2015

Intra-regional Currency Linkages and the Evolution of Exchange Rate Regime of the ASEAN Region

Tung Nguyen
Illinois Wesleyan University

Intra-regional Currency Linkages and the Evolution of Exchange Rate Regime of the ASEAN Region

Tung Nguyen
Illinois Wesleyan University

Abstract

This paper investigates the intra-regional currency linkages and evolution of exchange rate regimes of the Association of South East Asian Nations (ASEAN) region. Do nations follow regimes they are classified into? Have exchange rate regimes of ASEAN nations become more flexible and less dependent on the US dollar? Are the intra-regional currency linkages strong enough for ASEAN nations to form a monetary union? Answers to these are important as the official regimes announced by ASEAN countries may not reflect their actual behaviors. Using monthly exchange rates per unit SDR and foreign exchange reserves data spanning the entire post-Bretton Woods era (1973-2014), and employing the Frankel-Wei estimation model, I find that before the Asian financial crisis period (1973-1996), ASEAN currencies were mostly de facto dollar peggers and the intra-regional currency linkages were very weak. However, post-crisis (1999-2014) ASEAN currencies have become more flexible and the intra-regional currency linkages have increased considerably.

Keywords: currency linkage, exchange rate regime, ASEAN

JEL Classification: F31, O53

1. Introduction

The Association of Southeast Asian Nations (ASEAN) was established in 1967 with only five members: Singapore, Malaysia, Indonesia, Philippine and Thailand (Asean.org, n.d.). It quickly grew in size, expanding its membership to Brunei, Cambodia, Laos, Myanmar and Vietnam (Asean.org, n.d.). Its GDP share of world total also rose stably from 2.4% in 1980 to 3.8% in 2013, indicating the increasing importance of ASEAN economy in the world (Economywatch.com, n.d.). Since its establishment in 1967, ASEAN has always been working towards the goal of accelerating economic growth and social progress in the region through a joint effort and close collaboration among its members (Asean.org, n.d.). In order to achieve this long-term goal, since the early 1990s, ASEAN has focused on promoting regional economic integration among its ten members (Rillo *et al.*, 2013). Throughout the continuing integration process, there have been numerous studies aiming to analyze and assess the integration level of ASEAN countries. These studies cover a wide range of economic integration aspects, from trade and investment integration (Rillo *et al.*, 2013) to stock market integration (Lim, 2009).

Present study, however, examines the extent of integration from a different perspective. I examine the extent of intra-regional currency linkages over the last three decades. Secondly; the paper aims to discern the evolution of ASEAN exchange rate regimes over time. Have exchange rates of ASEAN nations become more flexible after crisis?[1] Do nations follow regimes they are classified into? This question is motivated by the fact that that the official regimes announced by ASEAN countries may not reflect their actual behaviors. In order to address these issues, I attempt to use market-based data on exchange rates and foreign exchange reserves to examine the true nature of exchange rate regimes of ASEAN countries and their evolution over time.

Since regional economic integration became a priority in the 1990s, the level of integration among ASEAN countries has increased in almost all economic areas (Rillo *et al.*, 2013). Intra-regional trade has been promoted, resulting in an increase in average intra-regional merchandise trade openness (measured by intra-regional import/regional GDP) from 15.2% in 2004-2008 to 22.7% in 2011 (Rillo *et al.*, 2013). In addition, average trade tariff has been reduced drastically from around 5% in 2000 to less than 1% in 2012 (Rillo *et al.*, 2013). Besides

[1] With the increasingly integrated regional economy and capital mobility, pegged exchange rate regimes are thought to become more demanding and thus flexible exchange rate regimes are more desirable (Mussa et.al., 2000)

trade, there is also a steady progress in ASEAN investment integration, as the share of intra-regional FDI in total regional FDI has increased from 8% in 2000 to 20% in 2011 (Rillo *et al.*, 2013). While not being as apparent as integration in trade and investment, integration among ASEAN stock markets still exists, as documented by several studies. Both Lim (2009) and Click and Plummer (2005) conclude that ASEAN stock markets are co-integrated, although the integration process is not yet complete. With the increasing integration in multiple channels, the natural questions are whether ASEAN currencies are strongly linked and how their exchange rate regimes have changed.

While there are numerous studies on ASEAN integration, the topic of ASEAN currency linkages, which has not been investigated thoroughly, is of crucial importance to ASEAN governments' policymakers. The understanding of currency linkages can provide insight that helps policymakers to coordinate monetary policies better. Specifically, if currency linkages among ASEAN countries exist, it follows that monetary policies of ASEAN countries affect each other and policy makers can work together and coordinate monetary policies to attain common goals such as fighting inflation or stimulating the economy. For example, if the Thai baht is linked with the Singapore dollar, then policy makers in Thailand and Singapore can depreciate their currencies together to boost their exports and economies effectively. In addition, ASEAN currency linkages can serve as a criterion to assess the possibility of forming a monetary union among ASEAN countries. In particular, a low level of currency linkages or integration will imply that it is not yet an appropriate time for ASEAN countries to form a monetary union. A high level of currency linkages, together with other important economic indicators following Optimum Currency Area (OCA) theory such as wage flexibility, labor mobility and cultural similarities, could support the formation of a monetary union. Besides currency linkages, the actual exchange rate regime of ASEAN countries is also a very important economic indicator. Although there are some controversies, exchange rate regime have a profound effect on key economic outcomes like output growth, output volatility, inflation rate, etc. (see Levy-Yeyati & Sturzenegger, 2000).

With the purpose of examining the intra-regional currency linkages and evolution of exchange rate regimes of ASEAN countries, in this paper I attempt to work towards the following objectives. Firstly, I examine whether the linkages among the ASEAN currencies have

increased or decreased over the last three decades. Secondly, I determine which major currency in the world has significant impact on the ASEAN currencies. Lastly, I document the extent of *de facto* flexibility of ASEAN exchange rate regimes over time to find out whether they have become more flexible or not.

The results show that overall the intra-regional currency linkages among the ASEAN currencies have increased drastically after the Asian financial crisis of 1997-1998. In addition, the exchange rate regimes of ASEAN nations have become more flexible in the sense that their currencies have been less dependent on the USD post crisis.

The rest of the paper is structured as follows. Section 2 reviews the relevant studies to show the current understanding of ASEAN currency linkages and exchange rate regime, and set the ground for the contribution of this research. Section 3 illustrates trends and patterns in the data, performs some preliminary diagnostic statistics. Section 4 describes the methodology used in this research and presents the results along with their discussions. Section 5 performs some robustness checks. Finally, section 6 provides some concluding thoughts.

2. Literature review

The topic of intra-regional currency linkages that I investigate in this paper can be traced back to the original idea of Miles (1978) about the monetary dependence among countries. In his paper, Miles argues that investors in one country may diversify their cash portfolios by holding domestic and foreign currencies, and thus currencies are substitutes of each other. Such diversification makes it impossible for the monetary policy of a country to be independent from foreign ones. As a result, Miles concludes that to analyze monetary or currency issues, one needs to consider a monetary dependence model in which different currencies are substitutes of each other and influence the values of each other. Expanding from Miles's original idea, later studies continue to develop the theory of monetary dependence. In one such attempt, Spinelli (1983) again stresses the interdependence nature of currencies. He states that the concept of currency substitution proposed in Miles' paper is not the only reason for this phenomenon. His theoretical model shows that any deviation from purchasing power parity (PPP) can lead to a loss of monetary independence. In addition, a lack of perfect foresight of economic agents may also

contribute to the monetary dependence among countries. Combining these three factors, Spinelli reinforces Miles's original idea that domestic currency is usually affected by world currencies.

Together with the development of the theory, there have been numerous empirical studies that apply the theory to study the currency linkages in certain regions of the world. Kitamura (2012) studies the interdependence of three major currencies (euro, yen and Swiss franc) and claims that there is a relationship between the euro and the Swiss franc. Similarly, Dimitriou and Kenourgios (2013) investigate the linkages of five major currencies (euro, yen, pound, Swiss franc and Australian dollar) and discover that the linkages exist and decrease during crisis times. Beside these major countries and currencies, the Asian region is also of particular interest to scholars.

Turning to studies more specific to the region of my analysis, Lee and Azali (2010) examine the quarterly exchange rates of the ASEAN-4 (Malaysia, Indonesia, Thailand, Philippines) against the USD and the Singapore dollar in the period from 1980 to 2007. Lee and Azali utilize three different methods to capture the integration among these currencies: Johansen cointegration test for long run relationship, vector error correction model (VECM) for short run relationship and Granger causality for the direction of the relationship. They find that before the Asian crisis, there was no relationship among these countries while after the crisis; these countries' currencies have become more integrated. Disagreeing with this result, Truchis and Keddad (2013) apply fractional cointegration methods to the monthly exchange rates of the ASEAN-5 countries against the USD and the yen during the period from 1975 to 2011 and discover that the cointegration relation among these countries is not robust. In general, the extent of currency linkages among ASEAN region is still open to debate. This provides an additional incentive to pursue the issue in this present study.

Besides currency linkages of the ASEAN region, the evolution of exchange rate regime of ASEAN nations has also been discussed in recent studies. Before the Asian crisis, the exchange rate regimes of ASEAN countries are thought to be pegged to the US dollar at certain level. In related context, Zhou (1998) investigates 10 countries in the Pacific Basin area by using quarterly exchange rates against the USD from 1973 to 1993. Employing the method of cointegration tests, Zhou arrives at the conclusion that the USD has a dominant influence over

the currencies of the 10 countries of interest. He also notices a notable growing influence of the yen.

After the Asian financial crisis, there are several studies investigating the change in exchange rate regimes of countries in this region. In particular, the studies by Cavoli and Rajan (2009, 2010) examine the *de facto* exchange rate flexibility level of several Asian countries, including the ASEAN-5 nations, in comparison with their *de jure* exchange rate regimes (or officially announced regimes) using monthly exchange rates from 1999 to 2009. Following IMF's exchange rate regime classification, the authors report Malaysia, Indonesia, Singapore and Thailand to have a managed floating regime with no predetermined path and Philippines is reported to have an independent floating regime. Employing the synthesis model proposed by Frankel and Wei (2007), the authors conclude that regardless the official regimes announced by ASEAN-5 countries, their currencies still maintain a high level of fixity to the US dollar. Among these countries, Malaysia and Philippines have the highest dollar coefficients, indicating that they are pegged to the USD the most.

In a more recent research, Rizvi, Naqvi and Mirza (2013) study the dependence of the currencies of 10 Asian countries including the ASEAN-5, China, Hong Kong, India, Korea and Pakistan on 4 major currencies: the USD, euro, pound and yen using monthly exchange rates from 2001 to 2009. The authors conclude that many currencies still depend primarily on the USD while some other currencies start to depend increasingly on the euro.

In order to examine both the intraregional currency linkages as well as the evolution of exchange rate regime, I determine that the synthesis model proposed by Frankel and Wei (2007) would be appropriate. Unlike other existing studies, I cover the longest possible time period, encapsulating the entire post-Bretton Woods period (1973-2014), including the pre-crisis period from 1973 M3 to 1997 M6 and the post-crisis period from 1999 M1 onwards. The synthesis model is discussed in more details in section 4.

3. Data Description

3.1 Trends and patterns in ASEAN exchange rates

In order to assess the currency linkages of the ASEAN region, I use exchange rates per unit Special Drawing Rights (SDRs) for all countries of interest. The SDR is an international reserve asset that was created by the International Monetary Fund (IMF) in 1969 for book-keeping purpose (International Monetary Fund, 2014). Updated periodically by the IMF, the SDR serves not only as a supplementary asset but also as the unit of account for currencies of countries in the world (International Monetary Fund, 2014). In this paper, I obtain the data of exchange rates from the International Financial Statistics (IFS) Database for 6 countries in the ASEAN group: Singapore, Malaysia, Indonesia, Philippines, Thailand and Lao; as well as 3 major countries in the world: the United States, Japan and China[2]. Vietnam and Cambodia are excluded due to the lack of data. Myanmar is also excluded because it adopted a fixed exchange rate scheme for almost all of the period. The data consists of monthly exchange rates in terms of SDR from March 1973 to November 2014.

The usage of SDR as the numeraire currency is appropriate for certain reasons. One advantage of using SDR is that I can include all the major countries-the US, Japan and China in our regression equation. This is of crucial importance, because I would like to assess the linkages of ASEAN currencies with major currencies in the world together with the intra-regional linkages among the ASEAN countries. Instead of using SDR, if I used other measure such as exchange rate against the US dollar, I could not include the US dollar in my regression equation[3].

Figure 1 presents exchange rates against the SDR of the 12 countries. From the plot, in general, exchange rates of ASEAN countries were relatively fixed and stable before the Asian financial crisis in 1997. Almost all of them, except for Myanmar, had a sharp jump during the Asian financial crisis as they had to change from a fixed regime to a flexible one. After the crisis, exchange rates of ASEAN countries have slightly increased, indicating that their currencies have depreciated relatively to the SDR[4]. As for the major currencies, the exchange rates of the USD and the Yuan generally have increased during the period, suggesting that these currencies also

[2] The British pound is not included due to a limited trade relation between ASEAN and Britain.
[3] On the other hand, one disadvantage of using exchange rates in terms of SDR is that the data set is only available in monthly frequency while exchange rates in terms of the US dollar are available in higher frequency such as weekly and daily.
[4] The movement of exchange rate against SDR of each individual ASEAN nation is quite similar to its exchange rate against the USD.

have depreciated with respect to the SDR. The exchange rate of the Japanese yen has declined over time. This implies an appreciation of the Japanese yen.

Besides the trend and patterns in exchange rates of ASEAN currencies and major currencies, I present the correlation matrix of these exchange rates in Table 1a and 1b. From these tables, I observe that the correlations among ASEAN nations, except for Lao, seem to increase after the financial crisis of 1997-1998 while the correlations between the US and ASEAN nations seem to decline. From this observation, I expect the intra-regional currency linkage of ASEAN region to rise and the influence of the USD to fall post crisis.

3.2 FLEX index

Next I create a *de facto* measure of exchange rate flexibility index called FLEX similar to that of Bayoumi and Eichengreen (1998). It is defined as follows

$$\text{FLEX} = \frac{\Delta E}{\Delta E + \Delta FER}$$

where ΔE is the percentage change in exchange rate (in absolute value) and ΔFER is the percentage change in foreign exchange reserve (in absolute value). The index indicates the flexibility in exchange rate regime, with 0 being completely fixed and 1 being completely floating. Indeed, when a country actually follows a fixed exchange rate regime, it has to adjust the foreign exchange reserve radically to keep its currency pegged to another currency or a basket of currencies. As a result, the change in exchange rate is relatively small compared to the change in foreign reserve and the FLEX index will be low. On the other hand, if a country chooses a more flexible regime, then there is less fluctuation in foreign reserve to manipulate exchange rate. Accordingly, the change in foreign reserve is comparatively small, making the FLEX index closer to 1.

Table 2 documents the FLEX index (in 5-year averages) of 6 ASEAN countries from 1980 to 2014. During the entire time period, the FLEX indexes range from around 0.2 to around 0.6. This means most of the ASEAN countries' currencies are not at either one of the two extremes: completely fixed and completely floating. They seem to adapt flexible regimes at certain levels. Also, from the table, the FLEX indexes of ASEAN countries follow an increasing trend over the period. This indicates that ASEAN currencies have become more flexible over the

last three decades. This increasing degree of *de facto* flexibility is most apparent for Malaysia, Philippines, Thailand and Indonesia in the post Asian financial crisis period.

3.3 Unit root and stationarity test

The next step is to perform some preliminary diagnostic statistics with my data set. I perform unit root tests to check for stationarity. In this paper, I use the Augmented Dickey Fuller (ADF) test for unit roots and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test for stationarity. The tests' results are presented in Table 3a and 3b. For the exchange rates, the ADF and KPSS statistics for all the series in logarithmic values indicate that all the exchange rates have unit root and thus are not stationary. Next, I carry out the ADF test and the KPSS test for all series in first-order differences of logarithmic values, which are the growth rates of exchange rates. The results indicate that except for Philippines and Cambodia, all the other exchange rates are stationary in first-order differences. Therefore, from now on I use the exchange rates in first-order differences of logarithmic values, or the growth rates of exchange rates for all countries in my models. For the FLEX index, the ADF statistics indicate that the indexes of all ASEAN nations do not have unit root while the KPSS statistics suggest that the indexes of some countries are not stationary. While there are some discrepancies, I decide to follow the original model and keep the FLEX index in levels for my models, as both the exchange rates and FER in the calculation of the FLEX index are already in first order differences of their logarithmic values.

4. Empirical model and result

4.1 Empirical model

In this paper, I follow the popular Frankel-Wei (2007) and Frankel-Xie(2010) estimation model to determine the currency linkages among the ASEAN countries as well as the evolution of their exchange rate regimes. The authors (2007, 2010) propose a regression equation called synthesis equation of the form

$$\Delta logH_t = c + \sum w_i \Delta logX_{it} + \delta\{FLEX_t\} + u_t$$

where $\Delta logH_t$ (Indonesia, Lao, Malaysia, Philippines, Singapore, Thailand) is the change in exchange rate of the home currency, or the currency of interest, $\Delta logX_{it}$ are the change in

exchange rates of all the other foreign currencies, and $FLEX_t$ is the flexibility index of the home country as discussed in the previous section. The coefficients w_i indicate currency linkages of the home country and the foreign countries and the coefficient δ shows the degree of *de facto* exchange rate flexibility. If $\delta = 0$, the currency of the home country is completely fixed and δ increases as the home country moves towards a more flexible regime.

In the context of this paper, the dependent variable $\Delta \log H_t$ is the change in exchange rate of one of the ASEAN currencies and the explanatory variables $\Delta \log X_{it}$ are the change in exchange rates of the other ASEAN currencies and major currencies (including the USD, the yen, the yuan and the euro)[5]. The coefficients corresponding to the ASEAN currencies are used as measure of intra-regional currency linkages. In particular, a positive coefficient indicates that two currencies have complimentary relationship, they appreciate or depreciate together. A negative coefficient shows a substitute relationship between two currencies; if one depreciates then the other would appreciate. In addition, the coefficients corresponding to the major currencies and especially the USD, together with the δ coefficient of the FLEX index, show the degree of *de facto* exchange rate flexibility of ASEAN countries. In particular, if the coefficient of the USD decreases and the coefficient of the FLEX index increases over time, then a floating exchange rate regime is assured. On the other hand, if the coefficient of the FLEX index is low and the coefficient of the USD is high, then the currency of interest is actually pegged to the USD regardless of how the regime is publicly announced.

Besides using the synthesis equation, I also impose a restriction following Frankel and Wei (2007) that all the weights add up to unity ($\sum w_i = 1$). This can sharpen the estimates by considering that the policymakers must adjust the movements of the home currency through the metric of distance from some reference rate of effective exchange rate. One country may adjust its currency by following a basket of other currencies, so it is reasonable to assume all the weights would add up to 1. The actual mathematical manipulation of the regression equation is shown in the appendix.

4.2 Result and discussion

[5] Unlike the existing literature that focuses on the impact of major currencies, I include the intra-ASEAN currencies in the Frankel-Wei framework in addition to the USD, the yen and the yuan.

In this section, I use ordinary least square to estimate the coefficients in the final specification for the ASEAN countries. Table 4, 5 and 6 show the estimated coefficients with respect to the ASEAN countries in the pre-crisis period (1973-1997), post-crisis period (1999-2014) and whole sample respectively.

From Table 4, I observe that in the pre-crisis period, the intra-regional currency linkages among the ASEAN nations were very weak. There were only a few significant coefficients, namely the coefficients of Singapore affecting Malaysia and Lao. However, the situation has changed drastically after the Asian financial crisis of 1997-1998. Post crisis, the intra-regional currency linkages among the ASEAN nations have grown stronger. There have been several linkages among some particular ASEAN countries, except for Lao's currency which only has linkage with Indonesia's currency. However, the signs of the coefficients are not consistent across these countries. There are some negative coefficients, such as the one between Lao and Indonesia's currencies. This means the currency of Lao and Indonesia are negatively related; and investors may consider these currencies as having a substitute relationship. Still, most of the coefficients are positive, which indicates that the currencies of the majority of ASEAN countries are positively related and they appreciate and depreciate together. From perspective of investors, these currencies have complimentary relationship. Altogether, the intra-regional currency linkages among ASEAN countries are not complete, but have been greatly increased after the Asian financial crisis of 1997-1998.

In addition, the coefficients of Singapore and Thailand's currencies with respect to other countries seem to be the highest among ASEAN countries. In particular, if the Singapore dollar appreciated by 10%, then the Indonesian rupiah, the Malaysian ringgit and the Thai baht would appreciate by 18.6%, 6.7% and 4.1% respectively. Also, if the Thai baht appreciated by10%, then the Indonesian rupiah, the Philippine peso and the Singapore dollar would appreciate by 4.5%, 4.1% and 1.4% respectively. This finding implies that the Singapore dollar acts as a currency leader among the ASEAN countries, forming strong linkages with several currencies in the group. Besides Singapore, the currencies of Malaysia, Indonesia, and Thailand also have significant linkages with three other currencies. In particular, the Malaysian ringgit significantly influences the currencies of Indonesia, Philippines and Singapore. The Indonesian rupiah significantly affects the currencies of Malaysia, Singapore and Thailand. Lastly, the Thai baht

influences the currencies of Indonesia, Philippines and Singapore. The currencies of Lao and Philippines seem to be rather isolated from the group, have linkages with only one or two others.

Next, I examine the evolution of *de facto* ASEAN exchange rate regimes using the results presented in Table 4 and 5. In particular, I compare the coefficients of the FLEX index and the USD between the pre-crisis and post-crisis periods

From Table 4, most of the FLEX index coefficients are not significant, except for the case of Lao and Singapore before the Asian financial crisis. Therefore, these coefficients do not provide much information on the evolution of exchange rate regimes of the ASEAN nations. However, there is a more obvious pattern in the USD coefficients in the pre-crisis and post-crisis period. Before the financial crisis, all of the ASEAN countries except for Lao have significant USD coefficients. This means these countries adopted a rather fixed exchange rate regime, and were pegged at the USD before the financial crisis. Among ASEAN countries, Thailand, Philippines and Indonesia have the highest USD coefficients of 0.81, 0.75 and 0.69 respectively. It seems before the crisis all these 3 countries were *de facto* dollar peggers regardless of their official exchange rate regime classification. Indeed, during this period Thailand was classified to be pegged at a basket of currencies and Indonesia was reported to have managed floating regime (Ariff, 1991), which are not consistent with the evidence found here.

While almost all coefficients of the USD are significant in the pre-crisis period, they have changed remarkably after the crisis. All the USD coefficients in the post-crisis period are insignificant, implying that the ASEAN countries have moved towards a more flexible exchange rate regime and become less dependent on the USD[6]. This weakened power of the USD is also consistent with the fact that the ASEAN countries have become more linked with each other as discussed earlier.[7]

4.3 Residual diagnostics

[6] As for other major currencies, before the crisis Singapore and Thailand were linked with the yen while after the crisis, Indonesia, Malaysia and Thailand had linkage with the yen. All the yen coefficients or weights are not high (under 0.2). See appendix Table 4, 5. In addition, I tried adding the Euro for the post-crisis period and found no significant different. The Euro coefficients are statistically insignificant except for Singapore.

[7] The results without imposing the constraints of the weights were very similar. Those are not shown for purposes of brevity.

Finally, I perform residuals diagnosis by using the Breusch–Godfrey serial correlation Lagrange multiplier (BG) test for autocorrelation, the Breusch–Pagan (BPG) test for heteroskedasticity and the Jarque–Bera (JB) test for normality. For the pre-crisis period, the BG test results indicate that the equations of Indonesia, Philippines and Thailand have autocorrelation issue. For the post-crisis period, residuals of all equations are autocorrelated. As a result, I follow a common treatment of autocorrelation: adding lagged terms of the dependent variable. I try adding one lagged term at a time for each of the equation until the autocorrelation is no longer detected. For most of the equations except for Philippines in the pre-crisis period, adding one or two lagged terms of the dependent variables eliminates autocorrelation issue. Since the significance, the sign and the magnitude of all the coefficients remain almost unchanged after the addition of the lagged terms, I do not show these results for the purpose of brevity and consistency across all the equations. Next, the BPG test shows that in some equations, the residuals are heteroskedastic. Therefore, I use a common approach to deal with heteroskedasticity in the residuals. I employ the HAC (Newey-West) procedure to obtain heteroskedasticity consistent standard errors for all equations. Finally, the JB test indicates that the residuals in the majority of the equations are not normally distributed. However, the lack of normality will not be addressed in this paper.

5. Further robustness tests

5.1 Robustness check with EMP

In this section I provide a robustness check with the introduction of Exchange Market Pressure (EMP) as the alternative explanatory variable in lieu of the FLEX index. This measure is used in several studies in the literature (Frankel&Wei, 2010, Cavoli and Rajan, 2010). The Exchange Market Pressure is defined as the sum of the change in exchange rate and the change in FER

$$EMP_t = \Delta E + \Delta FER$$

EMP represents shocks in demand for the currency (Frankel & Wei, 2010). An EMP coefficient close to 0 indicates a fixed regime while a coefficient close to 1 indicates a flexible regime. The summary of USD and EMP coefficients are shown in table 7 and 8 respectively.

From Table 7 and 8, the result is almost identical to the result using the FLEX index. Most of the USD coefficients are significant, except for Lao before the Asian financial crisis period. In addition, the nations with the highest USD coefficient are Philippines, Thailand and Indonesia. After the crisis, all USD coefficients become insignificant similar to the results using FLEX index. Also, for EMP, only Philippines' coefficients are significant before the crisis and only Lao's coefficients are significant after the crisis[8]. Again, the result using EMP supports a more flexible regime from the ASEAN nations.

5.2 Robustness check with rolling window regression

In this section, I further check for the robustness of my results using rolling regression. First of all, I create a window of the first 7 years (first 84 data points)[9]. Then I run the regression equation to obtain the coefficients estimation and the p-value for the first window. Then I move the window by moving the start date and the end date by one month (one data point), thereby keeping the sample size fixed throughout, and obtain the second set of coefficients and corresponding p-value. I continue moving the window until the last data point in my original data set (1974-2014) is reached. Finally, I have the time-varying values of all coefficients and their p-values. Figure 2 presents the USD coefficients over time[10].

From Figure 2, it is evident in the graph of Malaysia, Philippines, Singapore and Thailand that the USD coefficients have decreased after the crisis (due to the 7-year window, post-crisis in these graphs starts from 2006). The declining USD coefficient is most apparent for Malaysia and Singapore. Moreover, I observe that the p-values of the USD coefficients were close to 0 for several periods before the crisis for Philippines, Singapore, Thailand and Indonesia. This is consistent with the findings that the ASEAN currencies were dollar peggers prior to the crisis. However, after the crisis, the p-values of the USD coefficients are higher than 0.1 most of the time, indicating that the USD coefficients are statistically insignificant. This

[8] The coefficients of ASEAN currencies and other major currencies do not change sign or significance as well.
[9] The duration is chosen to be 7 years, which is long enough to deal with the problem of one currency being completely fixed at the USD for a period of several years, causing a multicolinearity issue.
[10] Lao is not included due to insufficient data

means the influence of the USD on ASEAN currencies has diminished post crisis. Therefore, the rolling window regression supports the results presented in Section 4.[11]

6. Conclusion

This paper seeks to investigate the intra-regional currency linkages and evolution of exchange rate regimes in the ASEAN region, in particular the 6 ASEAN nations including Indonesia, Lao, Malaysia, Philippines, Singapore and Thailand. In order to assess the currency linkages and the flexibility of exchange rate regimes, I make use of the monthly exchange rates per unit SDR of these ASEAN countries' currencies and three major world currencies (the USD, the yen and the yuan). Unlike the other studies in the literature, I cover the longest possible period encapsulating the entire post-BrittonWoods period (1973-2014), which includes the pre-Asian crisis period (1973-1997) and post-crisis period (1999-2014). I employ the Frankel-Wei well-known regression model to evaluate the intra-regional currency linkages and the degree of flexibility in ASEAN exchange rate regimes. Then I check the results for robustness by using an alternative explanatory variable and rolling window regression. Both methods indicate that the results are robust.

The results regarding intra-regional currency linkages and evolution of exchange rate regimes reveal a consistent trend across the ASEAN nations. Before the Asian financial crisis, most of the ASEAN currencies were dollar peggers and the intra-regional currency linkages were very weak and close to non-existence. Post crisis, however, the influence of the USD has been weaker; the ASEAN nations have moved towards a more flexible exchange rate regimes. In addition, the intra-regional currency linkages among the region have become stronger. Notably, among the ASEAN nations, the Singapore dollar stands out as the currency leader as it has strong linkages with several other major ASEAN currencies, namely Malaysia, Indonesia and Thailand (MIT group). Still, the currency linkages are not yet consistent and complete. Currencies of smaller economies like Lao and Philippines have limited linkages with only one or two other ASEAN currencies.

[11] The p-values of other ASEAN coefficients also show the statistical significance of several intra-regional linkages post crisis.

In general, the results of this paper are consistent with the views espoused by Lee and Azali (2010) that the ASEAN currencies have become more integrated post Asian financial crisis. Similar to these authors, this paper finds a growing power of the Singapore dollar in the region. As for the exchange rate regimes and connection of ASEAN currencies with major world currencies, I arrive at the same conclusion as Zhou (1998) that the USD had dominant power over the ASEAN currencies prior to the Asian financial crisis. However, for the post crisis, this paper's findings do not agree with the recent literature, which suggests that the USD still has much impact on the ASEAN currencies (Rizvi, Naqvi and Mirza, 2013& Cavoli and Rajan, 2010). I find that the ASEAN currencies have become less dependent on the USD. This difference can be explained by the difference in the approach of this paper and the approach of these recent studies. Unlike these studies which do not take into account the regional influences, I include both ASEAN currencies and major currencies in the regression equation and thus discover an increase in the intra-regional currency linkages post crisis. This indicates that with the collaboration efforts of ASEAN nations post crisis, their currencies have become more integrated as a group, which weakens the power of the USD over ASEAN currencies.

The findings of my research have several implications for policymakers. First of all, these findings can be used as a reference to assess the feasibility of ASEAN forming a monetary union. I discover that the linkages among ASEAN currencies are not yet consistent and complete, which makes the immediate formation of a monetary union not feasible. However, I also find that the linkages have increased and the Singapore dollar can be considered as the currency leader. This suggests that Singapore is a potential candidate for the common currency when the ASEAN countries become integrated enough to form a monetary union in the future. Besides, my findings also document the currency linkages among certain ASEAN countries like Singapore, Malaysia, Indonesia and Thailand to be greater post-crisis. Because the exchange rates of these countries are positively related, these countries' policymakers can coordinate monetary policies to attain a common goal. For example, Singapore and Malaysia can depreciate their currencies together to reach a common goal of boosting their economies. Altogether, these understanding of the intra-regional currency linkages would provide policymakers with the tools to improve collaboration among the ASEAN nations.

References

Asean.org,. Overview. Retrieved 12 September 2014, from http://www.asean.org/asean/about-asean/overview

Ariff, M. (1991). The Pacific economy: Growth and external stability. North Sydney, NSW: Allen & Unwin in association with the Pacific Trade and Development Conference Secretariat, the Australian National University, and the Institute of Strategic and International Studies (ISIS), Malaysia.

Bayoumi, T., & Eichengreen, B. (1998). Exchange rate volatility and intervention: implications of the theory of optimum currency areas. *Journal Of International Economics*, 45(2), 191-209.

Cavoli, T., & Rajan, R. S. (2009). Have Exchange Rate Regimes in Asia Become More Flexible Post Crisis? Re-visiting the Evidence. In Y. Cheung, K. Wong (Eds.) , *China and Asia: Economic and Financial Interactions* (pp. 135-155).

Cavoli, T., & Rajan, R. (2010). A Note on Exchange Rate Regimes in Asia: Are They Really What They Claim to Be? *Economics Bulletin*, 30(4), 2864-2876.

Click, R., & Plummer, M. (2005). Stock market integration in ASEAN after the Asian financial crisis. *Journal Of Asian Economics*, 16(1), 5--28.

Dimitriou, D., & Kenourgios, D. (2013). Financial crises and dynamic linkages among international currencies. *Journal Of International Financial Markets, Institutions & Money*, 26319-332. doi:10.1016/j.intfin.2013.07.008

Economywatch.com,. ASEAN 5 GDP Share of World Total (PPP) data, GDP Share of World Total (PPP) ASEAN 5. Retrieved 12 September 2014, from http://www.economywatch.com/economic-statistics/ASEAN-5/GDP_Share_of_World_Total_PPP/

Frankel, J., & Wei, S. (2007). Estimation of De Facto Exchange Rate Regimes: Synthesis of the Techniques for Inferring Flexibility and Basket Weights. *IMF Staff Papers*, 384-416.

Frankel, J., & Xie, D. (2010). Estimation of De Facto Flexibility Parameter and Basket Weights in Evolving Exchange Rate Regimes. *American Economic Review*, *100*(2), 568-572.

Kitamura, Y. (2012). Informational Linkages among the Major Currencies in the EBS Market: Evidence from the Spot Rates of the Euro, Yen and Swiss Franc. *Japan And The World Economy*, 24(1), 17-26. doi:http://dx.doi.org.proxy.iwu.edu/10.1016/j.japwor.2011.12.003

Lee, C., & Azali, M. (2010). Currency linkages among Asean. *Singapore Economic Review*, *55*(3), 459-470.

Levy-Yeyati, E., & Sturzenegger, F. (2000). Exchange Rate Regimes and Economic Performance. *IMF Staff Papers*, 49(1), 62--98.

Lim, L. (2009). Convergence and interdependence between ASEAN-5 stock markets. *Mathematics And Computers In Simulation*, 79(9), 2957--2966.

Miles, M. A. (1978). Currency Substitution, Flexible Exchange Rates, and Monetary Independence. *American Economic Review*, *68*(3), 428-436.

Mussa, M., Masson, P., Swoboda, A., Jadresic, E., Maudro, P., & Berg, A. (2000). Exchange Rate Regimes in an Increasingly Integrated World Economy. *Occasional Paper*, 193. Retrieved February 6, 2015, from https://www.imf.org/external/pubs/ft/op/193/index.HTM

Rillo, A., Sirivunnabood, P., Ahsan, A., & Maur, J. (2013). Association of Southeast Asian Nations (ASEAN) integration monitoring report : a joint report by the ASEAN Secretariat and the World Bank. World Bank Group.

Rizvi, A. S., Naqvi, B., & Mirza, N. (2013). Choice of Anchor Currencies and Dynamic Preferences for Exchange Rate Pegging in Asia. *Lahore Journal Of Economics*,*18*(2), 37-49.

Truchis, G., & Keddad, B. (2013). Southeast Asian monetary integration: New evidences from fractional cointegration of real exchange rates. *Journal Of International Financial Markets, Institutions & Money*, *26*, 394-412.

Zhou, S. (1998). Exchange rate systems and linkages in the pacific basin. *Atlantic Economic Journal*, *26*(1), 66. doi:10.1007/BF02298372

Table 1a: Correlation matrix of exchange rates in the pre-crisis period

	Indonesia	Lao	Malaysia	Philippines	Singapore	Thailand	US	Japan	China
Indonesia	1.000	0.007	0.153	0.205	0.168	0.229	0.326	-0.098	0.285
Lao	0.007	1.000	-0.059	0.010	-0.109	0.013	0.015	-0.062	0.060
Malaysia	0.153	-0.059	1.000	0.330	0.675	0.384	0.508	-0.113	0.430
Philippines	0.205	0.010	0.330	1.000	0.308	0.435	0.561	-0.283	0.432
Singapore	0.168	-0.109	0.675	0.308	1.000	0.358	0.485	-0.043	0.464
Thailand	0.229	0.013	0.384	0.435	0.358	1.000	0.724	-0.240	0.522
US	0.326	0.015	0.508	0.561	0.485	0.724	1.000	-0.402	0.700
Japan	-0.098	-0.062	-0.113	-0.283	-0.043	-0.240	-0.402	1.000	-0.259
China	0.285	0.060	0.430	0.432	0.464	0.522	0.700	-0.259	1.000

Table 1b: Correlation matrix of exchange rates in the post-crisis period

	Indonesia	Lao	Malaysia	Philippines	Singapore	Thailand	US	Japan	China
Indonesia	1.000	-0.279	0.195	0.303	0.486	0.357	0.037	-0.153	0.029
Lao	-0.279	1.000	0.116	0.030	-0.019	0.046	0.181	0.077	0.182
Malaysia	0.195	0.116	1.000	0.559	0.637	0.431	0.572	-0.189	0.565
Philippines	0.303	0.030	0.559	1.000	0.494	0.560	0.449	-0.118	0.438
Singapore	0.486	-0.019	0.637	0.494	1.000	0.497	0.342	-0.011	0.331
Thailand	0.357	0.046	0.431	0.560	0.497	1.000	0.314	-0.003	0.312
US	0.037	0.181	0.572	0.449	0.342	0.314	1.000	-0.018	0.996
Japan	-0.153	0.077	-0.189	-0.118	-0.011	-0.003	-0.018	1.000	-0.004
China	0.029	0.182	0.565	0.438	0.331	0.312	0.996	-0.004	1.000

Table 2: Summary of FLEX index for ASEAN countries

	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014
Malaysia	0.252	0.278	0.244	0.449	0.357	0.389	0.527
Indonesia	0.212	0.349	0.340	0.594	0.600	0.375	0.392
Philippines	0.237	0.186	0.250	0.365	0.437	0.450	0.452
Thailand	0.235	0.225	0.287	0.392	0.414	0.367	0.425
Singapore	0.384	0.414	0.279	0.422	0.377	0.311	0.387
Lao	N/A	0.143	0.310	0.540	0.330	0.237	0.226

Table 3a: Unit Root and Stationarity Tests for exchange rates

Group	Variables	Levels		1st differenced	
		ADF t-stat	KPSS t-stat	ADF t-stat	KPSS t-stat
ASEAN	Log of Malaysia ER	-2.159	0.302***	-18.301***	0.111
	Log of Indonesia ER	-2.361	0.256***	-17.891***	0.065
	Log of Philippines ER	-1.242	0.463***	-18.345***	0.530**
	Log of Thailand ER	-2.140	0.292***	-17.033***	0.115
	Log of Singapore ER	-2.053	0.210**	-18.076***	0.090
	Log of Lao ER	-2.477	0.338***	-25.593***	0.088
Major currencies	Log of US ER	-2.835	0.085	-16.721***	0.079
	Log of EU ER	-2.543	0.188**	-14.018***	0.146
	Log of Japan ER	-1.601	0.511***	-16.624***	0.187
	Log of China ER	-1.122	0.483***	-15.535***	0.187

Note:
*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*
2. ADF test: Null hypothesis is that the series has a unit root. KPSS test: Null hypothesis is that the series is stationary.

Table 3b: Unit Root and Stationarity Tests for FLEX index

Group	Variables	Levels	
		ADF t-stat	KPSS t-stat
ASEAN	FLEX of Malaysia	-9.511595***	0.049624
	FLEX of Indonesia	-8.857197***	0.396774***
	FLEX of Philippines	-8.076095***	0.161766**
	FLEX of Thailand	-20.23916***	0.123245*
	FLEX of Singapore	-18.42084***	0.147296**
	FLEX of Lao	-11.99216***	0.354447***

Note:
*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*

2. ADF test: Null hypothesis is that the series has a unit root. KPSS test: Null hypothesis is that the series is stationary.

Table 4: Regression estimation results for ASEAN countries in the pre-crisis period

	Indonesia	**Lao**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**
Constant	**0.004***	**0.016****	0.001	**0.006*****	**-0.003*****	0.000
	(1.943)	(2.005)	(1.233)	(2.202)	(-2.889)	(0.383)
FLEX	0.008	-0.007	0.001	-0.007	0.002	0.002
	(0.963)	(-0.957)	(0.251)	(-1.381)	(0.971)	(0.593)
Indonesia		-0.130	-0.010	0.019	0.005	-0.004
		(-0.173)	(-1.410)	(0.887)	(0.661)	(-0.715)
Lao	0.000		0.000	0.000	**-0.001****	0.000
	(-0.012)		(-0.173)	(-0.307)	(-2.459)	(1.371)
Malaysia	-0.109	0.116		0.098	**0.447*****	0.018
	(-1.269)	(0.283)		(1.374)	(7.384)	(0.376)
Philippines	0.037	0.107	0.020		0.004	0.024
	(0.710)	(0.798)	(1.000)		(0.225)	(0.753)
Singapore	0.089	**1.206****	**0.746*****	0.027		0.035
	(0.782)	(2.002)	(10.292)	(0.166)		(0.943)
Thailand	-0.043	-2.942	0.018	0.118	0.013	
	(-0.882)	(-1.513)	(0.366)	(1.455)	(0.449)	
USD	**0.690*****	3.442	**0.213*****	**0.748*****	**0.228*****	**0.811*****
	(3.250)	(-1.068)	(2.849)	(5.586)	(3.623)	(10.358)
Japan	0.103	0.418	0.002	**-0.131***	**0.162*****	**0.089*****
	(1.276)	(1.657)	(0.087)	(-1.884)	(7.208)	(5.782)
N	292	103	292	292	292	292
Adj R^2	0.057	0.075	0.581	0.175	0.681	0.522
F-stat	3.200***	2.030*	51.449***	8.737***	78.715***	40.670***
D-W stat	1.567	1.837	1.733	1.610	1.690	1.704

Note:

*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*

2. t-stats are in the parenthesis.

3. I use the standard procedure HAC (Newey-West) to adjust the standard errors for heteroskedasticity

Table 5: Regression estimation results for ASEAN countries in the post-crisis period

	Indonesia	**Lao**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**
Constant	0.005	-0.008*	0.000	-0.001	0.000	-0.001
	(1.591)	(-1.930)	(-0872)	(-0.304)	(0.087)	(-0.444)
FLEX	0.001	**0.048****	0.000	0.004	-0.003	0.002
	(0.083)	(1.981)	(0.049)	(1.025)	(-1.832)	(0.547)
Indonesia		**-0.339***	**-0.047****	0.045	**0.102*****	**0.061****
		(-1.870)	(-2.372)	(1.431)	(4.887)	(2.060)
Lao	**-0.259*****		0.013	-0.012	0.016	0.031
	(-3.806)		(0.999)	(-0.428)	(1.320)	(0.943)
Malaysia	**-0.622****	0.222		**0.348*****	**0.466*****	0.047
	(-2.088)	(0.808)		(3.342)	(6.819)	(0.400)
Philippines	0.214	-0.019	**0.134*****		0.019	**0.296*****
	(1.472)	(-0.010)	(2.993)		(0.361)	(4.265)
Singapore	**1.863*****	0.642	**0.666*****	0.043		**0.409*****
	(3.999)	(1.420)	(8.240)	(0.230)		(3.146)
Thailand	**0.445****	0.154	0.027	**0.406*****	**0.144*****	
	(2.273)	(0.390)	(0.415)	(4.205)	(3.394)	
USD	0.255	-0.864	0.021	1.382	0.293	-0.748
	(0.243)	(-0.503)	(0.049)	(1.413)	(0.515)	(-0.737)
Japan	**-0.316*****	0.084	**-0.120*****	-0.049	**0.153*****	0.056
	(-2.952)	(0.420)	(-3.529)	(-0.978)	(7.168)	(0.951)
N	188	143	188	188	188	188
Adj R^2	0.397	0.200	0.490	0.356	0.676	0.458
F-stat	16.401***	5.439***	23.522***	13.908***	49.683***	20.752***
D-W stat	1.741	1.206	1.624	1.497	1.622	1.383

Note:

*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*

2. t-stats are in the parenthesis.

3. I use the standard procedure HAC (Newey-West) to adjust the standard errors for heteroskedasticity

Table 6: Regression estimation results for ASEAN countries in the whole sample

	Indonesia	Lao	Malaysia	Philippines	Singapore	Thailand
Constant	**0.005****	0.000	0.000	0.004*	**-0.001***	-0.001
	(2.297)	(0.109)	(0.070)	(1.841)	(-1.748)	(-1.118)
FLEX	0.001	**0.030****	0.002	-0.002	-0.001	0.004
	(0.170)	(2.144)	(0.690)	(-0.677)	(-0.685)	(1.276)
Indonesia		0.002	**0.037***	**0.052*****	**0.024***	**0.092*****
		(0.023)	(1.676)	(3.302)	(1.887)	(4.105)
Lao	0.002		0.000	0.000	**-0.001****	**0.001****
	(1.620)		(-0.300)	(0.403)	(-2.189)	(2.569)
Malaysia	0.472	0.378		**0.178****	**0.334*****	**0.338****
	(1.462)	(1.325)		(2.545)	(5.982)	(2.522)
Philippines	**0.273***	0.047	**0.072***		0.014	**0.200****
	(1.673)	(0.363)	(1.760)		(0.657)	(2.441)
Singapore	**0.653****	-0.013	**0.728*****	0.068		**0.193***
	(2.185)	(-0.054)	(10.058)	(0.577)		(1.890)
Thailand	**0.775*****	**0.289***	**0.217*****	**0.321*****	**0.055***	
	(2.841)	(1.688)	(2.623)	(6.591)	(1.847)	
USD	**-0.854****	1.151	-0.094	**0.478*****	**0.264*****	**0.308****
	(-2.218)	(0.750)	(-0.740)	(6.065)	(4.943)	(2.091)
Japan	-0.133	0.172	**-0.041***	**-0.143*****	**0.169*****	0.046
	(-1.379)	(1.217)	(-1.651)	(-3.144)	(9.465)	(1.158)
N	500	264	500	500	500	500
Adj R^2	0.331	0.203	0.598	0.340	0.661	0.542
F-stat	31.871***	9.390***	93.838***	33.112***	122.501***	74.831***
D-W stat	1.481	1.366	1.867	1.557	1.595	1.596

Note:

*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*

2. t-stats are in the parenthesis.

3. I use the standard procedure HAC (Newey-West) to adjust the standard errors for heteroskedasticity

Table 7: Summary table for the estimated USD coefficients (EMP specification)

	Pre-crisis	Post-crisis	Full-sample
Indonesia	**0.692***** (0.001)	0.360 (0.344)	**-0.825**** (-1.36)
Lao	3.685 (0.279)	0.231 (0.185)	1.281 (0.823)
Malaysia	**0.214***** (0.005)	0.021 (0.050)	-0.080 (0.517)
Philippines	**0.853***** (6.855)	1.377 (1.434)	**0.532***** (0.000)
Singapore	**0.232***** (0.000)	0.207 (0.352)	**0.262***** (0.000)
Thailand	**0.814***** (0.000)	-0.784 (-0.769)	**0.307**** (0.041)

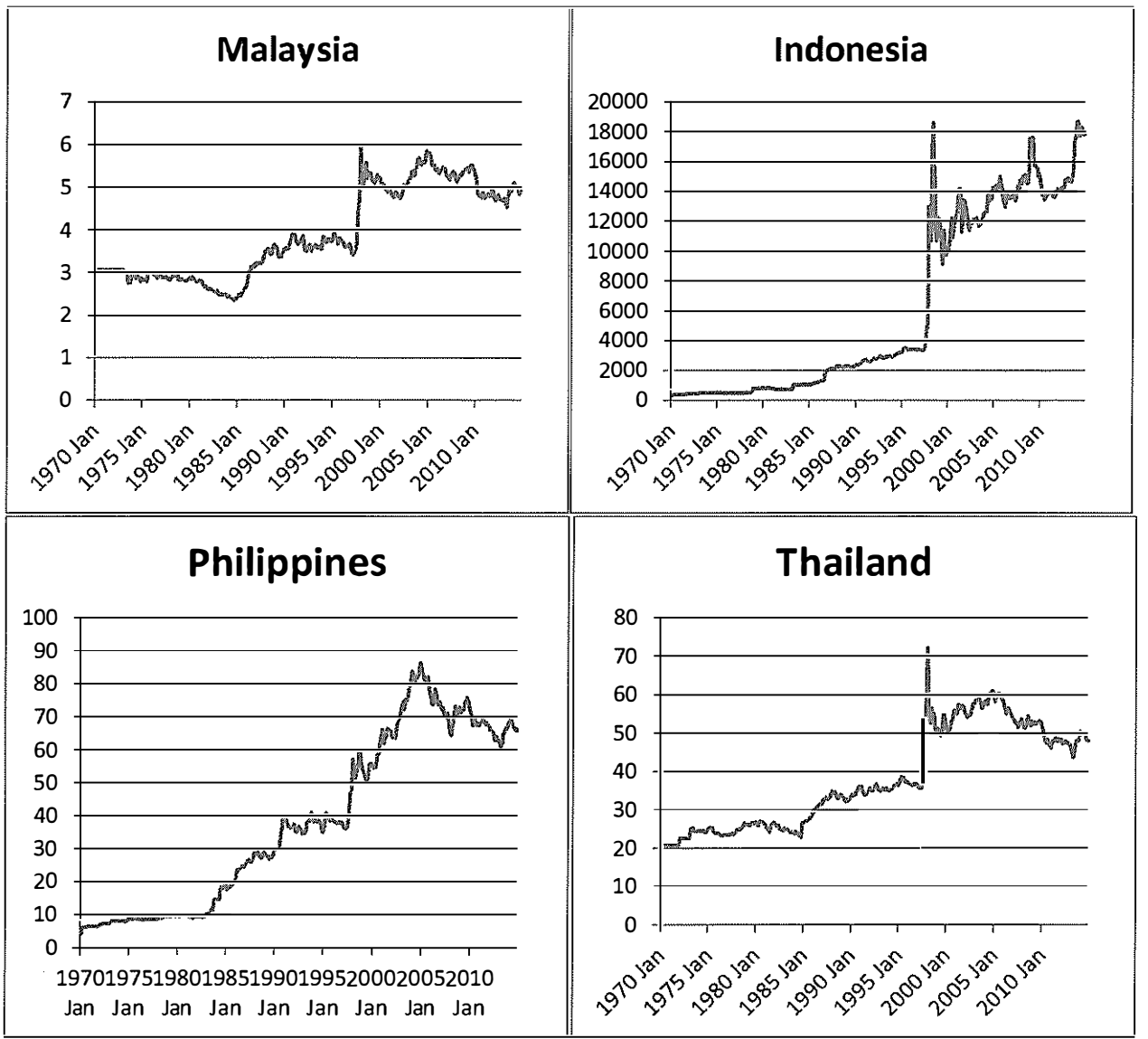
Note:
*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*
2. t-stats are in the parenthesis.
3. I use the standard procedure HAC (Newey-West) to adjust the standard errors for heteroskedasticity

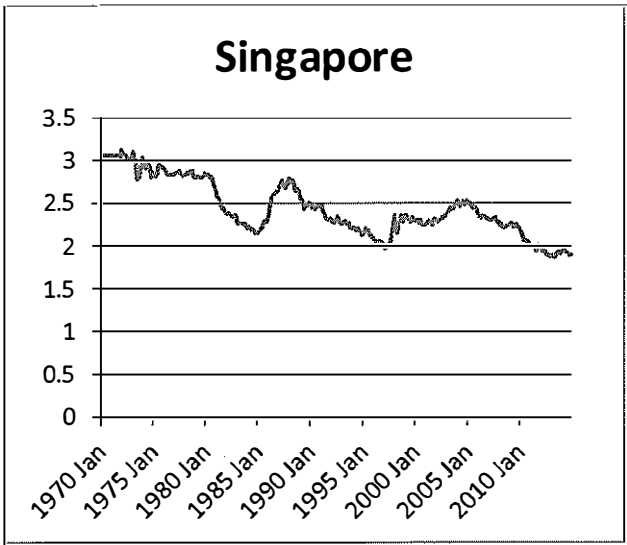
Table 8: Summary table for the estimated EMP index coefficients

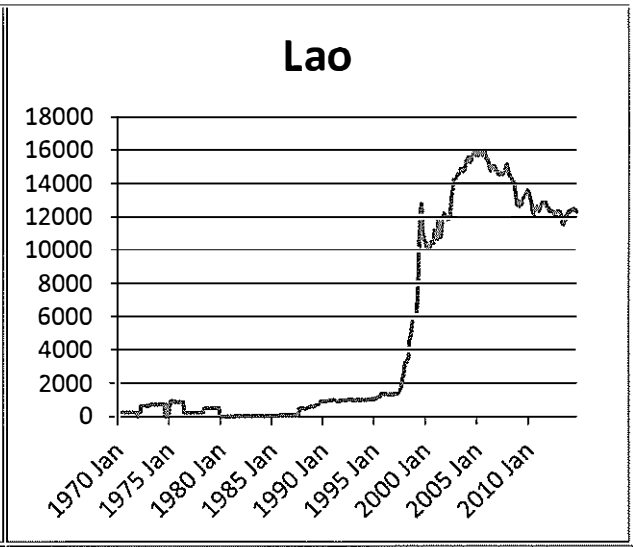
	Pre-crisis	Post-crisis	Full-sample
Indonesia	0.019 (0.311)	-0.061 (-0.990)	0.037 (0.264)
Lao	0.016 (0.140)	**0.281**** (2.080)	**0.029**** (0.039)
Malaysia	0.004 (0.346)	0.003 (0.096)	0.018 (0.298)
Philippines	**0.049**** (0.033)	-0.054 (-1.377)	**0.043**** (0.043)
Singapore	-0.047 (-1.850)	0.055 (1.613)	-0.011 (-0.366)
Thailand	0.010 (0.880)	-0.049 (-1.014)	0.004 (0.098)

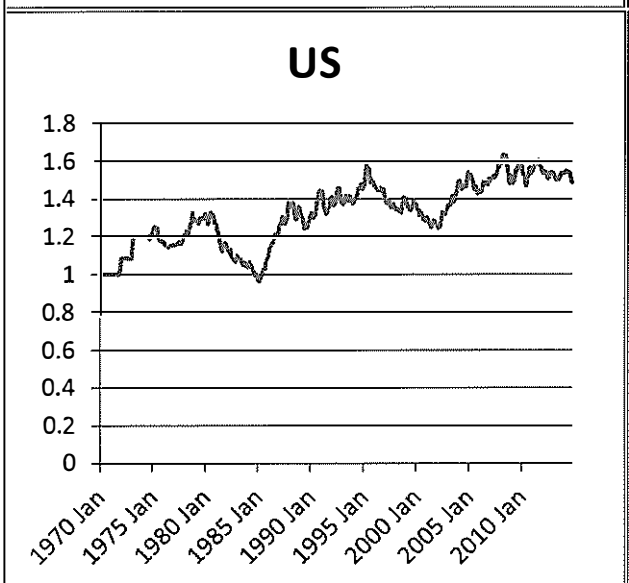
*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*
2. t-stats are in the parenthesis.
3. I use the standard procedure HAC (Newey-West) to adjust the standard errors for heteroskedasticity

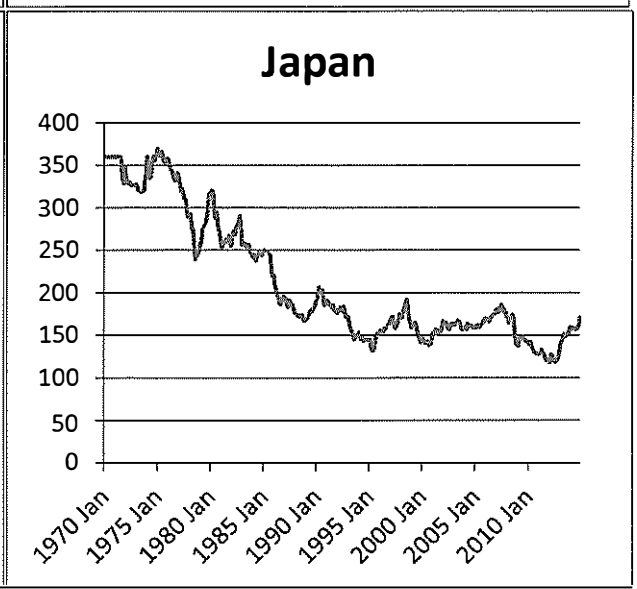
Figure 1: Exchange rates of ASEAN (per unit SDR) countries and major countries from 1973 to 2014




Singapore
3.5
3
2.5
2
1.5
1
0.5
0
1970 Jan
1975 Jan
1980 Jan
1985 Jan
1990 Jan
1995 Jan
2000 Jan
2005 Jan
2010 Jan


Lao
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1970 Jan
1975 Jan
1980 Jan
1985 Jan
1990 Jan
1995 Jan
2000 Jan
2005 Jan
2010 Jan


US
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1970 Jan
1975 Jan
1980 Jan
1985 Jan
1990 Jan
1995 Jan
2000 Jan
2005 Jan
2010 Jan


Japan
400
350
300
250
200
150
100
50
0
1970 Jan
1975 Jan
1980 Jan
1985 Jan
1990 Jan
1995 Jan
2000 Jan
2005 Jan
2010 Jan

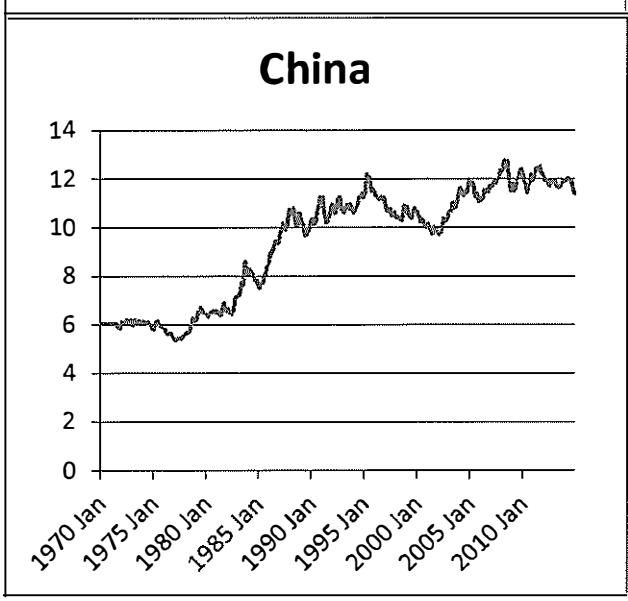
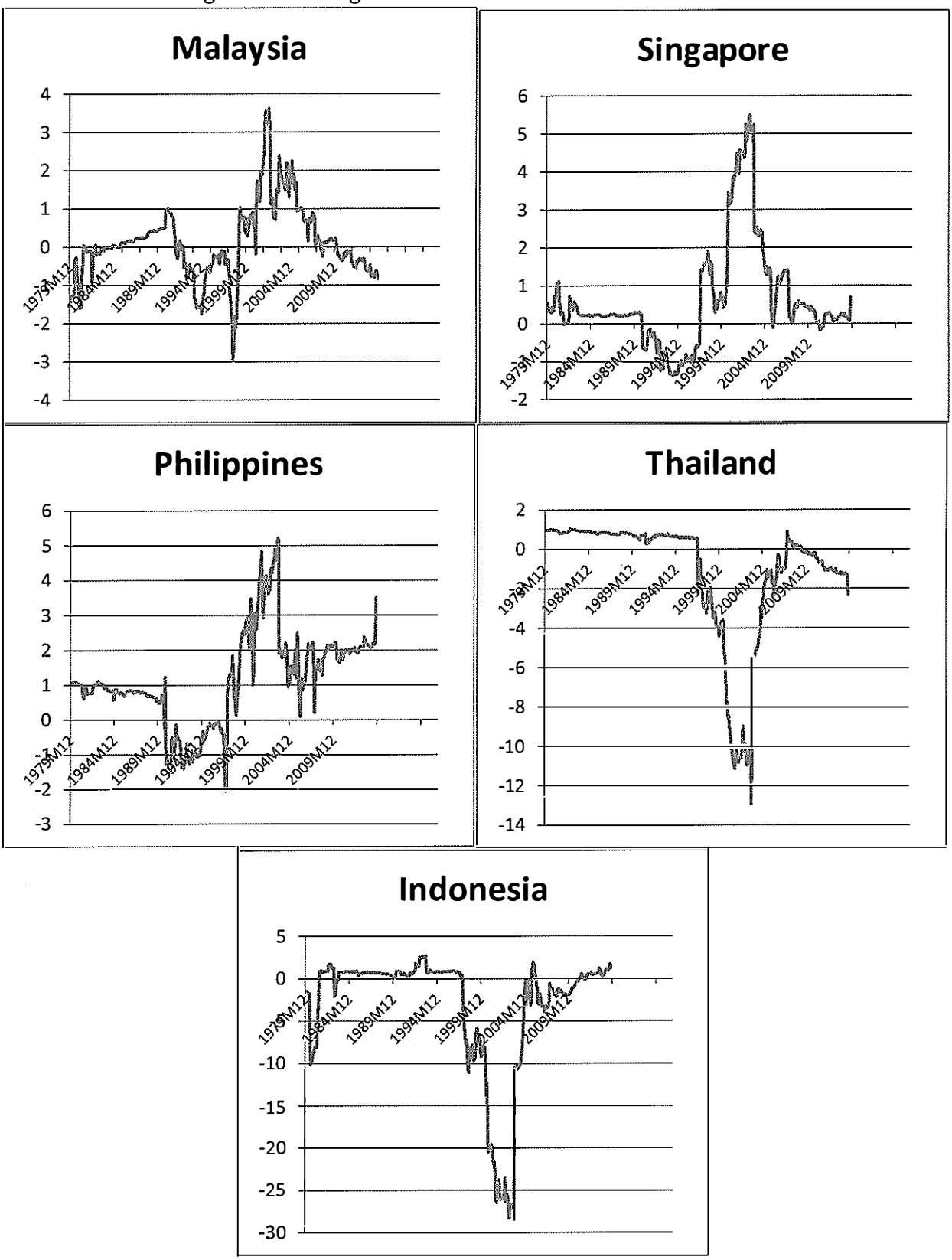

China
14
12
10
8
6
4
2
0
1970 Jan
1975 Jan
1980 Jan
1985 Jan
1990 Jan
1995 Jan
2000 Jan
2005 Jan
2010 Jan

Figure 2: Rolling USD coefficients for ASEAN countries



Appendix

Appendix 1: Unit Root and Stationarity Tests for Exchange Market Pressure

Group	Variables	Levels	
		ADF t-stat	**KPSS t-stat**
ASEAN	EMP of Malaysia	-17.32877***	0.400033***
	EMP of Indonesia	-5.798710***	0.125464*
	EMP of Philippines	-2.016316	0.349717***
	EMP of Thailand	-7.741149***	0.186765**
	EMP of Singapore	-18.54397***	0.055828
	EMP of Lao	-11.74563***	0.184476**

Note:
*1. * Denote rejecting the null hypothesis. *** = at the 1% level, ** = at the 5% level, * = at the 10% level.*
2. ADF test: Null hypothesis is that the series has a unit root. KPSS test: Null hypothesis is that the series is stationary.

Appendix 2: Mathematical manipulation of the regression equation under constraint

I impose a constraint that the weights of all currencies add up to 1. For example, the original equation for Malaysia is

$$Mal_t = c + w_1 Lao_t + w_2 Ind_t + w_3 Phil_t + w_4 Sing_t + w_5 Thai_t + w_6 US_t + w_7 Jap_t + w_8 China_t + \delta\, Mal\_FLEX_t + u_t$$

In this equation, I impose the condition $w_8 = 1 - w_1 - \cdots - w_7$ to make sure all the weights add up to 1. The equation becomes

$$Mal_t = c + w_1 Lao_t + w_2 Ind_t + w_3 Phil_t + w_4 Sing_t + w_5 Thai_t + w_6 US_t + w_7 Jap_t + (1 - w_1 - \cdots - w_7) China_t + \delta\, Mal\_FLEX_t + u_t$$

Simplifying the equation by subtracting China's exchange rate from both sides, I come up with the final specification[12]

$$[Mal_t - China_t] = c + w_1[Lao_t - China_t] + w_2[Ind_t - China_t] + \cdots + \delta\, Mal\_FLEX_t + u_t$$

[12] The implicit weight of the Chinese yuan can be calculated by adding up all weights of non-yuan currencies and subtracting the sum from 1.