Jurnal Ekonomi Malaysia 52(1) 2018 57 - 66
http://dx.doi.org/10.17576/JEM-2018-5201-5

Dynamic Interdependence of the Indonesian Rupiah with the ASEAN and the World Largest Forex Markets

(Kebergantungan Dinamik Matawang Rupiah dengan ASEAN dan Pasar Wang Terbesar Dunia)

M. Shabri Abd. Majid
Hizir Sofyan
Moh. Rizky Rahmanda
Syiah Kuala University

ABSTRACT

This study empirically investigates the dynamic interdependencies of the Indonesian Rupiah (IDR) with the ASEAN, European, and Japanese forex markets. Using daily nominal exchange rates of Indonesia, Thailand, Malaysia, Singapore, the Philippines, Europe, and Japan spanning from January 1, 2008 to December 31, 2015, the study employs the impulse response functions and variance decomposition analysis based on the vector autoregression method. The study documented that the IDR more responded to innovations in the forex market of Singapore as compared to other ASEAN forex markets. Additionally, the ASEAN forex markets were more interdependence with the forex markets of Japan rather than Europe. Since the forex markets become more interdependent both regionally and internationally, thus it needs for policy coordination among the countries to mitigate the impact of forex fluctuations if these countries are to grasp the benefits of greater forex markets' interdependence.

Keywords: Dynamic interdependence; forex markets; vector autoregression; forex stability; ASEAN

ABSTRACT

Penelitian ini mengkaji secara empirikal kebergantungan dinamik matawang Rupiah Indonesia dengan pasar wang ASEAN, Eropah, dan Jepun. Dengan menggunakan data matawang nominal harian Rupiah Indonesia, Bath Thailand, Ringgit Malaysia, Dolar Singapura, Peso Filipina, Euro Eropah, dan Yen Jepun selama period 1 Januari 2008 sampai dengan 31 Disember 2015, penelitian ini menganalisis data dengan model impulse response functions dan variance decomposition berbasis model vector autoregression. Penelitian ini menemukan bahawa Rupiah Indonesia lebih bergantung pada Dolar Singapura berbanding matawang negara ASEAN lainnya. Tambahan pula, pasar wang ASEAN lebih bergantung pada pasar wang Jepun berbanding Eropah. Kerana pasar wang semakin bergantung antar negara, samada secara kawasan mahupun antarbangsa, maka diperlukan koordinasi dasar ekonomi antar negara untuk mengurangi impak perubahan pasar wang dan sekaligus mendapatkan keuntungan daripada kebergantungan pasar wang yang semakin kuat.

Kata kunci: Kebergantungan dinamik; pasar wang; vector autoregression; stabiliti pasar wang; ASEAN

INTRODUCTION

The issue of dynamic interdependence among forex markets has become an important topic in the modern literature of international financial economics. Many empirical studies have empirically explored the dynamic causalities across forex markets worldwide using different types of statistical tests. For instance, the correlation coefficient analysis (Baig & Goldfajn 1998), the cointegration method (Baillie & Bollerslev 1989; Caporale et al. 2005; Nieh & Lee 2002; and Park & Song 2001; Reside & Gochoco-Bautista 1999), Granger causality (Khalid & Kawai 2003; Sander & Kleimeier 2003), and error correction model (Reside & Gochoco-Bautista 1999) have been used to empirically examine the dynamic co-movements among the forex markets. Of those methods, cointegration was documented to be the most widely technique adopted to explore the long-run relationships of the forex markets. Studies on the Asian currencies have been conducted by Aggarwal and Mougoue (1996) and Tse and Ng (1997). In their study, Aggarwal and Mougoue (1996) empirically assessed the relative influence of the Japanese yen and the US dollar on the Asian currencies and documented that these two most developed economies' currencies shared a long-run relationships with those of the Asian currencies. Similarly, Tse and Ng (1997) also found a long-run equilibrium among the currencies of Japan, Singapore, the Philippines, Malaysia, and Thailand.

In the context of ASEAN (Association of Southeast Asian Countries) markets, Sarmidi (2010), Gharleghi et al. (2014), and Kogid et al. (2015) have adopted different

empirical models to forecast and explore the dynamic interactions between the currencies of the markets. In his study, Sarmidi (2010) predicted the currencies of Malaysia, Indonesia, Thailand, the Philippines, Chile, Uruguay, Morocco, South Africa, and Tunisia using bootstrap technique over the period 1984-2005. Overall, the study found that the predictability of the Malaysian ringgit was very sensitive to selected currencies, forecasted horizons, and macroeconomic models. Gharleghi et al. (2014) modelled and forecasted currencies of Indonesia, Malaysia, and Thailand using the threshold model over the period January 1985 - September 2010. The study found that the self-exciting threshold autoregressive - exponential generalised autoregressive conditional heteroscedasticity (SETAR-EGARCH) model predicted better the currencies than the Autoregressive Integrated Moving Average (ARIMA) and the ARIMA-EGARCH model. Finally, Kogid et al. (2015) explored the dynamic interaction between the currencies of the ASEAN-5 (i.e., Malaysia, Indonesia, Singapore, Thailand, and the Philippines) using the mean generalised autoregressive conditional heteroscedasticity (MGARCH) based on the Baba-Engle-Kraft-Kroner (BEKK) approach during the period 1994-2012. The study documented that currency markets of Thailand, the Philippines, and especially Indonesia were more volatile. During the Asian and global economic crises, the markets were found to be positively and highly correlated, while the markets of Thailand and Singapore were positively and highly correlated even in non-crisis periods. Overall, the study also documented that the markets moving towards a higher correlation over the post-global financial crisis period.

Unlike many earlier studies investigated the relationships between currencies of the developed and emerging markets of Asia, similar study focusing on the currency of Indonesia and their interdependencies with other ASEAN and the developed forex markets of Japan and Europe has been meagre. This present study extends the existing empirical literature to address the question as the extent to which the forex market of Indonesia is dynamically interdependent with the currencies of ASEAN (i.e., Malaysia, Thailand, the Philippines, and Singapore), and developed economies of Europe and Japan. Thus, few areas of novelty could be offered by the present study comprising the following aspects. Firstly, Aggarwal and Mougoue (1996) did not include Indonesian Rupiah (IDR) when examined relationships between the forex markets of Asia and the US, while this study incorporates the IDR in its analysis. Secondly, apart from investigating the dynamic interdependencies among the five ASEAN forex markets (i.e., Indonesia, Malaysia, Thailand, the Philippines, and Thailand), this study also included the Japanese yen and the European euro in its analysis. Finally, this study used the recent data period of daily exchange rates of the ASEAN, Europe, and Japan spanning from January 1, 2008 to December 31, 2015.

Comparing to the enormous growing of the Indonesian economy, studies on the dynamic interdependencies of the IDR with other emerging ASEAN and developed forex markets of Europe and Japan has been limited. While identifying the dynamic co-movements of the exchange rate would provide important insights into the dynamic transmission mechanism of the changes in one currency and its effect to the other currencies, thus it enables the policy makers to design proper strategy to stabilise the forex markets. Figure 1 portrays the co-movement of the ASEAN currencies against the most developed forex markets of the US, Europe and Japan in a unit of the IDR.

The ASEAN currencies, particularly the IDR has fluctuated across the years, and its volatilities have even amplified after the 2008 global financial crisis. During the 2008 financial crisis, the IDR has weakened from

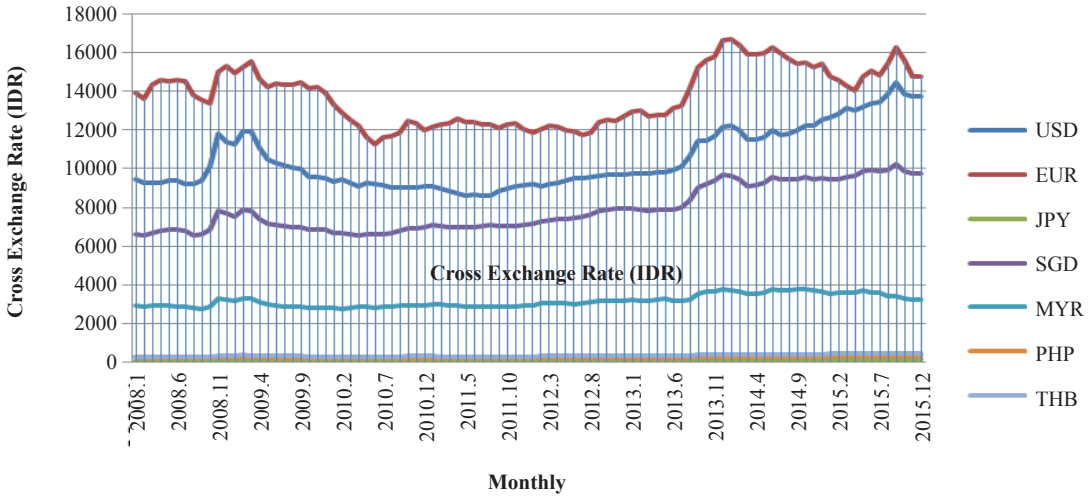

FIGURE 1. Movement of Foreign Currencies against the IDR

IDR10,048 per the US dollar in October, 2008 to IDR11,711 in a month later and its has depreciated to its lowest level of IDR14,802 per dollar in the end of September (Secretariat of the Republic of Indonesia 2009). Over the period 2014 to 2015, the weakening of the IDR against the US dollar becomes a real problem for Indonesia, which caused the Indonesia's economic growth to slow down from 5.41% to 4.71%. More than 43.085 workers have been retrenched and caused the imported food prices to increase by 0.54% from 2014 to 2015. Depreciations of the European euro (EUR) and Japanese yen (JPY) in the whole year 2014 by 13% and 12% respectively have caused the IDR to fluctuate (Bank Indonesia, 2014). Thus, this indicates that the fluctuations in the foreign currencies have been recognised as one of pivotal factors contributing to changes in other national currencies.

Motivated by the recent developments in the ASEAN forex markets as well as the drive to fill the gap in the literature by providing the empirical evidence on dynamic co-movement of the forex markets, this study attempts to arrive at empirical evidences on the Indonesian forex market's interdependence with those of ASEAN emerging and developed forex markets of the Europe and Japan. Thus, the findings of this study are expected to shed some lights on the importance of the foreign currencies' movements and their impacts to the national currency of Indonesia, as it provides numerous policy implications for businesses, government, and economy as a whole. As for businesses, predicting the movements of exchange rates would be beneficial to determine their strategies whether to arbitrage their monies locally or internationally. Having identified the nature of interdependencies between national and forex markets, the policy makers could design proper economic policies to stabilise its currency and, in turns, promote economic growth.

The rest of the paper is outlined into three following sections: Section 2 highlights the estimation technique and data; Section 3 discusses the estimation results; and finally, Section 4 concludes the study.

DATA AND METHODOLOGY

DATA

Daily nominal exchange rates of the five ASEAN forex markets [i.e., the Indonesian Rupiah (IDR), Malaysian Ringgit (MYR), the Philippine Peso (PHP), Singaporean Dollar (SGD), and Thai Baht (THB)], and the developed forex markets of Japanese Yen (JPY), and the European Euro (EUR) spanning from January 1, 2008 to December 31, 2015 were utilised. These data were gathered from the official websites of the Indonesian Central Bank, Bank Indonesia (http://www.bi.go.id). All currencies were transformed into the natural logarithmic form. The cross-rate currency of the respective foreign currencies towards the US dollar (USD) was calculated. The use of nominal exchange rates instead of the effective exchange rates in this study is simply due to its advantages that the data are easily obtainable and the findings could be compared with the previous studies in the literature (Aggarwal & Mougoue, 1996; Tse & Ng, 1997; AuYong et al. 2004).

METHODOLOGY

Based on the vector autoregression (VAR) framework, this study estimates the following empirical models:

$$\Delta IDR_{1t} = \alpha_{10} + \sum_{i=1}^{k} \alpha_{11}\Delta IDR_{1t-i} + \sum_{i=1}^{k} \alpha_{12}\Delta ASEAN_{2t-i} + \sum_{i=1}^{k} \alpha_{13}\Delta JPY_{3t-i} + \sum_{i=1}^{k} \alpha_{14}\Delta EUR_{4t-i} + \varepsilon_{1it} \quad (1)$$

$$\Delta ASEAN_{2t} = \alpha_{20} + \sum_{i=1}^{k} \alpha_{21}\Delta ASEAN_{1t-i} + \sum_{i=1}^{k} \alpha_{22}\Delta IDR_{2t-i} + \sum_{i=1}^{k} \alpha_{23}\Delta JPY_{3t-i} + \sum_{i=1}^{k} \alpha_{24}\Delta EUR_{4t-i} + \varepsilon_{2it} + \quad (2)$$

$$\Delta JPY_{3t} = \alpha_{30} + \sum_{i=1}^{k} \alpha_{31}\Delta JPY_{1t-i} + \sum_{i=1}^{k} \alpha_{32}\Delta IDR_{2t-i} + \sum_{i=1}^{k} \alpha_{33}\Delta ASEAN_{3t-i} + \sum_{i=1}^{k} \alpha_{34}\Delta EUR_{4t-i} + \varepsilon_{3it} \quad (3)$$

$$\Delta EUR_{4t} = \alpha_{40} + \sum_{i=1}^{k} \alpha_{41}\Delta EUR_{1t-i} + \sum_{i=1}^{k} \alpha_{42}\Delta IDR_{2t-i} + \sum_{i=1}^{k} \alpha_{43}\Delta ASEAN_{3t-i} + \sum_{i=1}^{k} \alpha_{44}\Delta JPY_{4t-i} + \varepsilon_{4it} \quad (4)$$

where the IDR is the Indonesian Rupiah, ASEAN is the other forex markets of ASEAN, consisting of the Malaysian Ringgit (MYR), Thai Baht (THB), the Philippine Peso (PHP), and Singaporean Dollar (SGD), respectively; JPY is the Japanese Yen; and EUR is the European Euro (EUR).

Since the Equations (1) to (4) incorporate lags, thus the lag length for all the models is selected based on the Akaike Information Criteria (AIC) (Akaike 1969). As in a time series empirical model, the study undertakes the necessary pre-testing to determine the stationary properties of the data series using a widely unit root test of the standard Augmented Dickey Fuller (ADF).

STATIONARY TEST

Due to the non-stationarity of macroeconomic variables (Serletis 1993), the unit root test would be conducted first in the study for the purpose of ensuring all variables are stationary, thus it might not lead to spurious regression. Findings from regression analysis become invalid when it is applied to non-stationary variables (Thomas 1997). Basically, stationary indicates that the mean, variance, and covariance of variables are constant over time. To test for the stationarity, this study adopts the standard ADF (Dickey & Fuller 1979; 1981) as follows:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \gamma_i \sum_{i=1}^{m} \Delta y_{i-1} + \varepsilon_i \quad (5)$$

where Δy_t is the first difference of y, β_1 is the intercept, β_2 is the estimated coefficient for a trend, δ is the estimated coefficient for lagged y, γ is the estimated coefficient for difference of the lagged y, ε is the error term, m is number of lag, and t is the time period. In testing the stationarity, if the null hypothesis (H_0: $\delta = 0$) of unit root is rejected, thus the variables are identified to be stationary, and vice versa.

IMPULSE RESPONSE FUNCTIONS (IRFS)

In this study, the VAR models are estimated to generate Impulse Response Functions (IRFs) with the purpose of exploring the interdependence of the IDR with the other forex markets of ASEAN, the UK, and Japan. The IRFs measure the time profile of the effect of shocks at a given point in time on the (expected) future values of variables in a dynamic system (Pesaran & Shin 1998). This approach is well suited because not only that it allows for the relative strength of the various shocks to be quantified in terms of their contributions to variations in a particular variable of interest, but it also enables the pattern and direction of the transmission of shocks to be explored.

Additionally, the uses of IRFs could capture the innovation in an exchange rate due to its contemporaneous correlation to other exchange rates. This implies that shocks in one forex market might be caused by its contemporaneous correlation with innovations in other forex markets. If isolated shocks to individual forex market could not be recognized due to contemporaneous correlation, the responses of a forex market to innovations in other forex markets would not be satisfactorily represented (Lutkepohl 2005). The most effective approach to solve this problem of identification is to utilize Sims' (1980) empirical strategy by orthogonalizing the innovations using the Cholesky factorization. However, this approach necessitates a pre-specified order of causalities among the exchange rates that turn out to be its main drawback. This is due to sensitiveness of the IRFs' estimates to the ordering of the forex markets, especially when the error terms in the VAR model are highly contemporaneously correlated. Thus, this study employs the generalized IRFs developed by Pesaran and Shin (1998) to overcome these shortcomings. The uses of the generalized IRFs would completely capture the different shocks of historical correlation patterns (Pesaran & Shin 1998). Consequently, they are distinctive and invariant to alternative orderings of the forex markets. Additionally, the generalized IRFs enables to measure initial impact response of a forex market to various shocks due to its non- orthogonalization of the error structure. This makes the generalized IRFs to be predominantly and practically useful to study forex markets that are highly characterized by fast transmissions and adjustments among the forex markets (Ewing et al. 2003).

VARIANCE DECOMPOSITIONS (VDCS)

After analysing the IRFs, the Variance Decompositions (VDCs) is further tested to explore the relative importance of random shock in a forex market to the other forex markets in the model. The VDCs which is termed as an out-of-sample causality tests, provides an indication of the dynamic properties of the system by partitioning the variance of forecast error of a certain variable into proportions attributable to innovations (or shocks) in each forex market in the system including its own. In other words, the VDCs provides a literal breakdown of the change in the value of the forex market in a given period arising from changes in the same forex market in addition to others in previous periods. According to Sims (1986), a variable optimally forecast from its own lagged values will have all its forecast error variance accounted for by its own disturbances. It is generally observed that in applied research, it is typical for a variance to explain almost all its forecast error variance at short horizons and smaller proportions at longer horizons.

RESULTS AND DISCUSSION

Prior to the 1997 East Asian economic turmoil, the Indonesian Rupiah (IDR) was relatively stable. It has becoming more volatile recently, particularly during the post- 1997 and 2008 economic crises. The presence of these economic crises has hit the IDR to its lowest level in the history. The IDR has depreciated by 68.76% from IDR2,275 during the 1997 economic turmoil. Although the IDR has recovered from the 1997 economic crisis few years later, but during the 2008 global financial crisis which started in the US, which then has adversely impacted the world economy, the IDR has depreciated by 37.31% from IDR10,098,5 per USD during the period 2008-2015 (Bank Indonesia 2016). The episodes of the IDR depreciation was intimately related to changes in other economies and the movements of their exchange rates, as the world economy has moving towards a more globalised and integrated.

Due to higher volatilities of the IDR compared to other foreign exchange rates, transactions of the IDR have decreased lately. Bank Indonesia (2016) reported that the IDR was the lowest transacted currencies in the ASEAN markets amounting to only USD5 trillion daily at the end of 2015. Meanwhile, the transactions of Thai Baht (THB) and Malaysian Ringgit (MYR) have reached USD12 trillion daily. These facts provided evidences that the IDR was the lowest demanded currencies among the ASEAN countries.

Table 1 reports the descriptive statistics of the exchange rates of Indonesia, ASEAN, Japan, and the Europe over the period 2008 to 2015. On the average, the IDR against the USD was IDR10,398.236 with maximum value of IDR14,468, minimum value of IDR8,574.790 and standard deviation of IDR1,548.111. The mean value of

TABLE 1. Descriptive Statistics of the Forex Rates against the US Dollar

Currency	IDR	MYR	PHP	SGD	THB	JPY	EUR
Mean	10,398.236	3.308	44.334	1.328	32.250	95.785	0.756
Minimum	8,574.790	2.984	39.121	1.209	29.047	76.716	0.634
Maximum	14,468.000	4.310	49.180	1.530	36.003	123.671	0.930
Median	9,693.940	3.223	44.147	1.297	32.309	94.850	0.750
Kurtosis	–0.469	3.263	–0.427	–0.787	–0.586	–0.698	0.760
Skewness	0.862	1.658	0.168	0.573	0.391	0.438	0.810
Std. Dev.	1,548.111	0.281	2.159	0.084	1.692	13.517	0.066
J-B test	19.676*** (0.021)	17.745** (0.013)	18.976** (0.019)	8.798** (0.019)	16.986** (0.037)	3.456*** (0.005)	3.671*** (0.008)

Note: *** and **indicate significance at the 1% and 5% levels, respectively. J-B is the Jarque-Bera test for normality. The figures in parentheses show the *p*-values for the tests against the null hypothesis of a normal distribution.

cross rates of other foreign currencies was MYR3.308, PHP44.334, SGD1.328, THB32.250, JPY95.785, and EUR0.756. In terms of volatility, comparing to other currencies in the region, the IDR was documented to be the most volatile currency in the region, as shown by the largest value of standard deviation of IDR1,548.111, followed by the Japan (JPY13.517), the Philippines (PHP2.159), Thailand (THB1.692), Malaysia (MYR0.281), Singapore (SGD0.084), and Europe (EUR0.066). The higher volatility of the IDR compared to other ASEAN currencies is in harmony with the finding by Kogid et al. (2015) who documented that currency markets of Indonesia was the highest volatile over the other ASEAN currencies during the period 1994-2012. Finally, the Jarque-Bera test indicates that all investigated exchange rates are normally distributed at least at the 5% level of significance.

CORRELATION COEFFICIENTS

Before testing the stationarity of the variables as the basis for determining model specification, the correlation between the currencies was firstly tested. Table 2 reports the correlation coefficients between the IDR and other foreign exchange rates.

As observed from Table 2, comparing to other ASEAN forex markets, the IDR was found to be highly correlated to the MYR with coefficient of correlation of 0.771, while the lowest correlated forex markets with the coefficient of correlation of 0.235 was found between the IDR and SGD. These findings showed that changes in the IDR were very much related positively to the changes in the MYR, and vice versa. This could be due to Malaysia has been the major trading partners of Indonesia, and the largest foreign workers in Malaysia was from Indonesia. This further indicated that geographically and economically close markets in a region would not necessarily result in high correlated forex markets. The patterns of international trade were more important in understanding how forex markets interrelated, where the changes in a forex market affect clusters of countries tied together by international trade (Glick & Rose 1999; Karim & Majid 2009).

As for the correlation between the forex markets of ASEAN and the developed countries of Europe and Japan, the IDR and other ASEAN forex markets were found to have the highest correlated to the JPY with the coefficient of correlation ranging from 0.287 to 0.818, as compared to the EUR with the coefficient of correlation spanning from 0.157 to 0.707. The IDR was documented to be the highest correlated, while the PHP was documented to be the lowest correlated to both developed forex markets of Japan and Europe, the findings consistent with the study by Kim et al. (2013). These findings showed that the changes in forex markets of developed markets would transmitted to the other national forex markets, as the international markets has been becoming more integrated (Aggarwal & Mougoue 1993). The movements of the

TABLE 2. Coefficients of the Correlation between the Forex Markets

Currency	IDR	MYR	PHP	SGD	THB	JPY	EUR
IDR	1.000	-	-	-	-	-	-
MYR	0.771***	1.000	-	-	-	-	-
PHP	0.362***	0.670***	1.000	-	-	-	-
SGD	0.235***	0.661***	0.781***	1.000	-	-	-
THB	0.593***	0.857***	0.845***	0.803***	1.000	-	-
JPY	0.818***	0.709***	0.287***	0.346***	0.543**	1.000	-
EUR	0.707***	0.595***	0.157***	0.172**	0.291**	0.477***	1.000

Note: *** and **indicate significance at the 1% and 5% levels, respectively.

TABLE 3. Augmented Dickey Fuller Test for Stationarity

Variable	I(0)	Remarks	I(1)	Remarks
IDR	0.852	Non-stationary	0.012***	Stationary
MYR	0.991	Non-stationary	0.014***	Stationary
PHP	0.473	Non-stationary	0.015***	Stationary
SGD	0.955	Non-stationary	0.011***	Stationary
THB	0.827	Non-stationary	0.016***	Stationary
JPY	0.785	Non-stationary	0.019***	Stationary
EUR	0.432	Non-stationary	0.013***	Stationary

Note: *** indicates significance at the 1% level.

ASEAN forex markets positively related to the world forex markets. However, to accurately measure the extent to which the changes in one currency affecting the changes in other currencies, the study would estimate the Impulse Response Functions (IRFs) and Variance Decompositions (VDCs), where their findings would be reported in the next section.

STATIONARY TESTS

To arrive at the robust finding, all estimated variables should be in the form of stationary. Table 3 provides the findings from the stationary test based on the Augmented Dickey Fuller (ADF) framework. The cross rates of all currencies against the USD were found to be non-stationary at the level, while it become stationary after taking the first difference.

Confirming that all currencies were having the same order of integration, thus, in the case of anticipating cointegration among forex markets, the study would consider applying the VECM approach instead of VAR. As for the analyses of the IRFs and VDCs, the study utilizes the variables in the first different. The findings for these analyses would be reported in the next section.

IMPULSE RESPONSE FUNCTIONS (IRFS)

The IRFs allow for the analysis of the IDR interdependence with other ASEAN emerging and developed forex markets. Figure 2 portrays the responses of the IDR to innovations in the other forex markets over the 30-day horizon. In order to provide some idea of certainty surrounding the estimated responses based on Sims and Zha (1998), one SD of confidence bands have been obtained by Monte Carlo simulation methods with 1,000 replications.

As observed from Figure 2, the results of the IRFs show that the IDR was found to be more sensitive to the innovations in the JPY as compared to the innovations in the European forex markets. This is indicated by its significant responses to the innovations during the period of observation. During the study period, the IDR responds significantly and negatively to the shocks in the developed forex markets, reflecting the interdependence of the IDR to changes in the developed forex markets. However, the innovations in the JPY has a longer impact up to more than 30-day period on the IDR as compared to the innovations in the EUR which only impacted the IDR for only 30-day period. This finding is simply due to the closed trading connection between the ASEAN and Japan's economy (Waltz 1993). Of 159 trillion yen trading value of Japan in 2014, ASEAN was the second largest trading partner after China (Japan's Ministry of Finance 2015) and the trends of Japan's foreign direct investment into the ASEAN markets keeps increasingly over the last decades (Bank of Japan 2015). This findings also supported by Majid et al. (2008) who found that the ASEAN markets have become more interdependence in recent years due to their financial deregulation and external capital control relaxation. Additionally, these findings also reflect the Japan's persistent dominant role in the ASEAN region (Majid et al. 2009).

Specifically, the unexpected strengthening of the exchange rate of the JPY and Euro against the US Dollar causes the IDR to drop within a week period thereafter. Afterwards, the IDR began strengthening and reached a point of equilibrium within a 30-day period. The strengthening of the EUR was likely to cause transaction in the EUR to decline, thus the traders would prefer to transact in other currencies. Furthermore, the strengthening of the unexpected JPY tends to weaken the IDR and fluctuate around 8-day thereafter. Afterwards, the IDR began to strengthen back and reached an equilibrium point within 30-day period.

As for the interdependence of the IDR from the ASEAN forex markets, the IDR was also found to be very much interdependence from the other ASEAN forex markets. The innovation in the SGD was found to affect most the IDR, followed by the innovations in the PHP, MYR and THB. The innovations in the SGD and PHP have longer effects up to more than a month period, while the innovations in the MYR and THB only took a month period before the IDR went back to its equilibrium level. Specifically, there was a positive response of the IDR to the forex markets of the ASEAN, when the SGD, PHP, MYR and THB appreciated, the IDR would also appreciate. The direct relationship between the forex markets of ASEAN can be attributed to the nature of the interdependencies itself and trends of the trading occurred among the markets. The dominant role of the

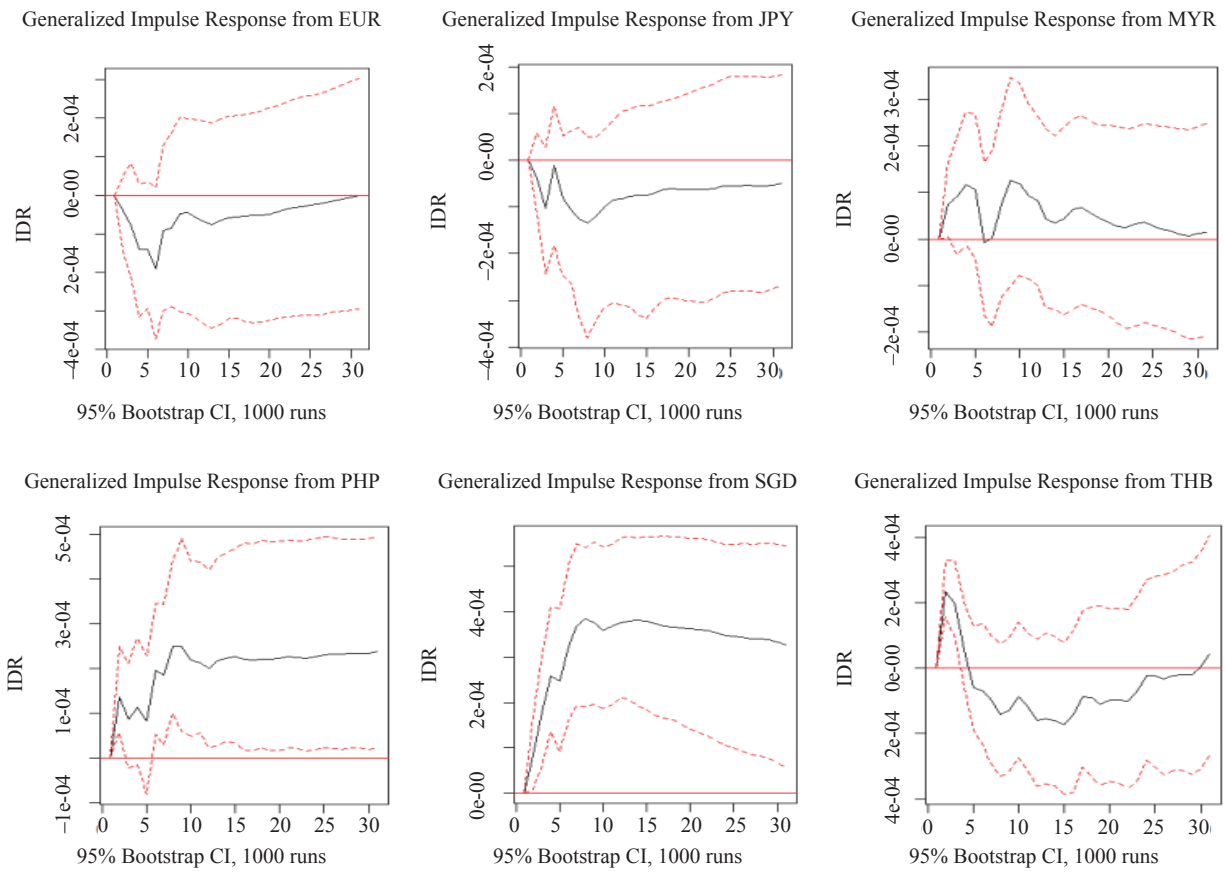

FIGURE 2. Responses of the IDR to Innovations in other Forex Markets

SGD over the other ASEAN forex markets, particularly Indonesia was due to Singapore was the only country that opened up its market earlier and guaranteed free capital flows, while the other ASEAN markets still put strict restrictions on foreign ownership, which block foreign direct investment and other foreign exchange transactions (Cha & Sekyung 2000).

Pertaining to the innovations in other ASEAN forex markets, the IDR was affected in the first 4-day towards the strengthening of the MYR, the first 3-day towards the innovations in the THB and PHP, and the first 9-day towards the shocks in the SGD. The innovations in these forex markets were continuing to a-month. This further implies that any macro-economic policies regulating the other forex markets should be at least noted by the authorities in stabilising the IDR. Rather, as the ASEAN forex markets become more interdependent regionally, there is a call for macro policy synchronization among the ASEAN economies to manage the impact of forex fluctuations, as the markets become more interdependence. Ultimately, a greater policy harmonization in conjunction with the relaxation of investment and trade barriers would be fundamental if these countries are to take advantage of greater forex and economic interdependence (de Bruyn et al. 2013; Kotorri & Korbi 2009; Majid et al. 2008). Thus, knowledge of forex market interdependence could be used by the policy makers to determine the decision for forex union, a current topic of debate.

Next, the study further reports the findings from the VDCs, as it is used to empirically assess the dynamic interdependencies between the IDR and other forex markets. As observed from Table 4, the VDCs results suggest the IDR are vulnerable to the innovations in both other ASEAN and developed forex markets. At the second day horizon, 99.329% of the variations in the IDR are explained by innovations in itself, while 0.422% is explained by innovations in the MYR, 0.136% is explained by the PHP, 0.052% is explained by the SGD, 0.040% is explained by the THB, 0.012% is explained by the JPY, and 0.001% is explained by the EUR. Meanwhile, at the 12-day horizon, 97.231% of the variations in the IDR are explained by innovations in itself, while 1.178% is explained by the JPY, 1.611% is explained by the SGD, 0.444% is explained by the PHP, 0.339% is explained by the MYR, 0.099% is explained by the THB, and 0.098% is explained by the EUR.

Finally, at the end of the 30-day horizon, 97.268% of the variations in the IDR are explained by innovations in itself, while 1.666% is explained by the SGD, 0.100 are

TABLE 4. Responses of the IDR to Innovations in other Forex Markets

Period (Daily)	IDR	EUR	JPY	MYR	PHP	SGD	THB
1	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	0.99329	0.00001	0.00012	0.00422	0.00136	0.00052	0.00039
3	0.98957	0.00059	0.00045	0.00520	0.00134	0.00214	0.00069
6	0.98132	0.00076	0.00275	0.00338	0.00224	0.00849	0.00106
9	0.97426	0.00117	0.00221	0.00334	0.00399	0.01405	0.00099
12	0.97231	0.00098	0.00178	0.00339	0.00444	0.01611	0.00099
16	0.97076	0.00074	0.00143	0.00390	0.00487	0.01755	0.00075
20	0.97109	0.00065	0.00116	0.00359	0.00511	0.01781	0.00061
25	0.97191	0.00072	0.00096	0.00314	0.00534	0.01741	0.00052
30	0.97268	0.00099	0.00099	0.00268	0.00554	0.01666	0.00051

explained by the JPY, 0.554% is explained by the PHP, 0.268% is explained by the MYR, 0.099% is explained by the EUR, and 0.051% is explained by the THB. Comparing to the other ASEAN forex markets, this findings show that the IDR was more interdependence from the forex market of the SGD, while the least interdependent was with the THB.

As for its interdependence from the developed markets, the IDR was response more to the innovations in the JPY as compared to the EUR. Comparing to the entire markets, the IDR was found to be more interdependence on the JPY, the most leading markets in the Asian region. These findings show that economically and geographically close markets such as ASEAN and Japan, their forex markets were highly interdependence. This finding is in line with that of Janakiramanan and Asjeet (1998) who documented that economically and geographically close markets exhibited high interdependence. The different responses of the forex markets to innovations in other markets over the study period could be due, inter alia, to dissimilarities in the economies' external capital controls (Cheung & Mak 1992), financial deregulation (Chowdhury 1994), financial factors (Ibrahim 2003), and trade bilateral dependencies (Pretorius 2002; Karim & Majid 2010). The countries with strict capital control were not receptive to innovations in the overseas markets (Sheng & Tu 2000). Our findings of interdependence between the IDR and other ASEAN and developed forex markets were very much in line with the previous study by AuYong et al. (2004), Majid and Kassim (2009; 2010), where the markets of ASEAN countries have become highly interconnected due to their macro-economic policy deregulation in facing the ASEAN economic community era that has been launched since 2015.

CONCLUSION

This study empirically explored the interdependence of the Indonesian Rupiah (IDR) with other ASEAN emerging and the developed markets of the Europe and Japan for the period from January 1, 2008 to December 31, 2015. Using the Impulse Response Functions (IRFs) and Variance Decompositions (VDCs), the study documented that the IDR was more affected by the innovations in the developed forex markets of Japan compared to the Europe. Comparing to other ASEAN markets, the IDR was found to be more interdependence from the forex markets of Singapore, followed by Malaysia, the Philippines, and Thailand.

The findings of the study implied that the forex markets of ASEAN, particularly Indonesia become more integrated regionally and internationally, thus it needs for macro synchronization policies among the countries to manage the impacts of forex fluctuations. The extent of the effectiveness of the macro-economic policies of each ASEAN in dealing with its forex market imbalances would crucially depend on the extent of trading interdependence of each market with the rest. Similarly, the extent of interdependence of each of the ASEAN forex market would provide important implications on the formulation of the macroeconomic policies of the country, thus a greater policy harmonization regulating the forex markets would be crucial if these economies are to take advantage of greater forex and economic interdependence. The knowledge of forex market integration could be used by the government or policy makers to design a forex union in the ASEAN region, a current topic of debate. Additionally, the ASEAN countries should take into consideration of any developments in the world forex markets in formulating policies to stabilise their forex markets.

To further add to the present literatures on forex market interdependence, future empirical studies on the topic could cover broader areas of forex markets and investigate factors contributing to forex market interdependence. Further studies could also compare and quantify the forex trading benefits earned at the different forex risks by the forex traders when holding combination of foreign currencies of the ASEAN.

REFERENCES

Aggarwal, R. & Mougoue, M. 1993. Cointegration among Southeast Asian and Japanese Currencies: Preliminary Evidence of a Yen Bloc? *Economics Letters* 41(2): 161–166.

Aggarwal, R. & Mougoue, M. 1996. Cointegration among Asian Currencies: Evidence of the Increasing Influence of the Japanese Yen. *Japan and the World Economy* 8(3): 291–308.

Akaike, H. 1969. Fitting autoregressive models for prediction. *Annals of the Institute of Statistical Mathematics* 21(1): 243–247.

AuYong, H. H., Gan, C. & Treepongkaruna, S. 2004. Cointegration and Causality in the Asian and emerging foreign exchange markets: Evidence from the 1990s financial crises. *International Review of Financial Analysis* 13(4): 479–515.

Baig, T. & Golgfajn, I. 1998. Financial market contagion in the Asian Crisis. *IMF Working Paper* 98(155): 1–32.

Baillie, R. T. & Bollerslev, T. 1989. Common stochastic trends in a system of exchange rates. *The Journal of Finance* 44(1): 167–181.

Bank Indonesia. 2014. *Laporan Tahunan*. Jakarta: Bank Indonesia.

Bank Indonesia. 2016. *Laporan Tahunan*. Jakarta: Bank Indonesia.

Bank of Japan. 2015. *Annual Report*. Tokyo: Bank of Japan.

Caporale, G. M., Cipollini, A. & Demetriades, P. O. 2005. Monetary Policy and the exchange rate during the Asian Crisis: Identification through heteroscedasticity. *Journal of International Money and Finance* 24(1): 39–53.

Cha, B. & Sekyung, O. 2000. The relationship between developed equity markets and the pacific basin's emerging equity markets. *International Review of Economics & Finance* 9(4): 299–322.

Cheung, Y. L. & Mak, S. C. 1992. The international transmission of stock market fluctuation between the developed markets and the Asian—Pacific markets. *Applied Financial Economics* 2(1): 43–47.

Chowdhury, A. R. 1994. Stock market interdependencies: Evidence from the Asian NIEs. *Journal of Macroeconomics* 16(4): 629–651.

de Bruyn, R., Gupta, R. & Stander, L. 2013. Testing the monetary model for exchange rate determination in South Africa: Evidence from 101 Years of Data. *Contemporary Economics* 7(1): 19–32.

Dickey, D. A. & Fuller, W. A. 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* 74(366a): 427–431.

Dickey, D. A. & Fuller, W. A. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society* 49(4): 1057–1072.

Ewing, B. T., Forbes, S. M. & Payne, J. E. 2003. The effects of macroeconomic shocks on sector-specific returns. *Applied Economics* 35(2): 201–207.

Gharleghi, B., Shaari, A. H. & Sarmidi, T. 2014. Application of the threshold model for modelling and forecasting of exchange rate in selected ASEAN countries. *Sains Malaysiana* 43(10): 1609–1622.

Glick, R. & Rose, A. K. 1999. Contagion and trade: Why are currency crises regional? *Journal of International Money and Finance* 18(4): 603–617.

Ibrahim, M. 2003. Macroeconomic forces and capital market integration: A VAR analysis for Malaysia. *Journal of the Asia Pacific Economy* 8(1), 19–40.

Janakiramanan, S. & Asjeet, L.S. 1998. An empirical Examination of linkages between pacific-basin stock markets. *Journal of International Financial Markets, Institutions and Money* 8(2): 155–173.

Japan's Ministry of Finance. 2015. *Trade Statistics*, Tokyo: Ministry of Finance.

Karim, B. A. & Majid, M. S. A. 2009. International linkages among stock markets of Malaysia and its major trading partners. *Journal of Asia-Pacific Business* 10(4): 326–351.

Karim, B. A. & Majid, M.S.A. 2010. Does trade matter for stock market integration? *Studies in Economics and Finance* 27(1): 47–66.

Khalid, A. M. & Kawai, M. 2003. Was financial market contagion the source of economic crisis in Asia?: Evidence using a Multivariate VAR Model. *Journal of Asian Economics* 14(1): 131–156.

Kim, B. H., Kim, H. & Min, H. G. 2013. Reassessing the Link between the Japanese Yen and emerging Asian currencies. *Journal of International Money and Finance* 33: 306–326.

Kogid, M., Hassan, A. H. S. A. & Sarmidi, T. 2015. Volatility spillover and dynamic correlation of exchange rate in ASEAN-5. *Jurnal Ekonomi Malaysia* 49(2): 39–51.

Kotorri, A. & Korbi, A. 2009. Can a South East European country have a strong currency? Albania Case. *Contemporary Economics* 3(1): 43–52.

Lutkepohl, H. 2005. *A New Introduction to Multiple Time Series Analysis.* Springer: Germany.

Majid, M.S.A., Meera, A.K.M. & Omar, M.A. 2008. Interdependence of ASEAN-5 stock markets from the US and Japan. *Global Economic Review* 37(2): 201–225.

Majid, M.S.A., Meera, K.M., Omar, M.A. & Abdul Aziz, H. 2009. Dynamic linkages among ASEAN-5 emerging stock markets. *International Journal of Emerging Markets* 4(2): 160–184.

Majid, M.S.A. & Kassim, S.H. 2009. Impact of the 2007 US financial crisis on the emerging equity markets. *International Journal of Emerging Markets* 4(4): 341–357.

Majid, M.S.A. & Kassim, S. H. 2010. Potential diversification benefits across global Islamic equity markets. *Journal of Economic Cooperation and Development* 31(4): 103–126.

Nieh, C. C. & Lee, C. F. 2002. Dynamic relationship between stock prices and exchange rates for G-7 countries. *The Quarterly Review of Economics and Finance* 41(4): 477–490.

Park, Y. C. & Song, C. Y. 2001. Institutional investors, trade linkage, macroeconomic similarities, and contagion of the Thai Crisis. *Journal of the Japanese and International Economies* 15(2): 199–224.

Pesaran, H. H. & Shin, Y. 1998. Generalized impulse response analysis in linear multivariate models. *Economics Letters* 58(1): 17–29.

Pretorius, E. 2002. Economic determinants of emerging stock market interdependence. *Emerging Markets Review* 3(1): 84–105.

Reside Jr, R. E. & Gochoco-Bautista, M. S. 1999. Contagion and the Asian currency crisis. *The Manchester School* 67(5): 460–474.

Sander, H. & Kleimeier, S. 2003. Contagion and causality: An empirical investigation of four Asian crisis episodes. *Journal of International Financial Markets, Institutions and Money* 13(2): 171–186.

Sarmidi, T. 2010. Ringgit Malaysia predictability: Do currencies and prediction horizon matters? *Jurnal Ekonomi Malaysia* 44(1): 51–60.

Secretariat of the Republic of Indonesia. 2009. *Economic Report on Indonesia*, Jakarta: Secretariat of the Republic of Indonesia.

Serletis, A. 1993. Money and stock prices in the United States. *Applied Financial Economics* 3(1): 51–54.

Sheng, H. C. & Tu, A. H. 2000. A study of cointegration and variance decomposition among national equity indices before and during the period of the Asian Financial crisis. *Journal of Multinational Financial Management* 10(3): 345–365.

Sims, C. A. 1980. Macroeconomics and reality. *Econometrica: Journal of the Econometric Society* 48(1): 1–48.

Sims, C. 1986. Are forecasting models usable for policy analysis? *Quarterly Review* 10(1): 2–16.

Sims, C. A. & Zha, T. A. 1998. Does monetary policy generate recessions? *Federal Reserve Bank of Atlanta Working Paper 98-12:* 1–61.

Thomas, R.L. 1997. *Modern Econometrics: An Introduction*. Essex: Addison-Wesley Longman Ltd.

Tse, Y. K. & Ng, L. K. 1997. The cointegration of Asian currencies revisited. *Japan and the World Economy* 9(1): 109–14.

Waltz, K. N. 1993. The emerging structure of international politics. *International Security* 18(2): 44–79.

M. Shabri Abd. Majid*
Faculty of Economics and Business
Syiah Kuala University
Banda Aceh
INDONESIA
E-mail: mshabri@unsyiah.ac.id

Hizir Sofyan
Faculty of Mathematics and Natural Sciences
Syiah Kuala University
Banda Aceh
INDONESIA
E-mail: hizir@unsyiah.ac.id

Moh. Rizky Rahmanda
Faculty of Mathematics and Natural Sciences
Syiah Kuala University
Banda Aceh
INDONESIA
E-mail: mohrizkyrahmanda@unsyiah.ac.id

*Corresponding author