IJER © Serials Publications
12(3), 2015: 633-647
ISSN: 0972-9380

COMOVEMENT OF ASEAN CURRENCY: A COINTEGRATION ANALYSIS

Pattra Sriputtangkul[*], Penpattra Tarsakoo[*] and Rattakarn Komonrat[**]

Abstract: *The emergence of globalization has moved economic of intra-regional and inter-regional to closer tie. ASEAN economy continues to enhance its integration toward Asean Economic Community (AEC) by the end of 2015, thus, understanding economics linkages among ASEAN become a significant concern. This paper examines the long-run comovement of currencies among five ASEAN countries, namely; Indonesia, Malaysia, the Philippines, Singapore, and Thailand. By using weekly data from 2003 to 2013, this paper has employed unit root test to examine stationary property, such as Augmented Dickey–Fuller (ADF), the Phillip–Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS). To determine long-run comovement, Engle-Granger and Johansen cointegration tests were employed. The results indicated that there is a cointegration vector among ASEAN currencies. This implies that currencies among the five ASEAN share long-run comovement with each other. These results suggest important implications for assessing ASEAN financial markets, developing proper monetary policies and diversifying financial risk.*

Keywords: *ASEAN, foreign exchange rate, cointegration, Engle-Granger test, Johansen test, Market Integration*

JEL Classification: *C22, F31, F33*

I. INTRODUCTION

In the era of globalization, the economic framework has been altered around the globe. Meanwhile, economic integration has been gathering at pace in both developed and developing nations. This may due to the increase in international trade and the development of financial markets, trade policies and technological infrastructure. In addition, the existence of global market has resulted greater stability on economic growth around the world (Aggarwal & Mougoue, 1998). However, the global market has faced significant changes such as exchange rates fluctuation and greater capital movement in the international markets environment (Lee & Boon, 2007).

* International College of National Institute of Development Administration

** Mahidol University International College

Corresponding author Email: rattakarn.kom@mahidol.ac.th

During the last thirty years, three major regional economic blocks have arisen, resulting closer ties of economic integration and higher interaction of trade as can be seen from regional economic integration such as NAFTA (North American Free Trade Agreement), the EU (European Union) and ASEAN (Association of South East Asian Nations) (Aggarwal & Mougoue, 1998).Consequently, the trend towards greater economic integration have increased the flows of capital between countries and led to greater interdependence and integration in the world's financial markets. This bring about benefit to various segments including both equity and goods markets.

As economies have become more closely integrated, trade has risen in both goods and services, and also investment in counties within regional trading blocks. The cost of transactions has fallen and fluctuations in exchange rates have been minimized. Financial markets have stabilized and economic growth has resulted from the cooperation and closer economic links (Aggarwal & Mougoue, 1998). It has also been the case that the greater capital availability and greater investment diversification have also been of benefit to businesses and investors.

Although there are several benefits from international diversification, international investors might also encounter greater financial risk, especially in terms of dynamic exchange rates. Therefore, it is important for international investors to manage this foreign exchange risk. In order to manage the risk from exchange rate fluctuations affecting asset valuations and portfolio management, one solution is to consider exchange rate cointegration, which allows investors to utilize useful information regarding the linkage of exchange rates across countries in the analysis (Chin & Azali, 2010).

In terms of exchange rate linkages, a large amount of empirical evidences from previous researches examining these linkages through cointegration techniques have been found around the globe. However, the exchange rate linkage studies that focus on developing countries are still lacking (Baharumshah & Goh, 2005). The results from the previous studies that examine the currency linkages among developed regions may not be assumed to mirror the cointegration and linkages between currencies in developing regions because of differences in terms of the business environment, information technology infrastructures and cultural factors.

The objective of this research is to examine the regional currency linkages among five ASEAN countries, which are regarded as emerging markets and a part of important regional economic integration within Asia. The countries involved are Indonesia, Malaysia, the Philippines, Singapore, and Thailand, over the period from 2003 to 2013. Also, this study attempts to assess the extent of financial integration among ASEAN countries by examining the exchange rate movements among ASEAN currencies through cointegration analysis.

ASEAN currently comprises ten nations: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. The goal of ASEAN is to establish economic cooperation and integration

to eventually create a free trade area, although at present this integration is still in its early stages.

The rationale for examining the exchange rate comovement in ASEAN countries is that the economies of the ASEAN states are become more integrated and are continuing to expand. Thus, the impact of exchange rate changes is significant for the region. In addition, since the economies of ASEAN have moved towards trade integration and closer economic ties, it can be inferred that neighboring countries are more likely to be affected by a currency shock in one country. Thus, the context of exchange rate comovement becomes significant for investors and also policy makers. Furthermore, the researcher found that a number of researchers have analyzed ASEAN exchange rates using cointegration prior to the implementation of the ASEAN Economic Community (AEC) in 2015. In this paper, the cointegration analysis should be employed for the five most important currencies in the ASEAN region, which are the Indonesian Rupiah, Malaysian Ringgit, Philippine Peso, Singaporean Dollar, and Thai Baht. In alignment with the literature, the currencies are all assessed with reference to the US Dollar.

The empirical results from this study should provide useful information concerning implications for policy-makers and international investors. With regard to the perspective of policy-makers, the dynamics of exchange rates are crucial for decision making for monetary policy that facilitates trade and development in emerging market economies. This is because the policy makers need to place more emphasis on the implications of monetary and foreign policies to facilitate the growth in economic integration. Furthermore, Basnet *et al.* (2014) mentioned that the influence of exchange rates on macroeconomic stability is associated with interest rates and other significant macroeconomic variables such as inflation. The primary purpose of this study is to determine the linkages among five ASEAN currencies, which determine the level of financial integration among the ASEAN. In this light, economic stability and growth might be better served through a deeper understanding of the nature of exchange rate volatility in the region (Lee & Boon, 2007).

In terms of implications for international investors, the dynamics of exchange rates play an important role in governing terms of trade since exchange rate movements directly impact the relative prices of goods and services in both foreign and domestic markets. Additionally, exchange rate movements have an impact on foreign asset holdings values due to possible economic shock transmission across countries (Basnet *et al.*, 2014). Therefore, an investigation of exchange rate movements can provide useful insights for assessing public policies regarding international economic linkages, exchange rate management, portfolio management, and other practical decisions among the five ASEAN currencies.

This paper consists of five sections as follows. In section II, the relevant literature is presented. Section III includes the data and methodology used in this study. The empirical findings are discussed in section IV, and section V presents the conclusion of this paper with the main findings and implications.

II. LITERATURE REVIEW

Over the few decades, the consequence of globalization has caused world economic toward higher degree of relationship around the globe. The world financial markets have become more integrated and interdependent, which enabled business and investors to facilitate greater flow of capital across countries (Lim, 2007). The economic integration has enhanced the economy cooperation and efficiency in both developed and developing nations. For example, since the establishment of the Association of Southeast Asian Nations (ASEAN) in 1967, ASEAN economy have been expanded which is justified by the growth of ASEAN'S Gross Domestic Product (GDP) by 5.7 percent in 2012 from the previous year by reaching to USD 2.31 trillion (ASEAN, 2013). To date, ASEAN has continued to display significant economic development to pursuit of an ASEAN Economic Community in 2015.

In term of foreign exchange market efficiency across countries, many researchers have tested by applying the concept of cointegration to a number of foreign exchange rates. The cointegration among different exchange rates is possibly used to predict economic situation of one market from another market (Jeon&Lee, 2002). This study aims to examine the comovement and linkages among ASEAN currencies to assess regional financial market and provide useful information for policy-makers and international investors. This section will provide a review of literature regarding linkages of exchange rates based on cointegration approach.

Regarding exchange rates comovement, there are a great number of studies using the cointegration technique. However, most of the literatures have focused on the advanced economy countries while there are only few studies that investigated exchange rates linkages among developing countries. In this section, the previous researches that examined the exchange rates movement in developed nations are first presented followed by the studies in developing nations focusing on ASEAN countries.

There are several previous studies the exchange rates cointegration among developed countries to identify the financial integration focusing on develop countries. Some studies indicated the exchange rates cointegration existed which imply that the exchange rate of one country is predictable from exchange rate of another countries. However, there are some evidences found in previous studies that the exchange rates of different developed countries was not cointegrated.

According to Hakkio and Rush (1989), their cointegration analysis was conducted by using monthly data during the period of 1975-1986 for identifying the efficiency of the market by investigating the cointegration of the spot and forward exchange rates within Germany and the UK, in which the finding were aligned with market efficiency, given no evidence of cointegration both within country and across countries. Rapp and Sharma (1999) explored the market efficiency of forward and spot exchange rates both within country and across countries of all G-7 countries (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States) with the use of cointegration analysis based on the daily spot and one-month forward exchange rates

for 283 months from 1973 to 1996, in which the findings confirmed that the market efficiency were found in the case of across countries while the results involving with the efficiency market were mixed within countries. Coleman (1990) conducted the cointegration test with the use of daily data of 18 foreign currencies and found that there was no confirmation of cointegration that can be concluded that foreign exchange rates follow a process of random walk. Meanwhile, Lajaunie and Naka (1997) investigated the cointegrating association among seven foreign exchange rates (Canadian dollar, Deutche mark, British pound, Swiss franc, French franc, Japanese yen and Italian lira) against the US dollar through the model of Johansen (1988), in which the finding indicated that the pairings of exchange rate indicated no cointegration.

Baillie and Bollerslev (1989) applied the cointegration test of Johansen (1988) for daily data of seven spot exchange rates including the UK pound, the French franc, the German mark, the Japanese yen, the Swiss franc, the Canadian dollar, and the Italian lira against the US dollar during 1980 to 1985, and conclude that the movement of spot exchange rate can be predictable in which the deviations from the long term association can be applied in predicting the future exchange rates that is a violation of relatively weakly efficient market. However, Baillie and Bollerslev's suggestion (1989) was argued by Diebold *et al.* (1994) through applying the same set of data of Baillie and Bollerslev's study (1989) but came up with distinguish finding which indicated no cointegration and pointed out that the model of cointegration is sensitive to the assumption in relation to the drift existence in the data without predictability for the trend of exchange rate in sample out of the experiment. In this regard, some additional evidences on the presence of cointegration in the same set of data were provided. Also, Sephton and Larsen (1991) investigated the existence of cointegration of Canadian, Japanese, and West German currencies relative to the US dollar through the use of data set during 1975-1986, and proved that the cointegration test between different foreign exchange rates for identifying the market efficiency is sensitive to the selected period or the applied model, which in turn makes the inconclusive results.

According to Norrbin (1996), the cointegration was found in the European Monetary System (EMS) rates. In addition, Aroskar *et al.* (2004) indicated that the evidence of market efficiency of EMS rates was not found before introducing the Euro because parities were strongly fixed. Kühl (2010) explored the cointegration among the US dollar, Euro and another four major currencies during 1994-2007, and indicated that there was the cointegration between US dollar and the Australian dollar, as well as between US dollar and the British pound after the Euro was introduced. Therefore, it can be concluded that the Euro had not contributed to across-section inefficient market.

As mentioned earlier, it can be found that there are many previous researches that examined the linkages of exchange rates among developed nations, which are significantly ground concept to examine such linkages among developing nations.

However, the results from the developed regions might not be applied for developing regions as a whole because of differences in terms of business environment, information technology infrastructures and cultural factors. Hence, the previous researches of the linkages of exchange rates among ASEAN countries should be emphasized as an important line of thought for this study, which are explained in following part.

Aggarawal and Mougoue (1996) examined the cointegration of exchange rates between Japanese yen with two groups of Asian countries by using daily data from 1983 to 1992. First group of Asian countries comprises of Hong Kong, Korea, Singapore and Taiwan. Malaysia, Philippine, Thailand and Singapore are included in the second group. The study was conducted in two periods during the crashed of stock market in October 1987. Aggarawal and Mougoue (1996) indicated that the cointegration was found in both two groups. Also, they found that the exchange rates of both groups were influenced by Japanese yen and USD. Besides,Tse and Ng (1997)examined the cointegration of the exchange rates of seven Asian currencies consisting of Japan, Malaysia, Philippines, Singapore, Thailand, South Korea and Taiwan during the period from September 1982 to June 1994. This study found that there was the cointegration among these currencies unless the Korean won and the new Taiwan dollar are not included from the analysis.

Apart from that, Baharumshah and Goh (2005) investigated the relationship of exchange rates between Japan and some East Asian countries comprising of Indonesia, Malaysia, Philippine, Singapore, Korea, Taiwan and Thailand during the period of 1978 to 1998 whether these financial markets has been affected by the rise of US dollar and the Mexico tequila crisis. The result of this study revealed that there were two currencies that did not cointegratein the relationship comprising of Korean currency (Korean Won) and the Philippine currency (Peso). Azali and Chin (2009) examined the cointegration in a set of eight ASEAN and other 3 currencies in pre-currency crisis, during crisis and post-currency crisis periods in 1997. They investigated that the cointegration among these currencies were not found during the pre-currency crisis period. However, the cointegration was found among some of Asian currencies in the currency crisis and post-crisis periods. From the results, the significant implication is the development of a common currency in this region.

Another study of ASEAN 5 currencies linkages is the study of Chin and Azali (2010). This study examined the ASEAN 5 currencies linkages and focused on the potential of a Singapore dollar bloc during the before and after Asian financial crisis periods by employing the Johansen and the Granger cointegration test. The results of the Johansen cointegration test by using four ASEAN exchange rates (Indonesia, Malaysia, Philippines, and Thailand) against the Singapore dollar revealed that cointegration during the before crisis period was not found whereas two cointegrating vectors among ASEAN exchange rates were found in the after crisis period. Regarding

to the results, Chin and Azali (2010) commented that it could be implied the financial integration in ASEAN nations is less integrated before financial crisis whereas it is more integrated after the crisis. Besides, the finding indicated that Singapore dollar might be a potential common currency for ASEAN as role of the Singapore dollar in ASEAN becomes important in this region. Additionally, this study indicated the influence of the US dollar on ASEAN currencies before crisis by adding the US dollar to the analysis.

Basnet *et al.* (2014) investigated common trends and common cycles among the exchange rates of five ASEAN nations (ASEAN5) consisting of Indonesia, Malaysia, the Philippines, Singapore, and Thailand during the period of 1976–2012 by employing multivariate trend–cycle decomposition. This study found that common cycles and common trends of the real exchanges rates of four nations (Malaysia, the Philippines, Singapore and Thailand) were shared. As a result, Basnet *et al.* (2014) suggested for monetary policies synchronization and monetary alliance among these four countries.

In recent study, Gharleghi *et al.* (2015) employed the Augmented Dickey-Fuller and Phillips-Perron unit root tests with Johansen cointegration approach to examine the cointegration among five ASEAN exchange rates (Indonesia, Malaysia, the Philippines, Singapore, and Thailand) by collecting data from 1985 (January) to 2010 (September) and dividing data into two periods consisting of pre-crisis (Jan 1985 to Dec 1996) and post-crisis (Jan 1999 to Sep 2010). The result revealed that a unique cointegrating vector was found in post-crisis period only. Gharleghi *et al.* (2015) also commented that there was a long-run equilibrium relationship between ASEAN exchange rates. The results of this study suggested important implications to form a common currency for ASEAN.

Table I
Previous literatures of ASEAN exchange rates linkages

Previous Researches	*Examined Currencies*	*Key Findings*
Aggarawal and Mougoue (1996)	▪ Hong Kong Dollar (HKD) ▪ Japanese Yen (JP) ▪ Korea Won (KR) ▪ Malaysia Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Taiwan Dollar (TWD) ▪ Thailand Baht (TH)	▪ The cointegration was found in both two sets of Asian countries. ▪ The exchange rates of both groups are influenced by Japanese yen and USD.
Tse and Ng (1997)	▪ Japanese Yen (JP) ▪ Korea Won (KR) ▪ Malaysia Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Taiwan Dollar (TWD) ▪ Thailand Baht (TH)	▪ There was the cointegration among the currencies unless the Korean won and the new Taiwan dollar are not included from the system.

contd. table 1

Previous Researches	*Examined Currencies*	*Key Findings*
Baharumshah and Goh (2005)	▪ Japanese Yen (JP) ▪ Indonesian rupiah (ID) ▪ Korea Won (KR) ▪ Malaysia Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Taiwan Dollar (TWD) ▪ Thailand Baht (TH)	▪ Korean Won and Peso were not included in the cointegration relationship.
Azali and Chin (2009)	▪ China Yuan (CN) ▪ Japanese Yen (JP) ▪ Indonesian rupiah (ID) ▪ Korea Won (KR) ▪ Malaysia Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Thailand Baht (TH)	▪ No cointegration among these currencies during the pre-currency crisis period. ▪ The cointegration was found among a few Asian currencies during the currency crisis and after crisis periods.
Chin and Azali (2010).	▪ Indonesian rupiah (ID) ▪ Malaysian Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Thailand Baht (TH)	▪ No cointegration among these currencies after the period of currency crisis. ▪ There were two cointegrating vectors of among ASEAN exchange rates in the post-crisis period. ▪ Singapore dollar might be a potential common currency for ASEAN ▪ The US dollar influences on ASEAN currencies before crisis period.
Basnet *et al.* (2014)	▪ Indonesian rupiah (ID) ▪ Malaysian Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Thailand Baht (TH)	▪ The real exchanges rates of four nations (Malaysia, the Philippines, Singapore and Thailand) share both common cycles and common trends whereas Indonesian currency does not share such relationships. ▪ Monetary policies synchronization are suggested or these four countries
Gharleghi *et al.* (2015)	▪ Indonesian rupiah (ID) ▪ Malaysian Ringgit (MY) ▪ Philippines Peso (PH) ▪ Singapore Dollar (SG) ▪ Thailand Baht (TH)	▪ A unique vector of cointegration was found only in post-crisis period. ▪ There was a long-run equilibrium relationship between ASEAN exchange rates.

It can be indicated from the previous studies focusing on ASEAN currencies that evidencesof the cointegration among different currencies provided by the literature o this area is still inconsistent which impliesvarious implications of financial integration in this region.

Most of the previous studies have investigated the exchange rates linkages across countries focusing on developed nations and less focus on ASEAN that is regarded as an emerging market. However, there are several empirical evidences examining the currencies of ASEAN countries found from previous researches summarized in Table I which are a significant line of thought to examine and analyze the linkages of exchange rate among five ASEAN currencies (Thai Baht, Malaysian Ringgit, Philippines Peso, Singaporean Dollar and Indonesian Rupiah) to provide more recent data. In aligning with the literature, currencies are reference with the US-Dollar. In the next section, research methodology will be explained and then followed by results and discussion.

III. DATA AND METHODOLOGY

3.1. Data Collection

The data set consist of average weekly exchange rate during the period of January 2003 to December 2013. The data set is gathered from Datastream. All the five ASEAN exchange rates are measured proportional to US dollar, which including Indonesian Rupiah, Malaysian Ringgit, Philippines Peso, Singaporean Dollar, and Thai Baht. Then, the currencies data are transformed into a logarithmic form for all the tests applied in this analysis. The analysis is based on the statistical software, Eview 8.0.

3.2. Methodology

Unit Root Tests

Regarding to time series econometric analysis, it is crucial to find out whether the time series possesses a unit root. This is a procedure to determine stationary property of the data set. Gujarati (2004) mentioned that unit root test is regarded as the test of stationarity that has been widely applied by a number of researchers. Before applying the cointegration test, the order of intergration of each variable that are under consideration need to be determined and integrated in the same order, whether the variables are stationary or not.

According to Granger and Newbold (1974), the spurious regressions are crucial problems that led to the standard error of non-stationary variables, which cause bias results. There are many techniques that can be employed to ensure that there is no spurious regression of the correlation. In this study, the unit root test of the Augmented Dickey–Fuller (ADF), the Phillip–Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) are employed for stationary property. The tests are aimed to examine and evaluate the robustness of the data among the five ASEAN exchange rates. If all

series results indicate I (1), then this imply that there may be one or more linear relationship among the data that is stationary. Then the following step is to examine the relationship among the exchange rate by using cointegration test.

Cointegration Tests

The term cointegration, Gujarati (2004) mentioned that cointegration means a linear combination of two or more time series can be stationary even though it is individually non-stationary. In other words, cointegration refers to stationary linear combination of non-stationary variables. However, non-linear relationships are likely to be existed among the combination of variables, which is regarded as non-linear cointegration.

Besides, Ma and Genton (2000) mentioned that cointegration is regarded as the statistical property that is possessed by some time-series data defined by stationarity concept and the integrated series order. The cointegration test is employed to investigate long-run relationship between economic variables. According to Dickey and Fuller (1981) the difference between unit root test and cointegration test is that unit root test are performed univariate of time series, while cointegration related to the relationship among a group of variables which has unit root individually. For cointegration test, a number of methods for testing cointegration have been proposed in the literature. In this paper, two techniques are employed for cointegration analysis, which are Engle-Granger (EG) test and Johansen test.

IV. EMPIRICAL RESULTS

The analysis begins by examining the summary statistics of the logarithm of the foreign exchange rates in the sample (Table II). The results indicate that Malaysian Ringgit and Singapore Dollar exhibit negative skewness while other currencies show positive skewness. The degree of skewness for all the foreign exchanges however is not substantial, revealing that the probability distributions of the exchange rates variables in the sample are not deviate much from being asymmetrical.

Table II
Summary Statistics of Foreign Exchange Rates

Statistics	*USD/IDR*	*USD/MYR*	*USD/PHP*	*USD/SGD*	*USD/THB*
Mean	9.14	1.23	3.86	0.38	3.54
Median	9.13	1.24	3.85	0.38	3.51
Std. Dev.	0.08	0.08	0.11	0.12	0.12
Skewness	1.37	-0.12	0.23	-0.01	0.38
Kurtosis	5.04	1.50	1.63	1.60	1.64

The correlation coefficients results are shown in Table III. Most of the correlation coefficients reveal significant at 1% and 5% level. Only Indonesian rupiah (ID) that shows the value of correlation coefficients lower than 0.5, while others reveal higher correlation at 0.9. The significant and high correlation between each pair of the

currencies, however, is static and could only show the result of the spurious relationship.

Table III
Correlation Coefficients among 5-ASEAN Exchange Rate Indices

	USD/IDR	*USD/MYR*	*USD/PHP*	*USD/SGD*	*USD/THB*
USD/IDR	1.00				
USD/MYR	-0.03	1.00			
USD/PHP	-0.16[b]	0.95[a]	1.00		
USD/SGD	-0.20[b]	0.97[a]	0.93[a]	1.00	
USD/THB	-0.13	0.94[a]	0.96[a]	0.93[a]	1.00

Note: a and*b* imply the correlation coefficients are significant at 1% and 5% level respectively.

The Augmented Dickey-Fuller (ADF), Phillp-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit root test results are presented in Table IV. All unit root tests are estimated in two models; a constant without trend and a constant with trend. The results of ADF and PP unit root tests show that the null hypothesis of a unit root cannot be rejected in the level stationarity at the 1% significance level. However, the null hypothesis is rejected at 1% significance level when it is tested in their first-difference.

For KPSS unit root test, the null hypothesis can be reject at 1% significant level in the level test and cannot be reject at 1% significant in the first difference. According to all of the unit root test results, it can be conclude that all of the five ASEAN currencies are integrated of order one or I (1). The results suggest the suitability to proceed a test for cointegration relations among the exchange rate variables.

Table IV
The Unit Root Test Results

	ADF		*PP*		*KPSS*	
	Level	*First Difference*	*Level*	*First Difference*	*Level*	*First Difference*
USD/IDR	-2.01	-8.53[a]	-1.39	-8.60[a]	0.29[a]	0.14
USD/MYR	-1.25	-8.31[a]	-1.18	-7.83[a]	1.23[a]	0.13
USD/PHP	-1.42	-7.40[a]	-1.16	-7.33[a]	1.17[a]	0.09
USD/SGD	-1.10	-8.00[a]	-0.88	-7.90[a]	1.37[a]	0.06
USD/THB	-1.84	-8.00[a]	-1.72	-8.06[a]	1.21[a]	0.15

Note: The results show t-statistics, adjusted t-statistics and the LM statistics for the ADF, PP and KPSS unit root tests respectively. The test results are based on the model with constant but without trend in their level and first difference. *a* indicates that the test statistic is significant at 1% level.

Refer to Table IV, the results have identified that all the exchange rate exhibit I(1) property. Therefore to examine the integration relationship, the Engle-granger (EG) cointegration test has been employed to examine whether there is a long-term relationship between each pair of the exchange rates. The EG test was performed which based on the two models; only the constant and constant with trend.

The results in Table V show the z-statistic of the EG tests using these different settings. EG cointegration tests reveal that there is significant pair-wised relationship among the five ASEAN currencies in both models. The findings show evidences of bidirectional relationship between Philippines Peso and Thai Baht as well as Indonesian Rupiah and Philippines Peso in both models. Singaporean Dollar currency shows a bidirectional relationship with all other ASEAN currencies in the constant and trend model. The results suggest the existence of a strong regional currency cointegration across countries, particularly higher degree with Singaporean Dollar.

Table V
The Z-Statistics from Engle-Granger Test

	Independent Variable									
	Constant					*Constant and Trend*				
	IDR	*MYR*	*PHP*	*SGD*	*THB*	*IDR*	*MYR*	*PHP*	*SGD*	*THB*
IDR	-	-18.05[c]	20.02[b]	-21.89[b]	-20.50[b]	-	-30.66[b]	-24.39[c]	-20.21	-17.51
MYR	-2.70	-	-15.45	-17.09[c]	-14.83	-34.16[a]	-	-15.30	-30.31[b]	-16.41
PHP	-4.50	-23.59[b]	-	-14.66	-26.54[a]	-13.60	-21.51	-	-17.33	-26.31[b]
SGD	-3.72	-15.13	-13.22	-	-12.26	-29.91[b]	-55.49[a]	-27.28[b]	-	-29.54[b]
THB	-4.73	-15.95	-27.49[a]	-14.53	-	-7.88	-13.32	-24.56[c]	-17.46	-

Note: a, b, c imply significance at 1%, 5% and 10% level respectively.

To examines long-run relationship whether the exchange rate of ASEAN are cointegrated, Johansontest has been employed for further analysis. The results of Johansen test from Table VI show models and the lag of variables that best fit model which explains the variation of the dependent variables. The summary of the Johansen test shown in Table VI reveals that the model without deterministic trend and with intercept (Model II.) in the cointegrating equations should be selected. According to the SIC and the consistency between the Trace and the Maximum Eigenvalue statistics, there is one cointegrating relationship that is confirmed.

Table VI
Multivariate Johansen Cointegration Test Results

Null Hypothesis	*Intercept (No Trend) in CE / No Intercept in VAR*			
	Trace Statistic	*5% Critical Value*	*Maximal Eigen value Statistic*	*5% Critical Value*
r = 0	81.15[b]	76.97	38.35[b]	34.81
r ≤ 1	42.81	54.08	21.74	28.59
r ≤ 2	21.06	35.19	14.01	22.30
r ≤ 3	7.06	20.26	4.08	15.89

Note: r indicates the number of cointegrating vector. Trace and Max-Eigen value denote the trace statistic and maximum eigenvalue statistic. *b*implies significance at 5% level. Critical values for the trace and maximal eigenvalue tests are obtained from MacKinnon-Haug-Michelis (1999).

Table VII
Summary of Johansen Cointegration Test Results

Information Criteria by Rank and Model					
Model	*I*	*II*	*III*	*IV*	*V*
Deterministic Trend	*None*	*None*	*Linear*	*Linear*	*Quadratic*
Intercept and Trend in CE	*No Intercept No Trend*	*Intercept No Trend*	*Intercept No Trend*	*Intercept Trend*	*Intercept Trend*
	Selected (0.05 level) Number of Cointegrating Relations by Model*				
Trace	0	1	0	1	2
Max-Eig	0	1	1	0	2
Rank or No. of CEs	*Schwarz Criteria by Rank (rows) and Model (columns)*				
0	-27.58*	-27.58*	-27.48	-27.48	-27.30
1	-27.41	-27.46	-27.40	-27.36	-27.22
2	-27.14	-27.21	-27.18	-27.19	-27.09
3	-26.82	-26.90	-26.84	-26.91	-26.84

Note: * indicates the best fit model and rank according to SIC. The lag length for VAR model was selected based on the sequential modified LR test statistic at 5% level.

The result of multivariate Johansen cointegration test with intercept and no trend are presented in Table VII. The evidence from both Trace statistics and the Maximal Eigenvalue statistics indicate that there is at most a single cointegration vector. The null hypothesis is rejected among the currencies in the sample, where the t-statistic for trace and maximal eigenvalue are 81.15 and 38.35 respectively. Both value of t-statistic are statistically significance at 5% level. The finding demonstrated the existence of long-run relationship among the five ASEAN currencies.

V. DISCUSSION AND CONCLUSION

With development of ASEAN Economic Community (AEC), this study assesses empirical evidence on the regional financial linkage of five ASEAN countries namely; Indonesia, Malaysia, Philippines, Singapore and Thailand. The paper has examined the integration relationship of exchange rates among the five ASEAN currencies. The results of Engle-Granger (EG) test and Johansen cointegration test show that there is a relationship among ASEAN currencies during the selected period. Both models have revealed significant cointegration among the variables. Most of the empirical results reveal similar findings with previous researches such as Chin and Azali (2010), Gharleghi et al. (2015) and Tse and Ng (1997). The results from Engel-Granger (EG) reveal that ASEAN countries are financially integrated, where Singapore dollar tend to have bidirectional relationship with all ASEAN currencies. This may imply that Singapore dollar has played an important role in currency linkage in ASEAN region.

Regarding to the results of cointegration among five ASEAN exchange rates, it can be indicated that ASEAN countries are characterized by significant intra-regional

financial linkages. It might be implied that the ASEAN currencies would restraint investors in these markets to diversify their investment in currencies across regions. Consequently, it leads to greater financial risk in exchange rates volatility when member country of ASEAN encounter with economic crisis. For international investors, policy makers and portfolio manager, these evidences have important implication for assessment on ASEAN financial markets such as assessing asset diversification, hedging decisions and risk management. Besides Singapore dollar, many ASEAN currencies are not sufficiently liquidate in some international transactions, thus making financial difficulties for business. Another implication of cointegration among ASEAN currencies would be that policy makers should consider for policies that liberalize international financial and capital movement outside ASEAN region. This will allow international investors to diversify their portfolio and risk valuation from intra-regional exchange rate volatility.

In conclusion, this study illustrate that the ASEAN exchange rate are linked and interrelated. Thus, financial integration such as exchange rate market may be an important ingredient towards a more integrated ASEAN Economic Community (AEC) and possible tightening monetary policies among the members. This study only focuses on five ASEAN currencies and limited only intra-regional markets. Thus, further investigation could be extended by including more ASEAN countries into the analysis or incorporate with countries outside ASEAN order to verify the financial diversification opportunity.

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