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CURRENCY COINTEGRATION AND GLOBAL FINANCIAL CRISIS: THE CASE OF ASEAN CURRENCIES

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ABSTRACT

This study examines the short-run causality and the long-run cointegrating relationships among ASEAN national currencies prior to and after the 2008 Global Financial Crisis (GFC) with the aim to assess the ASEAN's readiness to form an Optimal Currency Area (OCA). We support the notion that ASEAN is not ready to become an OCA, as the linkages among national currencies appear to vanish due to varying responses to an asymmetric external economic or monetary shock toward the region. In addition, there are only weak and scatter (ing) ties among the currencies. In contrary to the findings in the extant literature, we find that a financial crisis does not always lead to a more cointegrated currency group as there is a strong evidence of cointegrating relationships among ASEAN currencies prior to the 2008 Global Financial Crisis, but there is only a minimal pairwise relationship and no long-term linkage among the currencies after the crisis. We observe that nature of the crisis could take part in explaining the effect of a financial crisis on currency cointegration.

Keywords: ASEAN, global financial crisis, currency cointegration, optimal currency area

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Introduction

Since an inception of the Association of Southeast Asian Nations (ASEAN) in 1967, one of the key aims of ASEAN has been to promote the economic growth of its members through the expansion of trade and investment across the region. Despite the significance of ASEAN's trade and investment volumes with counterparts outside of Southeast Asia, intra-regional trade and investment have surprisingly accounted for the highest proportions of the total trade and investment volumes and have been increasing at a staggering pace in recent years[1]. The facts further highlight the needs for more attention on the development toward intra-ASEAN economic and financial integration.

A recent development in the region is the plan to establish the ASEAN Economic Community (AEC) by 2015 with a view to transform Southeast Asia into a single market and production base, a highly competitive economic region with free movements of goods, services, investment, skilled labour, and capital, and a region which is highly integrated to the global economy (The ASEAN Secretariat, 2014). To achieve the objective, the existence of long-run linkages among national currencies of the ASEAN members, indicating a synchronization of their business cycles and economic policies, is a precondition required to facilitate the ever-increasing intra-regional trade and investment transactions and a prerequisite for ASEAN to become an Optimal Currency Area (OCA). Coherence in the movement of the ASEAN national currencies would lead to a higher market stability and a greater intra-regional trade and investment. Understanding the nature and the dynamics of short- and long-run relationships among its members' currencies would benefit policy makers in assessing ASEAN's readiness toward reaching the AEC goal.

Despite an increasing importance of intra-regional economic and monetary integration in Southeast Asia, most of the related studies have concentrated on finding linkages among national currencies and an OCA potential of ASEAN+3 countries[2]. In addition, empirical results concerning cointegrating relationships among ASEAN currencies in the extant literature have been mixed in terms of the currencies involved in the linkages and the effect of an economic shock on the currency linkages. Furthermore, only a few studies with regard to currency cointegration have been conducted over the period spanning through the Global Financial Crisis (GFC) in 2008 (Ahmad, Rhee, & Wong, 2012; Gharleghi, Shafighi, & Fah, 2015; Kawasaki, 2012). In this regard, the extent and the nature of the impacts of the 2008 GFC on the relationships among ASEAN currencies may be different from those of the Asian Financial Crisis (AFC), one started right at the heart of Southeast Asia in 1997. The main objective of this study is, thus, to evaluate ASEAN's readiness toward becoming an OCA and a highly financially integrated region by re-examining currency linkages among the national currencies of ASEAN economies during 2004-2013, the period, which spans through the 2008 GFC, employing cointegration techniques.

The Context of Currency Cointegration: Theory and Empirical Evidence

According to the theory of Optimal Currency Area (OCA) developed by Mundell (1961) and McKinnon (1963), a group of economies having close economic ties and sharing common stochastic economic trends, would see the stability of the bilateral exchange rates involving their national currencies. The rationale is that countries with strong economic relationships can share factor mobility in their national income processes and, consequently, the real exchange rates of the economies as the functions of national income processes should be highly correlated and cohesively stable. A strong linkage among the national currencies would allow the countries in the group to abandon their own

[1] According to the ASEAN Statistics Database, intra-regional ASEAN trade had increased by seven times from USD 82 billion to USD 609 billion during 1993-2013 and accounts for almost 30% of the ASEAN's total trade volumes in 2013. The foreign direct investment (FDI) flows originated and received from ASEAN members also accounts for a significant 20% of the total FDI flows in 2013 (The ASEAN Secretariat, 2015).

[2] ASEAN+3 refers to ASEAN members, China, South Korea and Japan also known as East Asian countries.

currencies and adopt a common currency to facilitate intra-group trades and investments. In the context of the current study, the existence of a significant long-term linkage among national currencies of ASEAN members would imply that there is a convergence of monetary policies and a synchronization of economic cycles among the ASEAN members. The conditions allow for an exchange rate stability which in turn leads to a lower transaction cost and an increase in intra-regional trade and investment (Chang, 2008; De Grauwe, 1994). An evidence of a cointegrating relationship among ASEAN currencies would also indicate that Southeast Asia would be a prime candidate to become an OCA, either through a creation of a new common currency or through a joint adoption of a major global currency or a basket of major currencies (Ng, 2002).

During the past three decades, much effort has been put into the assessment of whether and how ASEAN+3 economies could form an OCA. Most of the related studies suggested that only a subset of the ASEAN+3 economies are ready to become an OCA. Using traditional cointegration techniques, Aggarwal and Mougoue (1996) examined the possibility that Japan and two groups of East Asian countries (Hong Kong, South Korea, Singapore and Taiwan as the "Tigers" group and Myanmar, Philippines, Thailand and Singapore as the "ASEANs" group) can become a Yen bloc. They found the evidence of a long-run relationship among the currencies for both groups, suggesting that the Tigers and the ASEANs could form an OCA by adopting Japanese Yen as the standard currency. Zhang, Sato, and McAleer (2004) set up an economic model containing output, exchange rate and price level and employed the Structural Vector Auto Regression (S-VAR) approach developed by Bayoumi, Eichengreen and Mauro (2000) to examine the symmetry of underlying shocks affecting East Asian economies. They found that only some Asian Newly Industrialized Economies (NIEs) and some ASEAN countries are better candidates for a common currency arrangement and that the speed of adjustment to shocks in East Asia is much faster than in Europe. In a similar avenue, Sun and Simons (2011) examined monetary integration in East Asia using Real Exchange Rate (RER) data but found no support for monetary integration in the entire region except in the group of four ASEAN members and South Korea. In addition, Kawasaki (2012) investigated ASEAN-5 plus some combinations of China, Korea and Japan as a suitable candidate for an OCA and found that the whole group could become an OCA in the near future.

Due to the increasing importance of the regional economic and monetary integration in Southeast Asia, more studies have emphasized on assessing the region's readiness to form an OCA. The empirical results, however, have been rather mixed. Ng (2002) examined the possibility of the formation of a currency union in ASEAN, in comparison with EU and NAFTA countries and found that only Indonesia, Singapore, and Malaysia could be ready for a currency union. Cortinhas (2007) tested whether an increase in intra-ASEAN trade and business cycle synchronization would lead to a greater economic integration, which in turn would prepare member countries for a common currency adoption. The author found that only the group of Malaysia, Thailand, Singapore, and Philippines has potential to become an OCA. Along the same line, Thong, Santhapparaj, and Hossain (2010) assessed the asymmetry of the demand and supply shocks experienced by ASEAN-5[3] countries and found that the ASEAN-5 countries as a whole were not ready to form an OCA. However, the authors found that Malaysia, Singapore, and Thailand, could spearhead the formation of a single currency. Added to the list of studies with mixed results, Gharleghi et al. (2015) found that Indonesia, Singapore and Thailand could form an OCA.

Many studies in the extant literature took into account the effects that the 1997 Asian Financial Crisis (AFC) may have on the degree of economic

[3] ASEAN-5 refers to five largest economies in Southeast Asia including Indonesia, Malaysia, the Philippines, Singapore and Thailand.

and monetary integration and on the possibility to form an OCA by ASEAN members. Despite being different in term of the outside currencies chosen, most of these revealed a similar result that the linkages among ASEAN currencies strengthened after the 1997 AFC compared to those pre-crisis, possibly due to foreign exchange market interventions, the contagion effect, and coordinated macroeconomic policies under the IMF's mandate (Jeon & Seo, 2003). For instance, Choudhry (2005) investigated the effects of 1997 AFC on the Generalized Purchasing Power Parity (G-PPP), the approach developed by Enders and Hurn (1994), and found that the possibility for Thailand, Indonesia, Malaysia, Philippines, and South Korea to form an OCA existed only after the crisis. Chin and Azali (2010) examined potential linkages among ASEAN-5 currencies pre- and post-1997 AFC and found that ASEAN countries were financially more integrated after the crisis, with an increasingly role of Singapore dollar in ASEAN. In a recent and similar study, Gharleghi et al. (2015) found that ASEAN currencies became more tightly integrated in the post-crisis period.

Recently, only a few studies explored the impacts of the 2008 Global Financial Crisis (GFC) on ASEAN currency cointegration. Ahmad et al. (2012) observed that the 1997 AFC was more disturbing event to the Asia-Pacific currency cointegration than the 2008 GFC, which may be partly due to the policy failure of Asian countries. Kawasaki (2012) adopted the G-PPP approach to examine East Asian currencies and suggested that ASEAN-5, China, Korea, and Japan were more ready to become an OCA only after the 2008 GFC.

Data and Methodology

Sample construction

The sample in this study is constructed using weekly bilateral exchange rate data during the period 2003 to 2014, involving national currencies of six ASEAN economies against the US dollar as the outside currency[5]. The six currencies include the Indonesian Rupiah (IDR), the Malaysian Ringgit (MYR), the Philippine Peso (PHP), the Singapore Dollar (SGD), the Thai Baht (THB) and the Vietnamese Dong (VND)[6]. The data are extracted from DataStream and are natural logarithmic transformed for unit root and cointegration tests and subsequent analyses. To examine the effect of the GFC started in 2008 on the short- and long-run linkages among the ASEAN currencies, the data set is divided into two subsamples. The pre-crisis subsample contains the data from January 2003 to December 2007, while the post-crisis subsample includes the data from January 2010 to December 2014. The two-year period from January 2008 to December 2009[7] is intentionally omitted to avoid a potential bias in cointegration test results which may occur due to an extremely turbulent nature of financial markets during the period around a financial crisis. The resulting number of observations is 262 for pre-crisis and post-crisis samples.

Unit root, bivariate and multivariate cointegration tests

Our investigation of the cointegrating relationships among the six ASEAN currencies began by performing unit root tests to examine the stationarity of the data and to ensure that the cointegration technique, rather than the traditional multivariate regression, was appropriate for the investigation of

[4] See Baak (2004); Bowman (2005); Brailsford, Penm, and Terrell (2005); Click (2009) for further evidence on a stronger post-crisis cointegration among the ASEAN currencies.

[5] The US Dollar is chosen to be the outside currency in this study due to its continued dominance in the global financial system. Despite the fear of eroding USD due to the rising level of the US public debt, the aggressive use of unconventional monetary policies and the fiscal tightening, the USD has remained a dominant foreign currency reserves and global investors have increased their holdings of US financial assets (Prasad, 2014).

[6] The Vietnamese Dong (VND) is included together with ASEAN-5 currencies in the sample due to the fact that the Vietnamese economy has been growing rapidly in recent years. According to a report in December 2005 forecasted by Goldman Sachs, Vietnamese economy will become the world's 21st-largest by 2025. In 2008, Price Waterhouse and Coopers also predicted that Vietnam may be the fastest-growing of the world's emerging economies by 2025, with a potential growth rate of almost 10% per annum in real dollar terms.

[7] The two-year period was selected based on the coincidence of the turbulent periods of all the ASEAN currencies in the sample as can be shown upon requested.

the relationships among the currencies[8]. Three standard unit root tests widely adopted in the existing currency cointegration literature are employed in the current study. These included the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1981). The Phillip-Perron (PP) test (Phillips & Perron, 1988) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowski, Phillips, Schmidt, & Shin, 1992). The unit root tests are conducted both on the level and the first-different data to also ensure that all the time series in the sample have an equal order of integration, $I(1)$, a necessary basis for further cointegration tests.

We proceed to examine pairwise cointegrating relationships among the bilateral exchange rates in the sample by employing the Engle-Granger (EG) test (Engle & Granger, 1987), the linear cointegration test which can be employed to examine whether the deviations from the long-run equilibrium are subject to a mean-reverting behavior. If two exchange rates are both $I(1)$ and have a long-run relationship, any error deviation must be pulled back to the long-run equilibrium level of zero. In other words, there must be an error correction in the data which can be modeled as shown below.

$$y_t = \alpha + \beta x_t + \varepsilon_t \quad (1)$$

$$\hat{\varepsilon}_t = y_t + \hat{\alpha} + \hat{\beta} x_t \quad (2)$$

Where, y_t and x_t are two bilateral exchange rates in the sample. The OLS residuals from (1) are a measure of disequilibrium. The EG cointegration test is a test of whether $\hat{\varepsilon}_t$ is stationary. This is determined by ADF tests on the residuals, with critical values adjusted for the number of variables (MacKinnon, 1996). The rejection of the null hypothesis of nonstationary $\hat{\varepsilon}_t$ indicates that y_t and x_t are cointegrated.

The investigation of the long-run relationships among the ASEAN currencies extends to the adoption of the Johansen multivariate cointegration test (Johansen, 1988), to seek for and to determine the number of multivariate cointegrating relationships. The Johansen cointegration test is conducted on both the pre-crisis and post-crisis subsamples. According to Johansen (1988), when n time series in the sample are all $I(1)$, there can be up to n-1 cointegrating long-run relationships among the variables. The author suggests a multivariate generalization of the Dickey Fuller test as shown below to determine the number of cointegrating vectors and to estimate all the distinct relationships.

$$\Delta F_t = (A_t - I)F_{t-1} + \mu_t = \pi F_{t-1} + \mu_t \quad (3)$$

Where, for this study, F_t denotes the matrix of bilateral ASEAN exchange rates in the sample. μ_t is the error matrix and A_t is the matrix of parameters, while I is the identity matrix. If the rank of vector π is zero, each element of π equals zero. F_t, is then a first-order Vector Autoregressive (VAR) process where all the variables follow unit root processes, indicating no linear combination of the exchange rates and no cointegration among them. If the rank of π is r then there are r cointegrating vectors in which each of these r equations is an independent restriction on the long-run relationship solution of the variables.

The rank of π is the number of characteristic roots of π that differs from zero and can be determined by using the following two likelihood ratio test statistics.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_t) \quad (4)$$

$$\lambda_{max}(r, r+1) = -T\ln(1 - \hat{\lambda}_{r+1}) \quad (5)$$

[8] Employing a traditional regression technique on non-stationary time series (time series with unit root) may cause a spurious regression problem. Although the problem can be remedied by running regression tests on the first difference of the non-stationary data, a valuable long-run information may be lost due to the first-difference transformation. A cointegration technique however can be used to test whether a long-run relationship among non-stationary time series exists. More specifically, there exists a long-run relationship among two or more non-stationary time series (the times-series are cointegrated) if a linear combination among the time series is found to be significant and stationary.

Where, $\hat{\lambda}_t$ denotes the eigenvalue obtained from the reduced rank regression problem and T is the number of observations. λ_{trace} and λ_{max} are the trace and the maximum eigenvalue test statistic respectively. Using the trace statistic, the null hypothesis is that $\lambda_{trace}(r) \leq r$, against the alternative hypothesis of $\lambda_{trace}(r)=0$ while the null hypothesis, using the λ_{max}, is λ_{max} against $\lambda_{max}=r+1$

Vector Error Correction Model (VECM)

Given an evidence of a multivariate cointegrating relationship among the national currencies of the six emerging ASEAN economies, we continue to set up and to estimate a VECM, which provided us a richer understanding of the dynamics of the short-run deviation from the long-run relationship equilibrium, as shown by the following VECM specification.

$$\Delta F_t = \pi F_{t-1} + \sum_{i=1}^{k-1} \varphi_i \Delta F_{t-i} + \theta_t \quad (6)$$

$$\varphi_i = -\sum_{j=i+1}^{k} A_j, \quad i=1,\ldots,k-1 \quad (7)$$

$$\pi = -(I - A_1 - \ldots - A_k) = -A(1) \quad (7)$$

Where, π denotes the coefficient vector of error correction terms, φ_i signifies the matrix of the coefficients of short-run relationships while θ_t symbolizes the residual vector, assumed to be multivariate normal with mean vector equal to zero and covariance matrix independent across time periods. k is the number of lag of the variables in matrix ΔF_t A negative and significant error correction coefficient indicates that there exists a long-term multivariate cointegrating relationship among the ASEAN currencies. Short-run causality was determined using the Wald test on the joint significance of the lagged explanatory variables.

Results and Discussions

The cointegration analysis of six ASEAN currencies

Table 1 Panel A and B, displays the results of the stationarity tests on the logarithmic transformed bilateral exchange rates in the sample. Almost all of the t-statistics and adjusted t-statistics, obtained from the ADF and the PP tests respectively, are significant at 1% level on the first difference but not on the level data. The results indicate that the null hypothesis of a unit root cannot be rejected for all the exchange rate time series and are integrated of order 1, or $I(1)$, Along the same line, the rejection of the null hypothesis of stationarity at 1% on all the level but not on the first difference data when employing the KPSS test confirms that all the time series in the sample are non-stationary and are $I(1)$, The results stand for the data in the pre- and post-2008 GFC subsamples and provide us a basis to proceed to the cointegration tests and analyses.

Table 1 Panel A: The unit root test results for 6 ASEAN currencies against the USD (Pre-GFC 2008)

	ADF					PP					KPSS		
	Level		First Difference			Level		First Difference			Level		First Difference
	t-statistic	p-value	t-statistic		p-value	Adjusted t-statistic	p-value	Adjusted t-statistic		p-value	LM statistic		LM statistic
USD/IDR	-2.2914	0.4367	-11.0822	***	0.0000	-0.0280	0.5829	-11.0075	***	0.0000	0.3163	***	0.0692
USD/MYR	-0.9969	0.9415	-13.7495	***	0.0000	-0.8497	0.9586	-13.7934	***	0.0000	0.4857	***	0.0397
USD/PHP	-0.1489	0.9938	-11.4455	***	0.0000	0.0186	0.9963	-11.5180	***	0.0000	0.4915	***	0.0422
USD/SGD	-2.7113	0.2329	-11.1977	***	0.0000	-1.7826	0.7106	-10.6248	***	0.0000	0.2756	***	0.0309
USD/THB	-0.7619	0.9666	-8.8573	***	0.0000	-0.8737	0.9562	-10.3234	***	0.0000	0.3982	***	0.0811
USD/VND	-2.3778	0.3903	-15.3965	***	0.0000	-2.3003	0.4318	-15.5764	***	0.0000	0.2841	***	0.0422

Table 1 Panel B: The unit root test results for 6 ASEAN currencies against the USD (Post-GFC 2008)

	ADF					PP					KPSS		
	Level		First Difference			Level		First Difference			Level		First Difference
	t-statistic	p-value	t-statistic		p-value	Adjusted t-statistic	p-value	Adjusted t-statistic		p-value	LM statistic		LM statistic
USD/IDR	-2.1213	0.5311	-10.2061	***	0.0000	-2.2045	0.4846	-10.0241	***	0.0000	0.4367	***	0.0702
USD/MYR	-2.5293	0.3137	-11.6355	***	0.0000	-2.1845	0.4958	-11.4179	***	0.0000	0.3560	***	0.0450
USD/PHP	-2.1393	0.5210	-11.3593	***	0.0000	-1.6320	0.7778	-10.9459	***	0.0000	0.4111	***	0.0325
USD/SGD	-1.4312	0.8497	-10.3311	***	0.0000	-1.3930	0.8610	-9.1875	***	0.0000	0.3705	***	0.0371
USD/THB	-2.5891	0.2857	-10.2866	***	0.0000	-2.3499	0.4051	-10.2635	***	0.0000	0.3012	***	0.0434
USD/VND	-2.4814	0.3372	-7.9289	***	0.0000	-2.2278	0.4717	-15.8730	***	0.0000	0.4213	***	0.0601

Note: The figures shown in the table are 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 containing a constant and a trend term. The lag length selection for the ADF test is based on the AIC. The bandwidth selection for the PP and KPSS is based on Newey-West. *** indicates that the test statistic is significant at 5% level. The asymptotic critical LM value (constant and trend model) for the KPSS test is 0.146 at 5% level. The null hypothesis of the ADF and the PP tests is that the times series has a unit root while the null hypothesis of the KPSS is that the time series is stationary. The critical values for the ADF and the PP tests are based on the values provided by MacKinnon (1996) one-sided p-values. The critical values for the KPSS test are based on the Kwiatkowski et al. (1992) in Table 1).

Table 2 Panel A: The tau-statistics from Engle-granger test (constant and trend model) Pre-GFC 2008

	Pre-GFC 2008 Dependent Variable											
	IDR		MYR		PHP		SGD		THB		VND	
Independent Variable	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value
IDR	-	-	-1.7974	0.8483	-1.2261	0.9601	-3.2226	0.1842	-2.1058	0.7272	-2.5018	0.5230
MYR	-2.7733	0.3783	-	-	-2.7781	0.3759	-3.5308	0.0985	-3.1279	0.2185	-3.5609	0.0921
PHP	-2.7143	0.4088	-3.0436	0.2523	-	-	-3.6980	0.0670	-2.5938	0.4730	-3.9101 ***	0.0394
SGD	-2.8394	0.3453	-2.3830	0.5873	-2.3091	0.6266	-	-	-2.9052	0.3137	-2.8393	0.3453
THB	-2.8798	0.3257	-3.8709 ***	0.0437	-2.1363	0.7130	-3.8868 ***	0.0419	-	-	-2.8343	0.3478
VND	-2.1995	0.6824	-2.6654	0.4346	-2.7460	0.3924	-2.8140	0.3578	-1.4007	0.9387	-	-

Note: *** implies significance at 5% level. Critical values are obtained from MacKinnon (1996) p-values (adjusted for degree of freedom). Automatic lags specification is based on Schwarz criterion with maximum lag of 18. All the exchange rates involve ASEAN national currencies and the USD.

Table 2 Panel B: The tau-statistics from Engle-granger test (constant and trend model) Post-GFC 2008

	Post-GFC 2008 Dependent Variable											
	IDR		MYR		PHP		SGD		THB		VND	
Independent Variable	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value	tau-statistic	p-value
IDR	-	-	-3.1343	0.2161	-3.2770	0.1662	-2.7324	0.3994	-3.1688	0.2032	-3.3673	0.1392
MYR	-2.6477	0.4441	-	-	-2.7425	0.3942	-3.5792	0.0884	-3.2120	0.1879	-3.1658	0.2044
PHP	-3.1881	0.1963	-3.0915	0.2327	-	-	-1.7798	0.8538	-2.8694	0.3308	-2.7245	0.4035
SGD	-2.7114	0.4103	-4.0262 ***	0.0288	-2.0804	0.7388	-	-	-3.0294	0.2582	-3.5427	0.0960
THB	-2.7675	0.3813	-3.3241	0.1517	-2.5345	0.5053	-1.9774	0.7830	-	-	-2.6631	0.4359
VND	-2.9915	0.2746	-3.2323	0.1809	-2.1484	0.7073	-2.6349	0.4510	-2.7754	0.3773	-	-

Note: *** implies significance at 5% level. Critical values are obtained from MacKinnon (1996) p-values (adjusted for degree of freedom). Automatic lags specification is based on Schwarz criterion with maximum lag of 18. All the exchange rates involve ASEAN national currencies and the USD.

The results of the pairwise cointegration tests employing the EG test procedure with a drift are shown in Table 2, Panel A and B. At the 5% confidence level, during the pre-2008 GFC, uni-directional long-term relationships are found to be running from the Thai Baht to the Malaysian Ringgit and the Singapore Dollar, suggesting loose long-run ties between Thailand vis-ι-vis Malaysia and Singapore with the latter two being the ones adjusting policies in response to changes in Thailand. Another uni-directional cointegrating relationship is also found between the Philippine Peso and the Vietnamese Dong during the pre-crisis period. The relationship however is relatively independent from the first group of cointegrated currencies.

Surprisingly, only one uni-directional co-movement between the Malaysian Ringgit and the Singapore Dollar is found in the region during the post-2008 GFC period. As opposed to the mutual suggestion in the extant literature, currency cointegration is generally strengthened after a financial crisis as a result of a higher level of economic policy coordination and links in the exchange rate policies among group members (Chin & Azali, 2010; Choudhry, 2005; Enders & Hurn, 1994; Gharleghi et al., 2015; Kawasaki, 2012); we find ASEAN currencies appear to be less cointegrated after the 2008 GFC in the current study.

There is no bi-directional cointegrating relationship among the currencies of ASEAN members in both pre- and post-2008 GFC periods. This indicates an absence of a strong tie among their currencies and suggests that it may be difficult for ASEAN economies to form a monetary union (Thong et al., 2010). Unlike other members for cointegration of ASEAN currencies, and a leading currency to form an OCA in the region, found by most previous studies (Choudhry, 2005; Gharleghi et al., 2015; Kawasaki, 2012; Ng, 2002; Sun & Simons, 2011), we find that the Indonesian Rupiah does not have any significant pairwise cointegrating relationship with other currencies in the present study, despite Indonesia's status as the largest economy in Southeast Asia. Figure 1 illustrates all the pairwise relationships found to be statistically significant at 5% in this study, as shown in Table 2, Panel A and B.

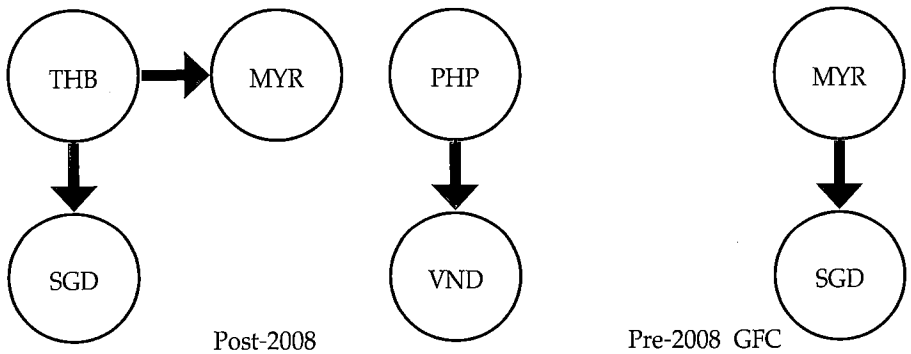

Figure 1 Significant pairwise cointegrating relationships among ASEAN currencies

The first step in performing the Johansen multivariate cointegration test is to choose a model and the lag of variables in the model that best explains the variation of the dependent variables. We perform the lag structure analysis on the unrestricted vector autoregressive (VAR) model and chose the lag length of 2 based on the AIC and SIC test statistic at 5% level. The summary of the Johansen test shown in Table 3, Panel A and Panel C reveals that the model without a deterministic trend but an intercept should be tested according to the SIC and the consistency between the Trace and the Maximal Eigenvalue statistics regarding the number of cointegrating relationship found.

The Trace statistics and the Maximal Eigenvalue statistics shown in Table 3, Panel B, suggest a rejection of the null hypothesis of no cointegration among the currencies in the sample. The result reveals an

evidence of one cointegrating relationship at 5% significance level among the six ASEAN currencies in the sample prior to the 2008 GFC. Nevertheless, no significant multivariate cointegrating association can be found among the currency group post-2008 GFC (See Table 3, Panel D). Similar to the findings from the pairwise cointegration analysis, ASEAN currencies seems to be less cointegrated after the crisis. A possible explanation for the findings in this study is that the 1997 AFC originated at the center of ASEAN region and resulted in a relatively higher impact on the ASEAN members, forcefully requiring them to converge their economic and monetary policies after the crisis. The 2008 GFC, however, began in the US and has infected European economies, potentially causing fund outflows to emerging markets including those in Southeast Asia after the crisis. Nonetheless, the choice of fund flows destinations may be differ due to the differences in the extent of the financial market development of the destination economies. Consequently, the value of ASEAN currencies may move divergently due to uneven fund inflows to the region.

The dynamics of the short-run and long-run relationships among currencies of six ASEAN members are further examined for the pre-crisis subsample by constructing and estimating a VECM. The chi-square test statistics of the short-term and long-term causality among the currencies are reported in Table 4. The only equation in the VECM where the coefficient of the error-correction term is negative and significant is the one in which the difference of the Philippine Peso (PHP) is the dependent variable. This finding confirms the result from the Johansen cointegration test in Table 3, Panel B, that there is one cointegrating relationship among the ASEAN currencies and it also provides an evidence that the ASEAN members could form an OCA during the pre-2008 GFC. The error-correction coefficient of -0.0005 indicates that a change in the PHP/USD in the VAR responds to the disequilibrium changes represented by the cointegration vector at the rate of about 0.05% per week toward the long-run equilibrium. We also find short-term casual relationships from the Malaysian Ringgit, the Thai Baht and the Vietnamese Dong to the Philippine Peso to be significant at 5 percent level, indicating that the short-term movement of the Philippine Peso can be explained by the short-term movements of the three currencies.

Table 3 Panel A: Summary of all five sets of assumptions for Johansen cointegration test (Pre-GFC 2008)

	Information Criteria by Rank and Model				
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	1	1	0	0	0
Max-Eig	1	1	0	0	0
Rank or No. of CEs	Schwarz Criteria by Rank (rows) and Model (columns)				
0	-49.0280	-49.0281 *	-49.0388	-49.0388	-48.9569
1	-48.9353	-48.9140	-48.8565	-48.8804	-48.8381
2	-48.7657	-48.7292	-48.6910	-48.6966	-48.6746

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

Table 3 - Panel B: Multivariate Johansen cointegration test results (Pre-GFC 2008)

Null Hypothesis	Trace Statistic	5% Critical Value	Maximal Eigenvalue Statistic	5% Critical Value
r = 0	114.5752 ***	103.8473	42.6867 ***	40.9568
r ≤ 1	71.8885	76.9728	24.3705	34.8059
r ≤ 2	47.5181	54.0790	18.6472	28.5881
r ≤ 3	28.8708	35.1928	12.9777	22.2996

Note: *** implies significance at 5% level. Critical values for the trace and maximal eigenvalue tests are obtained from MacKinnon, Huag, and Michelis (1999). The lag length for the VAR model was selected based on the AIC and SIC test statistics at 5% level.

Table 3 Panel C: Summary of all five sets of assumptions for Johansen cointegration test (Post-GFC 2008)

Deterministic Trend	Information Criteria by Rank and Model				
	None	None	Linear	Linear	Quadratic
Intercept and Trend in CE	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
	Selected (0.05 level*) Number of Cointegrating Relations by Model				
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0
Rank or No. of CEs	Schwarz Criteria by Rank (rows) and Model (columns)				
0	-46.8624	-46.8626 *	-46.7837	-46.7837	-46.6912
1	-46.6864	-46.6666	-46.6006	-46.5893	-46.5183
2	-46.4886	-46.4620	-46.4059	-46.3783	-46.3267

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

Table 3 - Panel D: Multivariate Johansen cointegration test results (Post-GFC 2008)

Null Hypothesis	Trace Statistic	5% Critical Value	Maximal Eigenvalue Statistic	5% Critical Value
r = 0	76.2336	103.8473	21.4776	40.9568
r ≤ 1	54.7560	76.9728	19.2647	34.8059
r ≤ 2	35.4913	54.0790	11.8039	28.5881
r ≤ 3	23.6874	35.1928	9.6156	22.2996

Note: *** implies significance at 5% level. Critical values for the trace and maximal eigenvalue tests are obtained from MacKinnon et al. (1999). The lag length for the VAR model was selected based on the AIC and SIC test statistics at 5% level.

Table 4 Temporal causality results based on the vector error correction model (VECM)

	Short-run causality, chi-square-statistic						Error-correction term, t-statistic	
	ΔIDR	ΔMYR	ΔPHP	ΔSGD	ΔTHB	ΔVND	Coefficient	t-statistic
ΔIDR	23.3627 ***	0.8015	0.3547	0.5833	0.6560	1.3509	0.0001	0.5308
ΔMYR	2.5250	1.9509	1.9244	0.1184	1.8004	5.1312	-0.0003	-1.3519
ΔPHP	4.7200	6.0926 ***	28.7738 ***	3.9425	7.2647 ***	12.7035 ***	-0.0005 ***	-4.1565
ΔSGD	1.0584	0.3982	3.1878	25.5782 ***	0.1643	5.2966	-0.0002	-1.0131
ΔTHB	0.2492	1.6013	1.8395	5.8996	26.2204 ***	3.6751	-0.0002	-1.4431
ΔVND	4.1589	6.6198 ***	2.3213	0.0436	2.5448	7.2268 ***	0.0001	2.5768

Note: the result shown was estimated from the AR equation in the VECM in which the first difference of the logarithm of bilateral exchange rate enter the model as the dependent variable one at a time. *** implies significance at the 5% level. Δindicates the first difference. The lag length for the VECM was selected based on the sequential modified LR test statistic at 5% level. All the exchange rates are against USD.

Conclusion

In this study, we evaluate the readiness of ASEAN members toward becoming an OCA and examine a disruptive effect of the 2008 GFC on the short-run and long-run linkages among the ASEAN currencies. We employ bivariate and multivariate cointegration techniques on the pre- and post-crisis subsamples containing weekly bilateral exchange rates of the national currencies of six ASEAN members with regard to the USD. The results reveal that there are short-run and long-run multivariate linkages and there are relatively more pairwise cointegrating relationships among the ASEAN currencies prior to the 2008 GFC. The cointegrating relationships, however, disappear after the crisis. Therefore, we suggest that although ASEAN has potential, it is not ready to form an OCA within Southeast Asia due to its members' varying sensitivity to an asymmetric external shock such as the 2008 GFC, and the absence of some key ASEAN currencies in the weekly cointegrated group. An emerging observation worth noting in this study is that financial crisis does not always result in a relatively greater extent of currency cointegration as suggested by previous studies and that the origin of a crisis may play an important part in explaining the effect of a financial crisis on currency linkages.

References

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), 291-30

Ahmad, R., Rhee, S. G., & Wong, Y. M. (2012). Foreign Exchange Market Efficiency Under Recent Crisis: Asia-Pacific Focus. *Journal of International Money and Finance, 31*(6), 1574-1592.

Baak, S. (2004). Japanese Yen and East Asian Currencies: Before and After the Asian Financial Crisis. *Journal of the Asia Pacific Ecnomy, 9*(3), 271-287.

Bayoumi, T., Eichengreen, B. J., & Mauro, P. (2000). On Regional Moentary Arrangements for ASEAN. *CEPR Discussion Paper*, 2411.

Bowman, C. (2005). Yen Bloc or Koala Bloc? Currency Relationships After the East Asian Crisis. *Japan and the World Economy, 17*, 83-96.

Brailsford, T. J., Penm, J. H. W., & Terrell, R. D. (2005). An Analysis of Asian Market Integration Pre- and Post-Crisis. *International Journal of Theoretical and Applied Finance, 9*(4), 483- 501.

Chang, S. C. (2008). Asymmetric Cointegration Relationship among Asian Exchange Rates. *Economic Change & Restructuring, 41*(2), 125-141.

Chin, L., & Azali, M. (2010). Currency Linkages Among ASEAN. *Singapore Economic Review, 55*(3), 459-470.

Choudhry, T. (2005). Asian Currency Crisis and the Generalized PPP: Evidence from the Far East. *Asian Economic Journal, 19*(2), 137-157.

Click, R. W. (2009). the ASEAN Dollar Standard in the Post-Crisis Era: A Reconsideration. *Journal of Asian Economics, 20*(3), 269-279.

Cortinhas, C. J. F. (2007). Intra-Industry trade and Business Cycles in ASEAN. *Applied Economics, 39*(7), 893-902.

De Grauwe, P. (1994). *The Economics of Monetary Integration* (2 rev. ed.). New York: Oxford University Press.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with Unit Root. *Econometrica, 49*(4), 1057-1072.

Enders, W., & Hurn, S. (1994). Theory and Tests of Generalized Purchasing Power Parity: Common Trends and Real Exchange Rates in the Pacific Rim. *Review of International Economics, 2*(2), 179-190.

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and Error Correction: Representation, Estimation, and Testing. *Econometrica, 55*(2), 251-276.

Gharleghi, B., Shafighi, N., & Fah, B. C. Y. (2015). Financial Integration and Common Currency Area in ASEAN. *Journal of Economics, Business and Management, 3*(1), 111-114.

Jeon, B. N., & Seo, B. (2003). The Impact of the Asian Financial Crisis on Foreign Exchange Market Efficiency: the Case of East Asian Countries. *Pacific-Basin Finance Journal, 11*, 509-525.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economics Dynamics and Control, 12*(2), 231-254.

Kawasaki, K. (2012). Are the "ASEAN Plus Three" Countries Coming Closer to an Optimum Currency Area? *China Economic Policy Review, 1*(2), 1250011-1250031.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. *Journal of Econometrics, 54*, 159-178.

MacKinnon, J. G. (1996). Numberical Distribution Functions for Unit Root and Cointegration Tests. *Journal of Applied Econometrics, 11*, 601-618.

MacKinnon, J. G., Huag, A. A., & Michelis, L. (1999). Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration. *Journal of Applied Econometrics, 14*, 563-577.

McKinnon, R. (1963). Optimum Currency Areas. *The American Economic Review, 53*(4), 717-725.

Mundell, R. A. (1961). A Theory of Optimum Currency Areas. *The American Economic Review, 51*(4), 657-665.

Ng, T. H. (2002). Should the Southeast Asian countries Form a Currency Union? *The Developing Economies, 40*(2), 113-134.

Phillips, P. C., & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika, 75*(2).

Prasad, E. S. (2014). *The Dollar Trap: How the Dollar Tightened its Grip on Global Finance.* Princeton, N.J.: Princeton University Press.

Sun, W., & Simons, G. (2011). Monetary Integration in East Asia: Evidence from Real Effective Exchange Rates. *Review of International Economics, 19*(5), 869-876.

The ASEAN Secretariat. (2014). *ASEAN Economic Community Blueprint (8th Reprint).* Jakarta, Indonesia: The ASEAN Secretariat.

The ASEAN Secretariat. (2015). *ASEAN International Merchandise Trade Statistics Yearbok 2014.* Retrieved from Jakarta, Indonesia: The ASEAN Secretariat.

Thong, S. K., Santhapparaj, A. S., & Hossain, S. (2010). Feasibility of a Single Currency for the ASEAN-5. *International Journal of Business and Accountancy, 1*(1), 47-62.

Zhang, Z., Sato, K., & McAleer, M. (2004). Is a Monetary Union Feasible for East Asia? *Applied Economics, 36*, 1031-1043.