variable (LSDV) estimator to reduce the constant across time for each panel id from the estimation. This model transform all variable to group specific means.

$$\overline{y}_i = \beta_0 + \beta_1 \overline{x}_{1i} + \beta_2 \overline{x}_{2i} + a_i + \overline{u}_i \tag{3.5.2}$$

Transforming equation 3.5.2 by using equation 3.5.1 to

$$y_{it} - \overline{y} = \beta_0 - \beta_0 + \beta_1 (x_{1,it} - \overline{x}_{1i}) + \beta_2 (x_{2,it} - \overline{x}_{2i}) + a_i - a_i + (u_{it} - \overline{u}_i)$$

$$y_{it} - \overline{y} = \beta_1(x_{1,it} - \overline{x}_{1i}) + \beta_2(x_{2,it} - \overline{x}_{2i}) + (u_{it} - \overline{u}_i)$$

We will get rid of our unobserved variable as shown is equation 3.5.3

$$y_{it}^* = \beta_1 x_{1it}^* + \beta_2 x_{2it}^* + u_{it}^* \quad (3.5.3)$$

The estimated coefficient from this model is given by

$$\hat{\beta} = \left[(x_{it}*)' x_{it}*\right]^{-1}\left[(x_{it}*)' y_{it}^*\right]$$

Table 7 show the expected sign our determinants of stock market integration in panel fixed effect model in equation 3.5.4.

$$\rho_{ij,t} = \beta_0 G\,\mathrm{mkt}_{i,t} + \beta_1 G\,\mathrm{mkt}_{j,t} + \beta_2\,\mathrm{d}\ln tot_{ij,t} + \beta_3 dpe_{ij,t} + \beta_4 ddy_{ij,t} + \beta_5 d\,\mathrm{int}_{ij,t}$$
$$+\beta_6 d\,\mathrm{inf}_{ij,t} + \beta_7 exv_{ij,t} + a_{ij} + \varepsilon_{ij,t}$$

$$\rho_{ij,t} = \beta_0 G\,\mathrm{mkt}^*_{i,t} + \beta_1 G\,\mathrm{mkt}^*_{ij,t} + \beta_2\,\mathrm{d}\ln tot^*_{ij,t} + \beta_3 dpe^*_{i,j,t} + \beta_4 ddy^*_{ij,t} + \beta_5 d\,\mathrm{int}^*_{ij,t}$$
$$+\beta_6 d\,\mathrm{inf}^*_{ij,t} + \beta_7 exv^*_{ij,t} + \varepsilon_{ij,t}$$

(3.5.4)

Where $\rho_{ij,t}$ is long-run conditional correlation from DCC-MIDAS(22,21,114) model between countries i and j at time t (where i≠j and i,j =Thailand, Malaysia and Singapore) [2].

[2] In this case, we use three pairs of correlation; Thailand with Malaysia, Thailand with Singapore and Malaysia with Singapore.

Table 3.8

The expected sign of each coefficient in Panel fixed effect model

Type of variables	Variable	Expected Sign	proxy
Financial factor	Stock market development	+	$G\text{mkt}$
	Log(turnover)	+	$\ln tot_{i,t}$
Economic indicator	Difference in interest rate	-	$d\,\text{int}_{ij,t}$
	Difference in inflation rate	-	$d\,\text{inf}_{ij,t}$
	Exchange rate volatility	-	$exv_{ij,t}$
Expectation	Difference in Price to earning	-/+	$\ln tot_{i,t}$
	Difference in Dividend yield	-/+	$ddy_{ij,t}$

+ = increase the integrated level if that variable increase.

- = decrease the integrated level if that variable increase.

- /+ = can be both increase and decrease the integrated level if that variable increase

Source: Author's expectation

CHAPTER 4

EMPIRICAL RESULT

This chapter presents the estimated results with reference to the methodology chapter. To understand ASEAN stock market integration clearly, I separate my result into four parts. The first part shows the element to estimate the vector autoregressive model (VAR) to test the simple hypothesis of whether or not change in one country's return affects all of us. To analyze the efficiency of the previous cooperation, I separate the estimation into three criteria, namely, full observation, pre-ASEAN trading link, and post-ASEAN trading link. The complex properties, such as volatility, are included in the next two parts using dynamic conditional correlation-GARCH (DCC-GARCH) and dynamic conditional correlation with mixed data sampling (DCC-MIDAS) to be the robustness tests and to estimate the integrated level in our regional stock market. The last part presents the determinant fundamental factor that affects the integrated level.

4.1 VAR model

To understand the mechanism of ASEAN stock market integration, I generate the simple hypothesis whether or not change in our countries affect all of us. For example, if we have high integrated levels with each other, the change in two countries may affect both parties. The VAR model is the popular method to apply for this hypothesis by using Granger causality testing. I include some crisis dummy variables to exclude the shock effect, called "contagion effect", which might increase the abnormal volatility in the model. The first hypothesis helps us to understand our first objective in simple level. The second objective can be analyzed by expanding the method into three criteria as introduced at beginning of this chapter.

At the beginning of time series analysis, we need to check the stationary properties. I examine the stationary of stock price and return indexes by using

Augmented Dickey fully (ADF) test and Phillips-Perron test. The result[1] supports the characteristic of financial data, in which much volatility exists in the stock price index. Thus, the return index is suitable in financial studies. The next step is the find the optimal element to generate VAR model. The important instruments to create VAR model are optimal lag length and stability condition. We use information criteria as the indicator (as shown in chapter 3). Lag length, which has the minimum information criteria (IC), is the optimal lag in the VAR model. We do this requirement not only one criteria but also other such as pre-ASEAN trading link and post-ASEAN trading link for achieve the second objective. The optimal lag for all of them is required. Lag 1 give the minimum SBIC for both all periods (SBIC = -18.8671) and pre-ASEAN trading link (SBIC = -18.5731)[2]. The result in Post-ASEAN trading link may not clear by using only SBIC indicator. Besides SBIC, AIC give the optimal lag result[3] (AIC = -20.9781) same as the previous criteria. After estimate the VAR model of all criteria, we need to check the stability condition through eigenvalue and unit circle test. The estimated result shows that all eigenvalues are within the inside of the unit circle. Therefore, the VAR(1) model in all criteria satisfies the stability properties.

4.1.1 Granger causality from VAR model

Table 4.1 shows the results from the Granger causality test that investigated the hypothesis on whether other stock markets are affected. During the total period, Singapore affects both Thailand and Malaysia at the 99 percent significant level. Malaysia affects Singapore at the 99 percent significant level. However, Thailand does not affect other countries in the ASEAN exchange cooperation.

In the pre-ASEAN trading link, the results are the same as in the total period. The change in SGX can affect both of SET and Bursa Malaysia at 99 percent significant level. Moreover, magnitude is higher than that in the first criteria (Table 4.2

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[1] See in Appendix A
[2] See in Appendix B
[3] See in Appendix B

Table 4.1

Granger Causality from VAR model

Equation		Excluded		
		Rsing	Rmal	Rthai
Total observation	Rsing		YES	NO
	Rthai	YES		NO
	Rmal	YES	NO	
Before ASEAN trading link	Rsing		YES	NO
	Rthai	YES		NO
	Rmal	YES	NO	
After ASEAN trading link	Rsing		NO	NO
	Rthai	NO		NO
	Rmal	NO	NO	

Source: Author's Calculation

Comparing among criteria (as shown in table 4.2), we find that total observation and pre-ASEAN trading link give indifferent result. One percentage change of SGX's return can increase 0.0632 percent of SET's return and 0.0521 percent of Malaysia's return in total period at 99 percent significant level. The change in Bursa Malaysia can decrease 0.0940 percent of SGX's return. All effect from Thailand cannot change others. However, the post-ASEAN trading link does not show the relationship among the countries. This result may be due to the insufficient number of observations needed to explain the lagged effect.

Table 4.2

Estimated Result from VAR model

Variables	Total period			Before ASEAN trading link			After ASEAN trading link		
	Rsing	Rthai	Rmal	Rsing	Rthai	Rmal	Rsing	Rthai	Rmal
L.dlsing	0.0734***	0.0632***	0.0521***	0.0800***	0.0664***	0.0574***	-0.0106	0.0325	-0.0434
	(0.0205)	(0.0222)	(0.0158)	(0.0229)	(0.0242)	(0.0169)	(0.0479)	(0.0667)	(0.0551)
L.dlthai	0.00446	-0.0241	0.0181	0.00354	-0.0251	0.0201	0.0126	-0.0158	0.00174
	(0.0168)	(0.0182)	(0.0130)	(0.0192)	(0.0203)	(0.0142)	(0.0289)	(0.0403)	(0.0333)
L.dlmal	-0.0940***	0.0341	0.0816***	-0.107***	0.0257	0.0744***	0.00039	0.0885	0.150***
	(0.0251)	(0.0272)	(0.0193)	(0.0289)	(0.0307)	(0.0214)	(0.0405)	(0.0564)	(0.0466)
us	-0.00119	-0.00154*	-0.000640	-0.00104	-0.00132	-0.000638			
	(0.000823)	(0.000890)	(0.000633)	(0.000947)	(0.00100)	(0.000700)			
eurozone	-0.000227	0.000464	-0.000347	-0.000493	0.000164	-0.000454	0.00076	0.00146	0.000216
	(0.000612)	(0.000662)	(0.000471)	(0.000754)	(0.000800)	(0.000558)	(0.000708)	(0.000987)	(0.000814)
bmonday	-0.00404**	-0.00251	-0.0040***				-0.0035***	-0.0021	-0.00369***
	(0.00173)	(0.00188)	(0.00134)				(0.00102)	(0.00142)	(0.00117)
Constant	0.000293	0.000325	0.0006***	0.000398	0.000389	0.0006***	-0.00016	4.76e-05	-1.23e-05
	(0.000222)	(0.000240)	(0.00017)	(0.000264)	(0.000280)	(0.000195)	(0.000288)	(0.000401)	(0.000331)
Observations	4,094	4,094	4,094	3,329	3,329	3,329	765	765	765

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author’s Calculation

This estimated results also support that the completely integrated does not occur in our region because some countries can be affected by others. Not only the incomplete integration was shown but we can also rearrange the integration level between all countries by using the estimated result in Table 4.2. Countries that have the highest integration level are Singapore and Malaysia as changes in each country can affect one another. Thailand and Malaysia have the lowest level of integration as they do not affect each other. Therefore, we can rank level of integration from highest to lowest as follow: Singapore-Malaysia, Singapore-Thailand, and Malaysia-Thailand. Mathematically, the relationship is $IL_{\text{Singapore and Malaysia}} > IL_{\text{Singapore and Thailand}} > IL_{\text{Malaysia and Thailand}}$.

4.1.2 SVAR model (Structural Vector autoregressive model)

As we cannot separate the simultaneous effect in the VAR model directly, SVAR, which can be called restricted VAR, is applied in this study by assuming some structural restriction. In this model, I generate the results based on a previous VAR model in which Singapore affects both Thailand and Malaysia. However, Thailand does not affect Malaysia and Singapore.

According to Table 4.3, the results present that Increase in Singapore's return can reduce 0.456 percent of Malaysia's return at 99 percent significant level simultaneously. Both Singapore and Malaysia can affect Thailand at the different level. 1 percent increase in Singapore's return and Malaysia's return can reduce 0.442 and 0.225 percent of Thailand return respectively.

For pre-ASEAN trading link and post-ASEAN trading link, the result might be indifferent. The structural estimated result give the same as in total period at 99 percent significant level. This support the estimate result from previous VAR model.
Most of the magnitude from SVAR model in all criteria are not too different from each other. However, only one magnitude changes significantly when comparing pre- and post- ASEAN trading link which is the effect from the change in Singapore's return to Malaysia's return. SVAR model shown that the effect from Singapore increase from 0.439 percent to 0.719 percent in Bursa's return at 99 percent significant level. This estimated results consist with the expansion of Singapore portfolio investment in figure 4.1. More than 100 percent of Singapore's portfolio invested on Malaysia increased

after 2012. Comparing to Singapore's holding Thailand asset, we find that less than 50 percent of portfolio increase on holding Thailand's asset during the same period. This level is less than 200 percent of Singapore's portfolio value on Malaysia asset. Therefore, the effect from Singapore's return on Malaysia's return was higher than before 2012.

Table 4.3

Estimated result from SVAR model

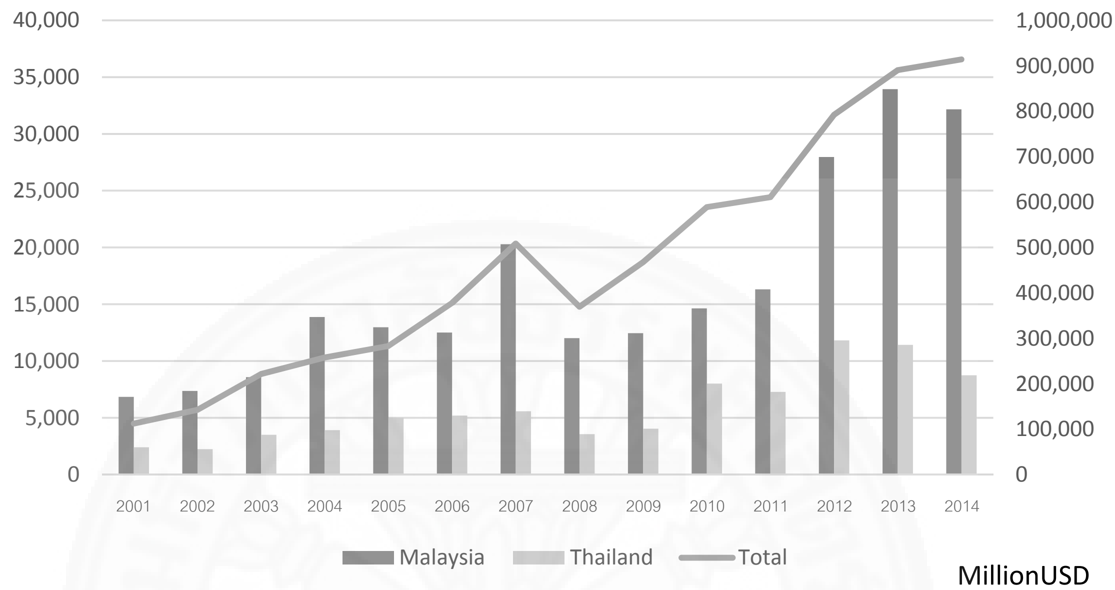
Equation		Excluded		
		Rsing	Rmal	Rthai
Total observation	Rsing	1 (0)	0 (0)	0 (0)
	Rmal	-0.456*** (0.00970)	1 (0)	0 (0)
	Rthai	-0.442*** (0.0179)	-0.225*** (0.0233)	1 (0)
Before ASEAN trading link	Rsing	1 (0)	0 (0)	0 (0)
	Rmal	-0.439*** (0.0103)	1 (0)	0 (0)
	Rthai	-0.440*** (0.0194)	-0.231*** (0.0262)	1 (0)
After ASEAN trading link	Rsing	1 (0)	0 (0)	0 (0)
	Rmal	-0.719*** (0.0324)	1 (0)	0 (0)
	Rthai	-0.458*** (0.0578)	-0.193*** (0.0503)	1 (0)

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Author's Calculation

Figure 4.1

Portfolio investment of Singapore on SET and Bursa Malaysia



Source: Coordinated Portfolio Investment Survey (CPIS)

However, we cannot imply that by using only the magnitude to show that the level of integration increased dramatically after ASEAN-trading link occurred.

4.2 Trivariate-GARCH model (DCC-GARCH model)

A robustness check may be required to support our result because of the constant variance assumption of the VAR and SVAR models. The GARCH model is the additional instrument. Volatility can occur in this model through GARCH (1,1), which consists of high-frequency data, such as financial data. This additional model increases the efficiency of the model, and its form can estimate the conditional correlation, which is a popular indicator in studies in this field. Therefore, we use the estimated conditional correlation to measure the integration level between our returns.

We use the DCC-GARCH model in this study (Engle, 2002). The important additional assumption of this model compared with the original is the change in conditional correlation that can occur all the time. Therefore, we can estimate the daily integrated level, which is called "short-run conditional correlation." After this step, we can determine the estimated level of integration from the dynamic conditional correlation.

Table 4.4 shows the estimated mean equation using GARCH model with a multivariate case. In the first hypothesis, we do not find complete ASEAN stock market integration, and Singapore is the leader of our regional cooperation. The mean equation, which adds a volatility condition, gives different results from the original VAR and SVAR models. The change in SGX's return on Bursa Malaysia is one-fold the change from Malaysia to Singapore but the directional effect is opposite. This result opposites with original VAR result. The interesting result we find is the relationship between Thailand and Malaysia. Original VAR model cannot be estimated our relationship directly. We find the causal relationship from the different criteria. The 1 percentage change from Malaysia can stimulate the 0.05 percentage change in the SET's return in the total period case at the 95% significant level. The opposite side is shown in the pre-ASEAN trading link period at the 90% significant level. We found not only an observable relationship but also a relationship after we established our observed regional cooperation, such as the ASEAN trading link. Adding the multivariate GARCH model supports our previous interesting result from SVAR model in the total and pre-cooperation period. Thus, the 90% statistical significant level supports the finding that the effect increases from a 0.05 to a 0.08 percentage change in Thailand's return from Malaysia. The regional cooperation link Black Monday crisis in China is another impulse that can affect the change in our ASEAN stock market.

Table 4.4

Estimated result from VAR with trivariate GARCH model

Variables	Total period			Before ASEAN trading link			After ASEAN trading link		
	Rsing	Rmal	Rthai	Rsing	Rmal	Rthai	Rsing	Rmal	Rthai
L.dlsing	0.0311	0.0492***	0.0246	0.0377*	0.0533***	0.0259	-0.00578	-0.0166	0.0205
	(0.0191)	(0.0149)	(0.0213)	(0.0213)	(0.0156)	(0.0228)	(0.0468)	(0.0545)	(0.0593)
L.dlmal	-0.0241	0.0964***	0.0499**	-0.0393	0.0868***	0.0387	0.0243	0.174***	0.0829*
	(0.0206)	(0.0192)	(0.0246)	(0.0250)	(0.0211)	(0.0279)	(0.0377)	(0.0499)	(0.0486)
L.dlthai	0.0194	0.0161	0.0173	0.0135	0.0217*	0.0156	0.0232	-0.0372	0.000701
	(0.0134)	(0.0115)	(0.0186)	(0.0157)	(0.0124)	(0.0207)	(0.0257)	(0.0292)	(0.0415)
Us	-0.00107	-0.000531	-0.00104	-0.00126	-0.000746	-0.00104			
	(0.000888)	(0.000670)	(0.000777)	(0.000976)	(0.000717)	(0.000861)			
eurozone	0.000147	-0.000162	0.000360	7.07e-05	-1.83e-05	0.000235	0.000654	9.13e-05	0.00120*
	(0.000402)	(0.000340)	(0.000457)	(0.000599)	(0.000434)	(0.000598)	(0.000559)	(0.000652)	(0.000707)
bmonday	-0.00282*	-0.00273*	-0.00280**				-0.00220*	-0.00257**	-0.00297**
	(0.00146)	(0.00157)	(0.00132)				(0.00114)	(0.00124)	(0.00117)
Constant	0.00051***	0.00069***	0.00105***	0.000719***	0.000750***	0.00112***	7.41e-05	0.000339	0.000524
	(0.000149)	(0.000132)	(0.000199)	(0.000189)	(0.000147)	(0.000237)	(0.000245)	(0.000299)	(0.000333)
Observations	4,094	4,094	4,094	3,329	3,329	3,329	765	765	765

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Author's Calculation

Table 4.5 shows the estimated results of the variance equation for both GARCH and MGARCH models. Both sets of the GARCH model add a dummy crisis variable in the mean equation to eliminate some contagion effects from shock in all criteria. Both estimated results show that the sum of α_i and β_i is less than one in all criteria, and the multistep forecasting of volatility converges to an unconditional variance (Tsay, 2002). Although a mean reverting variance process is available, the summation in the GARCH model is close to one, which makes the reverting process lower than that in the MGARCH (Engle, 2001). Therefore, MGARCH is more efficient than the univariate GARCH in our study. We find different magnitudes for both models. The results show that σ_{t-1}^2 affects the M-GARCH model at the 99% significant level. Comparing the second and third criteria, the effect from σ_{t-1}^2 is reduced after the pre-ASEAN trading link period except for Thailand. Our effect increases after the cooperation. However, this effect does not mean that our cooperation is the main cause of increase in fluctuation, but this result may have emerged because of the contagion effect, such as Black Monday, which we found in the previous part.

Although the result from the added DCC model is not clear enough to imply our hypothesis, this type of GARCH model can provide an estimated result that we can use as proxy for stock market integration. This proxy is a conditional correlation that is estimated from assuming a time-variant, short-run conditional correlation. This factor is the reason why the DCC model is suitable in our study. We start with long-run conditional correlation that can be estimated from the DCC model shown in Table 4.6. We estimate this correlation for all criteria. For Singapore and Malaysia, no differences can be found between the pre- and post-ASEAN trading link periods. Their integrated level is 0.606. A decreasing result is found in Thailand and others. Around 20% of the integrated level between SET and SGX decreases after the cooperation occurred. In the case of Thailand and Malaysia, the correlation ranges from 0.390 to 0.309 after the ASEAN trading link cooperation. This result is doubtful when we consider the booster, such as our cooperation. A time-variant correlation may help to clear all doubts. A short-run conditional correlation is the next indicator to be analyzed.

Table 4.5

Comparing estimated result between GARCH and multivariate GARCH model

Type	Variable	Total period			Before ASEAN trading link			After ASEAN trading link		
		Rsing	Rmal	Rthai	Rsing	Rmal	Rthai	Rsing	Rmal	Rthai
GARCH	L.arch	0.0938***	0.0940***	0.0936***	0.0903***	0.0950***	0.0889***	0.105***	0.103***	0.110***
		(0.00603)	(0.00729)	(0.0185)	(0.00473)	(0.00523)	(0.0145)	(0.00797)	(0.00936)	(0.0179)
	L.garch	0.902***	0.895***	0.881***	0.896***	0.897***	0.857***	0.848***	0.827***	0.867***
		(0.00576)	(0.00727)	(0.0268)	(0.00513)	(0.00528)	(0.0247)	(0.00931)	(0.0130)	(0.0194)
	_cons	1.15e-06***	2.28e-06***	1.40e-06**	1.72e-06***	1.41e-06***	3.82e-06***	8.76e-06***	1.38e-05***	2.63e-06***
		(1.94e-07)	(3.55e-07)	(5.71e-07)	(1.61e-07)	(1.98e-07)	(8.67e-07)	(5.64e-07)	(1.06e-06)	(7.95e-07)
M-GARCH (DCC)	L.arch	0.0643***	0.0690***	0.0938***	0.0641***	0.0732***	0.0927***	0.0840***	0.104***	0.0906***
		(0.00530)	(0.00785)	(0.00930)	(0.00573)	(0.00862)	(0.0103)	(0.0171)	(0.0284)	(0.0200)
	L.garch	0.927***	0.915***	0.859***	0.922***	0.915***	0.844***	0.860***	0.766***	0.878***
		(0.00588)	(0.0104)	(0.0126)	(0.00686)	(0.0105)	(0.0158)	(0.0293)	(0.0667)	(0.0260)
	_cons	1.17e-06***	1.63e-06***	8.61e-06***	2.17e-06***	1.36e-06***	1.25e-05***	2.65e-06***	8.30e-06***	3.11e-06***
		(2.20e-07)	(3.44e-07)	(1.06e-06)	(4.04e-07)	(3.43e-07)	(1.68e-06)	(8.32e-07)	(2.90e-06)	(1.07e-06)

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Author’s Calculation

Table 4.6

Conditional quasicorrelation (unconditional correlation)

Criteria	Pair case		
	Singapore and Malaysia	Singapore and Thailand	Malaysia and Thailand
Total period	0.596*** (0.0261)	0.437*** (0.0326)	0.366*** (0.0348)
Before ASEAN trading link	0.606*** (0.0300)	0.465*** (0.0364)	0.390*** (0.0398)
After ASEAN trading link	0.606*** (0.0299)	0.368*** (0.0405)	0.309*** (0.0420)

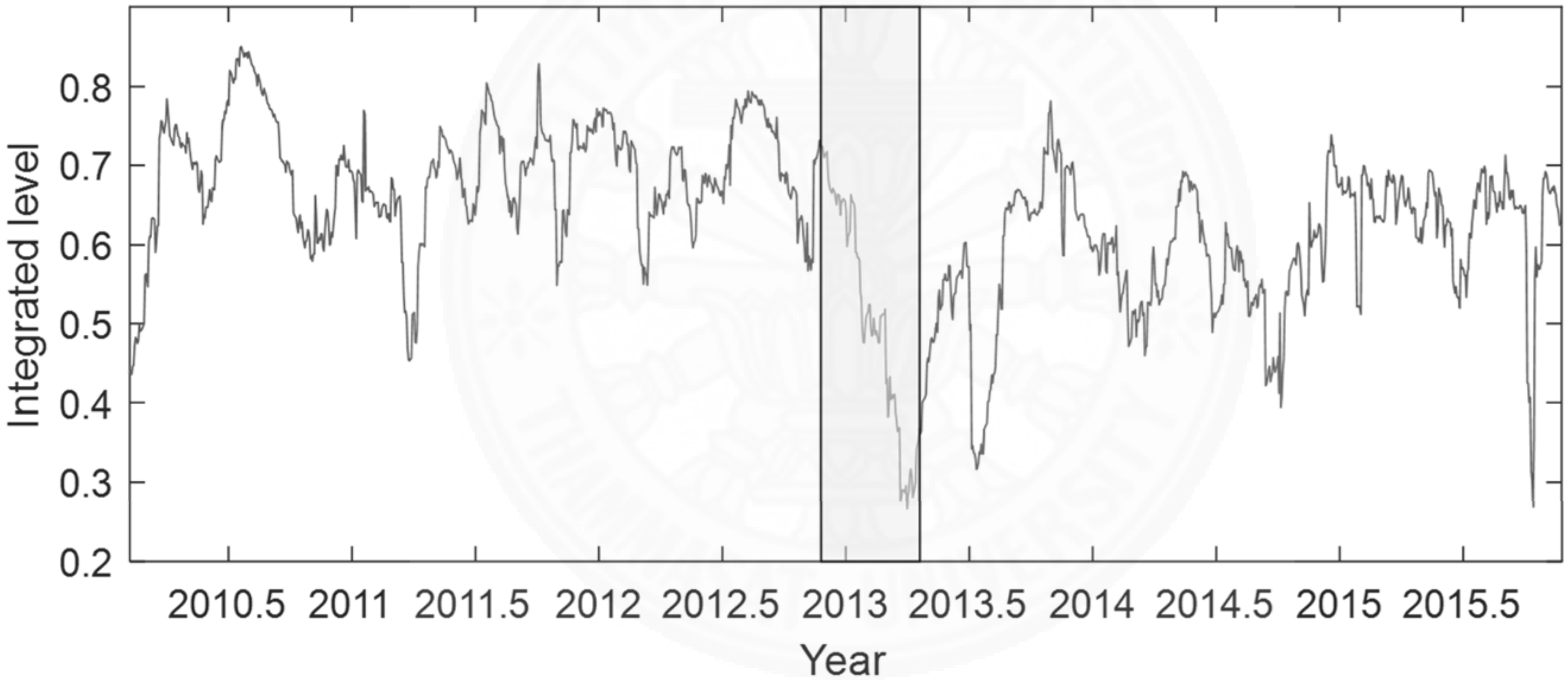
Source: Author's Calculation

The result in Figure 4.2 shows an unconditional correlation between Malaysia and Singapore from January 2010 to September 2015. For the first objective, most of the integrated levels between the countries range from 0.5 to 0.75, which are high values. This result supports the analysis from the VAR model in the previous part. We compare the form of conditional correlation between pre- and post-ASEAN to achieve the second objective. The shaded area shows half of year after the ASEAN exchange cooperation occurred. The finding shows that the integrated level between both periods does not change dramatically, but this result seems slightly lower than that in the before period. This result also supports our analysis of the VAR and SVAR models that the previous cooperation may not be efficient.

Figure 4.2

Short-run Conditional correlation Between Malaysia and Singapore

(January 2010 - September 2015)



Source: Author's Calculation

According to Figure 4.3, most of the daily conditional correlations between Thailand and Singapore from January 2010 to September 2015 are between 0.45 and 0.65, which are lower than those between Singapore and Malaysia. For the second objective, we find that the integration level do not increased dramatically in the shaded area, which we implies the inefficient cooperation. These results support the previous analytic part that the integrated level of Thailand and Singapore is lower than that of Singapore and Malaysia, and that cooperation does not change the integrated level we have.

The level of integration between Malaysia and Singapore from January 2010 to September 2015 is shown in Figure 4.4. The estimated level presents that most of the daily integrated levels are between 0.30 and 0.55. We can imply from this result that our countries are not correlated with each other. Did regional cooperation increase our integrated level? Comparing the correlations between pre- and post-ASEAN, we find that the result is the same as the previous one. This previous cooperation does not change the integrated level we have in the quantitative analysis.

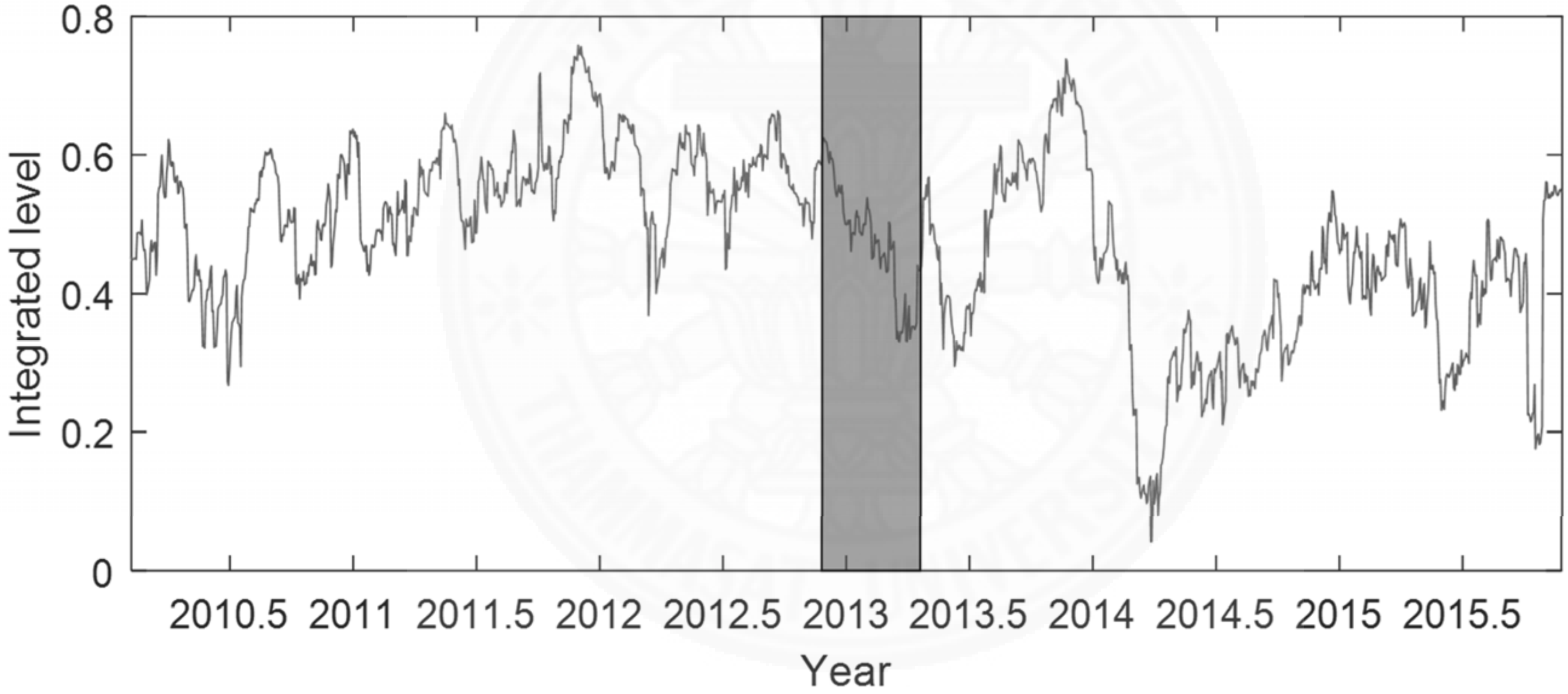
The integration levels in this part support the result from the VAR and SVAR models. Singapore and Malaysia have the highest level of integration. Thailand and Singapore have the second highest conditional correlation. The lowest integrated level in our analysis is Malaysia and Thailand. The result from comparing three criteria shows that the previous cooperation is not too efficient to increase the ASEAN stock market integration dramatically.

Comparing the integrated trend from Figures 4.2, 4.3, and 4.4, we find a decrease at the integrated level for all countries. We attempt to increase the cooperation to increase the power of our region in the global stage why the integrated level seem to be decreased after the impulse policy. Given the time-invariant, long-run conditional correlation, we check the robustness of this analysis by adding the opposite of this condition to see whether or not integrated level occur in long-run of cooperation.

Figure 4.3

Short-run Conditional correlation Between Thailand and Singapore

(January 2010 - September 2015)

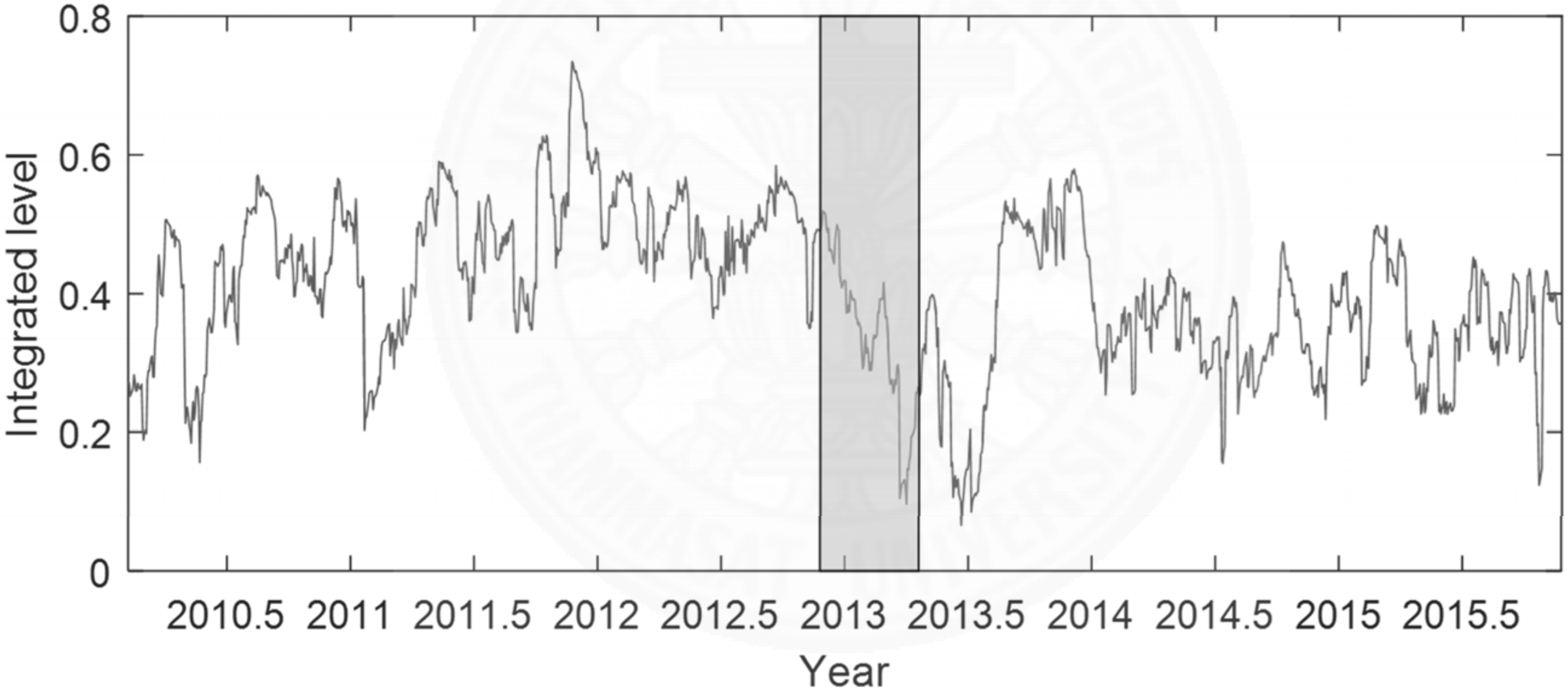


Source: Author’s Calculation

Figure 4.4

Short-run Conditional correlation Between Thailand and Malaysia

(January 2010 - September 2015)



Source: Author's Calculation

4.3 DCC-MIDAS model

Colacito et al. (2011) generated the new GARCH model that can separate the short- and long-run components of the conditional variance and correlation. This model is called the DCC-MIDAS. The procedure to obtain the DCC-MIDAS is similar to that of the DCC-GARCH from Engle (2002). Instead of using the univariate GARCH model, Colacito et al. used the univariate GARCH-MIDAS model, which includes polynomials. These polynomials enable the estimation of all the different frequency data only in one model. The estimated conditional variance is used to estimate the conditional correlation in the second step. We apply this model to separate the long-run from the short-run conditional correlation in the DCC model.

Before estimating the short- and long-run conditional correlations, we assume some parameters, such as number of days in one month and number of months in one year. Given that cooperation does not last too long to use a low-frequency unit, I use the first form. In this study, I use the default of the estimation in the MATLAB code with the model created by Ghysels (2015). In this part, we consider a full sample only for comparing cases. The default of this model is 22 days in one month. The next step to estimate the GARCH-MIDAS is to find the optimal lag length for the monthly weight polynomial. Lag length, which can give the maximum log likelihood, is the optimal lag for the GARCH-MIDAS.

Therefore we can estimate the GARCH-MIDAS for all of Malaysia, Singapore and Thailand by assuming 22 lags for number of days in one month and 21 lags of month for weight polynomial.

Using the maximum log likelihood estimation, we find that 42 lags of the GARCH-MIDAS give the highest log-likelihood values, and the results from these lags are valid. The optimal lag length we use is 21 lags (see in Appendix E). Therefore, we can estimate the GARCH-MIDAS for Malaysia, Singapore, and Thailand by assuming 22 lags for the number of days in one month and 21 lags of months for the weight polynomial.

We estimate the DCC-MIDAS after obtaining the estimated conditional variance. The first step is to estimate the DCC-MIDAS, which follows the same procedure as the previous model. We need to find the optimal lag for the estimated procedure. The number of lags we use for the weight polynomial is from 10 to 120 lags per month because we want to achieve the target and test the efficiency of the ASEAN exchange cooperation for two years before and after the beginning of the ASEAN trading link. We repeat the same step with the different levels of lags as the GARCH-MIDAS estimation and use the same indicator to find the optimal lag length.

Table 4.7 shows the estimated result from the univariate GARCH–MIDAS model. Most coefficients from the GARCH-MIDAS are significant at the 99% significant level. Only the weighted variable of Thailand is significant at the 95% significant level. Although the results from GARCH-MIDAS satisfies the mean reverting variance process, the converging process seems to be lower than that of MGARCH. Table 4.8 presents the estimated coefficient from all GARCH models in our study. The GARCH-MIDAS models give an estimated result close to that of the GARCH.

Table 4.7

The Estimated result from GARCH-MIDAS model

Variable	μ	α	β	θ	w	m
Singapore	0.0005*** (0.00015)	0.0898*** (0.00706)	0.9001*** (0.00793)	0.1574*** (0.02791)	0.1574*** (0.04578)	0.0093*** (0.00156)
Malaysia	0.0006*** (0.00013)	0.1117*** (0.00737)	0.8322*** (0.01264)	0.1797*** (0.00936)	1.0475*** (0.06724)	0.0049*** (0.00053)
Thailand	0.0010*** 0.00020	0.0957*** (0.01027)	0.8341*** (0.01832)	0.0932*** (0.01303)	7.8287* (4.4932)	0.0114*** (0.00047)

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Author’s Calculation

Table 4.8

Comparing all types of GARCH model in total period case

(GARCH, M-GARCH and GARCH-MIDAS)

Type	Variable	Total period		
		Rsing	Rmal	Rthai
GARCH	ε_{t-1}^2	0.0938***	0.0940***	0.0936***
		(0.00603)	(0.00729)	(0.0185)
	σ_{t-1}^2	0.902***	0.895***	0.881***
		(0.00576)	(0.00727)	(0.0268)
	_cons	0.0938***	0.0940***	0.0936***
		(0.00603)	(0.00729)	(0.0185)
M-GARCH	ε_{t-1}^2	0.0643***	0.0690***	0.0938***
		(0.00530)	(0.00785)	(0.00930)
	σ_{t-1}^2	0.927***	0.915***	0.859***
		(0.00588)	(0.0104)	(0.0126)
	_cons	1.17e-06***	1.63e-06***	8.61e-06***
		(2.20e-07)	(3.44e-07)	(1.06e-06)
GARCH-MIDAS	ε_{t-1}^2	0.0898***	0.1117***	0.0957***
		(0.00706)	(0.00737)	(0.01027)
	σ_{t-1}^2	0.9001***	0.8322***	0.8341***
		(0.00793)	(0.01264)	(0.01832)

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Author's Calculation

After obtaining the results for the GARCH-MIDAS, we use these models as the instruments in the next step in the DCC-GARCH case. DCC-MIDAS is the next model we use in our study. The estimated procedure is the same as that in the GARCH-MIDAS cases. We need to find the optimal lag length before estimating the model. Maximum log-likelihood is still the best indicator. We consider 114 lags per month for the DCC-MIDAS to give the maximum log-likelihood (Appendix F), which is statistically significant for all parameters. Therefore, the optimal DCC model in our study is DCC-MIDAS (22,21,114). The first number shows the number of days in one month. The weighted polynomials for the GARCH-MIDAS and DCC-MIDAS are 21 and 114 lags per month, respectively.

Table 4.9

The estimated result from DCC-MIDAS model

Type	Total period		
	A	b	w
DCC-MIDAS	0.0643*** (0.00530)	0.83405*** (0.02159)	6.1286*** (0.95437)
DCC	0.0362*** (0.00337)	0.944*** (0.00584)	-

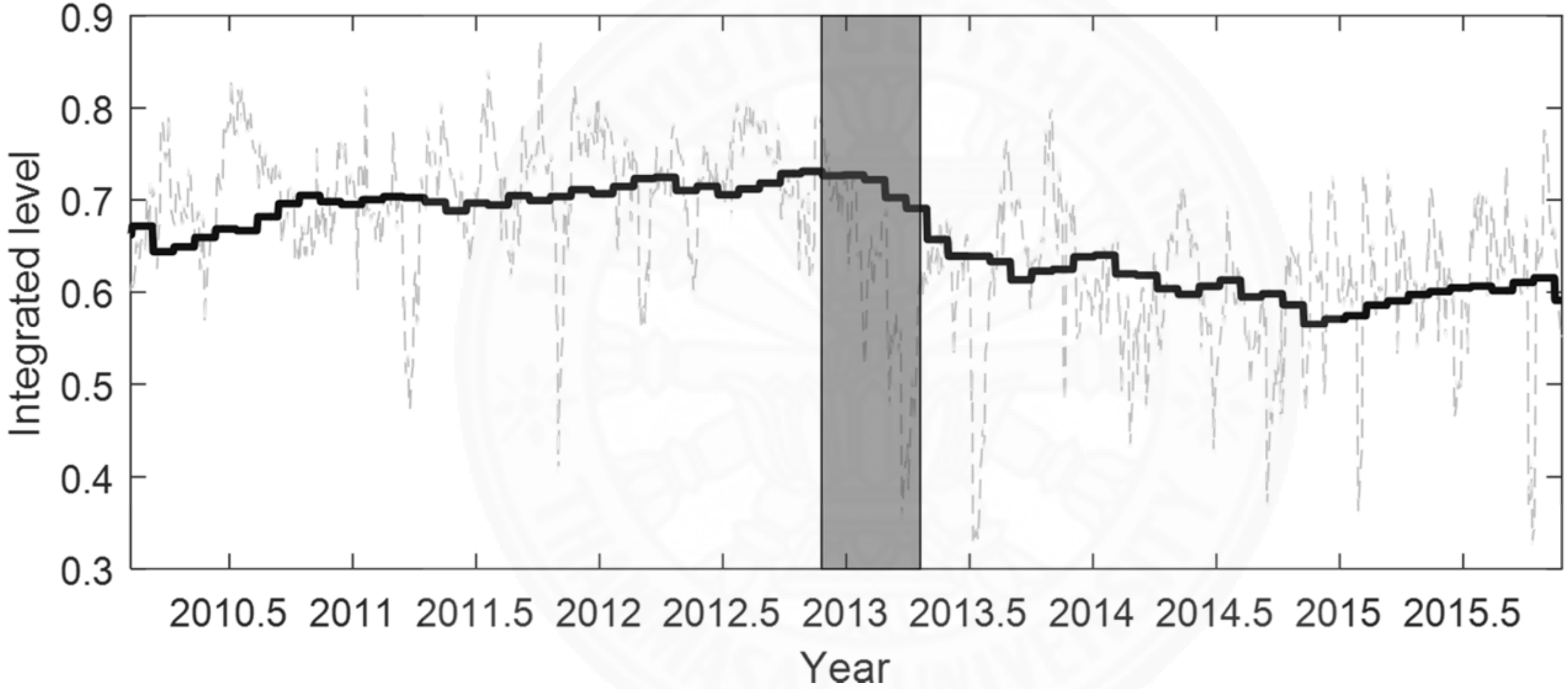
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Author's Calculation

The first row of Table 4.9 presents the coefficient from the DCC-MIDAS model. The result shows that all coefficients are statistically significant at the 99% significant level. The coefficient from this model is different in the case of parameter a. Half of the effect from the arch increases in the DCC-MIDAS model. Indifference in parameter b is shown in the next column.

Figure 4.5 shows the long- and short-run components of the conditional correlation between Malaysia and Singapore from January 2010 to September 2015. The dashed line shows the short-run conditional correlation, such as DCC-GARCH, and the solid line represents the long-run conditional correlation. The long-run conditional correlation is the narrow range compared with the short-run conditional correlation. The integrated level of Singapore and Malaysia is between 0.6 and 0.7, which remains at a high level. In comparing the conditional correlation between the pre- and post-ASEAN trading links, we find that the integrated level does not change for half a year after the ASEAN trading link project as shown in the shaded area.

Figure 4.5

Short-run and Long-run conditional correlation between Malaysia and Singapore



Source: Author’s Calculation

The results in Figures 4.6 and 4.7 show the long- and short-run components of the conditional correlations between Thailand and Singapore and between Thailand and Malaysia from January 2010 to September 2015, respectively. The dashed line represents the short-run conditional correlation, such as the DCC-GARCH. The solid line shows the long-run conditional correlation.

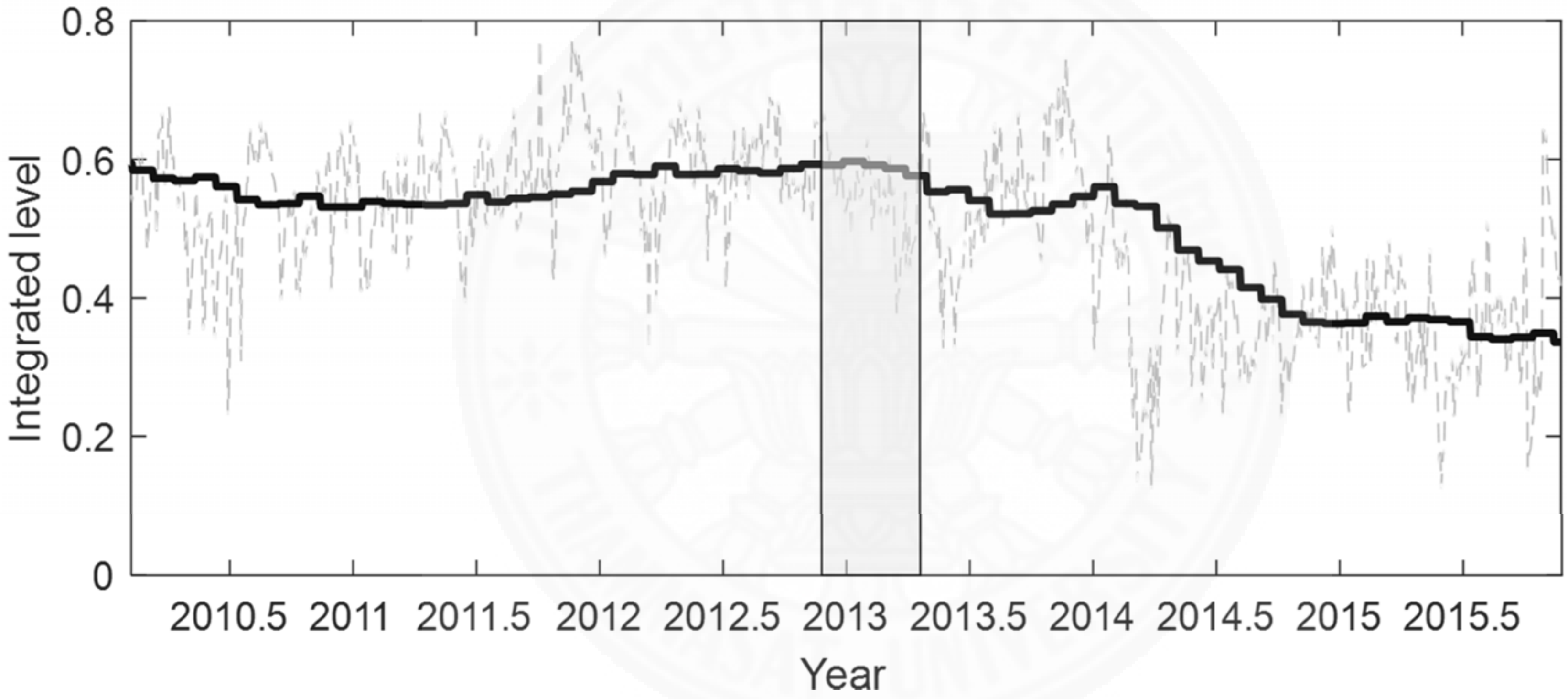
For Thailand and Singapore, the long-run integrated level is between 0.4 and 0.6. In comparing the conditional correlation between the pre-ASEAN trading link and the post-ASEAN trading link, we find that the integrated level does not change in half on the year after the ASEAN trading link project, consistent with the previous group. The important event is the year after the ASEAN stock market integration project. The integrated level between Thailand and Singapore seems to decrease dramatically.

According to Figure 4.7, the long-run conditional correlation of Thailand and Malaysia is between 0.35 and 0.5. To achieve the second objective, we compare the result between the pre- and post-ASEAN cooperation. The result is the same as the previous one. Clearly, this cooperation does not change the level of integration.

Comparing all of the long-run integrated level, we find the interested notice that most of integrated level is reduce after the cooperation though we try to stimulate this by using the cooperation. But decrease in integrate level is not violate and fluctuated like previous DCC model. This leads us to concern more whether there are other determinants which can affect our integration more than our cooperation. If the result from our stock market cooperation is less than the effect from the determinants, all attempts will be waste.

Figure 4.6

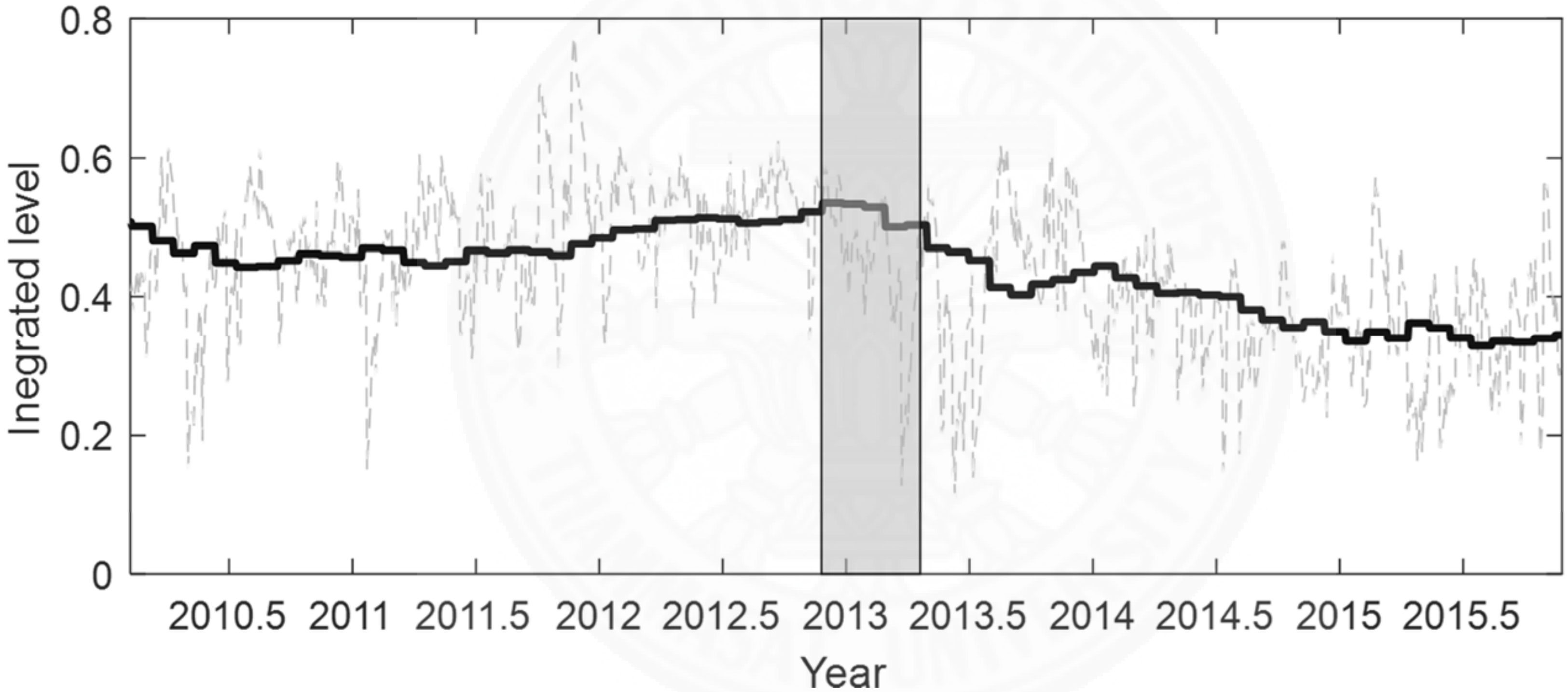
Short-run and Long-run conditional correlation between Thailand and Singapore



Source: Author's Calculation

Figure 4.7

Short-run and Long-run conditional correlation between Thailand and Malaysia



Source: Author's Calculation

Not only level of stock market integration show the efficiency of our cooperation but also investors' decision. ? What is the benefit to our countries from this project? We try to attract the intra-regional fund flows to our countries. If ASEAN exchange can add more investment for Malaysia's and Singapore's investors, this should increases the foreign holding of Thailand's asset significantly. Because of the price of asset was moved by a lot of factors especially the investor's decision and expectation. We applied these with the optimal portfolio investment by Markowitz to test whether optimal portfolio investment of three asset change after previous cooperation.

We assume that the investor chooses optimal weights from three assets. We then use their stock market returns as the asset return, and the sum of these three asset weights should be equal to one. Minimum variance portfolio investment requires the variance–covariance of return as the indicator of risk. The DCC-MIDAS model is the best choice when comparing with the original DCC (Colacito et al, 2011). We use the long-run conditional variance and covariance as the risky matrix. Figure 4.8 shows the Markowitz portfolio optimization, which is estimated from the optimal portfolio investment. This estimated result shows no difference among the weights of all countries, especially Thailand. Our weights in optimal weights do not change dramatically.

The result in figure 4.9 shows the average of the optimal weights in three criteria; total periods, pre-ASEAN trading link and post-ASEAN trading link. The first column shows the optimal weights of Singapore's asset in portfolio investment. We find that the optimal weights of this countries seem to be increase after our stock market cooperation. That weights seem to be moved from Malaysia as shown in the third column of this figure. Second column show Thailand's optimal weights in portfolio investment which seem to be indifference in both period. Assuming minimum variance portfolio investment[4],[6]we can imply that our cooperation seems to benefit Singapore more than other countries. Thailand seems to be the last receiver in this cooperation.

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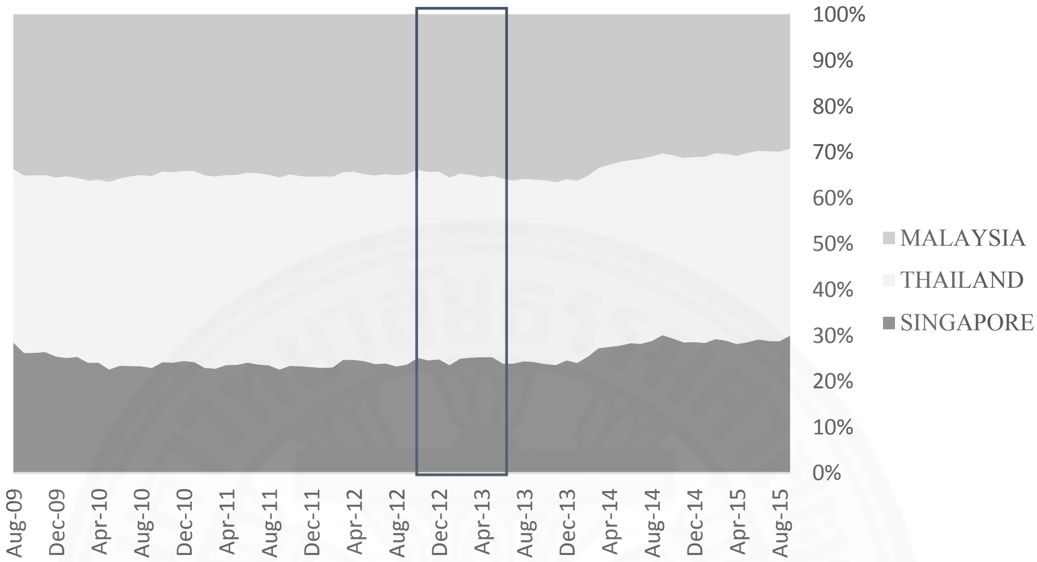
[4] See in Appendix F

Figure 4.8

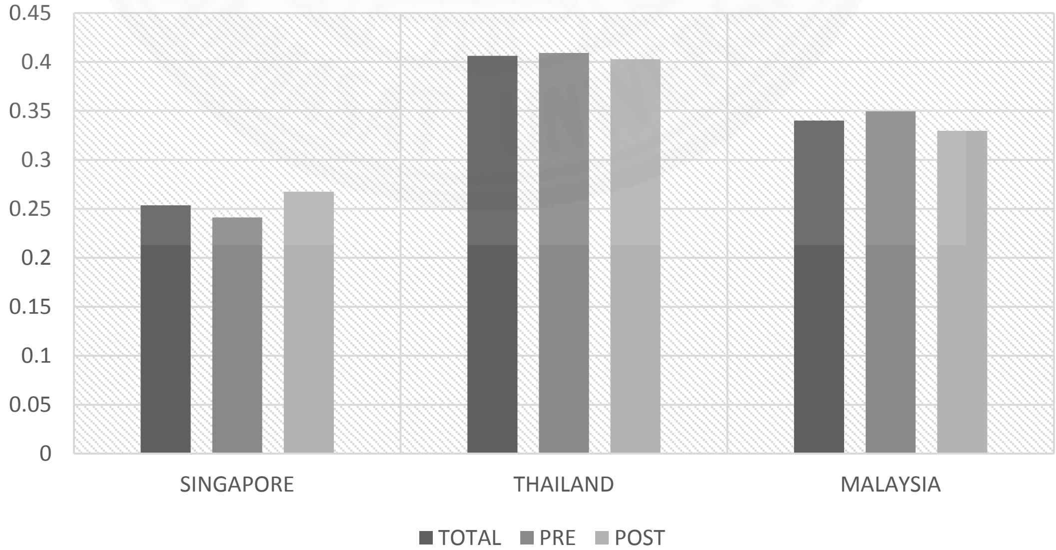
Optimal weighted portfolio investment for three stock markets



Source: Author's Calculation

Figure 4.9

Comparing three criteria of optimal weights



Source: Author's Calculation

4.4 The Determinant of Stock Market Integration (Fundamental Factor)

The previous analysis indicates a decrease in the integrated level of the ASEAN stock market cooperation. However, this result raises doubts. We want to stimulate our relationship with the trading network, reduce home bias for our investors, and develop our stock market to be competitive in the global stage. Thus, we question why the result is opposite that of our expectation. We use the fundamental factors to explain this result, which is similar to that in the literature on this field. The main theory is based on law of one price. The more differences we have, the more uncorrelated we are. Therefore, the most expected signs in Chapter 3 are negative. Given the limitations of fundamental data, we use monthly data as the base unit in this part and use the estimated long-run conditional correlation from the DCC-MIDAS model as the proxy for integrated level.

Table 4.10 presents the estimated values from the OLS and the fixed effect model. Based on the OLS assumption, F-test from the end of the table indicates a fixed effect in the model. This result can lead to a bias estimation at the 99% significant level. Therefore, the panel fixed effect model is suitable. In the third column, we find that stock market development is the main determinant of stock market integration. A 1% growth in low-level development increases by 0.170 of the integrated level at the 90% significant level.

The difference in the economic indicator, such as interest rate, is the next factor. If the difference in interest rate increases by 1 percent, our integrated level will decrease by 0.0709 at the 99 percent significant level. In case of exchange rate volatility, an increase in one unit of fluctuation decreases by 0.0216 of the integrated level at the 99 percent significant level. This result is consistent with the empirical evidence on the relationship between exchange rate volatility and our integrated level

In investor expectation, 99 percent of the significant level shows that increases in the difference in the dividend yield decrease by 0.00741 of the integrated level. The P/E ratio is the lowest booster in our study. The 0.0186 increase in integrated level is created by a 1 percent increase in the difference at the 99 percent significant level.

Table 4.10

Determinants of Stock market integration

VARIABLES	OLS	Fixed Effect
	Integrated level$_{ij}$	Integrated level$_{ij}$
Difference of Price per Earning ratio$_{ij}$	-0.00198	-0.00741***
	(0.00164)	(0.00169)
Difference of Dividend yield$_{ij}$	-0.0104	-0.0186***
	(0.00703)	(0.00649)
Difference of Interest rate spread$_{ij}$	-0.0732***	-0.0709***
	(0.00577)	(0.00863)
Difference of Inflation$_{ij}$	-0.00176	0.000708
	(0.00678)	(0.00613)
Exchange rate volatility	-0.0331***	-0.0216***
	(0.00478)	(0.00482)
Difference of ln(turnover volume)$_{ij}$	-0.0470***	-0.0112
	(0.00560)	(0.00731)
Stock market development of higher	0.0398	0.0632
	(0.0981)	(0.0883)
Stock market development of lower	0.185*	0.170*
	(0.0998)	(0.0896)
Constant	0.533***	0.495***
	(0.00834)	(0.0121)
Observations	204	204
R-squared	0.833	0.557
Number of pairs	-	3
F-test(all a_i=0)	-	24.40***

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

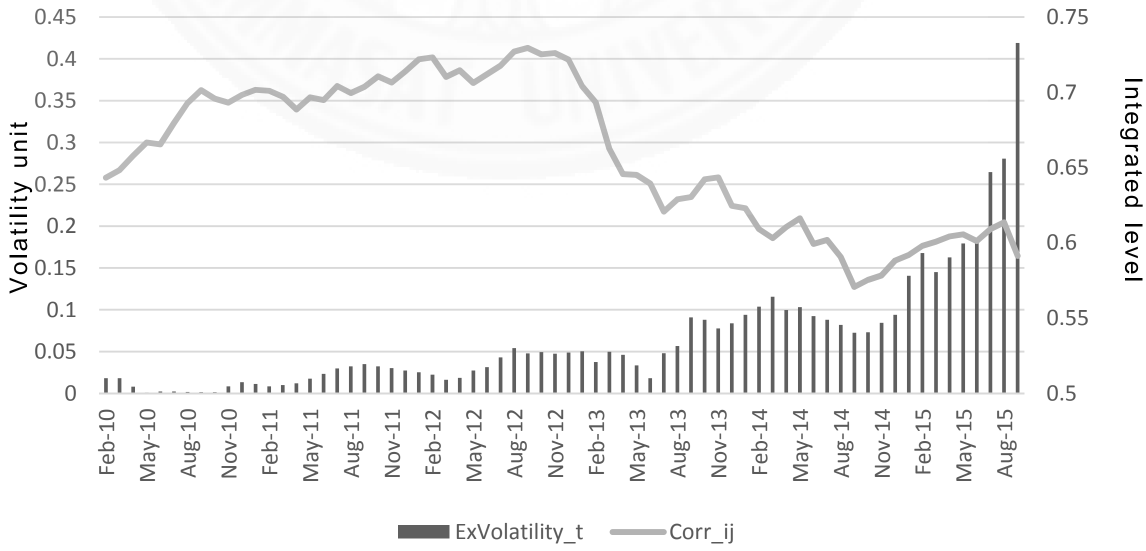
Source: Author's Calculations

Figures 4.10, 4.11, and 4.12 show the relationship between our integrated level and exchange rate volatility from January 2010 to September 2015. The exchange volatility is from the monthly data of the GARCH (1,1) model as shown in the bar chart. The line in the figure indicates the integrated level from the DCC-GARCH (22,21,114) model. For Singapore and Malaysia, the currency risk seems to increase slightly after 2010 and increases dramatically after 2014. The integrated level tends downward in the same period of the increase and seems heavy in high volatility. The same finding is indicated in the cases of Thailand and Singapore as shown in Figure 4.11. The more the fluctuation increases in the exchange rate volatility, the less the integrated level.

However, this result is clearly in the cases of Malaysia and Thailand only as shown in Figure 4.12. The relationship between exchange rate volatility and integrated level does not occur at the same time. Although the decrease in integrated level occurs before the highest volatility occurred, we can observe simultaneous effects between exchange rate volatility and integrated level after 2015. All these results support our analysis on the effect of exchange rate risk on our stock market integration.

Figure 4.10

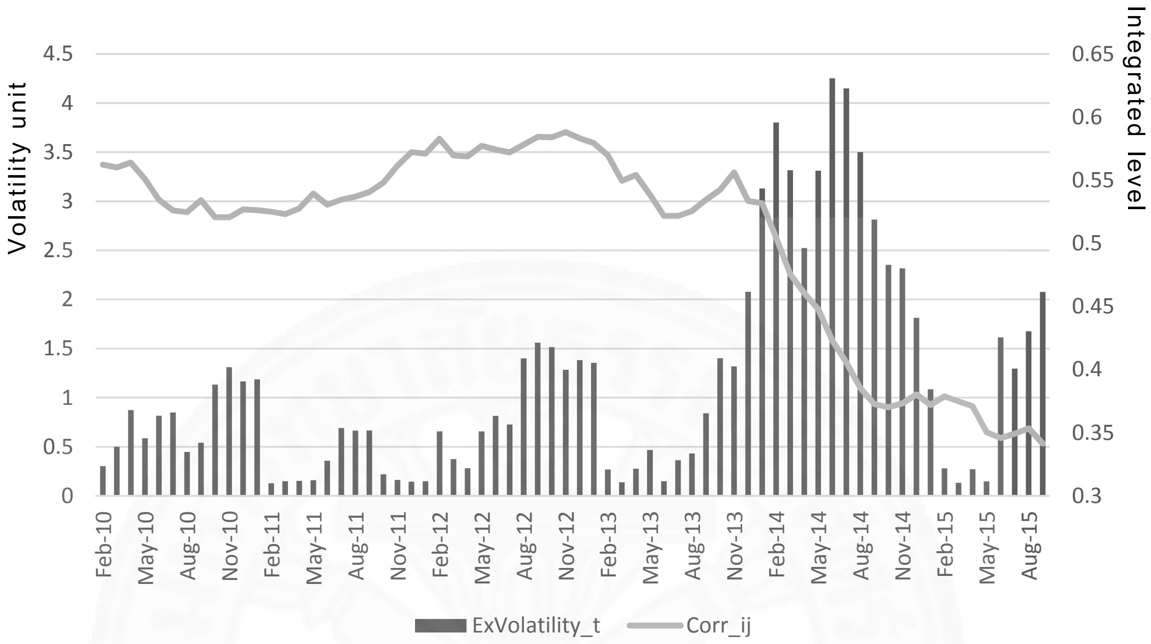
Exchange rate volatility and integrated level between Singapore and Malaysia



Source: Author’s Calculation

Figure 4.11

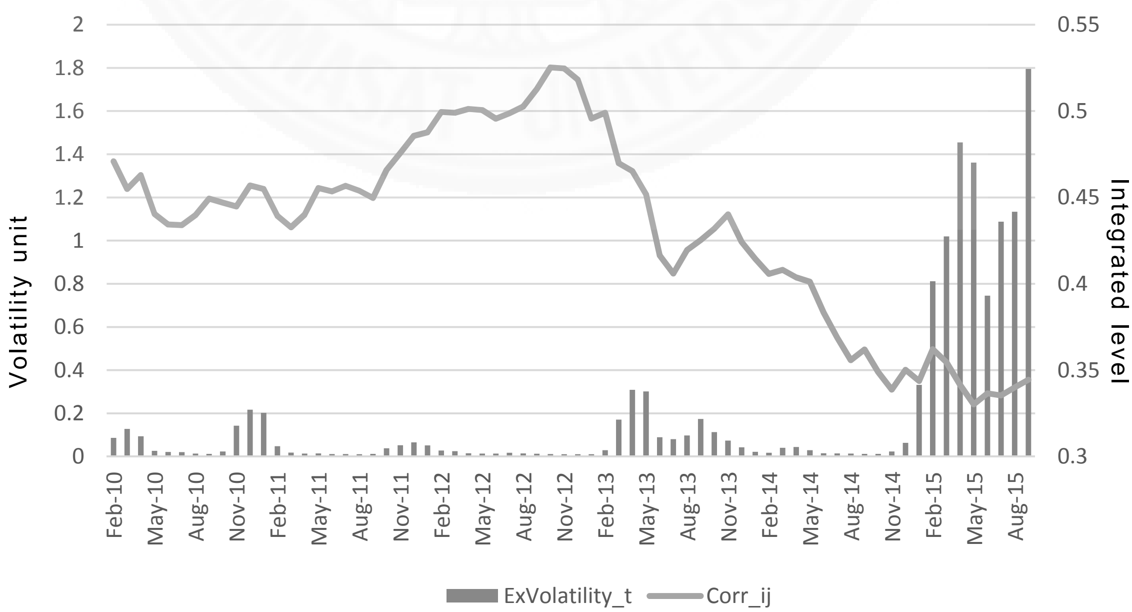
Exchange rate volatility and integrated level between Singapore and Thailand



Source: Author's Calculation

Figure 4.12

Exchange rate volatility and integrated level between Thailand and Malaysia



Source: Author's Calculation

CHAPTER 5

CONCLUSION

5.1 Summary

We study the mechanism of the ASEAN stock market integration, which is part of the implementation plan to achieve the AEC Blueprint 2015 target. Daily stock market return data from Singapore Stock Exchange, Bursa Malaysia, and Stock Exchange of Thailand, which have already joined the regional stock market cooperation, are used in this study. We define complete equity market integration through the law of one price, which implies that the return should be the same if the same risk and no trading barrier exist. Although this situation seems impossible in the real world, regional cooperation can increase such a possibility. The ASEAN exchange is an example of this regional cooperation.

To understand the mechanism of our regional cooperation, we begin with the simple hypothesis on our stock market. In this step, we investigate whether or not complete stock market integration occurred. The causality among stock markets should be the instrument used. If causality among markets occurs at the same level, then complete integration occurs. Through various econometric models, the result shows that no similar response occurred among the causalities. Thus, complete integration did not occur in our regional cooperation. The result shows the effect of Singapore on Thailand and Malaysia. Singapore is the leader of the stock market integration in our region. The highest correlation is between Singapore and Malaysia, followed by the correlation between Singapore and Thailand. Thailand and Malaysia have the lowest level of integration.

For an in-depth analysis, we separate the study into three criteria to test whether or not a previous regional cooperation such as the ASEAN exchange can develop the relationship. If this cooperation is efficient, the relationship between markets will increase dramatically. We use basic and advance techniques, such as DCC-GARCH and DCC-MIDAS, to test this hypothesis. This procedure starts from the

Granger causality test through the VAR; the SVAR is the same as in the previous case. The result shows indifference between before and after the occurrence of the ASEAN trading link. For better efficiency, we use the dynamic conditional correlation as proxy for integrated level to observe the change at the integrated level.

The result is the same as the arrangement in the simple hypothesis case. Singapore and Malaysia have the highest correlation between their markets. Comparing the pre- and post-ASEAN exchanges, both short- and long-run conditional correlations show doubtful results. The stable integrated level is shown in the beginning of our stock market cooperation. This result may have occurred because of the indifferent expectations of the investor that is consistent with the optimal portfolio investment. Other than a constant level occurring at the beginning, a decrease occurred after the ASEAN exchange. Given that the three countries want to integrate, the results of the cooperation contradict the expectations. Other factors could have affected this relationship more than our cooperative impulse. This result leads us to the next analysis, which is to seek the factor that could have affected stock market integration. Several studies in this field reported on the fundamental factors that stimulate stock market integration.

We estimate our integrated level and check which factor could affect our relationship. The result shows that the growth of stock market development is the main factor that could increase the relationship. The next determinants are expectations of investor, such as differences in dividend yield and P/E ratio of each country. The important instruments that can stabilize our economy are the exchange and interest rates. Policy makers use these tools to stabilize the economy. Different economic situations and policy responses create different instruments. Stabilized policies decrease the level of integration.

5.2 Implications and Recommendations

We cannot imply that stock market integration will be beneficial to the economy in the long run because the more we integrate with each other, the less we can diversify risk. Efficient portfolio investment supports a set of assets with a low correlation. High correlation lessens risk diversity and increases the crisis effect (i.e., contagion effect) more than usual, such as the experience of the EU. Policy makers should be careful in following the steps toward capital market integration.

The results show that increasing stock market development is the best choice for increasing stock market integration as other determinants, such as interest and exchange rates, decrease the stabilized power. Although this policy seems to be useful, the limitations are significant. These limitations include exchange rate volatility and differential interest rate. Therefore, complete stock market integration will not occur in our cooperation if the countries are unable to manage our determinants, such as interest and exchange rate volatility, before applying other choices to increase stock market integration. If we cannot control these factors, much money will be wasted. The more that integrated level increases, the less the policy autonomy we will have. This relationship should make us cautious in all steps of our cooperation.

5.3 Recommendation for future studies

In this study, we use the aggregate stock market index that includes all stock markets of all three stock exchanges. Future studies should separate the index into two criteria. First, focus should be given on the micro level, such as the SET50 and STI indexes, which include only top companies. These indexes may show more volatility and better results than that used in the current study. Integration among industries in the stock exchanges is also an interesting topic.

Many macro-level factors should focus on the second criterion. We will add more countries with inter and intra-regional counties to see whether or not our relationship changes during the normal period and to distinguish the contagion effect from the current issue. Having more countries in the study will increase the number of portfolio investment choices and will determine whether or not our ASEAN exchange will be an interesting choice among investors.

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APPENDICES

APPENDIX A

UNIT ROOT TEST

Testing Method

1. Augmented-Dickey Fuller test

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \sum_{t=1}^{m} \zeta_i \Delta y_{t-i} + \varepsilon_t$$

2. Phillips-Perron test

$$y_t = \alpha + \beta y_{t-1} + \delta t + \varepsilon_t$$

Step 1: Including trend, intercept and lag in the model

H0: $\beta = 0$

(target: reject the null hypothesis then stationary occurred)

If $\beta \neq 0$, we will test trend property in this variable.

Next H0: $\delta = 0$

(target: accept the null hypothesis then time trend is not occurred in this variable. This means stationary occurred.)

Next If $\delta \neq 0$, Rejecting show that trend is not occurred in this variable. Unit root problem might occur because other problem.

Step 2: Including intercept and lag in the model

H0: $\beta = 0$

(target: reject the null hypothesis then stationary occurred)

If $\beta \neq 0$, we will test constant characteristics.

Next H0: $\alpha = 0$

(target: accept the null hypothesis then stationary occurred.)

Step 3: Including lag in the model

H_0: $\beta = 0$

(target: reject the null hypothesis then stationary occurred)

Finally, If $\beta \neq 0$, There is Unit root.

Because of stationary properties in VAR model, Unit root test is required for all variables. According to Table A.1, Augmented-Dickey fuller test and Phillips-Perron test show that there are non-stationary variables in my model then solving is required. First order in VAR model might drop some characteristics of the variable. Using continuous compound rate of return is the better method to solve this problem. Both test show the stationary properties of all return index (As shown in Table A.2).

Table A.1

Unit root test for all stock price indices

Test	Variable (Price index)	P-value					conclusion	integrated series of order d I(d)
		Including trend, lags and constant		Including lags and constant		only lags		
		MacKinnon approximate (Lags)	t-test (trend)	MacKinnon approximate (Lags)	t-test (constant)	t-test (Lags)		
		H0: unit root	H0: no unit root	H0: unit root	H0: no unit root	H0: unit root		
ADF-test	Singapore	0.4373	0.043**				non-stationary	I(1)
	Malaysia	0.8275	0.179	0.8464	0.18	0.386	non-stationary	I(1)
	Thailand	0.3417	0.011**				non-stationary	I(1)
Phillips-perron	Singapore	0.4296	0.065	0.689	0.270	0.000	stationary	I(0)
	Malaysia	0.8132	0.269	0.8377	0.158	0.000	stationary	I(0)
	Thailand	0.333	0.012**				non-stationary	I(1)

** Reject null hypothesis at 5 percent

Source: Author's Calculation

Table A.2

Unit root test of continuous compound rate of return for all stock market

Test	Variable (Return)	P-value					conclusion	integrated series of order d I(d)
		Including trend, lags and constant		Including lags and constant		only lags		
		MacKinnon approximate (Lags)	t-test (trend)	MacKinnon approximate (Lags)	t-test (constant)	t-test (Lags)		
		H0: unit root	H0: no unit root	H0: unit root	H0: no unit root	H0: unit root		
ADF- test	Singapore	0.000					stationary	I(0)
	Malaysia	0.000					stationary	I(0)
	Thailand	0.000					stationary	I(0)
Phillips-perron	Singapore	0.000					stationary	I(0)
	Malaysia	0.000					stationary	I(0)
	Thailand	0.000					stationary	I(0)

**Reject null hypothesis at 5 percent

Source: Author's Calculation

APPENDIX B

STABILITY CONDITION
AND OPTIMAL LAG LENGTH FOR VAR MODEL

B.1 The optimal lag length for VAR model

Optimal lag length is most important step to generate VAR model. There are a lot of indicator for finding the optimal lag. In this study, I use information criteria as the indicator (as shown in chapter 3). Lag length which has the minimum information criteria(IC) will be the optimal lag in VAR model. Not only one criteria but also other such as pre-ASEAN trading link and post-ASEAN trading link we do for achieve the second objective. The optimal lag for all of them is required. After estimate VAR model of all criteria, we need to check the stability condition through Eigenvalue and Unit circle test. The estimated result will be show in the next part.

The result in table B.1 present the optimal lag length in total observation. The minimum AIC show in lag 6, while the optimal lag length for SBIC is lag 1(AIC = -18.91, SBIC = -18.8671). Because of consistent in information, most economic study prefer SBIC more than AIC. Therefore the optimal lag length for VAR model in this criteria is lag one. For stability testing, table B.2 show that all Eigenvalues are lay inside the unit circle, figure B.1 which refer to the stability condition for this VAR model

Table B.1

Optimal lag length for total period

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	38554.1				1.30E-12	-18.8686	-18.8604	-18.8454
1	38635.8	163.35	9	0.000	1.20E-12	-18.9042	-18.8911*	-18.867*
2	38635.8	30.805	9	0.000	1.20E-12	-18.9073	-18.8893	-18.8563
3	38635.8	22.246	9	0.008	1.20E-12	-18.9084	-18.8854	-18.8434
4	38635.8	16.874	9	0.051	1.20E-12	-18.9081	-18.8802	-18.8292
5	38635.8	12.067	9	0.210	1.20E-12	-18.9066	-18.8738	-18.8139
6	38635.8	31.835*	9	0.000	1.2e-12*	-18.91*	-18.8723	-18.8034
7	38635.8	11.244	9	0.259	1.20E-12	-18.9084	-18.8657	-18.7878
8	38635.8	3.7463	9	0.927	1.20E-12	-18.9049	-18.8573	-18.7704
9	38635.8	14.388	9	0.109	1.20E-12	-18.904	-18.8514	-18.7556
10	38635.8	15.018	9	0.090	1.20E-12	-18.9033	-18.8458	-18.7409

Endogenous: dlsing dlthai dlmal
Exogenous: us eurozone bmonday _cons

Source: Author’s Calculation

Table B.2

Stability test for total period

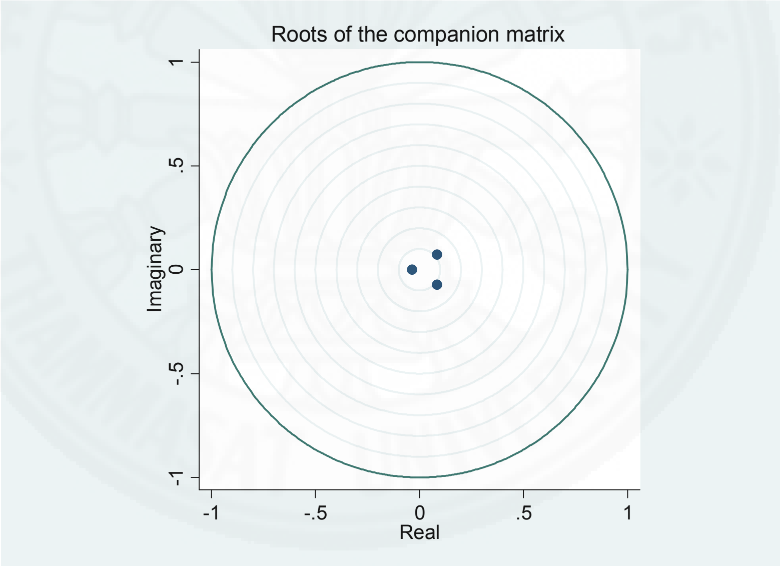
Eigenvalue	Modulus
0.08318954 + .07227094i	0.110198
0.08318954 - .07227094i	0.110198
-0.03544866	0.035449

Source: Author's Calculation

Figure B.1

Unit Circle for 1 lag

(Total period)



Source: Author's Calculation

The optimal lag length for pre-ASEAN trading link is shown in table B.3. The minimum AIC show in lag 6, while the optimal lag length for SBIC is lag 1 (AIC = -18.6118, SBIC = -18.5731). From the previous criteria, SBIC is prefer than AIC then lag 1 is the optimal lag length for this system equation. The result in table B.4 show that all Eigenvalues are lay inside the unit circle, figure B.2. We can imply that VAR model in this criteria satisfied the stability properties.

Table B.3
Optimal lag length
(Before ASEAN trading link)

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	30834				1.70E-12	-18.5693	-18.5634	-18.5527
1	30904.4	140.77	9	0.000	1.70E-12	-18.6063	-18.5944*	-18.5732*
2	30919.4	29.953	9	0.000	1.70E-12	-18.6099	-18.5921	-18.5602
3	30930.7	22.684	9	0.007	1.70E-12	-18.6113	-18.5876	-18.5451
4	30939.5	17.535	9	0.041	1.70E-12	-18.6112	-18.5815	-18.5284
5	30945	10.892	9	0.283	1.70E-12	-18.609	-18.5735	-18.5097
6	30958.6	27.249*	9	0.001	1.7e-12*	-18.612*	-18.5703	-18.4959
7	30963.8	10.471	9	0.314	1.7E-12	-18.6095	-18.5621	-18.4771
8	30966.3	4.8625	9	0.846	1.70E-12	-18.6056	-18.5522	-18.4566
9	30972.9	13.253	9	0.151	1.70E-12	-18.6041	-18.5449	-18.4386
10	30980.7	15.548	9	0.077	1.70E-12	-18.6034	-18.5382	-18.4213

Exogenous: us eurozone bmonday _cons
Endogenous: dlsing dlthai dlmal

Source: Author's Calculation

Table B.4

Stability test

(Before ASEAN trading link)

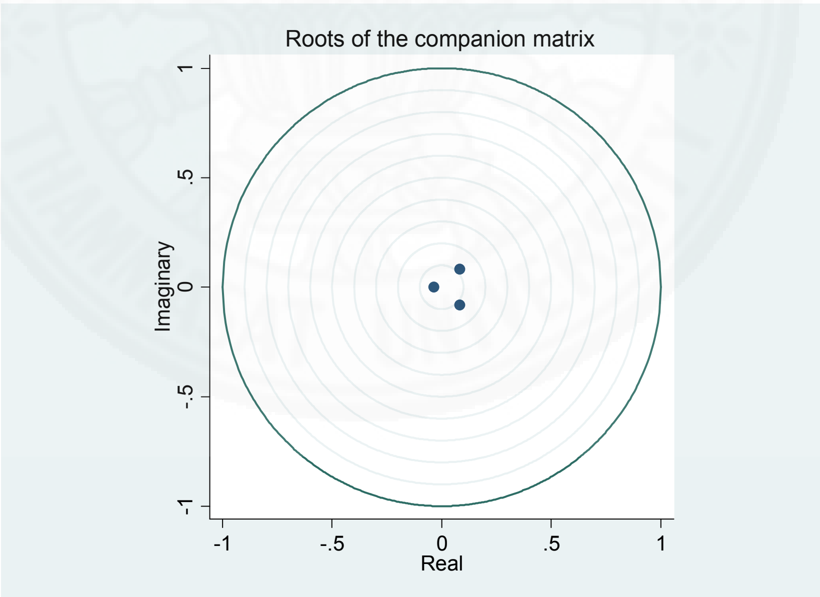
Eigenvalue			Modulus
0.8306189	+	.08171142i	0.116516
0.8306189	-	.08171142i	0.116516
-0.03684881			0.036849

Source: Author's Calculation

Figure B.2

Unit Circle for 1 lag

(Before ASEAN trading link)



Source: Author's Calculation

For post-ASEAN trading link, the optimal lag length for AIC is lag 1, while the optimal lag length for SBIC is lag 0 (AIC = -20.9781, SBIC = -20.9139). Although the SBIC is preferred in the most of econometric study, AIC give the minimum value than others. Lag 1 is another choice to find the optimal lag length in this case. According to figure B.3, all Eigenvalues are table B.6 lay inside unit circle which means stability condition is satisfied for VAR(1) model.

Table B.5
Optimal lag length
(After ASEAN trading link)

lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	8029.44				1.60E-13	-20.9685	-20.9475*	-20.9139*
1	8042.1	25.397	9	0.003	1.6e-13*	-20.9781*	-20.9361	-20.869
2	8046.67	9.0581	9	0.432	1.60E-13	-20.9665	-20.9034	-20.8027
3	8052.27	11.207	9	0.262	1.60E-13	-20.9576	-20.8735	-20.7392
4	8056.16	7.7634	9	0.558	1.60E-13	-20.9442	-20.8391	-20.6713
5	8064.03	15.749	9	0.072	1.60E-13	-20.9413	-20.8152	-20.6137
6	8074.96	21.859	9	0.009	1.60E-13	-20.9463	-20.7992	-20.5642
7	8083.7	17.472	9	0.042	1.6E-13	-20.9456	-20.7775	-20.5089
8	8089.81	12.228	9	0.201	1.60E-13	-20.9381	-20.7489	-20.4468
9	8098.57	17.519*	9	0.041	1.60E-13	-20.9374	-20.7273	-20.3916
10	8104.15	11.17	9	0.264	1.60E-13	-20.9285	-20.6974	-20.3281

Endogenous: dlsing dlthai dlmal
Exogenous: bmonday _cons

Source: Author's Calculation

Table B.6

Stability test

(After ASEAN trading link)

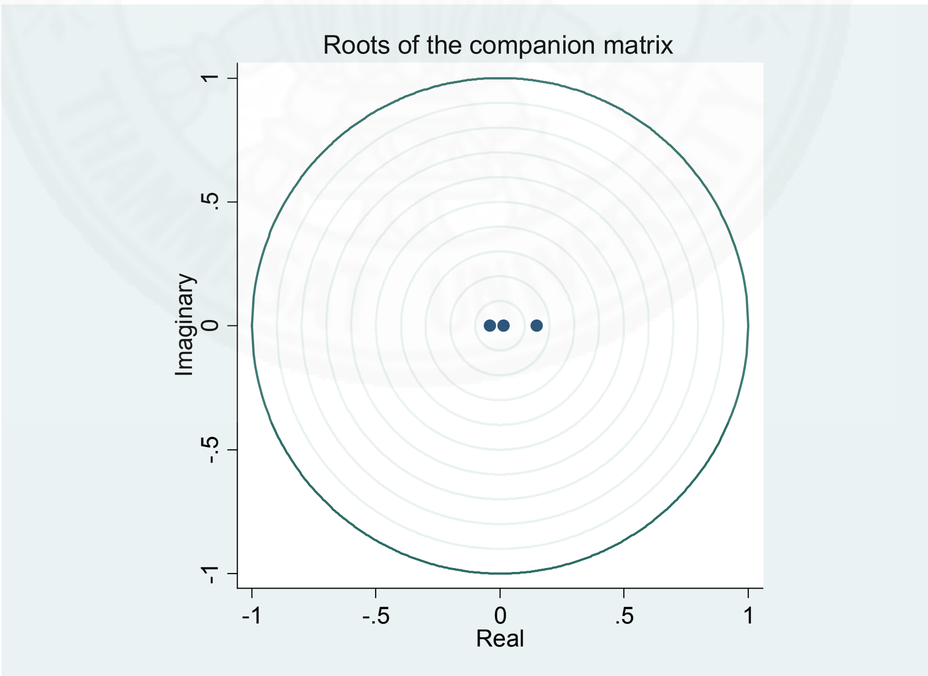
Eigenvalue	Modulus
0.1489143	0.148914
-0.03956401	.039564
0.01422576	0.014226

Source: Author's Calculation

Figure B.3

Unit Circle for 1 lag

(After ASEAN trading link)



Source: Author's Calculation

APPENDIX C

CONTAGION EFFECT TEST

C.1 Total period

```
 ( 1)  [dlmal]us = 0
 ( 2)  [dlmal]eurozone = 0
 ( 3)  [dlmal]bmonday = 0
 ( 4)  [dlsing]us = 0
 ( 5)  [dlsing]eurozone = 0
 ( 6)  [dlsing]bmonday = 0
 ( 7)  [dlthai]us = 0
 ( 8)  [dlthai]eurozone = 0
 ( 9)  [dlthai]bmonday = 0

           chi2(  9) =   16.14
         Prob > chi2 =    0.0641
```

The result show that in total period case the contagion effect is occur with 90 percent significant level.

C.2 Pre-ASEAN trading link

```
 ( 1)  [dlmal]us = 0
 ( 2)  [dlmal]eurozone = 0
 ( 3)  [dlsing]us = 0
 ( 4)  [dlsing]eurozone = 0
 ( 5)  [dlthai]us = 0
 ( 6)  [dlthai]eurozone = 0

           chi2(  6) =    6.48
         Prob > chi2 =    0.3719
```

The result show that in pre-ASEAN stock market cooperation the contagion effect from US and Eurozone did not affect our country.

C.3 Post-ASEAN trading link

```
 ( 1)  [dlmal]eurozone = 0
 ( 2)  [dlmal]bmonday = 0
 ( 3)  [dlsing]eurozone = 0
 ( 4)  [dlsing]bmonday = 0
 ( 5)  [dlthai]eurozone = 0
 ( 6)  [dlthai]bmonday = 0

           chi2(  6) =   17.01
         Prob > chi2 =    0.0093
```

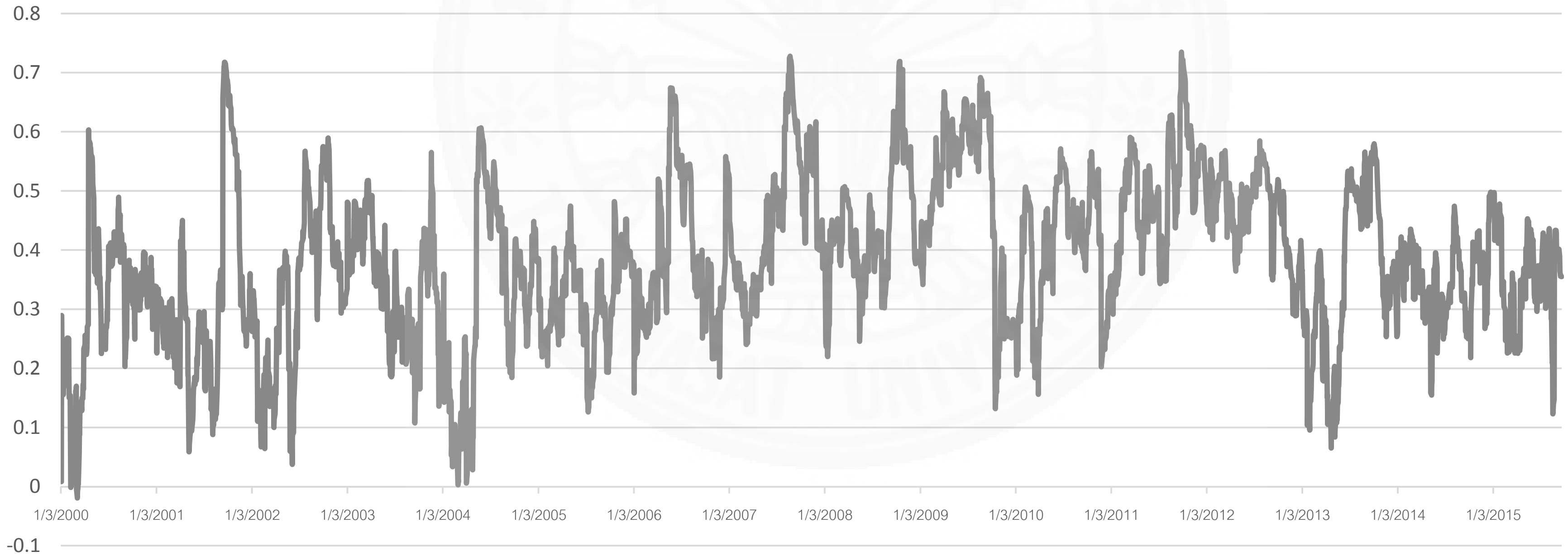
The result show that in pre-ASEAN stock market cooperation the contagion effect from Eurozone and China’s Black Monday affect our country at 99 percent significant level.

APPENDIX D

FULL RANGE OF SHORT-RUN CONDITIONAL CORRELATION

Figure D.1

Estimated conditional correlation
(Thailand and Malaysia)



Source: Author's Calculation

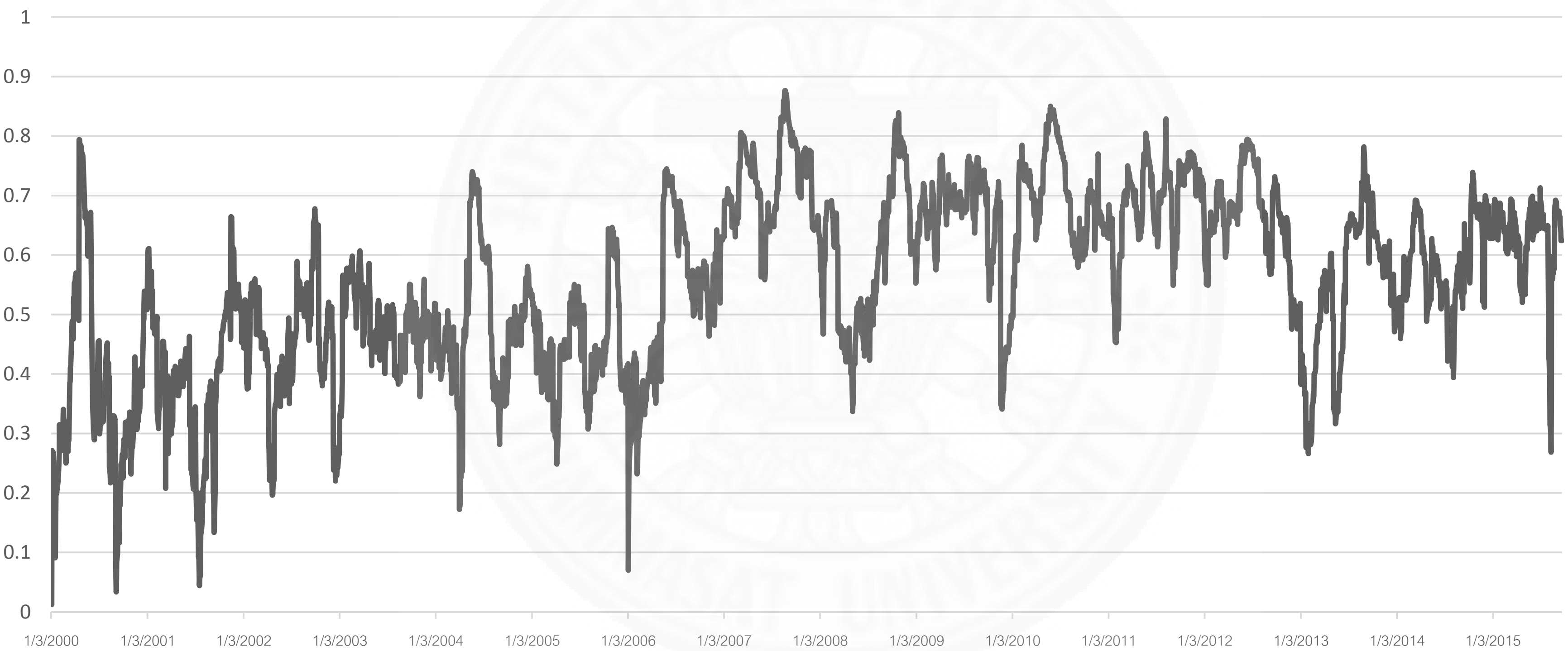
Figure D.2

Estimated conditional correlation
(Thailand and Singapore)

Source: Author’s Calculation

Figure D.3

Estimated conditional correlation
(Singapore and Malaysia)



Source: Author's Calculation

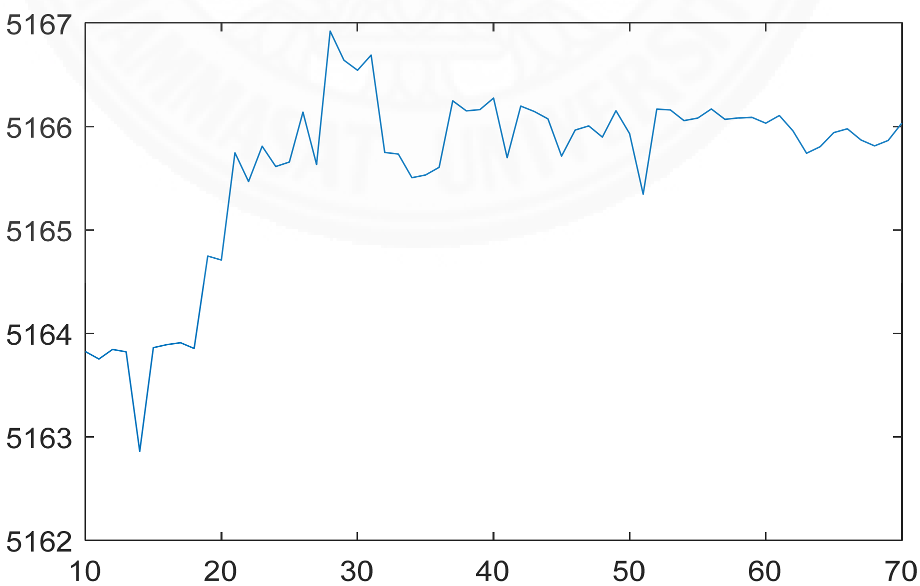
APPENDIX E

OPTIMAL LAG LENGTH OF GARCH-MIDAS

Before estimating the short-run and long-run conditional correlation, we need to assume some parameter such as number of days in one month, number of months in one year. Because the cooperation is not spend too long to use low frequency unit, I will use the first form. In this study, I use the default of estimation in MATLAB code with created by Ghysels (2015). The default of this is 22 days in one month. The next step to estimate GARCH-MIDAS is to find the optimal lag length for the monthly weight polynomial. Lag length which can give the maximum log likelihood will be the optimal lag for GARCH-MIDAS. Because the initial value for each parameter in MLE estimation is important, we use the default as Ghysels(2015) setting and check the result with other initial. For Singapore, we find that 28 lags of month for weight polynomial give the maximum log-likelihood as shown in figure E.1

Figure E.1

Log-likelihood for estimating GARCH-MIDAS of Singapore

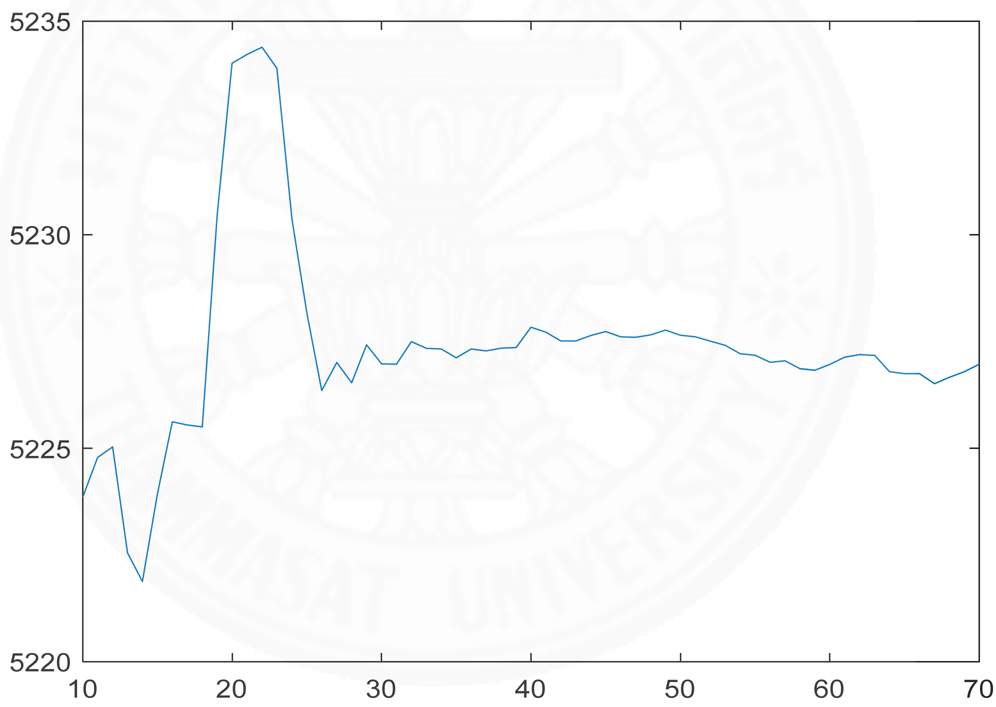


Source: Author’s Calculation

In case of Malaysia, The optimal lag is 21 of month in GARCH-MIDAS model (figure E.2). But estimated log likelihood value of Thailand is different. According to figure E.3, there is no clearly maximum point of log-likelihood. Because balanced result is important instrument to estimate DCC-MIDAS model in the next step. We decide to use only one lag length which give the maximum log-likelihood level from comparing with all country. The result show that lag 21 is optimal lag length we use in our study.

Figure E.2

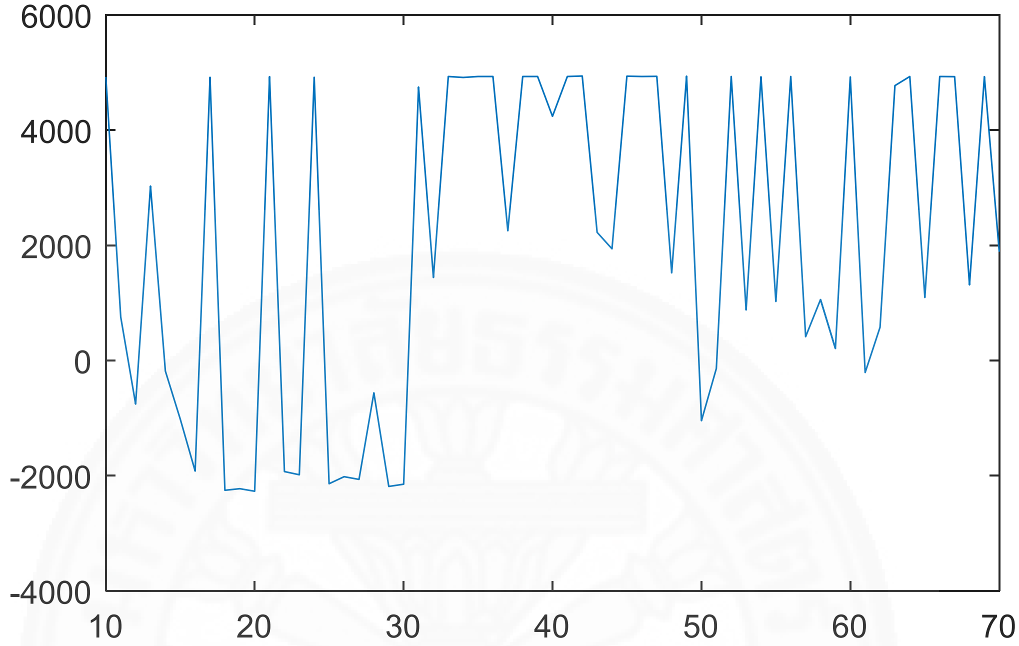
Log-likelihood for estimating GARCH-MIDAS of Malaysia



Source: Author's Calculation

Figure E.3

Log-likelihood for estimating GARCH-MIDAS of Thailand



Source: Author's Calculation

APPENDIX F

OPTIMAL LAG LENGTH OF DCC-MIDAS

Table F.1 present the top five of log-likelihood for five lag length. 114 lag of month for DCC-MIDAS give the maximum log-likelihood (as shown in figure 4.8) and statistically significant for all parameter. Hence, the optimal DCC model in our study is DCC-MIDAS(22, 21, 114). First number shows the number of days in one month. Weighted polynomial for GARCH-MIDAS and DCC-MIDAS is 21 and 114 lag of months respectively.

Table F.1

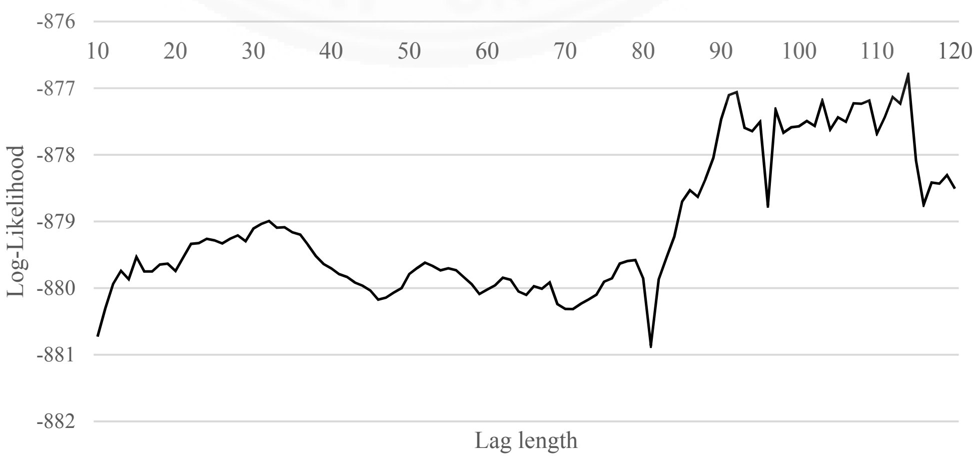
Optimal Lag for DCC-MIDAS

Log-likelihood	lag
-876.8013963	114
-877.0589788	92
-877.1026633	91
-877.1303289	112
-877.1848733	109

Source: Author’s Calculation

Figure F.1

Optimal Lag for DCC-MIDAS



Source: Author’s Calculation

APPENDIX G

MINIMUM VARIANCE PORTFOLIO INVESTMENT

According to Markowitz portfolio optimization, investor use the optimal portfolio weights of k assets to minimize their portfolio variance.

$$\min_{w_t} w_t H_t w_t^{'}$$

$$s.t. \quad w_t i = \bar{w}$$

Where H_t is the k x k vector of variance-covariance for k assets in their portfolio.

w_t is the 1 x k vector of portfolio weights for k assets in their portfolio.

i is the k x 1 vector of ones.

In this study, I assume that the investors have only three securities in their portfolio choice. Those assets are used the stock index of Singapore, Thailand and Malaysia as their price then the return will be the same as the return of those country's stock market index. We use variance-covariance matrix of DCC-MIDAS as the proxy of asset's risk in this model and using the minimum portfolio optimization to find the optimal weights of investment.

MATLAB CODE

```
clc

nnnn=4100

for i=1:4100
    A=[1,1,1];
    x0=[0,0,0];
    b =1;
```

```
    H=LongRunCorrMatrix(:,:,i);
    m11=@(w)[w(1),w(2),w(3)]*H*[w(1),w(2),w(3)]';
    lb=[0,0,0];
    ub=[1,1,1];
    w=fmincon(m11,x0,[],[],A,b,lb,ub);
    w23(i,:)=w(:);
end

 for ii=1:187
     nc=(ii-1)*22;
     wxx(ii,:)=w23(nc+1,:);
 end
```

BIOGRAPHY

Name	Miss Phenpimol Boonbandanrit
Date of Birth	February 20,1992
Educational Attainment	2013: Bachelor of Economics (Second Honors), Thammasat University.
Scholarship	2014-2016: Bank of Thailand