MSc Thesis in Finance

The Feasibility of Optimal Currency Area for ASEAN after adopting the ASEAN Economic Community Blueprint in 2008

Does it facilitate the region to move closer to a single currency area?

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Abstract

This paper investigates the feasibility of OCA for ASEAN after the implementation of ASEAN Economic Community Blueprint in 2008. Dynamic Conditional Correlation (DCC) model with and without a structural break are used to identify whether the policy implemented facilitates the region to move closer to a single currency area. Industrial production index growth rate and change in short-term interest rate for ASEAN founders (Indonesia, Malaysia, Philippines, Singapore, and Thailand) from the period of 2001-2013 are selected as a proxy for OCA and Maastricht criteria respectively, which are cited as significant factors for successful functioning of OCA. The results show that there is a structural break for most conditional correlation of country pairs of the two variables after the implementation of integration policy in 2008 and that most of the conditional correlations decrease over time. The results imply that the whole region diverges away from OCA and Maastricht criteria and that the feasibility of OCA is decreased. As discussed by a number of previous researches regarding the issue, there is a possibility that higher economic integration resulted from integration policy may cause economic divergence due to specialization in industry of country members. For higher effectiveness of future integration policy formulation, a formal quantitative testing is required in order to precisely identify that higher economic integration causes higher specialization in the industry and, hence, more divergence in business cycle.

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1. Introduction

After the introduction of the Euro in January 1999, there has been much interest in monetary integration by both academics and policy-makers. In the case of Southeast Asia, a key historical event which led to an initiative of a common currency is the currency crisis of 1997/98, which developed to become one of the worst economic crises of the region. The currency crisis has decreased the credibility of unilateral fixed exchange rate and increased the attention of more solid pegs, for instance currency boards, using some country's currency as domestic currency and common currency arrangement (Bayoumi and Mauro 2001).

When considering the adoption of a common currency, it is inevitable for countries involved to face a tradeoff. Major advantages of single currency area include price and exchange stability, increases in intra-regional trade, elimination of transaction cost, among others. Nevertheless, there is no "free lunch" to any kind of economic decisions and adoption of a common currency is not an exception. The key disadvantage of monetary integration is the loss of control in nation's monetary policies (i.e. policy flexibility) to balance the economic disequilibrium from macroeconomic shocks.

Nevertheless, the cost of moving to monetary union can be reduced through a number of prerequisites deemed as being essential: (1) high degree of factor mobility, (2) openness of the economy and size of the economy, (3) product diversification, (4) similarity of inflation rate, (5) price and wage flexibility, and (6) the need for exchange rate variability.

In the case of ASEAN[1], monetary integration is one of the main objectives of the development plan for ASEAN called "ASEAN Vision 2020". To reach the goal of a common currency, higher economic integration is the key element. This reason is a significant driver for the ASEAN leaders to agree and form ASEAN Economic Community (AEC) by 2015 which transforms ASEAN into a region with free movement of goods, services, investment, skilled labor, and free flow of capital.[2]

After the agreement, each country in the region has adopted the ASEAN Economic Community Blueprint (AECB) established during the regional meeting in 2007 as a guideline towards establishment of AEC. The key elements of the Blueprint includes (1) tax on most imported goods from ASEAN countries will be completely exempted (2) Foreign Direct

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[1] ASEAN stands for The Association of South East Asia Nations, which include 10 countries: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.
[2] Yong, Ong K. "Towards ASEAN Financial Integration." 18 February 2004. <http://www.asean.org/resources/2012-02-10-08-47-56/speeches-statements-of-the-former-secretaries-general-of-asean/item/towards-asean-financial-integration>

Investment (FDI) within ASEAN is more liberalized and (3) higher free flow in skilled labor among ASEAN countries.[3]

As a consequence, the region's economy is expected to be more and more integrated during the preparation towards AEC as there will be higher factor mobility and intra-regional trade induced by AECB.

The purpose of this paper is to investigate the feasibility of OCA for ASEAN after the implementation of AECB in 2008 (i.e. integration policy). The main research question is to answer whether the preparation towards AEC, which expects a higher economic integration, facilitates the region to move closer to a single currency area. Dynamic Conditional Correlation (DCC) model with and without a structural break is used to examine the evolution of ASEAN countries' two macroeconomic variables: industrial production index and short-term interest rate. The selection of variables is based on OCA and Maastricht criteria and previous papers regarding OCA for ASEAN.

This paper contributes to the literature of the feasibility of OCA for ASEAN in two aspects. First, it updates the picture of the possibility of OCA for ASEAN after the most recent political attempt concerning economic integration of the region. Information regarding the development of convergence for ASEAN as a whole as well as individual country can be useful in formulating effective future policy for promoting further economic integration. Secondly, the Dynamic Conditional Correlation (DCC) model is used to examine OCA issue in this paper. There are a number of reasons to justify the selection of this methodology over the others.

First of all, since an objective of this paper is to investigate the movement of economic variables across sample countries in order to identify to what extent ASEAN converges to a single currency area, methodology that is relevant to answer this research question must exhibit convergence and divergence of comovement of variables over time. Since the DCC model allows correlation of economic variables to be time-varying, it is suitable to apply this model to examine OCA issue in this paper. Secondly, among methodologies that allow comovement of economic variables to be time-varying, DCC model has been proved to be more accurate than other types of estimation such as simple multivariate GARCH and moving average (Robert Engle 2002). Thirdly, this methodology has been widely used not

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[3] For more on the information of ASEAN Economic Community Blueprint and its strategic schedule see ASEAN Economic Blueprint (2008)

only in financial area but also in economic application such as the paper by Jim Lee (2005) which examines the comovement of output and price of the US over time.

The paper is organized as follows. Section 2 reviews theoretical progress and empirical methodologies to execute OCA theory. Section 3 analyzes the relevant integration indicators as a way to obtain preliminary idea regarding convergence development of OCA for the region. Section 4 explains and describes the DCC model. Next, brief description of data employed in this paper is presented in section 5. Finally, the paper is concluded in section 6.

2. Literature Review

2.1 OCA Criteria explained

2.1.1 Early Development of Optimal Currency Area (OCA) theory

2.1.1.1 High Degree of Factor Mobility
The theory of Optimal Currency Area (OCA) was primarily discussed by the work of Mundell (1961). The literature asked an important question regarding the domain of the currency area i.e. which countries should be included in the monetary union. Mundell argues that the main criteria necessary for OCA is high degree of factor mobility. He explained his argument through hypothetical example of changes in consumption pattern between two countries and regions (i.e. a country or region respond to macroeconomic shocks differentially or asymmetrically) under assumption that price is sticky and central bank acts to prevent inflation. If the shift in demand corresponds with national and currency boundaries, for an instance an increase in demand for product in country B compared with product in country A, then a flexible exchange rate between the two individual currencies would adjust to maintain the external and internal balance of both countries, relieving unemployment in country A and restraining inflation pressure in country B.

Nevertheless, if the shift in demand does not correspond with national and currency boundaries i.e. the shift is between the regions within the countries, then the flexible exchange rate would only serve to maintain the external balance between the two countries but not between the two regions. Hence, a region with higher demand would experience trade surplus and inflation and a region with lower demand would experience trade deficit and unemployment. Monetary authority in each country can pursue monetary policy to relieve inflation in a region with higher demand at the expense of higher unemployment in a region

with lower demand or vice versa. Alternatively, the inflation-unemployment burden can be shared between the two regions.

The main result of this illustration is to show that the Optimal Currency Areas are the two regions. With separate currency, flexible exchange rate would permit external and internal balance between the two regions. As a consequence, it can be show that factor mobility (primarily labor mobility) can keep internal and external balance when there is a shift in demand between the two regions. It takes place when labor migrates away from deficit region to surplus region, concurrently relieving unemployment and wage-inflation respectively.

This argument brings about one of the Mundell's main conclusion that factor mobility (mainly labor mobility) can replace a system of individual regional currencies as it has the capability to maintain internal and external balance among regions within a multi-regional currency area. Therefore, the cost of switching to single currency is lower the higher the level of factor mobility.

2.1.1.2 Openness and Size of the Economy

McKinnon (1963) developed further the idea of optimum size of the domain of currency area by considering two key criteria: openness and size of the economy. In case where economies are comparatively open (i.e. the ratio of tradable to non-tradable goods is high), flexible exchange rates have a significant effect on internal price-level stability when devaluation increases the cost of tradable. Since a relatively open economy with flexible exchange rate may be able to satisfy the objectives of employment maximization and external balance but the increase in cost of tradable goods would affect the internal price-level stability. Thus, the opportunity cost of giving up flexible exchange rate system for a single currency is lower the more open the economy is.

As a result to the previous criteria, the smaller the size of the economy, the more open it is likely to be and, therefore, the lower the cost of switching to monetary union.

2.1.1.3 Product Diversification

Taking into account the works of Mundell (1961) and McKinnon (1963), Kennen (1969) came up with product diversification as another important structural precondition to find out if a region would be well suited for an OCA. A well-diversified country would be more insulated to different kind of shocks than less-diversified country and, therefore, less dependent on exchange rate movement for external adjustment.

Other characteristics, which also deemed to be relevant for selecting the potential countries in an OCA, are (1) similarity of inflation rate, (2) price and wage flexibility, and (3) the need for exchange rate variability.

2.1.1.4 Similarity of Inflation Rate

According to Fleming (1971), when inflation rates between countries are convergent, an external balance (i.e. current account) is more likely to be achieved within the currency area than if inflation rates are divergent. As a consequence, similarity of inflation reduces the need of exchange rate movement and, thus, the cost of moving to monetary integration.

2.1.1.5 Price and Wage Flexibility

When there is a high flexibility of price and wage between countries, the disequilibrium resulted from the shift in demand is less likely to be associated with unemployment in one country and inflation in another country. As a consequence, the need for exchange rate movement is lessen and, thus, the loss created by switching to monetary integration is reduced (Freidman 1953 and Kawai 1987).

2.1.1.6 The Need for Exchange Rate Variability

The exchange rate acts as a shock absorber. If there has been little cause for deviation in the exchange rate then there is not much to lose when countries move to monetary union. Thus, the cost of adopting monetary integration is lessened (Vaubel 1976 and 1978).

2.1.1.7 Summary Concerning Early Development of OCA Theory

The early works concerning the theory of OCA appear to point out that (1) flexible exchange rate is an adjusting variable for maintaining internal and external balance (Meade 1955) (2) the cost of adopting a common currency is the inability for a country to use exchange rate movement to adjust to asymmetric shocks and higher asymmetry of shocks increases such cost and (3) the cost of switching to monetary union can be reduced through adjustment mechanism discussed above (i.e. OCA criteria).

Particularly, the benefits implicitly assumed by the early literatures include "reductions in transactions costs and exchange rate uncertainty, increased liquidity and trade, economies of scale regarding currency reserves, and improvement in allocation efficiency" (Paul Duncan Adams 2005).

2.1.2 New development of Optimal Currency Area (OCA) theory

The theory of OCA has been transformed in line with important theoretical developments in other areas of economic, which seek to clarify the benefits and costs of joining single currency area. Compared with earlier works regarding monetary union, the new OCA theory points out that there are rather fewer costs and relatively more benefits in the adoption of monetary integration. These developments include the vertical Phillips Curve and policy ineffectiveness, time consistency and credibility, the role of exchange rate disputed, positive effect of monetary union on trade, and the endogeneity of OCA criteria.

Despite less emphasized in the formal theory of optimal currency area, similar level of economic development and similarity of financial systems are another two criteria that may have an influence on selecting countries into a common currency area (Bayoumi and Mauro 2001).

2.1.2.1 The Vertical Phillips Curve and Policy Ineffectiveness

The traditional OCA theory assumes that flexible exchange rate would permit a country to employ independent monetary policy in order to achieve the desired trade-off between inflation and unemployment, as suggested by Phillips Curve. Hence, it would exert a cost using monetary integration as countries are unable to adjust the economy to the desired balance of inflation and unemployment. This permanent trade-off between inflation and unemployment has been undermined by a number of developments.

Lucas (1972) and Friedman (1968) claim that monetary policies are ineffective in managing unemployment in the long-run. The shape of long-run Phillips Curve is vertical since unemployment is associated with the Natural Rate of Unemployment (NRU). Therefore, inflation can be managed without negative effects on the level of long-run unemployment. Given that monetary policy is ineffective in balancing unemployment and inflation in the long-run, the costs of using single currency are decreased.

Nevertheless, there are a number of issues associated with the idea of monetary neutrality and currency unions that are worth discussing when considering monetary integration. Frenkel and Goldstein (1986) point out possible political tension that could emerge from symmetric monetary systems (i.e. member countries cooperate in reaching policy solutions) under conditions of asymmetric shocks. In addition, De Grauwe (1992) also shows how asymmetric monetary system (i.e. one member country take a leadership role in setting policy) worsen the domestic business cycle in other member countries.

Artis (1991) argued that the production of member countries in single currency area will be more specialized, increasing the vulnerability of countries within the area to asymmetric shocks.

2.1.2.2 Time Consistency and Credibility

While traditional OCA theory suggested similarity of inflation rates as a precondition for the arrangement of single currency area, new theory shows how monetary integration could be more beneficial when the divergence of inflation rates is high. The high inflation country could accomplish low inflation without any cost by allowing the low inflation central bank, which adopts a credible policy stance of optimal inflation, to take control. This result is essentially based on the debate between discretionary and fixed policy rule.

Barro and Gordon (1983) demonstrated that central bank must pursue time consistent policy rule in order to gain credibility. Discretionary policy, determined in each time period, creates incentives for surprise inflation to decrease short-run unemployment level. However, such a decline comes at an expense of increase in inflation and lack of credibility in the long-run. The problem of time inconsistency can be solved by pursing a system of policy rule that the economic agent perceive to be either fixed or the cost of reneging from those rules outweigh the benefit from surprise inflation.

De Grauwe (2002) showed that Barro and Gordon's argument could also be applied to exchange rate policy. The promise to maintain fixed exchange rate will be credible only if the cost of breaking that promise exceeds the gain from pursing surprise devaluation.

The arguments discussed above have in-depth implications for OCA theory as monetary union incorporates a set of policy rules that "tie the hand" of domestic central bank authorities in terms of monetary and exchange rate policy. As a consequence, the loss of policy control in those countries would be considered beneficial as they will be able to attain lower inflation rate over the long-run, without any loss of unemployment.

2.1.2.3 The Role of Exchange Rate Disputed

With the development of the asset model of exchange rate determination had led recent works on the exchange rate to believe that, while movement in the exchange rate serve to maintain internal and external balance, the correction is imperfect and takes a longer period than assumed in the flow model of traditional OCA theory (Krugman 1991). This argument regarding the exchange rate has an implication for OCA theory that the loss of exchange rate

as policy tool may be less costly than initially thought. There are a number of models that associated in the argument such as the portfolio-balance model, exchange rate and Ricardian equivalence, and the 'sunk cost' model.

Since exchange rate volatility has a negative effect on trade, its removal has been cited throughout the earlier literature as a benefit of monetary union. However, recent papers argue that the belief is overestimated. De Grauwe (2000) demonstrated that reducing exchange rate uncertainty shifts the risk to another area of the economy by using an IS-LM model. Moreover, the paper emphasizes that despite the fact that monetary integration, which result in exchange rate certainty, would decrease risk, this effect would only have a one-off gain to economic growth as indicated by Neoclassical theory and was used in 'One Money, One Market' report (EC 1990).

In conclusion, the costs of monetary union have been reduced as lags in the effects of movement of exchange rate decrease their effectiveness. In contrast, the gain from monetary integration due to exchange rate certainty seems to be overestimated by the earlier works of OCA theory.

2.1.2.4 Positive Effect of Monetary Union on Trade

Later papers regarding OCA produce empirical works about the positive effect of currency union on member countries' trade. Rose (2000) demonstrates that trade between two countries that have the same currency is 200% bigger than trade between countries that have different currencies by using a gravity model. This paper's result is consistent with other studies of the impact of currency union on trade such as Flandream and Maurel (2001), Lopez Cordova and Meissner (2001) and Frankel and Rose (2002) which demonstrate an increase in trade of 220, 100, and 290%, respectively.

2.1.2.5 Endogeneity of OCA Criteria

In contrast with traditional OCA theory, Frankel and Rose (1997) assert that many structural preconditions for monetary integration proposed by traditional theorists could be supported by the establishment of monetary union. They believed that higher economic integration (most notably customs, monetary integration, higher factor mobility and trade integration) increases convergence among countries. Therefore, the cost in terms of loss of exchange rate control when switching to monetary union is reduced.

On the other hand, Krugman (1993) argued that increased economic integration increases the possibility of asynchronous income fluctuation among nations. He believed that countries would be more specialized which increases rather decreases the divergence of shocks among the countries. As a consequence, the cost of adopting single currency in a particular region is higher.

Nevertheless, a number of researches have a tendency to support Frankel and Rose's (1997) argument for the countries that have been examined, particularly the European Union. Artis and Zhang (1995) confirmed that higher trade among members of the European Monetary System brings about a more synchronous business cycle.

2.2 Maastricht Criteria explained

The Maastricht Treaty, which was established in 1991, identifies a required set of criteria needed to be accomplished for countries to become a member of European Monetary Union (EMU). The main objective of the Treaty is the convergence of both nominal and fiscal aspects which will guarantee the convergence of monetary and fiscal policy. "In formal terms, the criteria for nominal convergence say that a country must have an inflation rate within 1.5% of the average inflation rate of the three members with the lowest inflation rates and a long-run bond yield within 2% of the average of the bond yields of the same three countries. Furthermore, the Treaty requires that the exchange rate must have been stable within the plus or minus 15% ERM bounds for at least two years. As regards fiscal policy, the budget deficit should be no higher than 3% of the GDP and public debt less than 60% of the GDP" (Boreiko 2003).

2.3 Conclusion Concerning OCA and Maastricht Criteria

In conclusion, the main reason that both OCA and Maastricht criteria, which represent real convergence and nominal convergence (i.e. policy convergence), are required to be fulfilled is because they are considered to be the significant conditions for successful functioning of monetary union. It has been argued that while countries in European Union were converging in Maastricht criteria before joining the EMU, a few countries were converging in OCA criteria. In fact, some are even reported to show divergence. As a result, countries whose preconditions are poor and lose monetary policies to adjust to different types of shocks will suffer from low economic growth and high unemployment rate after entering monetary union (Boreiki 2003). Furthermore, Bayoumi and Eichengreen (1997) pointed out that a

convergence in Maastricht criteria (nominal convergence) does not guarantee a convergence in OCA criteria (real convergence).

2.4 Operationalizing the OCA Criteria

There are several key methodologies for testing OCA criteria. The past application of these methodologies is discussed and their advantages and disadvantages for the analysis of this paper are evaluated.

2.4.1 An OCA Index

OCA index is primarily constructed by Bayoumi and Eichengreen (1997), which based upon following equation:

$$SD(e_{ij}) = \alpha + \beta_1 SD(\Delta y_i - \Delta y_j) + \beta_2 DISSIM_{ij} + \beta_3 TRADE_{ij} + \beta_4 SIZE_{ij}$$

The equation demonstrates the relationship between the variability of the nominal exchange rate, $SD(e_{ij})$, with four independent variables related to OCA theory: (1) the differences in output disturbances, $SD(\Delta y_i - \Delta y_j)$, (2) difference of commodity export components to capture asymmetric hocks, $DISSIM_{ij}$, (3) trade linkages, $TRADE_{ij}$, and (4) country size, $SIZE_{ij}$.

The equation stated above is estimated and, in the paper of Bayoumi and Eichengreen (1997), Germany is a base country. In order to identify the level of convergence for each country in the future, the movement of dependent variable, which refer to as OCA index, is compared over time using out-of-sample forecasts.

The advantage of this method is that it is strongly based on the theoretical background of OCA. However, there are a number of issues that needed to be considered when applying this method. Since the forecast of dependent variable is out-of-sample, which implies that it is backward-looking, the relationship between dependent variable and independent variables has to be stable over time in order for the forecast to be reliable (Bayoumi and Eichengreen 1997). Moreover, Paul Duncan Adams's result of OCA in Africa (2005) shows that the strength of the regressions in terms of predictive ability is relatively poor, suggesting that OCA theory is less applicable in Africa and claims that it may be less relevant for developing countries in general. The paper further supports the stance of the insensitivity of exchange rate movement by arguing that "the exchange markets in these countries are less developed, with a large amount of black market and barter exchange taking place. Furthermore, developing countries have in the past felt it necessary to maintain greater control over

exchange rate movements in order to manipulate the current account". According to Obiyathulla Ismath Bacha (2008), this latter argument also applies to ASEAN countries where central banks did not adopt free floating exchange rate system. This results in a correlation of several ASEAN currencies to the US dollar to be as high as 70%. As a consequence, this method may be unsuitable for its application to ASEAN.

2.4.2 Generalized-Purchasing Power Parity Analysis

Generalized-Purchasing Power Parity Analysis was developed by Enders and Hurn (1994). It employs cointegration to evaluate the level of similarity in the movement of exchange rate between pair of countries. Higher cointegration of exchange rate means lower cost for a common currency. Mkenda (2001) uses this method to evaluate the appropriateness of common currency area for three East African countries (Kenya, Tanzania, and Uganda). He finds cointegration between the movements of real exchange rate, suggesting similarity in the movement of the underlying economic fundamental and, thus, a lower cost for switching to monetary union.

The method seems to be inaccurate and inappropriate for evaluating the effects of monetary integration as it assumes that real exchange rate captures economic fundamental. In reality, "policy intervention can change real exchange rate through nominal exchange rate without any underlying economic reason" (Paul Duncan Adams 2005).

2.4.3 Structural Vector Autoregression (SVAR)

SVAR technique, which is developed by Blanchard and Quah (1989), is applied to separate demand and supply shocks in a selected countries employing time series data of GDP growth. Once the shocks are identified, correlations of these shocks between countries are computed and used as a representative for asymmetry of shocks. Bayoumi and Eichengreen (1994) use the methodology to find the potential common currency area in different regions of the world. The advantage of SVAR technique is that it is based upon OCA theory of asymmetry of shocks. Nevertheless, it does not consider any change in economic structure.

2.4.4 Correlation and Cluster Analysis

This methodology aims to identify the suitable countries for monetary union by finding similarity of different types of OCA criteria (high positive correlation) within an interested group of countries in order to determine subsets or clusters of countries that share similar economic structure.

Artis and Zhang (2001) employ six criteria to find the suitable countries for European Monetary Union (EMU). These include business cycle correlation, openness to trade, inflation convergence, real exchange rate volatility, real interest rate correlation and labor market flexibility. Boreiko (2003) selects only four variables to evaluate countries for EMU.

There are a number of advantages and disadvantages of using this methodology. The method is flexible when it comes to selecting OCA criteria, permitting for necessary adjustment to be made. Nevertheless, it fails to capture the effect of changes in economic and monetary structure, which may result in a decline or rise of correlations in business cycles over time. The main reason is because the method characterizes a snapshot of the present economic situation and evaluates the suitability of monetary integration based on that snapshot (Paul Duncan Adams 2005).

2.5 Major ASEAN Studies

There are a number of studies regarding the feasibility of monetary union in the Association of Southeast Asia Nations (ASEAN). Using different methods and period of data, all of these papers conclude that ASEAN as a whole does not form optimum currency area. However, different studies suggested different clustering of countries as a starting point to create monetary union in the region.

The earliest paper that examined the issue is Bayoumi, Eichengreen, and Mauro (2000). Several OCA criteria and methodologies are used: patterns of trade, economic shocks, degree of factor mobility, and the monetary transmission mechanism. The paper finds that ASEAN is less suitable for monetary integration than the European Union was before the creation of Maastricht Treaty. However, the differences are not significant. They concludes that a strong political commitment is the key to the success of OCA in ASEAN as the attempt will not be considered as another fixed exchange rate system open to speculative attack.

Kraiwinee and Eugene (2003) used the convergence model to determine OCA for ASEAN. The paper concluded that ASEAN region as a whole may not be suitable to form a single currency area at the moment as there is an evidence of high divergence in GDP per capita. Instead, they suggested to start with a sub-group OCA arrangement of ASEAN countries i.e. ASEAN-6 (Brunei, Indonesia, Philippines, Thailand, Malaysia, and Singapore), which have similar level of income and supporting framework.

Vu Tuan Khai (2008) also investigated the feasibility of introducing single currency for 9 ASEAN countries (excluding Brunei) by analyzing the symmetry of shocks between these countries using the structural VAR method and two OCA criteria, CPI and GDP. The results suggested that a group of Indonesia, Malaysia, Philippines, Singapore, and Thailand with high correlation of structural shocks and high speed of adjustment to those shocks is appropriate to form an OCA.

Obiyathulla Ismath Bacha (2008) examined the possibility of an OCA for ASEAN and the broader ASEAN+5 i.e. ASEAN with Japan, China, South Korea, Australia, and New Zealand using two common methods: (1) VAR model to investigate how countries response to shock and (2) correlation analysis to examine the extent to which selected OCA criteria (percentage growth in real GDP, percentage inflation, percentage growth in money supply, and percentage change in the short-term interest rate) synchronize. Both of the methods suggested that region-wide monetary union for ASEAN and ASEAN+5 may not be possible at the moment and that the integration should begin with paired clusters: Malaysia/Singapore, Japan/Korea, Indonesia/Thailand, and Australia/New Zealand.

Khanh P. Ngo (2012) investigated the feasibility and cost and benefits of monetary union for five ASEAN founders (Thailand, Singapore, Indonesia, Malaysia, and Philippines) through qualitative and quantitative methods: descriptive statistics (using trade for OCA criteria), Ordinary Least Square, and Granger Causality (using nominal interest rate, inflation, budget deficit, and exchange rate for OCA criteria). The results demonstrated that ASEAN founders are not ready to adopt a monetary union. The paper further suggested that, despite evidences of increase in economic integration from ASEAN at the moment, the group should pursue more effective policies that aim to increase labor and capital mobility and trade within the region.

From the information above, the main focus of previous studies of OCA for ASEAN is to investigate whether the region is suitable for OCA and the conclusions suggest no single currency for the region as a whole at the moment. However, this paper's objective is different from the preceding studies in a sense that it examines to what extent the region moves closer towards becoming OCA after the implementation of AECB in 2009. The main objective of this framework is to increase regional economic integration. Another difference is the methodology employed. Methodologies used in previous papers regarding OCA for ASEAN are appropriate for investigating the possibility of adopting common currency while they may

be unsuitable to examine the development of the feasibility of OCA over time. As a consequence, the DCC model is employed to answer this paper's main objective. More details about why this model is selected over the others and how it works will be discussed in the methodology section.

3. Integration Indicators and Analysis

According to the endogeneity of OCA criteria (under new development of OCA theory section), political decision on economic integration has an influence on the criteria themselves. With the knowledge that ASEAN leaders had agreed to enhance regional economic integration and implement the established framework to achieve it since 2008, examining the integration progress of each countries and the region as a whole after such date can give a preliminary picture regarding the convergence.

According to the objective of AEC, the main areas concerning the economic integration include free movement of trade in goods and services, investment, skilled labor, and free flow of capital. As consequence, (1) intra-regional trade for ASEAN and each country member, (2) intra-regional investment (foreign direct investment or FDI and portfolio investment) for ASEAN and each country member, and (3) intra-regional labor mobility are selected as relevant indicators for variables mentioned above that will indicate progress toward economic integration of ASEAN nations. In fact, these indicators had been primarily identified by Dennis and Yusof (2003) in order to measure the development of ASEAN economic integration towards the goal of ASEAN Vision 2020. Subsequently, the indicators had been used by some papers to examine such economic integration progress in ASEAN. One of them is Guerrero (2008), who uses intra-regional trade and intra-regional trade index as the main indicators to look into the issue.

The first area of integration to be considered is trade in goods and services. Table 1 shows the evolution of intra-regional trade among ASEAN countries and by country member. After the implementation of the ASEAN Free-Trade Area (AFTA)[4] in 1993, Intra-regional trade among ASEAN members has been increased steadily for about 10 years and remained approximately at 24% since then. The indicator seems to suggest that implementation of ASEAN Economic Community Blueprint (AECB) in 2009 does not create any impact to the trade area of integration.

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[4] ASEAN Secretariat. "ASEAN Free Trade Area (AFTA): An Update." November 1999. <http://www.asean.org/communities/asean-economic-community/category/asean-free-trade-area-afta-council>

Nevertheless, intra-regional trade by country member provides a different picture in which there are some countries actually increase their dependency on trade in ASEAN from such political decision, though only a slight degree. Among these countries are Cambodia, Indonesia, Malaysia, Philippines, and Thailand.

Table 1: Intra-regional trade among ASEAN countries and by country member (%)

	1993-1996	1997-2000	2001-2004	2005-2008	2009-2012	2012
Brunei Darussalam	32.3	32.3	28.7	34.3	24.3	23.5
Cambodia	73.0	33.4	25.3	23.6	33.1	44.5
Indonesia	13.2	17.4	19.1	24.0	24.7	25.0
Lao PDR	53.9	67.2	61.0	66.4	61.9	62.3
Malaysia	23.6	24.2	24.5	25.3	26.3	27.4
Myanmar	36.5	37.1	41.4	49.9	43.2	39.9
Philippines	10.8	14.3	16.8	19.2	22.0	21.0
Singapore	25.3	24.9	28.3	28.5	26.9	26.5
Thailand	15.4	16.9	18.6	19.7	20.1	20.3
Vietnam	26.2	24.8	20.3	21.7	17.4	17.1
ASEAN	20.8	21.7	23.4	24.9	24.4	24.6

The second area of integration to be analyzed is investment. Since the data for FDI is not available after the implementation of AECB in 2009, only portfolio investment will be considered. However, the data for analysis is available for five countries (Indonesia, Malaysia, Philippines, Singapore, and Thailand). According to Table 2, intra-regional portfolio investment among ASEAN countries obviously increase. The number remains steady at around 8% for the three period of study: 2001-2004, 2005-2008, and 2009-2012. Nevertheless, it jumps to about 10% in 2012. When considering intra-regional portfolio investment by country member, most of the countries show an increase in dependency of portfolio investment in ASEAN.

Table 2: Intra-regional investment among ASEAN countries and by country member (%)

	2001-2004	2005-2008	2009-2012	2012
Indonesia	8.8	8.0	8.5	3.3
Malaysia	23.6	21.4	29.1	36.0
Philippines	2.2	11.8	13.9	18.7
Singapore	8.7	7.6	7.4	8.9
Thailand	8.7	10.9	3.6	3.8
ASEAN	8.8	8.0	8.5	10.2

According to Dennis and Yusof (2003), two indicators mentioned above are considered to be core indicators which provide insight into integration progress on which future policy formulation can be possibly based on. Nonetheless, since ASEAN develops beyond free trade area and progress more towards a common market (i.e. ASEAN Economic Community), relevant indicators require to be considered. One of them is intra-regional labor mobility in ASEAN (i.e. the number of ASEAN workers employed in ASEAN countries as a percentage of total labor employed), which provide the overall picture of intra-ASEAN labor market integration. As this indicator is not fully developed, Asian Economic Integration Monitor April 2014 is use to investigate the issue. According to this report, although modest, Southeast Asia's intra-regional share of Asian intra-regional migration increases over the period from 2010 to 2013, suggesting higher labor market integration after the AECB implemented in 2009 onwards. Unfortunately, the report does not provide details regarding intra-regional labor mobility by country member.

Overall, ASEAN seems to demonstrate a progress of economic integration after the implementation of AEB in 2009. However, a formal testing is required to perform in order to determine whether the integration policy facilitate ASEAN to move closer to a single currency area.

4. Methodology

In this paper, the multivariate generalized autoregressive conditional heteroskedasticity (GARCH) model[5] used is the dynamic conditional correlation (DCC) model. The DCC model, developed by Robert Engle (2002), is used to compute time-varying volatility and correlation between return of financial assets. Since the development, it has been widely used in financial application such as asset pricing, portfolio optimization, and risk management. The model is primarily applied in economic area of business cycle theory by Jim Lee (2005), who explores the historical evolution of output-price correlation for the US between the periods of 1900-2002 using quarterly data. Its empirical results are in line with previous papers regarding the issue using unconditional variance and covariance method that "the price level tended to move in the same direction as output in the period before World War II but opposite direction after the war". The result of this paper implies that not only the

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[5] For more on the information of multivariate generalized autoregressive conditional heteroskedasticity (GARCH) model see Silvennoinen and Terasvirta (2008) and Bauwens, Laurent, and Rombouts (2006)

correlation between financial assets but also economic variables is inclined to be time-varying as there are changes in economic structure.

In this paper the DCC model, which has never been applied to investigate OCA for any region or group of countries, is applied. There are two main reasons why this methodology is selected over the others. The first and main reason is that it is suitable for investigating main research question of this paper which requires a methodology that exhibits the evolution among the selected key macroeconomic variables' correlation (i.e. real GDP growth, interest rate, inflation rate, and exchange rate) of ASEAN countries before and after the implementation of AEBC in 2008, a political decision that inducing higher regional economic integration. Since this model allows correlation of variables to be time-varying, it is reasonable to apply in order to answer corresponding research question.

As discussed in literature review section, other methodologies that had been applied in the previous papers examining the feasibility of OCA are inappropriate for various reasons. Specifically, OCA index is not suitable for economic structure of ASEAN and Generalized-Purchasing Power Parity is inappropriate for the analysis of the suitability of monetary integration in general. Moreover, SVAR and basic correlation analysis represent a snapshot of the present economic situation and, thus, is incapable of demonstrating evolution of correlation among economic variables.

The second reason for using the DCC model is because there are two main advantages over other estimation methods of the same category: (1) it can compute very large correlation of matrices. According to the previous paper regarding correlation estimation such as Bollerslev, Engle, and Wooldridge (1988), Bollerslev (1990), Kroner and Claessens (1991), Engle and Mezrich (1996), Engle, Ng, and Rothschild (1990), Bollerslev, Chou, and Kroner (1992), Bollerslev, Engle, and Nelson (1994), and Ding and Engle (2001), very few of these articles consider more than five assets. Since this paper requires relatively large correlation of matrices to be computed as there are ten countries in each variable, it is appropriate to use the DCC model in that matter of fact. (2) It is more accurate than other types of estimation such as simple multivariate GARCH and moving average (Robert Engle 2002).

Every types of multivariate GARCH model, including the DCC model, are based on the following basic formulation. Consider a stochastic vector process $\{y_t\}$ with dimension N x 1:

$$y_t = \mu_t + u_t$$

$$u_t = H_t^{1/2} \, \varepsilon_t$$

μ_t is the conditional mean. ε_t is an i.i.d (independent and identically distributed) random vector (N x 1 dimension) such that $E(\varepsilon_t) = 0$ and $Var(\varepsilon_t) = I_N$, where I_N is identity matrix of order N. H_t is N x N positive definite and symmetric matrix and conditional variance-covariance matrix of y_t[6].

What remains to be specified is the matrix process H_t. There are various parametric formulations for the matrix H_t and different ways of parameterization demonstrate to yield different types of multivariate GARCH. Basically, there are four categories of model emerged from an effort to specify the variance-covariance matrix of H_t[7]. The class of model that is relevant and used in this paper is the DCC model which built on the concept of modeling the conditional variances and correlations instead of directly modeling the conditional variance-covariance matrix H_t.

H_t can be decomposed into $\{y_t\}$'s (it is three variables mentioned above in this paper) conditional standard deviation (D_t) and the conditional correlation (R_t).

$$H_t = D_t R_t D_t$$

where $D_t = diag(\sqrt{\sigma_{11,t}}\sqrt{\sigma_{22,t}} \cdots \sqrt{\sigma_{NN,t}})$ is the N x N diagonal matrix of time-varying standard deviation from univariate GARCH model. The conditional variance ($\sigma_{11,t}, \sigma_{22,t}, \ldots, \sigma_{NN,t}$) can be modeled as univariate GARCH model. The general formulation of univariate GARCH can be expressed as:

$$D_t^2 = diag(\sigma_{ii,t}) = diag(\omega_i) + diag(\alpha_i)u_{i,t-1}u'_{i,t-1} + diag(\beta_i)D_{t-1}^2$$

The conditions to ensure the positivity of variances and the stationarity: $\omega_i > 0$, $diag(\alpha_i) > 0$, $diag(\beta_i) > 0$ and $diag(\alpha_i) + diag(\beta_i) = 1$. The conditional correlation (R_t) is time-varying. The dynamic correlation structure of DCC model is taken from Robert Engle (2002) and can briefly be described as follow.

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

$$Q_t = (1 - \kappa - \gamma)\bar{Q} + \kappa(\epsilon_{t-1}\epsilon'_{t-1}) + \gamma Q_{t-1}$$

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[6] $Var(y_t \mid \theta_{t-1}) = Var_{t-1}(y_t) = Var_{t-1}(u_t) = H_t^{1/2}Var_{t-1}(\varepsilon_t)(H_t^{1/2})' = H_t$
[7] For more information see Silvennoinen and Terasvirta

where ϵ_t is N x 1 vector of standardized residual ($\epsilon_t = D_t^{-1}u_t$) which can be obtained when univaraite GARCH model is estimated. $\overline{Q} = E[\epsilon_t\epsilon_t']$ and κ_m and γ_n are non-negative scalar such that $\kappa_m + \gamma_n < 1$. In a general case, Q_t can be written as follow:

$$\begin{bmatrix} q_{11,t} & \cdots & q_{1n,t} \\ \vdots & \ddots & \vdots \\ q_{1n,t} & \cdots & q_{NN,t} \end{bmatrix}$$

Therefore, R_t can be expressed as:

$$\begin{bmatrix} 1 & \cdots & \dfrac{q_{1n,t}}{\sqrt{q_{11,t}}\sqrt{q_{nn,t}}} \\ \vdots & \ddots & \vdots \\ \dfrac{q_{1n,t}}{\sqrt{q_{11,t}}\sqrt{q_{nn,t}}} & \cdots & 1 \end{bmatrix}$$

When specify any multivariate GARCH model, including the DCC model, one of the most important issues that require attention is ensuring positive definiteness of variance-covariance matrix H_t. According to Engle and Sheppard (2001), the positive definiteness of Q_t will necessarily and sufficiently guarantee the positive definiteness of conditional correlation matrix R_t, which, in turn, implies positive definiteness of H_t. This paper uses unconditional variance-covariance matrix of standardized residual ϵ_t to substitute the $\overline{Q}$ matrix when calculating the parameters. Particularly, it means that sample variance-covariance matrix $\widehat{\overline{Q}} = \frac{\sum_{t=1}^{T}\epsilon_t\epsilon_t'}{T}$ represents the estimator of $\overline{Q}$.

Since this paper examines whether the integration policy (i.e. elimination of tax on imported goods from ASEAN countries, higher liberalization of FDI with the region, and promotion of higher free flow in skilled labor among the region) implemented in 2008 facilitates an increase in the correlation of selected macroeconomic variables, investigating the figure of the comovement over time is not sufficient. A formal testing is required. As a consequence, the model is extended to allow for possible structural change of the correlations due to a sudden implementation of the integration policy. A similar application of the model is used by Li and Zou (2008) to examine the impacts of policy and information shocks on the correlation of China's bond and stock returns.

The situation where breaks arise in the correlation mean is taken as an example and, therefore, the model can be extended to:

$$Q_t = (\bar{Q}_1 - \kappa'\overline{Q_1}\kappa - \gamma'\,\bar{Q}_1\,\gamma)(1 - d_t) + (\bar{Q}_2 - \kappa'\bar{Q}_2\kappa - \gamma'\bar{Q}_2\gamma)(d_t)\ \kappa'\epsilon_{t-1}\epsilon'_{t-1}\kappa + \gamma'Q_{t-1}\gamma$$

where $\bar{Q}_1 = E[\epsilon_t\epsilon'_t]$ for $n < \tau_{break}$ and $\bar{Q}_2 = E[\epsilon_t\epsilon'_t]$ for $n > \tau_{break}$. d_t is assumed to be the dummy variable 1 if $n \geq \tau_{break} < N$ and 0 otherwise. The null hypothesis is no structural breaks against the alternative hypothesis of structural breaks. The value of log likelihood function is obtained from both models to compute the likelihood ratio test statistic and the decision can be made based on the statistic whether or not the null can be rejected in favor of the alternative (Li and Zou 2008).

In order to estimate the parameters of the model, maximum likelihood estimation method can be employed. The log-likelihood can be expressed as:

$$L = -\frac{1}{2}\sum_{t=1}^{T}\{2\log(2\pi) + 2log\,|D_t| + log|R_t| + \epsilon'_t R_t^{-1}\epsilon_t\}$$

Basically, the model is estimated in two steps. The first step will be the estimation of the univariate GARCH model. The estimation results in the first step are input to compute the correlation coefficients in the second step. According to Engle and Sheppard (2001), the two-step estimation procedure is consistent. If the unknown innovation series ε_t is assumed to be multivariate normal distribution, the maximum likelihood function is obtained. Despite the absence of normality assumption, the estimators can still attain the Quasi-Maximum Likelihood Estimator (QMLE) properties[8].

5. Data

5.1 Choice of variables

The choice of variables to analyze convergence of OCA and Maastricht criteria for ASEAN is based on the paper of Obiyathulla Ismath Bacha (2008), which is discussed in literature review section. The main reason is because variables that this paper selects (real GDP growth rate, percentage growth in inflation, percentage growth in money supply, and percentage change in the short-term interest rate) cover both of the criteria, which, as also stated in literature review part, are important conditions for successful functioning of monetary union. Five ASEAN founders[9] will be examined as a representative of the whole ASEAN countries.

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[8] For more information on maximum likelihood estimation and its properties see "A Guide to Modern Econometrics" Marno Verbeek (2004).
[9] Five ASEAN founders include Indonesia, Malaysia, Philippines, Singapore, and Thailand.

The main reason is because the rest of ASEAN countries (Brunei, Cambodia Lao, Myanmar, and Vietnam) lack sufficient data of such variables.

In this paper, industrial production index growth rate and short-term interest rate are chosen for the analysis. As mentioned in Mundell (1961), asymmetry of shock is one of the key variables that affect the cost of using single currency. According to Artis and Zhang (1998), the most common way to analyze the asymmetry of shock is to study the cross-correlation of cyclical components of output using quarterly GDP growth rate. However, due to small numbers of observation of such variable for five ASEAN founders, monthly industrial production index growth rate is used as a proxy. The choice is justified on the ground that the growth rate of industrial production index and quarterly real GDP growth rate move closely over time. This type of reasoning is also used in Artis ad Zhang (1995).

The reason that short-term interest rate is selected over growth rate of money supply is because the former variable is actually stated in the Maastricht criteria while the latter is not. Furthermore, the reason that growth in inflation is abandoned is because it is also one of the OCA criteria and industrial production index growth rate is already selected as a proxy for the criteria. The data of both chosen variables are monthly and cover the period of January 2001 to December 2013. The data are obtained from national source of each country.

5.2 Descriptive Statistics
Prior to the estimation of GARCH model, diagnostic testing on residuals of mean equation (y_t) for every series of data is performed. Basically, autoregressive of order one (AR(1)) model is selected to regress y_t. According to Table 3 to 7, the first statistic demonstrates results of Ljung-Box test for serial correlation using the residuals. The Q-statistics for an order of 20 show the existence of autocorrelation in most of data series' residuals. The second statistic characterizes the Lagrange multiplier (LM) test for autoregressive conditional heteroskedastic (ARCH) with 10 lags. The evidence of conditional heteroskedasticity in most of the data series strongly verifies the use of ARCH and GARCH model to capture the time-varying volatility behavior of data series. The bottom section of the tables demonstrates results of normality testing using Jarque-Bera test statistic. Almost all of the data series' residuals demonstrate non-normality. These results lend support for this paper to the use of quasi-maximum likelihood method, which produces consistent standard errors that are robust to non-normality, to estimate the DCC model.

Table 3: Diagnostic test results for Thailand

AR(1) residuals	Industrial production index growth rate (%)	Change in interest rate (%)
Autocorrelation tests		
Ljung-Box Q(20)		
Residuals	48.30**	77.76**
Heteroskedasticity tests		
ARCH(10) LM test	18.33*	35.80**
Normality tests		
Jarque-Bera	1362.09**	30.13*

** Denotes statistical significance at the 1% level

* Denotes statistical significance at the 5% level

Table 4: Diagnostic test results for Indonesia

AR(1) residuals	Industrial production index growth rate (%)	Change in interest rate (%)
Autocorrelation tests		
Ljung-Box Q(20)		
Residuals	24.31	54.37**
Heteroskedasticity tests		
ARCH(10) LM test	21.51*	25.62**
Normality tests		
Jarque-Bera	661.28**	113.08**

** Denotes statistical significance at the 1% level

* Denotes statistical significance at the 5% level

Table 5: Diagnostic test results for Malaysia

AR(1) residuals	Industrial production index growth rate (%)	Change in interest rate (%)
Autocorrelation tests		
Ljung-Box Q(20)		
Residuals	43.04**	194.15**
Heteroskedasticity tests		
ARCH(10) LM test	32.47**	52.25**
Normality tests		
Jarque-Bera	0.46**	923.89**

** Denotes statistical significance at the 1% level

* Denotes statistical significance at the 5% level

Table 6: Diagnostic test results for Singapore

AR(1) residuals	Industrial production index growth rate (%)	Change in interest rate (%)
Autocorrelation tests		
Ljung-Box Q(20)		
Residuals	50.16**	47.88**
Heteroskedasticity tests		
ARCH(10) LM test	10.66	28.77**
Normality tests		
Jarque-Bera	29.34**	34.17**

** Denotes statistical significance at the 1% level

* Denotes statistical significance at the 5% level

Table 7: Diagnostic test results for Philippines

AR(1) residuals	Industrial production index growth rate (%)	Change in interest rate (%)
Autocorrelation tests		
Ljung-Box Q(20)		
Residuals	68.81**	53.43**
Heteroskedasticity tests		
ARCH(10) LM test	19.20*	25.15**
Normality tests		
Jarque-Bera	4.30	43.90**

** Denotes statistical significance at the 1% level

* Denotes statistical significance at the 5% level

6. Empirical Results

This section first investigates for evidence of structural break in the conditional correlation of country pairs of two economic variables: industrial production index growth rate and change in short-tern interest rate after the implementation of integration policy (i.e. ASEAN Economic Community Blueprint) in 2008 using the DCC model without a structural break. Then, the DCC model with a structural break is estimated and its results are discussed.

6.1 Structural Break and Integration Policy

To examine any sign of structural break, average value of conditional correlations for each country pairs of the two variables before and after the implementation of integration policy in 2008 is estimated using the DCC model without a structural break. As mentioned in the methodological section, the DCC model can be estimated in two steps. The primary step of estimation procedure is to fit univariate GARCH specifications for each of the five series of industrial production index growth rate and change in short-term interest rate. The model adequacy test is applied to specify the best fitted GARCH model (i.e. selecting the lag

length). Basically, the model is specified in such a way that there is no existence of serial correlation in standardized residuals of the mean equation and standardized residuals square of the variance equation. If both types of the residuals exhibit serial correlation, then the model does not sufficiently capture the dynamic of the data series and a better model specification is required (Walter Enders, 2009). In this paper, 10 lags are chosen for testing standardized residuals and standardized residuals square. The model specification of the data series is presented in Table 8 and 9. All of the data series does not show serial correlation in standardized residuals of the mean equation and standardized residuals square of the variance equation, suggesting that all of the data series are best represented by the selected model specification.

Table 8: GARCH models specification of industrial production index growth rate
for each countries

	Industrial production index growth rate (%)	
	Mean equation	Variance equation
Indonesia	$y_t = \mu + y_{t-1}$	GARCH(1,1)
Malaysia	$y_t = \mu + y_{t-1} + y_{t-2}$	GARCH(1,1)
Philippines	$y_t = \mu + y_{t-1}$	GARCH(1,1)
Singapore	$y_t = \mu + y_{t-1} + y_{t-2}$	GARCH(1,2)
Thailand	$y_t = \mu + y_{t-1}$	GARCH(1,0)

Table 9: GARCH models specification of change in short-term interest rate
for each countries

	Change in interest rate (%)	
	Mean equation	Variance equation
Indonesia	$y_t = \mu + y_{t-1} + y_{t-5}$	GARCH(1,1)
Malaysia	$y_t = \mu + y_{t-1} + y_{t-2} + y_{t-3}$	GARCH(1,1)
Philippines	$y_t = \mu + y_{t-1} + y_{t-2}$	GARCH(1,1)
Singapore	$y_t = \mu + y_{t-1} + y_{t-7}$	GARCH(1,1)
Thailand	$y_t = \mu + y_{t-3}$	GARCH(1,1)

Subsequently, as mentioned in the methodological section, the inputs from univariate GARCH model are used to estimate correlation coefficients for each country pairs of the two variables. Prior to estimating the DCC model, an appropriate break date is needed to specify. In this paper, July 2010 is selected as a break date (τ_{break}). There are two main reasons why this date is chosen. The first reason is because major integration policy is essentially implemented during 2008-2009. These are the elimination of import duties on most of the products for ASEAN countries and custom integration, which, as discussed in literature section, are cited as significant factors for convergence among countries in the region. Thus,

it may take some period of time for the impact of the policy to be felt. This reasoning is supported by the fact that the impact lags of economic policy, which measured from the time that the action is taken, is uncertain and can possibly be felt several quarters after the actual change (Blanchard and Perotti, 2002). The second reason is to avoid the global financial crisis during 2008-2009, which its inclusion in the estimation may distort the results of the correlation (i.e. unrealistic increase in correlation due to negative GDP growth rate across ASEAN countries during the crisis and positive GDP growth rate across ASEAN countries at the beginning of 2010 as the whole region recovers).

Table 10 to 13 present the estimation results of the average values of estimated conditional correlations for each country pairs of industrial production index growth rate and change in short-term interest rate before and after the implementation of integration policy in 2008 (which the selected break date is July 2010). It is notable that the results are obtained by employing a DCC model without a structural break. Overall, though not substantial, estimated conditional correlation for most of the country pairs of the two variables decrease after the policy is implemented, indicating a divergence in OCA and Maastricht criteria and a decrease in the feasibility of OCA for the region. These changes are discussed later in this section.

Table 10: Average values of estimated conditional correlations for each country pairs of industrial production index growth rate from January 2001 to June 2010

	Thailand	Indonesia	Philippines	Malaysia	Singapore
Thailand		0.212	0.258	0.590	0.236
Indonesia			0.059	0.025	-0.229
Philippines				0.288	0.217
Malaysia					0.445
Singapore					

Table 11: Average values of estimated conditional correlations for each country pairs of industrial production index growth rate from July 2010 to December 2013

	Thailand	Indonesia	Philippines	Malaysia	Singapore
Thailand		0.153	-0.052	-0.026	0.175
Indonesia			-0.143	0.062	-0.157
Philippines				0.242	0.173
Malaysia					0.541
Singapore					

Table 12: Average values of estimated conditional correlations for each country pairs of change in short-term interest rate from January 2001 to June 2010

	Thailand	Indonesia	Philippines	Malaysia	Singapore
Thailand		0.269	0.395	0.263	0.541
Indonesia			0.005	0.050	0.086
Philippines				0.295	0.491
Malaysia					0.310
Singapore					

Table 13: Average values of estimated conditional correlations for each country pairs of change in short-term interest rate from July 2010 to December 2013

	Thailand	Indonesia	Philippines	Malaysia	Singapore
Thailand		-0.144	0.313	0.512	-0.268
Indonesia			-0.056	-0.260	0.007
Philippines				0.630	-0.299
Malaysia					-0.399
Singapore					

6.2 Dynamic Conditional Correlation with a Structural Break

Table 14 reports the estimation results of the DCC model with a structural break for ten pairs of industrial production index growth rate and change in short-term interest rate. Most of the coefficients are statistically significant at conventional level of 5%.

Table 14: Estimation results of the DCC model with a structural break for ten pairs of Industrial production index growth rate and change in short-term interest rate

	Industrial Production Index growth rate (%)		change in nominal interest rate (%)*	
	α	β	α	β
Thailand vs. Indonesia	0,283**	0,479**	0,594**	0,207
Thailand vs. Philippines	0,455**	0,221	0,621**	0,180
Thailand vs. Malaysia	0,390**	0,541**	0,694**	0,213**
Thailand vs. Singapore	0,228**	0,682**	0,630**	0,210
Indonesia vs. Philippines	0,166*	0,732**	0,529**	0,339**
Indonesia vs. Malaysia	0,231*	0,378	0,725**	0,061
Indonesia vs. Singapore	0,420**	0,103	0,431**	0,481**
Philippines vs. Malaysia	0,497**	0,229	0,739**	0,027**
Philippines vs. Singapore	0,212*	0,498*	0,502**	0,391**
Malaysia vs. Singapore	0,286**	0,482**	0,734**	-0,036**

** Denotes statistical significance at the 1% level
* Denotes statistical significance at the 5% level

As discussed in the methodological part, to test for structural change, the value of log likelihood function is obtained from the estimation of the DCC model with and without a

structural break in order to calculate the likelihood ratio test statistic. Table 15 sets out likelihood ratio test statistic for testing the null hypothesis of no structural break in correlation mean against the alternative hypothesis of a structural break in the correlation mean. The results show that most conditional correlation of country pairs of industrial production index growth rate and change in short-term interest rate demonstrate an indication of structural change after the break date of July 2010 as the null hypothesis (i.e. no structural break) is rejected at 1% significant level in favor of alternative hypothesis (i.e. evidence of a structural break).

Table 15: Values of log likelihood function and likelihood ratio test statistic from the DCC model with and without a structural break of industrial production index growth rate

industrial production index growth rate (%)		
Value of log likelihood function		Likelihood ratio test statistic
The DCC model without a break	The DCC model with a break	
Thailand vs. Indonesia	-1067.792	-1028.76	78.06
Thailand vs. Philippines	-1107.36	-1075.19	64.33
Thailand vs. Malaysia	-1017.08	-956.46	121.24
Thailand vs. Singapore	-1186.52	-1148.62	75.80
Indonesia vs. Philippines	-1061.65	-1056.18	10.94
Indonesia vs. Malaysia	-988.23	-961.21	54.04
Indonesia vs. Singapore	-1128.51	-1121.59	13.84
Philippines vs. Malaysia	-1017.93	-994.27	47.31
Philippines vs. Singapore	-1176.18	-1170.51	11.34
Malaysia vs. Singapore	-1074.54	-1055.76	37.55

Note: Critical value for Chi-square distribution with one degree of freedom is 3.8 for 5% significant level and 6.6 for 1% significant level

Table 16: Values of log likelihood function and likelihood ratio test statistic from the DCC model with and without a structural break of change in short-term interest rate

change in short-term interest rate (%)		
Value of log likelihood function		Likelihood ratio test statistic
The DCC model without a break	The DCC model with a break	
Thailand vs. Indonesia	-1522.80	-1493.99	57.62
Thailand vs. Philippines	-1332.12	-1144.00	376.24
Thailand vs. Malaysia	-1212.81	-1211.57	2.47
Thailand vs. Singapore	-1460.72	-1329.54	262.35
Indonesia vs. Philippines	-1320.88	-1305.53	30.69
Indonesia vs. Malaysia	-1218.91	-1217.51	2.80
Indonesia vs. Singapore	-1447.52	-1413.00	69.04
Philippines vs. Malaysia	-710.49	-640.03	140.92
Philippines vs. Singapore	-1257.43	-939.00	636.85
Malaysia vs. Singapore	-713.95	-1072.05	716.09

Note: Critical value for Chi-square distribution with one degree of freedom is 3.8 for 5% significant level and 6.6 for 1% significant level

Based on the estimation results, time series plots of the conditional correlations for each country pairs of the two variables can be created to investigate their evolution before and after the implementation of integration policy in 2008. Figure 1 and 2 depict the dynamic of all the correlations derived from the model. Given the average value of conditional correlations shown in Table 12 and 13 and evidence of a structural break after the implementation of the integration policy in 2008, it is not surprising that these conditional correlation decrease over time, with the apparent change being between Thailand-Philippines and Indonesia-Philippines for industrial production index growth and Philippines-Singapore and Malaysia-Singapore for change in nominal interest rate.

A decrease in conditional correlation of most country pairs of industrial production index growth rate and change in short-term interest rate after the implementation of integration policy in 2008 indicates that the whole region diverges away from OCA and Maastricht criteria and that the feasibility of OCA is decreased.

As discussed in Mundell (1961), individual monetary policy is used to adjust to shocks which is specific to each country (i.e. asymmetric shocks). Therefore, the cost of adopting a common currency is the inability for a country to use monetary policy to adjust to asymmetric shocks. Following this logic, a higher asymmetric shocks increase the opportunity cost of using a common currency.

To illustrate this theoretical framework, the explanation of De Grauwe (1992) of how asymmetric monetary system (i.e. one member country take a leadership role in setting policy) and asymmetric shock can cause problem to a region that pursuit single currency area. Assuming that ASEAN adopts single currency and Singapore is allowed to be important in determining the overall monetary stance for the region (just like Germany is for European Union). Because of asymmetry of shock, if a specific macroeconomic shock hits the region, some countries will encounter a contraction in GDP growth rate and some countries (including Singapore for example) will experience an increase GDP growth rate. Since the center country (Singapore) does not change its monetary policy stance as it benefits from the shock, the rest of the countries which response negatively to shock can be in a deeper recession as they lose individual monetary policy to adjust to shock.

Since conditional correlation of industrial production index growth rate measures to what extent the two countries response differently to shocks (i.e. asymmetric shocks), a lower correlation of the variable for most of the country pairs suggest higher asymmetric of shocks

for ASEAN. Applying the theoretical framework above to the result of this paper, due to higher asymmetry of shock, there will be more countries response differently to the shock from Singapore and the region's GDP contraction will be even worsen than if asymmetry of shock is lower.

As discussed in Maastricht criteria, the conditional correlation of short-term interest rate measures monetary policy coordination, which is important for successful functioning of OCA. A decline correlation of the variable for most of the country pair indicates lesser policy synchronicity among country members and may interrupt functioning of OCA when the region adopts it.

Hence, a decline in the conditional correlation of most country pairs of both variables after the implementation of integration policy in 2008 demonstrates that the feasibility of OCA for the region is worsened.

The results of this paper that higher economic integration due to integration policy causes divergence in business cycle is in line with Krugman (1993) which, by using evidence from North America, argues that increased economic integration does not guarantee economic convergence but rather increase the possibility of asymmetric shocks as country members become more locally specialized from the integration. A recent paper regarding the issue by Imbs (2004) also confirm that specialization in the industry structure is negatively correlated with business cycle synchronization. The research uses US data and is carried out by employing system of simultaneous equations. Nevertheless, there is only weak evidence that trade-induced specialization is negatively correlated with output comovement.

7. Conclusion

This paper investigates the feasibility of OCA for ASEAN after the implementation of ASEAN Economic Community Blueprint (i.e. integration policy) in 2008. Dynamic Conditional Correlation (DCC) model with and without a structural break is used to identify whether the policy implemented facilitates the region to move closer to a single currency area. Industrial production index growth rate and change in short-term interest rate for ASEAN founders (Indonesia, Malaysia, Philippines, Singapore, and Thailand) are selected as a proxy for OCA and Maastricht criteria respectively, which are cited as significant factors for successful functioning of OCA.

In order to identify whether the integration policy implemented enables the region to converge to a single currency area, three formal testing procedures is carried out. First, average value of conditional correlations for each country pairs of the two variables before and after the implementation of integration policy in 2008 is estimated using the DCC model without a structural break. Second, the DCC model with a structural break for each country pairs of the two variables is estimated and the graph is plotted accordingly. Third, the likelihood ratio test statistic is computed using the value of log likelihood function from the DCC model with and without a break. The results of three formal testing procedures indicate that there is a structural break of conditional correlation of country pairs of the two variables after the implementation of integration policy in 2008 and that most of the conditional correlations decrease over time.

A decrease in conditional correlation of most country pairs of the two variables after the implementation of integration policy in 2008 indicates that the whole region diverges away from OCA and Maastricht criteria respectively and that the feasibility of OCA is decreased. The result of this paper that higher economic integration due to integration policy causes divergence in business cycle is in line with Krugman (1993) and Imbs (2004) which argues that increased economic integration does not guarantee economic convergence but rather increases the likelihood of asymmetric shocks (i.e. divergence in business cycle) as industry of country members become more specialized.

In the case of ASEAN, as discussed in integration indicator and analysis section, there is an evidence of higher economic integration after the implementation of integration policy in 2008, indicating by higher intra-regional trade, investment, and labor mobility. However, the conditional correlation analysis used in this paper is unable to identify whether economic integration actually causes specialization in the industry (integration-induced specialization) to decrease business cycle synchronization, which is evidence in this paper. It only demonstrates the development of the condition correlation of business cycle over time and, hence, a progress of the feasibility of OCA for ASEAN. Therefore, for higher effectiveness of future integration policy formulation, a further formal quantitative analysis needed to be carried out in order to precisely identify that higher economic integration causes higher specialization in the industry and, hence, more divergence in business cycle.

8. References

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9. Appendices

Figure 1: Conditional Correlations for each country pairs of industrial production index growth rate

Thailand vs. Indonesia
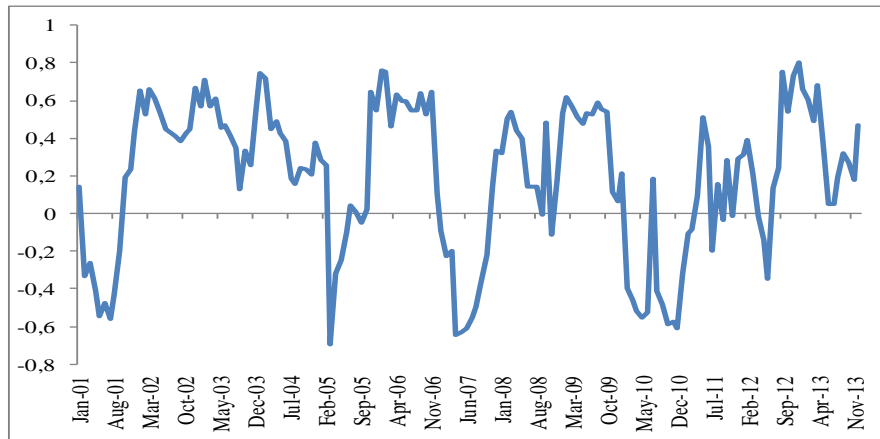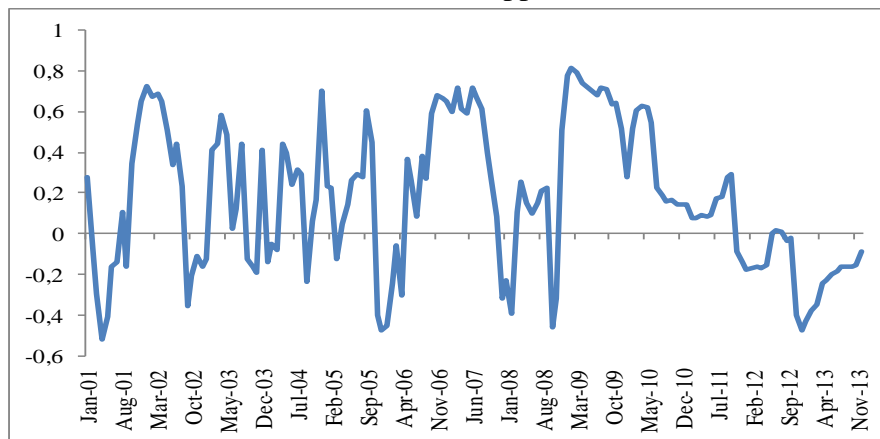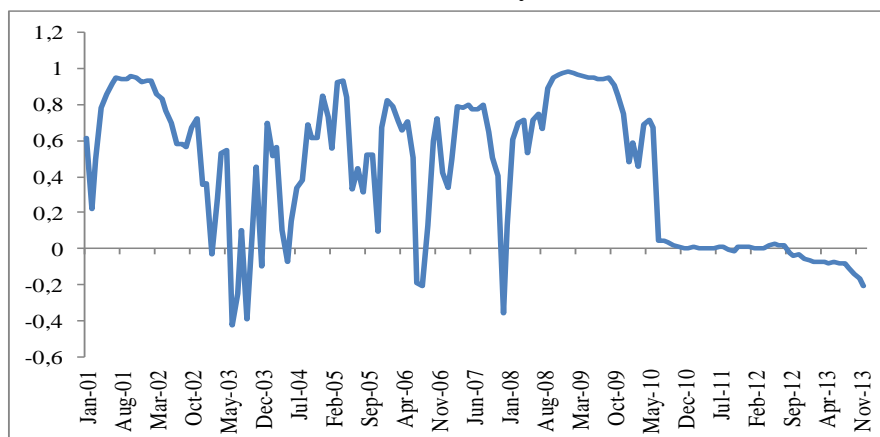
Thailand vs. Philippines

Thailand vs. Malaysia

Thailand vs. Singapore

Indonesia vs. Philippines
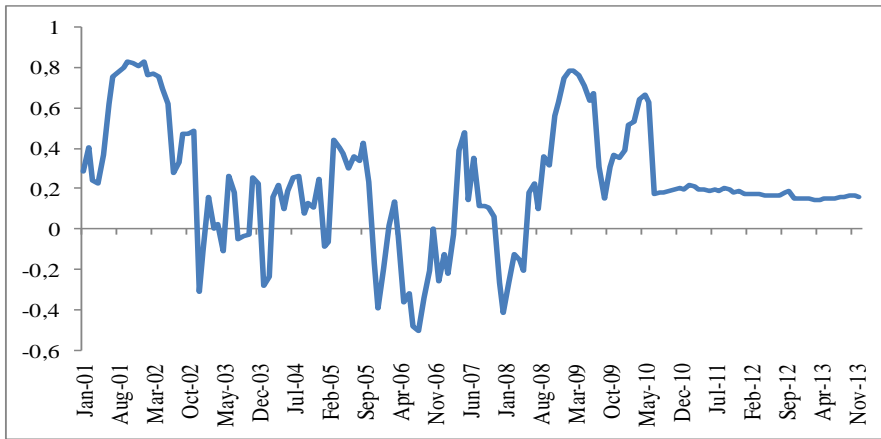
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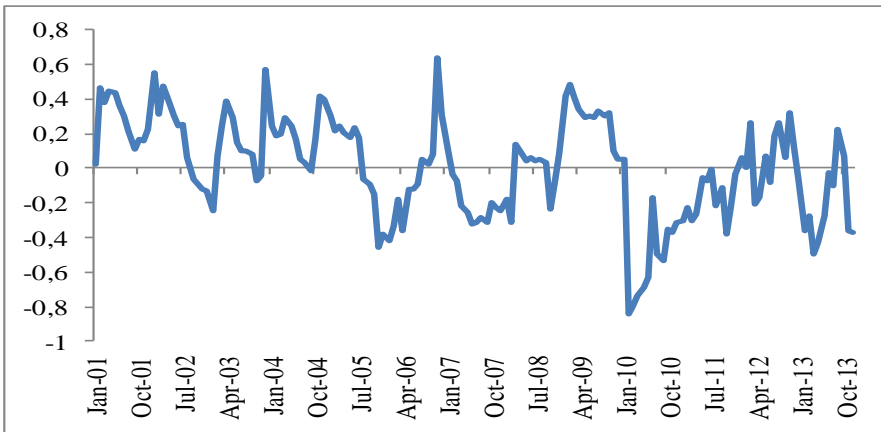
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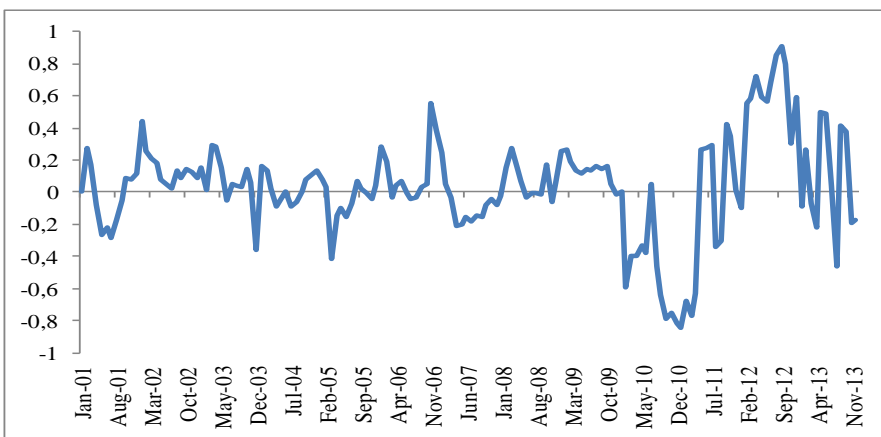
Philippines vs. Malaysia
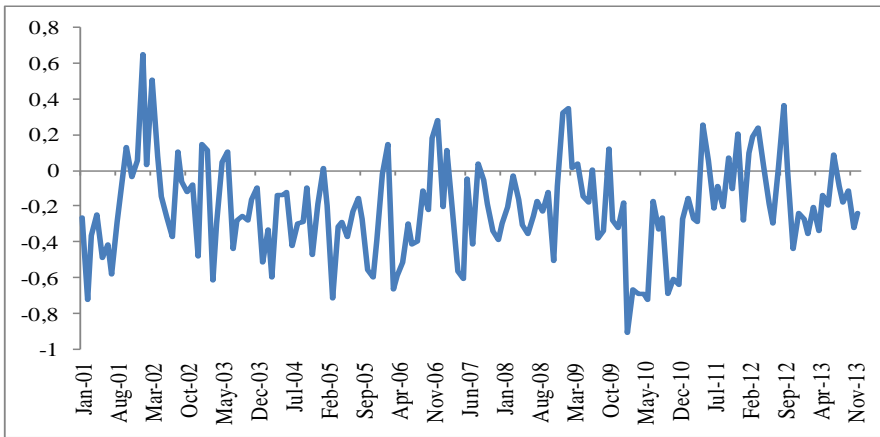
Philippines vs. Singapore
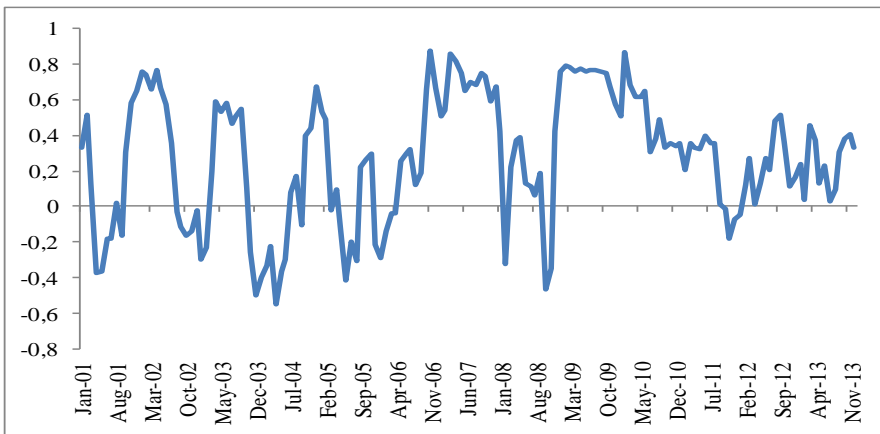
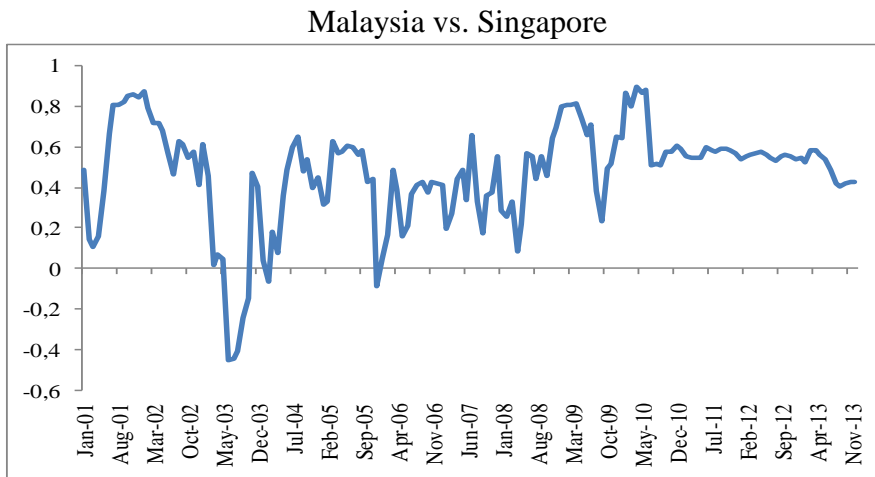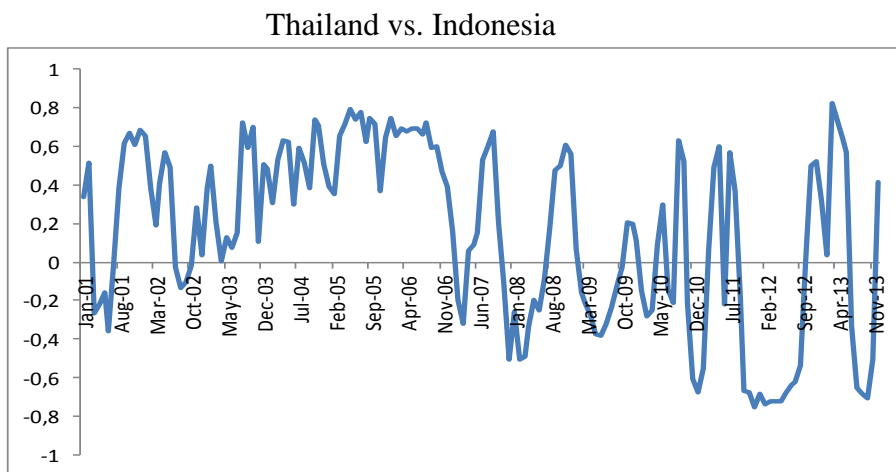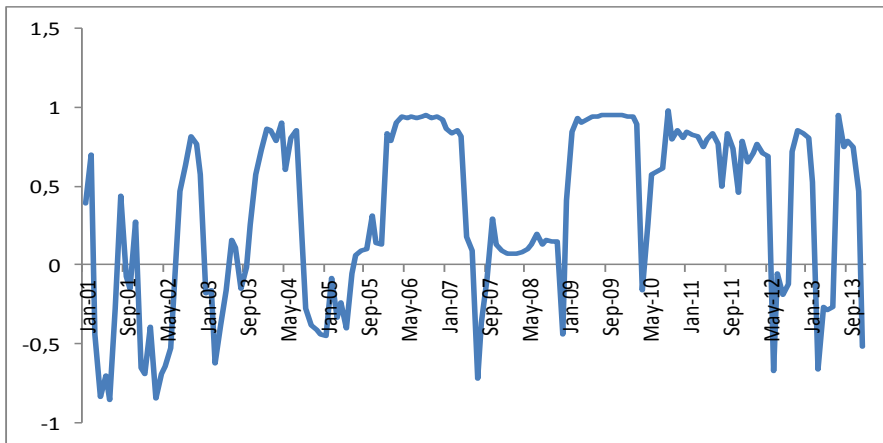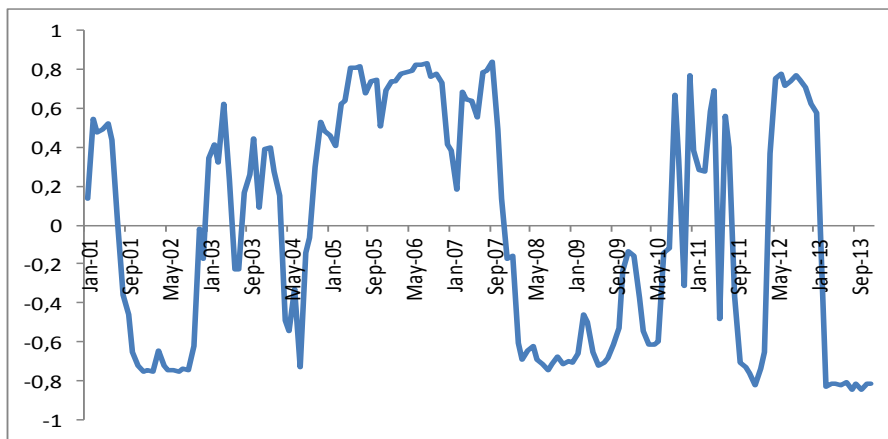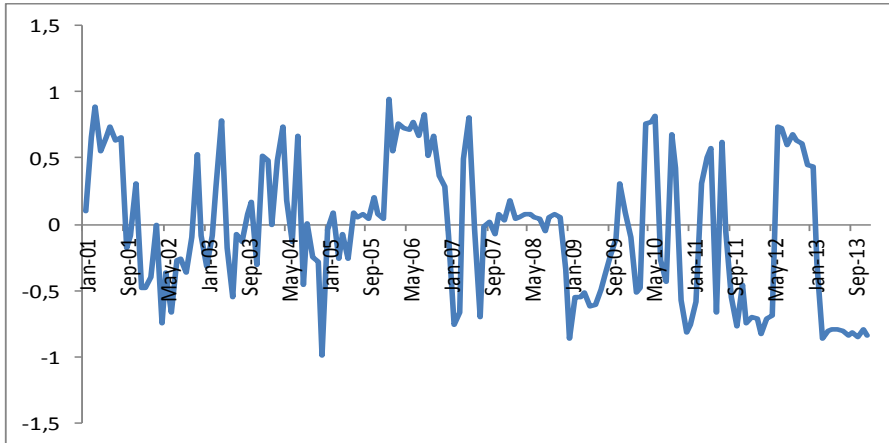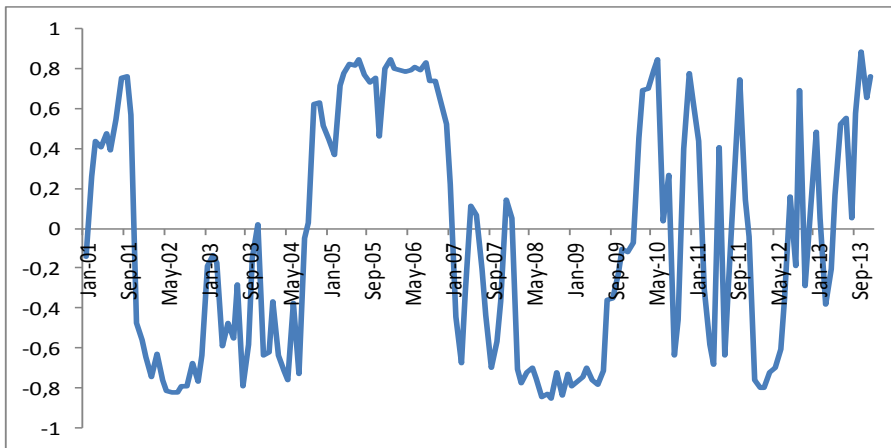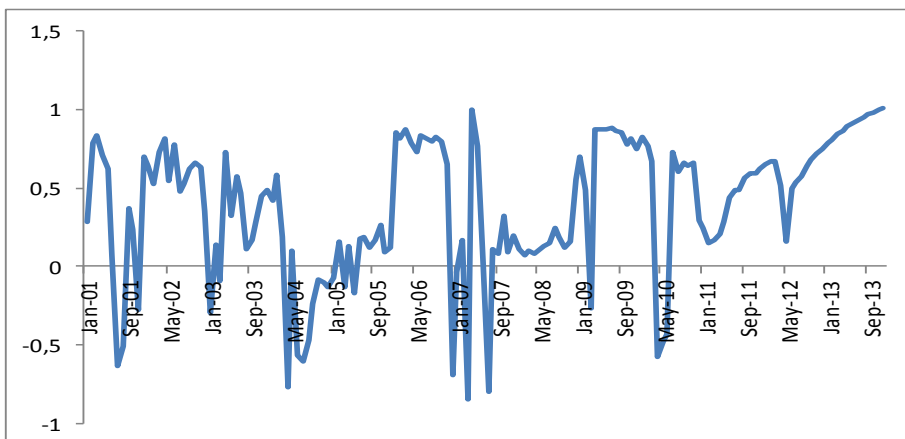Malaysia vs. Singapore
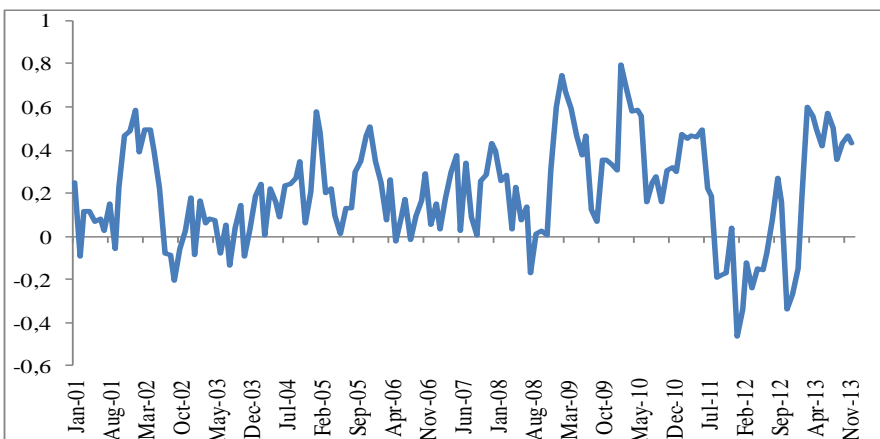
Figure 2: Conditional Correlations for each country pairs of change in short-term interest rate

Thailand vs. Indonesia

Thailand vs. Philippines

Thailand vs. Malaysia

Thailand vs. Singapore
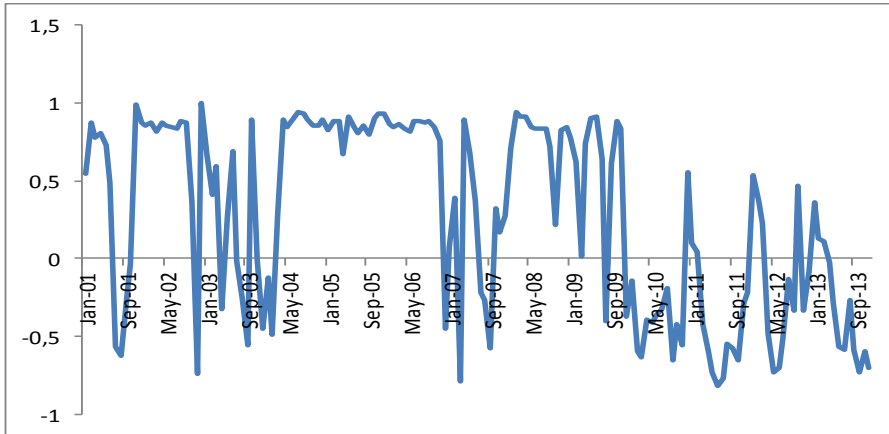

Indonesia vs. Philippines

Indonesia vs. Malaysia

Indonesia vs. Singapore

Philippines vs. Malaysia

Philippines vs. Singapore

Malaysia vs. Singapore