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YEN SYNCHRONIZATION AMONG ASEAN-5, KOREA AND JAPAN: EVIDENCE FROM THE MULTIVARIATE GARCH MODEL

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Abstract

In this study, we aim to investigate whether ASEAN-5 and the Korean currency regimes are ready to use Japanese Yen as an Asian future Exchange Rate Mechanism (AERM) by using Multivariate GARCH models. Overall findings show that Singapore, Thailand, and Korea are the potential countries that ready to adopt Japanese Yen as an AERM. However, Malaysian Ringgit, Indonesian Rupiah and the Philippines Peso are weakly correlated with Japanese Yen. This indicates that the East Asian free trade agreement such as ASEAN-10+3 and EAFTA does not enough to promote these low dynamic correlation countries (Malaysia, Indonesia, and the Philippines). Perhaps, the appropriate way to begin the AERM is to form a group of currency system which highly correlated with Japanese Yen (e.g. Singapore, Thailand, and Korea) whiles others could have a commitment to adopt Japanese Yen as a regional trade-invoicing currency in order to increase the level of Yen synchronization correlation.

JEL classification: E42, F31, F33

Keywords: Asian Monetary Union (AMU), Asian Exchange Rate Mechanism (AERM), Japanese Yen, Anchor Currency, BEKK GARCH,

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Introduction

Recently, the Europe's debt crisis and the Global Financial Crisis (GFC) both seems likes slower down that desire of East Asia for regional cooperation and the idea of Asian monetary union (AMU) (Katada, 2011). However, this temporary hinder does not mean an unavoidable weakening of regional cooperation and integration efforts in this area over the medium and long terms (Katada, 2011; and Kim, et al. 2012). According to Behrooz, et al. (2015), the main and crucial objective of forming an economic union in ASEAN is to build up a common currency area, in order to prevent the repeat of the 1997 financial crisis. In addition, the globalization trend worldwide has made it necessary for Asian countries to adopt a single currency over the long run – concerned including the Asian currency regimes as well.

In recent decades, the Asian region has field-tested the stability of regional monetary stability and has requested a good model for strengthening regional financial stability. For example, the AMU and an Asian Currency Unit (ACU) were one of the regional targets to reduce the currency mismatches in the regional balance sheets as well as increase the Asian regionalism trade integration. Besides that, Kawai and Takagi (2012), and Victor (2013) suggested that the Asian Currency Unit (ACU) or the currency deviation indicator can be a valuable analytical tool to help achieve the regional exchange rate stability. Hence, the initial step in establishing an AMU in the Asian region is to start with a suitable ACU (Mundell, 2003 and Becker, 2008).

In accordance, a further intermediate step towards an AMU is to establish an Asian Monetary System (AMS) with an Asian Exchange Rate Mechanism (AERM) between Asian countries. Inside the Asian currency regime, the Asian region would need an anchor currency to integrate the members, such as establishing an external or internal currency. In order to have a stable and strong regional currency unit, the anchor currency is believed to have a remarkable choice of uses (Mundell, 2003). Yet, the selecting of a suitable anchor currency must be met by some prior conditions and only large Asian country's currencies will qualify for a potential candidates as a parallel currency, [i] such as the Chinese Yuan (or renminbi) or the Japanese Yen.[ii]

Nowadays, China has emerged as the most populous country on the earth, and is, definitely, destined to become a superpower. Chinese growth over the recent decades has been remarkable with growth of national GDP topping at 10% annually. In addition, the Chinese has increasing degree of openness with below 38.2% of GDP (2000) to 64.3% of GDP (2007).[iii] However, Yuan is not a fully convertible currency yet as the Chinese exchange rate system has only been reform on July 21, 2005 and the exchange rate regime was shifted to a managed crawling peg regime. This change stimulated the global expectation on the yuan's international role which will arise over time, however, the yuan remains limited for global settlement, clearance, financing and liquidity holding due to the lack of its full convertibility (Becker, 2009).

According to Ogawa (2006), he found that there are no identifying hints showing that the Chinese monetary authority is adopting the currency basket system because the changes are too small in the economic sense. In addition, the financial system of China is not considered as well developed yet with some uncertainties concerning the future exchange rate policy of China towards the dollar. For the time being, therefore, Chinese Yuan would not be suitable to use as an anchor currency for the Asian region, a pegging towards the China Yuan would becomes a political decision (Mundell, 2003; and Becker, 2008).

Could the Yen emerge as a suitable Asian future anchor currency? Historically, Japanese Yen has been the strongest currency in the world since reformation from 10 old Yen to 1 new Yen at the 1948. In addition, Japan has been performing well on their economic development, with amongst the highest living standard in the world. According to Mundell (2003), Japan is by far the world's largest creditor nation, a position it has built up with high savings rate coupled with huge current account surpluses. Moreover, Japan has always been successful in maintaining their inflation under control than other countries in recent decades.[iv] Although, the demand of Japanese Yen in the international currency reserves have been decreasing, yet, it still remains more significant than other Asian currencies (Table 1).

Table 1: Currency Composition of Official Foreign Exchange Reserves (%)

Currency	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
US Dollar	70.5	70.7	66.5	65.8	65.9	66.4	65.7	64.1	64.1	62.1	61.8	62.1

Euro	18.8	19.8	24.2	25.3	24.9	24.3	25.2	26.3	26.4	27.6	26.0	25.0
Pound Sterling	2.8	2.7	2.9	2.6	3.3	3.6	4.2	4.7	4.0	4.3	3.9	3.9
Japanese Yen	6.3	5.2	4.5	4.1	3.9	3.7	3.2	2.9	3.1	2.9	3.7	3.7
Swiss Franc	0.3	0.3	0.4	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1
Other	1.4	1.2	1.4	1.9	1.8	1.9	1.5	1.8	2.2	3.1	4.4	5.1

Sources: 2000-2005 ECB: The Accumulation of Foreign Reserves and 2006-2011 IMF: Currency Composition of Official Foreign Exchange Reserves.

Furthermore, due to the strength of Japan's manufacturing export economy and the yen carry trade, the Japanese Yen continues to be internationally the fourth-most-traded currency, far ahead of the other Asian members (Kim et al., 2012). The forming of AMU may seem becoming a political agenda for the Asian region, however, the political criteria does not change the economic equation parts. Karras (2005) claimed that the decision on adopting the Japanese yen will promote or harm a country's economy depends on the economic criteria only. Based on those economic reviews, the Japanese Yen might be a suitable Asian common currency unit to increase the regional intra-trade and strengthen the Asian currency towards financial stability in the long-run. However, if the AMU members' currency movements are diverged from the Yen fluctuations, then it is dangerous to adopt yen as an ACU because of it can happen the mismatching of monetary policy across countries.

According to Kim et al. (2012), in order to move forward the renew regionalism efforts during the next decade, there is important to increase the East Asia's yen synchronization across countries. In addition, the increase of yen synchronization would assist to offer a favorable environment for a common-currency area, if it contributes to the stabilization of exports and the business cycle in East Asia. In addition, Karras (2005) point out that adopting yen would have helped only those countries with high positive correlation with Japan. However, would the Asian region have high yen synchronization across the countries? Would the Asian countries be readily able to adopt Japanese Yen as the intra-trade currency unit and form a first group of AMU? In order to answer these research questions, we aims to examine the possibility of adopting the Japanese Yen as the ASEAN-5 and Korea regional currency unit based on the yen synchronization perceptions by non-linear dynamic BEKK GARCH model.

According to Taylor and Taylor (2004), and Liew et al. (2008), the fluctuations in national exchange rates are not supposed to be demonstrated by linearity over time (nonlinearity movement). However, most of the previous AMU studies are based on the linearity assumption method, such as Behrooz et al. (2015). In this study, the BEKK GARCH model is adopted to estimate the yen synchronization with non-linear time-varying coefficients, which is different from the previous yen synchronization studies based on the assumption of linearity and time invariance. The remainder of this paper is organized as follows. Section 2 reviews some relevant literature for this study. Section 3 describes the econometrics methodologies with details on the data used. The empirical result and the discussion are reported in Section 4. Finally, Section 5 summarizes the findings and suggested some policy implications of the findings.

Literature review

Is it feasible for the Asian countries to establish an AMU?

Since 1961, the Optimum Currency Area (OCA) provided conditions model to measure the suitability of forming a common currency area. Based on this OCA theory, researchers have been debating the suitability of establishing an OCA in the Asian region. Some researchers suggested that the Asian region should form an OCA and have the ability to stabilize regional financial stability (Mundell, 2003; and Becker, 2008). However, another group of researchers criticized that it is not suitable for the Asian region to establish an OCA and argued that a lack of political and economic commitment in Asia constitutes the decisive factor against the formation of OCA (Kwack, 2004; Kim, 2007; and Bacha, 2008).

Based on the OCA theory, some previous studies estimated the economic symmetric shock especially for the internal and external trade correlation to decide whether it is appropriate for the Asian region to form an OCA (for example, Bayoumi and Eichengreen, 1994; and Ng, 2002). If we only based the feasibility on the symmetric shocks of internal and external trade to decide the potential countries, it seems that there would be insufficient evidence to determine the suitability of a regional common currency area. For instance, Bayoumi and Mauro (1999) extended the Bayoumi and Eichengreen (1994) study to examine the costs, benefits, preconditions and implications of an ASEAN regional currency arrangement. The authors rejected the Bayoumi and Eichengreen (1994) findings which conclude that ASEAN appears not to be very suitable for an Optimum Currency Area. Hence, this suggests that the missing relevant information or a limited research area will provide different findings and in the end influences the researchers' suggestion.

On the other hand, some findings show that the East Asian region's trade is integrated and the trade structures of the East Asian economies have became more similar over time (Lee et al., 2004; Kawai, 2005; and Peridy, 2005). Yet, this hypothetical statement is insufficient to judge the suitability of Asia to form an OCA. This is because the OCA preconditions strongly require that the Asian region has to fulfill all of the prior conditions, such as, having a high degree of economic convergence in growth and inflation rates, openness in external trade, similar economic structures, flexible factor prices as well as the factor mobility. According to Becker (2009), the conditions under the OCA theory represents ideal conditions. However, actually some OCA requirements generally improve within a monetary union. For example trade integration indicates that the Asian region is more focused on the monetary union criteria but not the OCA theory. A good example of this is the European countries where there only formed an European Monetary Union (EMU) but not the OCA in the current decade. So, these arguments have given new ideas for the Asian region to only focus on the monetary union criteria rather than the OCA theory.

Historically, the idea of establishing an European Union (EU) only began in 1952 with 6 core members. However, these six founder members never stopped in their steps towards establishing an economic cooperation roadmap. Five decades later, they have successfully implemented three stages of progress towards an EMU in Europe. On 1st

Jan 1999, the European Central Bank (ECB) announced and introduced the euro as a single currency. Continuously, the euro currency became a legal tender in the participating countries on 1st Jan 2002 and by the end of February 2002 national banknotes and coins ceased to be legal tender. By these efforts, now the EU has successfully grown from 6 core member countries to 27 members. Hence, perhaps the AMU could begin with a small number of core members like the EU which is suggested by Grace and Sharon (2012).

The Empirical Support for the Yen Bloc as an AMU

According to Bowman (2005), the Europe zone, the Americas, and the Asia region are the three main blocs were perceived to be forming in the world. The Europe zone has formalized into the European Union and the Americas has centered on the US and the North American Free Trade Agreement. In addition, the Asia region has centered on Japan and it association countries such as ASEAN-10+3. According to Kwan (1996), the author focuses on the formation of a yen bloc application for the stability of macroeconomic in Asian region and the international economy. Kwan (1996) found that the Asian NIE's, which compete with Japan in international markets, are better candidates than the ASEAN countries and China to join a yen bloc.

Nowadays, a lot of studies suggests that the Japanese Yen could be a suitable Asian common currency or AMU (Aggarwal and Mougoue, 1993; Kwan, 1994; Kwan, 1996; Chaudhry et al. 1996; Tse and Ng, 1997; Kang et al., 2002; Kwack, 2004; Baharumshah and Goh, 2005; Karras, 2005; Bowman, 2005; Kim, 2007; Bacha, 2008;

Azali et al., 2009; Moneta and Ruffer, 2009; and so on). For instance, Aggarwal and Mougoue (1993) employed the daily exchange rates to examine the cointegration relationship among the Japanese Yen with other Asian currencies and they found strong evidence to support a Yen bloc. In addition, Chaudhry et al. (1996) investigated the co-movement amongst the Japanese Yen, Australian Dollar, Singapore Dollar, Malaysian Ringgit, and New Zealand Dollar by using Vector AutoRegressive models (VAR) and also found that the Japanese Yen, Australian Dollar, and Singapore Dollar influenced the behavior of other regional currencies.

Besides that, Aggarwal and Mougoue (1996) investigated the stochastic properties of Asian exchange rates and the cointegration between the Japanese Yen and two sets of Asian currencies: (1) the Asian Tigers group – Hong Kong, South Korea, Singapore, and Taiwan; and (2) ASEANs group – Malaysia, Philippines, Thailand, and Singapore. The authors found both sets of Asian currencies were found to be cointegrated, with the influence of the Japanese Yen increasing relative to the US dollar. This shows that the Japanese currency regime had a significant influence on Asian and international markets.

However, some authors found opposite results especially in the period of during and after the Asian financial crisis. Kang et al. (2002) used the VAR models and impulse response functions to measure a static correlation coefficient between a pair of currencies, namely Korean Won and Japanese Yen. Their empirical results showed that the free floating exchange rate regime adopted by Korea since the crisis cannot insulate its economy from external nominal shocks such as yen/dollar exchange rate volatility. Similarly, Baharumshah and Goh (2005) showed that the Philippines Peso and Korean Won do not belong to the cointegrating relationship among the Japanese Yen, Indonesian Rupiah, Malaysian Ringgit, Singapore Dollar, Thai Baht as well as Taiwan Dollar. In contrast, based on the recent findings from Azali et al. (2009), the financial integration of the Asian currencies regimes was lower before the crisis period, but higher during and after the crisis period. The authors suggested the Japanese Yen as a potential alternative vehicle currency for the Asian region in the future, especially for Korea, the Philippines, Malaysia, and Singapore.

As an overall, the inconsistency of the findings indicates that we need more robust evidence to support the Yen bloc system in order to show its suitability for the Asian region. The reason for this inconsistency across the studies may be because of different sample sizes used, different periods of investigation as well as the alternative methodologies used. According to Taylor and Taylor (2004), as well as Liew et al. (2008), the fluctuations of national exchange rate are not supposed to demonstrate by linearity over time (nonlinearity movement). However, the VAR (as well as the structural VAR model) and Johansen's cointegration approaches are widely used to determine the exchange rate interdependencies (e.g. Aguilar and Hordahl, 1998; Klaassen, 1999; Bernard and Galati, 2000; Calvet et al. 2004; Oxana et al., 2008, and Behrooz et al., 2015), which are based on the assumption of linearity between two variables and time invariance. Hence, this may be sufficient to answer the doubt about the inconsistency of the findings. In order to avoid misspecification, the multivariate

GARCH model seems attractive and suitable for being applied to time-varying correlation coefficient testing. Yet, the non-linear GARCH model might able to provide more information (e.g non-linear time-varying estimated coefficient) than simple linear correlation approaches (static and time invariance).

Data and empirical methodology

This study covers the daily nominal exchange rate for selected Asian exchange rates: Japanese Yen (JPY), Korean Won (KRW), Malaysian Ringgit (MYR), Singapore Dollar (SGD), Thai Baht (TBH), Indonesian Rupiah (IDR), and the Philippines Peso (PHP) for three different sample periods[v]: (i) Pre Asian financial crisis spanning from 04/01/1988 until 13/05/1997; (ii) During Crisis covers from 14/05/1997 until 31/08/1998;[vi] and (iii) Post crisis period from 01/09/1998 until 06/02/2009. All of these daily exchange rates are collected from the website of the Federal Reserve Bank of St. Louis except for Rupiah and Peso which are obtained from the website of Bank of Canada. All exchange rate series are transformed into log-differences.

Commonly, it is well known that the movement of exchange rate is highly dependent on its past values and past volatility. So, the application of the GARCH model is sufficient for the application of investigating the symmetric shocks of regional currency regimes with the Japanese Yen. Firstly, the conditional mean and GARCH (1, 1)[vii] process can be represented as follows:

$$y_t = \mu_t(\theta) + \xi_t, \qquad \xi_t \sim N(0, H)$$

$$\begin{bmatrix} NC/USD_t \\ JPY/USD_t \end{bmatrix} = \begin{bmatrix} \mu_{NC/USD} \\ \mu_{JPY/USD} \end{bmatrix} + \begin{bmatrix} \xi_{1,t} \\ \xi_{2,t} \end{bmatrix} \quad (1)$$

The conditional mean equation for the model that is estimated in this study is shown by equation (1). Where y_t is a 2 x 1 vector of exchange rate series transformed into log-differences; μ_t is a 2 x 1 vector of intercepts in the equation (1), *NC* represent the selected national currency and ξ_t is a residual term. In order to test the bivariate correlation between the two currencies movement, the conditional variance-covariance equation or the bivariate BEKK-GARCH (1, 1) model are employed and are described as following:

$$H_t = \Omega\Omega' + A(\xi_{t-1}\xi_{t-1})A' + BH_{t-1}B'$$

$$H_t = \Omega\Omega' + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \xi_{1t-1}^2 & \xi_{1t-1}\xi_{2t-1} \\ \xi_{2t-1}\xi_{1t-1} & \xi_{2t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' +$$

$$\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} h_{11t-1} & h_{12t-1} \\ h_{21t-1} & h_{22t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \quad (2)$$

where Ω is a low-triangular 2 X 2 matrix; and H_t is a symmetric 2 X 2 matrix. The equation (2) is comprised of the elements of $h_{NC/USD,\ t}$ and $h_{JPY/USD,\ t}$ on the leading diagonal and $h_{NC,\ JPY\ t}$ as both of the off-diagonal terms. For clarity, equation (1) can be written out separately as

$$\Delta \log (\mathrm{NC/USD})_t = \mu_{NC/USD} + \xi_{NC/UDSD,t} \quad (3)$$

$$\Delta \log (\text{JPY/USD})_t = \mu_{JPY/USD} + \xi_{JPY/UDSD,t} \quad (4)$$

With the conditional variance and covariance equation as

$$H(1,1) = h_{NC/USD,t} = c_1 + a_{11}{}^2 \xi^2_{NC/USD,t-1} + b_{11}{}^2 h_{NC/USD,t-1} \quad (5)$$

$$H(2,2) = h_{JPY/USD,t} = c_2 + a_{22}{}^2 \xi^2_{JPY/USD,t-1} + b_{22}{}^2 h_{JPY/USD,t-1} \quad (6)$$

$$H(1,2) = h_{NC,JPY,t} = c_3 + a_{12} \xi_{NC/USD,t-1} \xi_{JPY/USD,t-1} + b_{12} h_{NC,JPY,t-1} \quad (7)$$

The equation (3) and (4) are the mean equation for national currency[viii] per US dollar (NC/USD) and Japanese Yen per US dollar (JPY/USD), respectively. However, the next two equations, estimation (5) and (6), give the conditional variances H(1, 1) and H(2, 2) which can be expressed as functions of their past values, past volatilities measured as a lag of squared residuals and constant term. The last equation H(1, 2) is given as the conditional co-variances for observing both estimated currencies of co-movements volatilities. Simplify, the H(1, 1) is a variance equation for the national currency, H(2, 2) is a variance equation for the Japanese Yen, and H(1, 2) stands for the covariance equation between the national currency and Japanese Yen.

Finally, the time-varying correlation coefficient ($corr_i$) is calculated from the variance and co-variance equation. The definition of the correlation coefficient is given as the following formula:

$$corr_t = \frac{\text{cov}(NC/USD, JPY/USD)_t}{\sqrt{\text{var}(NC/USD)_t}\sqrt{\text{var}(JPY/USD)_t}}$$

or

$$= \frac{H(1,2)_t}{\sqrt{H(1,1)_t}\sqrt{H(2,2)_t}} \qquad (8)$$

According to Oxana, et al. (2008), this is one of the indicators to assess readiness for future Euro adoption and it is the simplest way to determine the exchange rate interdependencies. For instances, this method has been used by Aguilar and Hordahl (1998) to investigate which of the eleven EU members was possible to join the EMU from the begin.[ix] Besides that, the higher value of GARCH correlations indicates that those countries experienced a similar behavior of exchange rate regimes and the synchronization of exchange rates' shocks across countries (Oxana et. al, 2008). If a high degree of dynamic correlation coefficients exists between the two pairs of currencies, then there is a higher probability of these countries successfully adopting the Japanese Yen as a future Asian currency unit. Hence, we will propose an analysis of the time-varying correlation coefficient (equation 8) to determine whether the Singapore Dollar (SGD), Malaysian Ringgit (MYR), Thai Baht (THB), Indonesian Rupiah (IDR), Korean Won (KRW), and the Philippines Peso (PHP) become *de facto*[x] more synchronized with the Japanese Yen in term of volatility.

Empirical results

The Augmented Dickey-Fuller (ADF) test is employed to assess the stationarity properties for the variables. Table 2 shows non-stationarity among series in levels for the pre-crisis, crisis, and post crisis periods. However, when the ADF test was carried out for the first difference of series, the null hypothesis of a unit root is strongly rejected by a 1% significance level. This indicates that our time series were stationary at order one or *I(1)*. Therefore, all series are transformed into the first difference to estimate the conditional mean equation and BEKK GARCH models.

Table 2: Augmented Dickey-Fuller (ADF) Unit Root Test Result

	Pre Crisis Period		Crisis Period		Post Crisis Period	
	Level	**First Difference**	**Level**	**First Difference**	**Level**	**First Difference**
IDR	0.6368 (4)	-30.5151*** (3)	-1.5397 (9)	-4.0467*** (4)	-2.5088 (4)	-9.8325*** (24)
JPY	-1.1917 (1)	-46.1260*** (0)	-0.4651 (6)	-4.6759*** (15)	-2.5196 (0)	-51.1139*** (0)
KRW	0.4179 (23)	-6.8987*** (22)	-1.7123 (13)	-3.3318** (12)	-1.4957 (27)	-8.7881*** (27)
MYR	-1.9382 (19)	-9.3489*** (18)	-1.4933 (2)	-11.0456*** (1)	-1.1457 (27)	-8.9069*** (26)
SGD	-1.5755 (10)	-14.7519*** (9)	-0.8694 (7)	-8.3426*** (6)	-0.8906 (9)	-15.5468*** (8)
THB	-1.9809 (3)	-29.7761*** (3)	-1.8530 (0)	-17.3605*** (0)	-1.2355 (16)	-10.4736*** (15)
PHP	-1.8102 (17)	-10.6896*** (16)	-1.2093 (3)	-11.4235*** (2)	-1.2778 (17)	-10.2716*** (16)

Note: *** and ** denote significant at 1% and 5% significance levels. The figures in parenthesis (…) represent the automatic selected lag length based on Akaike Info Criterion (AIC).

Table 3, Table 4, and Table 5 show that all the coefficients of the ARCH ($a_{i,j}$) and GARCH ($b_{i,j}$) are statistically significant at a 1% significance level for the conditional variance and co-variance models. The sum of ARCH and GARCH coefficients for all the conditional variances and co-variance models are below one for all the series except for the 'during crisis' period. On the other hand, the diagnostic checking of the Ljung-Box Q (12) statistic for the residuals and the Ljung-Box Q^2 (12) statistic for the square residuals are insignificant and therefore we fail to reject the null hypothesis, indicating that there are no significant serial correlation and heteroscedasticity problems. In addition, the ARCH LM test results reveal that the standardized residuals do not exhibit additional ARCH effects.

Table 3 Bivariate BEKK-GARCH (1, 1) Estimation Result, Pre-Crisis Period

	IDR	KRW	MYR	SGD	THB	PHP
c_1	3.81e-07	7.76e-08	1.88e-07	4.25e-07	1.42e-06	5.12e-06
	(37.42)***	(18.84)***	(21.27)***	(11.00)***	(33.75)***	(30.65)***
a_{11}^2	0.3715	0.1695	0.1364	0.1162	0.1909	0.4162 [c]
	(28.71)***	(22.12)***	(20.50)***	(12.18)***	(14.51)***	(14.38)***
b_{11}^2	0.4657	0.8251	0.8403	0.8156	0.4571	0.3363
	(41.88)***	(7.68)***	(172.30)***	(67.03)***	(32.33)***	(15.86)***
c_2	2.12e-06	2.06e-06	2.07e-06	2.31e-06	3.02e-06	2.41e-06
	(6.12)***	(6.45)***	(6.93)***	(7.28)***	(6.78)***	(6.15)***
a_{22}^2	0.0435	0.0460	0.0511	0.0563	0.0756	0.0570
	(7.11)***	(7.68)***	(9.17)***	(9.05)***	(8.37)***	(7.60)***
b_{22}^2	0.9056	0.9063	0.8995	0.8872	0.8560	0.8870
	(70.95)***	(79.09)***	(81.85)***	(74.35)***	(54.24)***	(62.97)***
c_3	5.9765e-08	2.65e-08	2.08e-07	4.51e-07	8.21e-07	-5.37e-08
	(1.57)	(1.35)	(7.35)***	(8.45)***	(9.87)***	(-0.20)
a_{12}	0.1272	0.0883 [c]	0.0835	0.0809	0.1202	0.1540
	(13.32)***	(14.37)***	(15.45)***	(12.75)***	(14.60)***	(12.63)***
b_{12}	0.6494	0.8648	0.8694	0.8506	0.6255	0.5462
	(69.09)***	(136.65)***	(140.65)***	(90.48)***	(57.34)***	(30.46)***
Q(12)	25.599	26.745	29.831	19.285	29.008	25.912
	[0.903]	[0.888]	[0.771]	[0.088]*	[0.787]	[0.895]
$Q^2(12)$	26.428	23.652	23.265	29.221	24.468	26.128
	[0.890]	[0.951]	[0.953]	[0.781]	[0.937]	[0.899]
ARCH	10.256	10.606	16.182	10.433	14.022	11.355
LM	[0.912]	[0.808]	[0.599]	[0.901]	[0.644]	[0.789]

Note: *, **, and *** denote significant at 10%, 5%, and 1% significance level, respectively. The figures in the parenthesis (…) represent the z-statistics and the figures in the bracket […] represent the p-value.

Table 4 Bivariate BEKK-GARCH (1, 1) Estimation Result, During-Crisis Period

	IDR	KRW	MYR	SGD	THB	PHP
c_1	1.02e-05	1.65e-07	7.74e-07	7.40e-07	0.0002	0.0001
	(6.75)***	(3.10)***	(3.48)***	(2.57)***	(6.70)***	(12.91)***
a_{11}^2	0.0861	0.2577	0.2090	0.1115	0.9090	0.7531
	(6.58)***	(11.68)***	(8.42)***	(5.45)***	(11.86)***	(6.11)***
b_{11}^2	0.9217	0.8186	0.8323	0.8837	0.0137	0.0541
	(107.80)***	(76.78)***	(53.35)***	(42.88)***	(0.31)	(-0.95)
c_2	2.37e-05	1.94e-05	5.12e-06	2.83e-06	1.52e-05	1.15e-05
	(2.58)***	(2.08)**	(1.76)*	(1.31)	(2.34)**	(1.25)
a_{22}^2	0.0673	0.0452	0.0588	0.0396	0.0667	0.0349
	(2.41)**	(2.21)**	(4.37)***	(3.32)***	(3.48)***	(1.91)*
b_{22}^2	0.6170	0.6858	0.8715	0.9218	0.7202	0.8084
	(4.63)***	(4.81)***	(17.30)***	(23.75)***	(7.00)***	(5.84)***
c_3	4.39e-06	3.35e-09	1.52e-08	8.30e-07	1.81e-05	1.49e-05
	(0.96)	(0.00)	(0.03)	(2.44)**	(1.84)*	(1.84)*
a_{12}	0.0761	0.1079	0.1108	0.0665	0.2462	0.1622
	(4.40)***	(4.24)***	(7.74)***	(5.14)***	(6.88)***	(3.45)***
b_{12}	0.7541	0.7492	0.8517	0.9025	0.0994	-0.2092
	(9.23)***	(9.62)***	(33.92)***	(36.04)***	(0.62)	(-1.86)*
Q(12)	44.256	43.256	40.311	31.161	24.708	40.712
	[0.168]	[0.189]	[0.247]	[0.698]	[0.897]	[0.269]
$Q^2(12)$	24.128	23.652	23.265	34.323	23.444	36.238
	[0.935]	[0.951]	[0.943]	[0.544]	[0.977]	[0.458]
ARCH LM	13.671	11.351	10.518	11.738	16.024	11.081
	[0.822]	[0.970]	[0.992]	[0.932]	[0.593]	[0.922]

Note: *, **, and *** denote significant at 10%, 5%, and 1% significance level, respectively. The figures in the parenthesis (…) represent the z-statistics and the figures in the bracket […] represent the p-value.

Table 5 Bivariate BEKK-GARCH (1, 1) Estimation Result, Post-Crisis Period

	IDR	KRW	MYR	SGD	THB	PHP
c_1	1.57e-06 (18.04)***	7.79e-07 (7.92)***	7.37e-09 (38.94)***	2.87e-07 (5.62)***	2.11e-07 (7.51)***	5.13e-07 (13.218)***
a_{11}^2	0.1507 (23.66)***	0.0798 (6.68)***	0.1500 (20.43)***	0.0402 (8.53)***	0.0876 (17.41)***	0.3489 (19.92)***
b_{11}^2	0.8593 (195.06)***	0.8845 (100.39)***	0.6000 (58.05)***	0.9226 (140.95)***	0.9007 (181.32)***	0.6998 (81.78)***
c_2	6.66e-07 (9.44)***	7.07e-07 (6.68)***	7.19e-07 (7.07)***	5.05e-07 (6.13)***	6.12e-07 (7.10)***	6.30e-07 (9.70)***
a_{22}^2	0.0048 (2.73)***	0.0212 (5.75)***	0.0159 (4.44)***	0.0285 (7.61)***	0.0220 (6.85)***	0.0035 (2.15)**
b_{22}^2	0.9771 (417.56)***	0.9601 (200.64)***	0.9647 (211.59)***	0.9582 (221.12)***	0.0.9620 (256.25)***	0.9792 (458.52)***
c_3	1.19e-07 (1.31)	2.94e-07 (5.64)***	-4.66e-09 (-0.37)	2.70e-07 (7.64)***	2.43e-07 (7.41)***	-3.23e-08 (-0.56)
a_{12}	0.0269 (5.40)***	0.0411 (10.34)***	0.04897 (8.67)***	0.0338 (9.73)***	0.0439 (12.07)***	0.0350 (4.30)***
b_{12}	0.9163 (356.58)***	0.9216 (183.35)***	0.7608 (111.62)***	0.9402 (210.45)***	0.9308 (273.90)***	0.8278 (162.59)***
Q(12)	30.912 [0.810]	32.225 [0.746]	32.448 [0.684]	29.434 [0.832]	31.716 [0.769]	28.121 [0.898]
$Q^2(12)$	36.877 [0.598]	30.545 [0.823]	33.661 [0.660]	28.716 [0.878]	31.001 [0.819]	30.812 [0.821]
ARCH LM	13.526 [0.839]	10.875 [0.865]	9.152 [0.989]	10.999 [0.858]	14.904 [0.804]	11.225 [0.847]

Note: *, **, and *** denote significant at 10%, 5%, and 1% significance level, respectively. The figures in the parenthesis (…) represent the z-statistics and the figures in the bracket […] represent the p-value.

Furthermore, we have proceeded to compute the dynamic correlation coefficients based on the equation (8). Figure 1[xi] shows that only 3 out of 6 currencies showed a positive dynamic correlation with the Japanese yen (JPY) during the pre-crisis period, namely the Singaporean dollar (SGD), Malaysian Ringgit (MYR), and the Thai Baht (THB). Concerning the currencies' volatility, the Singaporean dollar has the highest correlation with the Japanese yen (between 0.4 and 0.6), followed by the Malaysian Ringgit (between 0.4) and the Thai Baht (constant at 0.4). However, the volatility of the Korean won (KRW), Indonesia rupiah (IDR), and the Philippines peso (PHP) are almost fluctuated around zero. This indicates that the pair of the testing currencies volatility (KRW, IDR, and PHP) with the Japanese Yen's volatility is super weak correlated during the pre-crisis period.

During the crisis period, all the currencies were affected by the first shock of the massive 1997 currency attack. Figure 2 shows that after the first shock, the volatility of the Singaporean dollar (SGD) and Malaysian ringgit (MYR) become increasingly correlated with the volatility of Japanese yen to a value of almost 0.8 at graph (c) and graph (b). However, the dynamic correlation coefficient for Thai baht volatility with Japanese yen volatility decreases from 0.4 during the pre-crisis period to 0.2 during the crisis period. Besides that, the graph (e) and graph (f) shows that the financial crisis influenced the Indonesia rupiah and the Philippines peso volatility to have a low positive dynamic correlation with the yen. The dynamic correlation for the Korean won still remained around zero in the Figure 2 graph (a). The divergence of Korean Won with the Yen correlation coefficient also implies that the free floating exchange rate regimes adopted by Korea during the crisis could not insulate its economy from external shocks such as the volatility of Japanese Yen (Kang et al, 2002). As an overall, the dynamic correlation coefficient demonstrates that the currency of Singapore and Malaysia still remains as a *de facto* synchronicity with Japanese Yen before and during the crisis. Such differences in volatility or lower dynamic correlation between ASEAN currencies with Japanese Yen has suggested that those countries' economy should be more open in order to increase their share of intra-trade and capital flow with Japan (Oxana et. al 2008).

After the crisis period, only the volatility of the Singaporean dollar, Thai baht, and Korean won were positively correlated with yen volatility (Figure 3). During the post crisis period, Singapore dollar still represents the highest correlation with Japanese Yen as the dynamic correlation coefficient is up until 0.8 (Figure 3, graph (c)). During the 2007/08, the loose Yen correlation coefficient on Singapore's exchange rate regimes indicates that the impacts of Subprime Crisis spreading out from US actually do affect Singapore and Japan monetary policy. Moreover, the Figure 3 graph (a) shows that the correlation of Korean currency shocks are respectively increase with the Japan currency regimes during 1999 to 2005, in which the dynamic correlation coefficient has increased from 0.01 to 0.6. In Figure 3, the graph (d) was showed that Thailand experienced an increasing dynamic correlation coefficient from 0.2 increases until to 0.6. This indicates that the Thai Baht have shows a synchronicity pattern with Japan currency shocks during the post crisis. However, the down trend of Korean Won and Thai Baht with response to the correlation coefficient of Yen have suggested that (i) Korea and Thailand should increase their degree of openness, higher share of trade, capital flows, etc. with Japan, and (ii) Japanese yen should be used as a reference on exchange rate policy for both Korea and Thailand in order to prevent sharp fluctuations of the Korean Won and Thai Baht which were not related to the macroeconomic fundamentals such as regional economic growth (CBRF, 2004 and Oxana et al, 2008). The Singaporean dollar and Thai baht dynamic correlation showed an increasing trend of almost 0.75. However, the volatility of the Indonesian rupiah and the Philippines peso returned to fluctuate around zero during the pre-crisis period. Nonetheless, the volatility of the Malaysian ringgit (RM) was constantly at zero during the peg exchange rate system and followed a decreasing trend of dynamic correlation after the end of the pegging system. Thus, the feasibility of "Yen block" on Malaysia is still remains under observation. However, Rupiah keeps weak correlation with Japanese Yen (0.05 – 0.15), and the volatility of Peso also fail to show strong evidences on the Yen convergence.

In conclusion, the Singaporean dollar was strongly synchronized with the Japanese yen from the pre-crisis period until the post crisis period. So, Singapore seems ready to adopt the yen as an Asian currency unit. However, Thailand and Korea can be reviewed as potential countries to adopt the yen as an Asian currency unit in the future, because the results show that these two countries are positively correlated with the yen although not as strong as Singapore correlation with Japan. The other low dynamic correlation currencies implied that an increase in intra-regional trade with Japan is crucial for Malaysia, Thailand and the Philippines.

Summary and Conclusions:

The forming of AMU may seem becoming a political agenda for the Asian region, however, the economic equation parts does not changed by the political criteria. Karras (2005) claimed that the decision on adopting the Japanese yen will benefit or harm a country's economy depends on the economic criteria only. Therefore, this study aims to investigate whether ASEAN-5 and the Korean currency regimes are ready to use Japanese Yen as their AERM. Using the bivariate Baba-Engle-Kraft-Kroner GARCH (BEKK-GARCH) approach proposed by Engle and Kroner (1995), we estimate a time-varying correlation coefficient for the ASEAN-5 currencies, Korean Won, and Japanese Yen. The empirical results show that the full-fledged AMU members (the entire ASEAN-5 and Korea) are not yet ready to adopt the yen as an Asian currency unit. Instead, what appears to be more feasible initially is the formation of smaller sub-groupings within the region. For example, Singapore, Korea and Thailand as potential candidates and ready to adopt the yen as a first group of AMU, since this sub-grouping is close in trade and highly synchronized in exchange rate regimes with Japan. This indicates that the previous trade agreement introduced for the Asian free trade area development such as ASEAN-10+3, EAFTA, CEPEA, FTAAP, and CAFTA only promoted the Asian region trade liberalization than financial liberalization. Hence, the empirical results suggested that low dynamic correlation countries (Malaysia, Indonesia, and the Philippines) perhaps can increase their intra-regional trade with commonly accept the yen as an intra-regional trade invoice currency as Americas region. Increasing used of yen in the Asian region will assist to promote the region's degree of trade integration as well as a synchronization of the regional currency regime.

Figure 1: Dynamic Correlation Coefficient Based on Bivariate GARCH models During the Pre-Crisis Period.

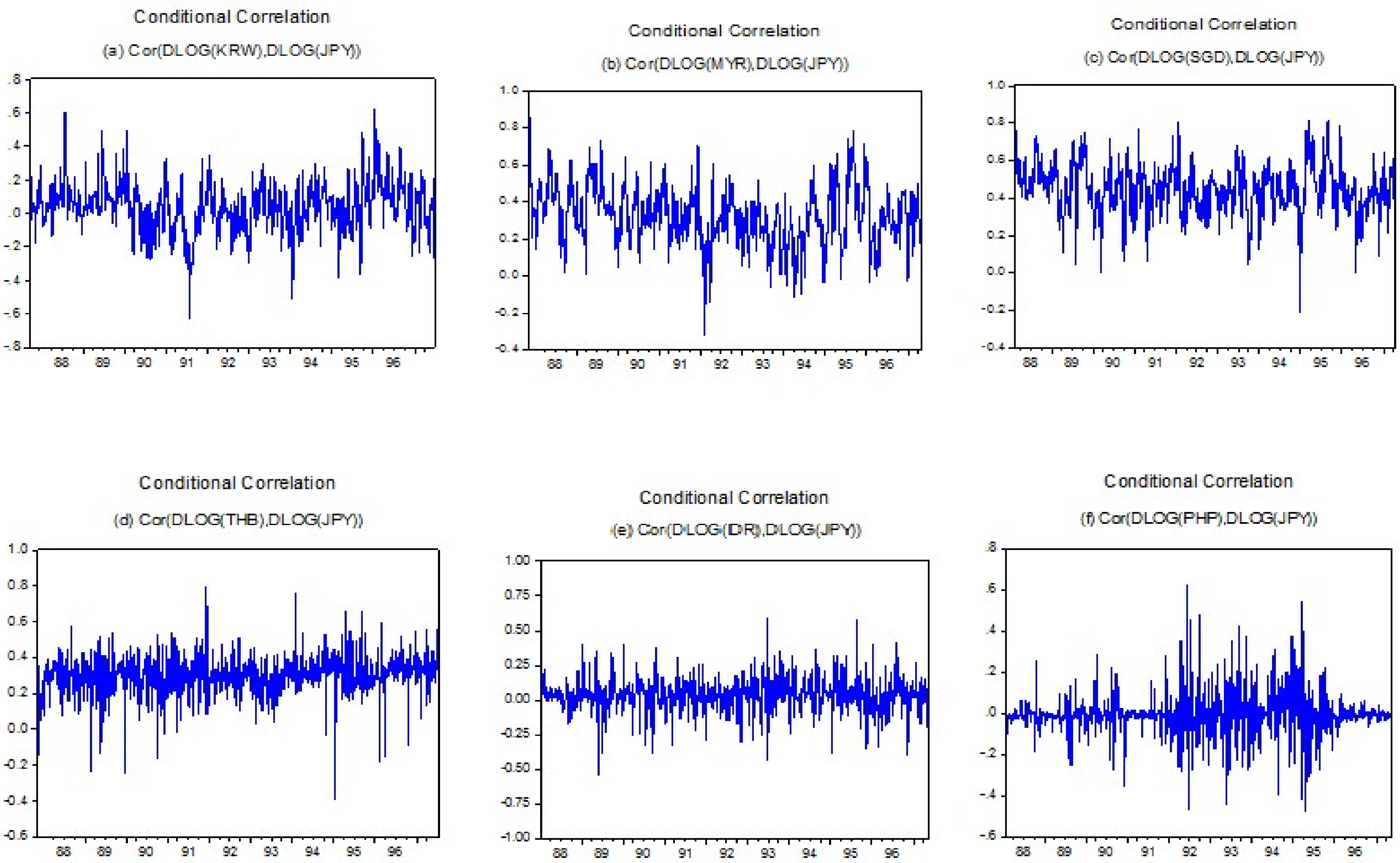


Figure 2: Dynamic Correlation Coefficient Based on Bivariate GARCH models During the Crisis Period.

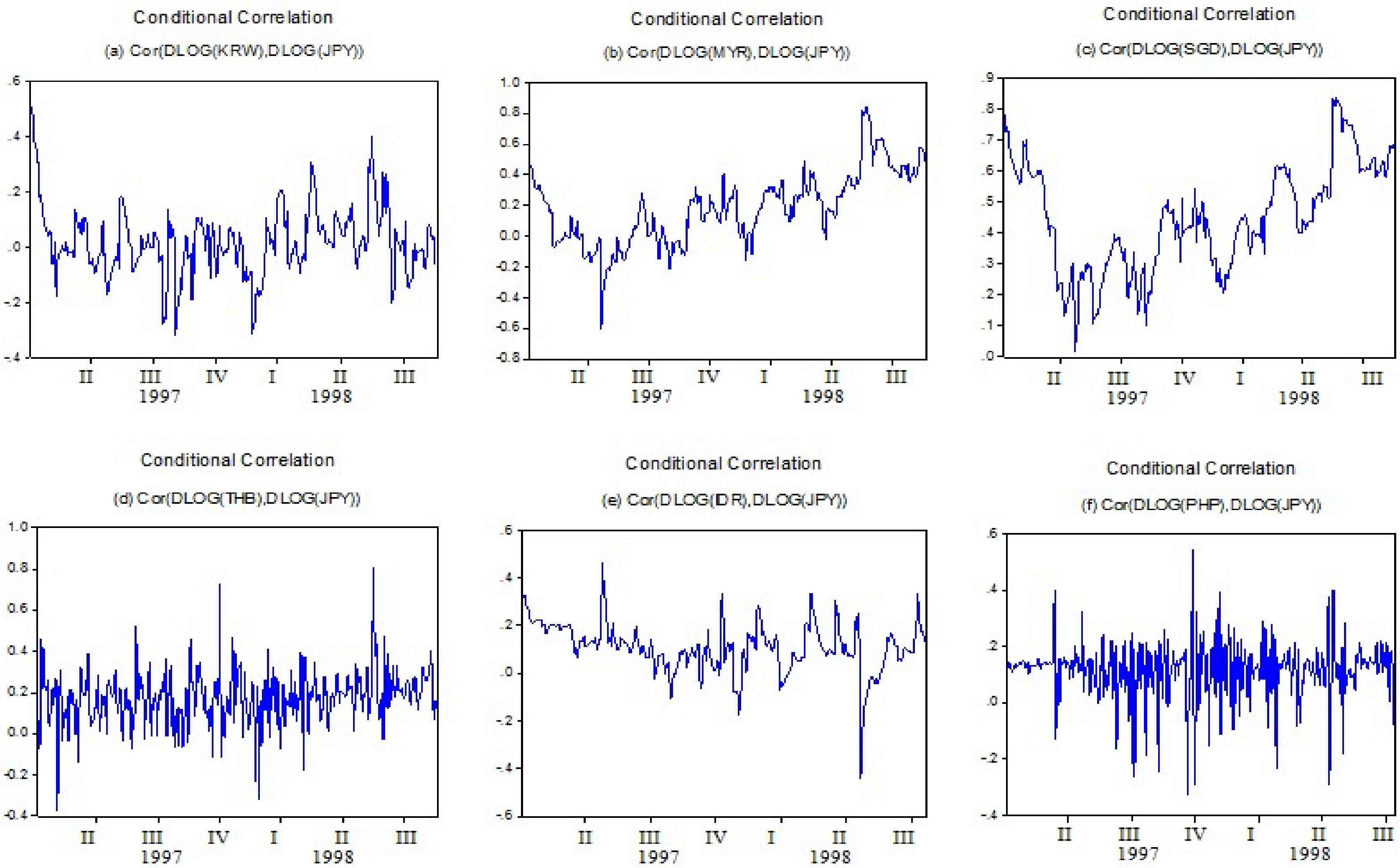
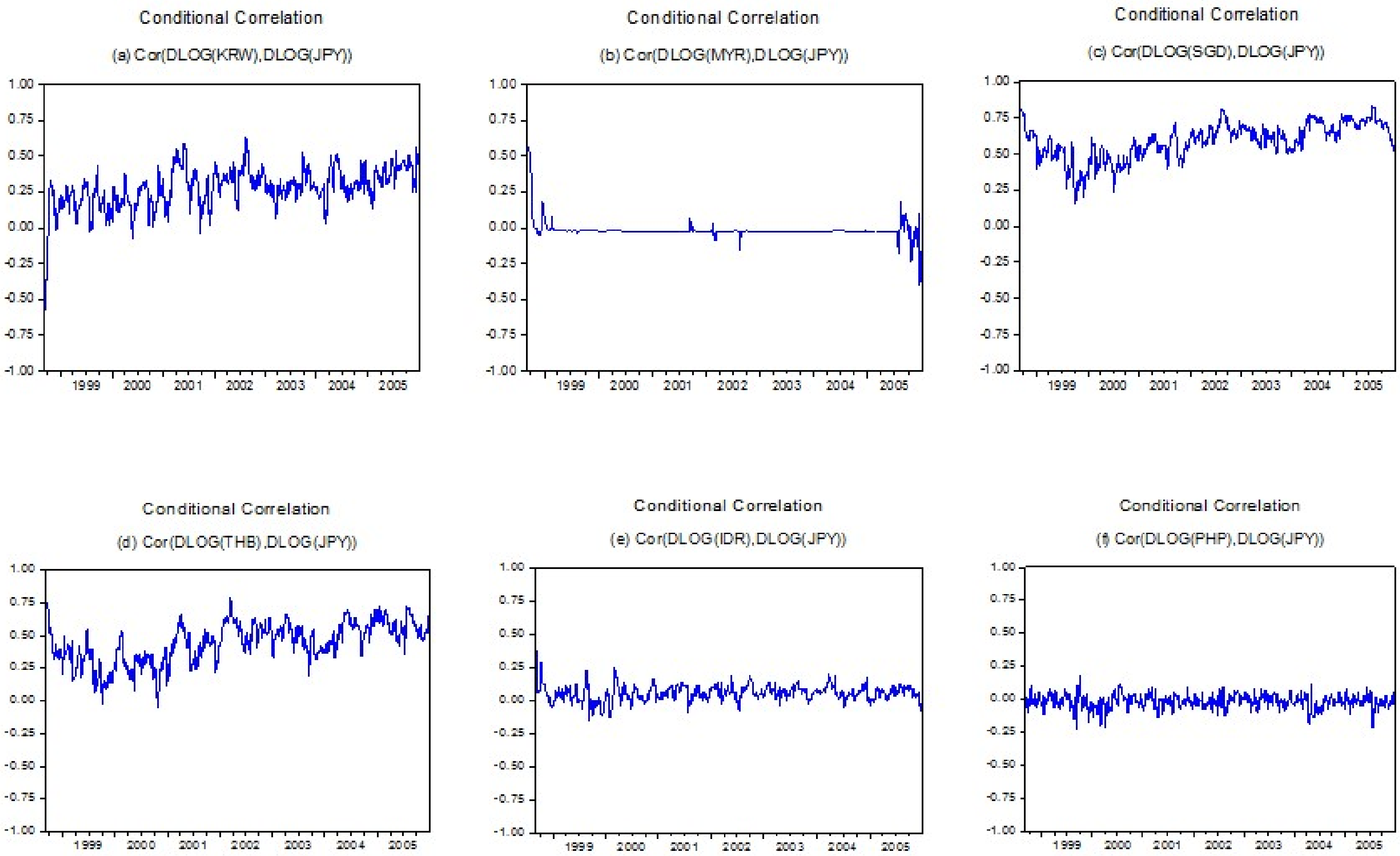


Figure 3: Dynamic Correlation Coefficient Based on Bivariate GARCH models During the Post-Crisis Period.



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[i] John Williamson (2005) defined a parallel currency as a currency that, as the name would suggest, circulates in parallel to the national currency and is also officially endorsed in some way.
[ii] According to Mundell (2003), the large currency areas are more stable because adjustment is in an inverse proportion to monetary mass.
[iii] See Becker, (2008).
[iv] According to Becker (2008), the average 12 months inflation rates up until June 2008 for ASEAN-5+3 countries are 7.4% (Indonesia), 2.3% (Malaysia), 4.7% (the Philippines), 5.0% (Singapore), 3.9% (Thailand), 7.1% (China), 3.4% (South Korea), and 0.6% (Japan), respectively.
[v] According to Lee C. and M. Azali (2010), the analysis of data was separated into 2 different crisis periods because of the 1997–1998 Asian crisis stands out as one prominent event that will likely have strong impact on the currency co-movements.
[vi] According to M. Azali et al, (2009), the crisis period was considered starting from massive attack on the Thai Baht on 14th May 1997 and ended on 31st August 1998; however, Malaysia pegged their exchange rate with US dollar on 1st September 1998.
[vii] According to Pagan and Schwert (1990) and Pagan (1996), the GARCH models perform well in comparison with alternative methods for modeling conditional volatility, except for a possible asymmetric leverage effect, a GARCH (1, 1) is enough to account for the volatility dynamics of most financial time series.
[viii] In this study, the national currency refers to the Singapore Dollar (SGD), Malaysian Ringgit (MYR), Thai Baht (THB), Indonesian Rupiah (IDR), Korean Won (KRW), and the Philippines Peso (PHP), respectively.
[ix] This method also re-used by Oxana, et al. (2008) to calculate the dynamic correlation of 4 central European states (CE-4) exchange rate with the Euro and to examine the closeness of the CE-4 countries to the EMU.

[x] *De facto* is a Latin expression that means "concerning the fact" or in practice but not necessarily ordained by law.

[xi] The y-axis for the graphs in Figure 1, 2, and 3 are denoted as correlation coefficient for the respective currencies. Graph (a) shows the dynamic correlation between Korean Won (KRW) and Japanese Yen (JPY). In addition, the pairs of dynamic correlation coefficient for Malaysian Ringgit (MYR) and JPY, Singapore Dollar (SGD) and JPY, Thai Baht (THB) and JPY, Indonesia Rupiah (IDR) and JPY, as well as the Philippines Peso (PHP) and JPY are shown in graph (b), (c), (d), (e), and (f), respectively.