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Evaluating Currency Convergence in East Asia

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Abstract

There have been increased debates among economic analysts and policy makers on the role of financial globalization in economic growth and the importance of openness to international trade followed the global financial crisis (GFC) of 2007-2009. The global crisis has affected both the developed and emerging-market economies in East Asia where major stock markets plunged along with the US market and many currencies also fell against the US dollar. Although the impact of the US-led GFC was less severe than the 1997-1998 financial crisis, a large empirical literature has emerged examining the future directions of monetary and exchange rate arrangements for many of the countries in the region The popular question asked in the literature: is East Asia the next optimum currency area after the European Monetary Union? This paper investigates the convergence of currencies in the East Asia region. Both the cluster analysis and time series tests of income convergence are used to determine whether increased trade and financial integration has led to currency convergence over the period January 1990 to June 2010. The countries included in this study are the high-performing East Asian economies, namely China, Hong Kong, Japan, South Korea, Taiwan and the five founding ASEAN member countries.

Keywords: Convergence; Cluster analysis; Exchange rates; Price co-movements

1. Introduction

There have been increased debates among economic analysts and policy makers on the role of financial globalization in economic growth and the importance of openness to international trade followed the global financial crisis (GFC) of 2007-2009. The global crisis has affected both the developed and emerging-market economies in East Asia where major stock markets plunged along with the US market and many currencies also fell against the US dollar (see Cline, 2010). Many currencies of East Asian economies have yet to recover fully from the aftermath of the 1997-1998 financial crisis, though the impact of the US-led GFC was less severe. In the last decade, a large empirical literature has emerged examining the future directions of monetary and exchange rate arrangements for many of the countries in the region (see Angresano, 2004; Grauwe, 2007; Lim, 2005; Ruland, 2000; Wyplosz, 2001). The popular question asked in the literature: is East Asia the next optimum currency area after the European Monetary Union (EMU)?

The literature on optimum currency area started in the early 1960s with the seminal contributions by Mundell (1962) and McKinnon (1963). There are costs and benefits for different countries to join a monetary union and adopt a single currency of its member countries. The benefits (in terms of reduction in transaction costs, increased price stability and positive external effects) and costs (in terms of the loss of control of monetary policies and macroeconomic management of the economy) to the union members largely depend on the similarities in their economic structures. The economic theory of convergence implies that relatively similar economies would make better candidates for monetary integration. If economies diverge in their development levels and macroeconomic conditions, the costs of monetary integration and sustaining integration would be high.

This is evidenced from the entry criteria listed in the Maastricht Treaty (see Krugman and Obstfeld, 2000). Preconditions for nominal convergence involve numerical targets on the convergence of interest rates, inflation, exchange rates, and government debts and deficits. The purpose of such convergence requirements is to reduce the pre-integration

levels of divergence among participating countries, so as to alleviate the costs of losing the exchange rate instrument in macroeconomic stabilization after integration.

The Association of South-East Asian Nations (ASEAN) was established in 1967 to promote economic, social and cultural cooperation, and to safeguard economic and political stability in the region. Over the last four decades, the rapid growth in East Asia has brought increased integration to economies in the South-East Asian region, and strengthened its position in the world economy. ASEAN is the fourth largest trading region in the world with a market of 590.6 million people and a combined gross domestic product of US$1,499.4 billion.[1] In recent years, the rapid growth of China and its Free Trade Agreement (FTA) with ASEAN has attracted international attention. The success of China has shifted the economic power toward East Asia which fosters a deeper level of interaction between ASEAN and the region. Both are experiencing rapid integration into the global economy and take on the role of supply chains and factories to the world.

The East Asia financial crisis of the late 1990s had raised doubt on the suitability of floating exchange rates for these countries in a financially integrated world, where funds can be moved instantly between national financial markets. To prevent future crisis, the Chiang Mai Initiative announced in May 2000 was to provide a network of bilateral short-term credit arrangements among ASEAN countries, China, Japan and South Korea (see Grauwe, 2007) An interesting proposition is whether these economies can be integrated to form a monetary union. A regional currency agreement would provide stable intra-regional exchange rates and maintain flexibility of the exchange rates against that of non-members. Experience in the EMU also supports that a currency union generates fewer costs and delivers greater benefits to its members. Empirical studies (see Grauwe, 2007) found the degree of trade integration[2] and asymmetry in the demand and supply shocks in East Asian countries were very much like the EU countries. This suggests that East Asia is close to forming an optimum currency area. However, the political issue and cultural differences are cited as major obstacles for a successful integration to forming a monetary union.

[1] These figures are extracted from selected basic ASEAN indicators for ten ASEAN countries in 2009 provided by the ASEAN Secretariat Homepage at website http://www.aseansec.org/.
[2] The exports of East Asian countries to the rest of East Asia as a percentage of their gross domestic products.

One of the important requirements for monetary integration is convergence in real exchange rates among its member countries. Currency convergence is the tendency of differences in real exchange rate between countries to disappear over time. There is no single precise definition of convergence in the literature and different statistical methods can be used to test whether convergence is present (Durlauf and Johnson, 2010). Cluster analysis is viewed as an exploratory data-analysis technique which attempts to determine the natural groupings of observations (State, 2009). Hierarchical clustering that creates related sets of clusters would be useful to detect similarity or dissimilarity in exchange rates between the East Asian countries and to determine whether the clusters have changed over the years.

There is a large literature on testing the income convergence hypothesis, arising from the diversity in average growth rates and income levels across countries, and found several convergence clubs, in which real per capita incomes have converged for selected groupings of countries and regions. Empirically, similar time series tests of convergence can be applied to evaluate currency convergence in East Asia. This paper focuses on China, Hong Kong, Japan, South Korea, Taiwan and the five founding members of ASEAN, namely Indonesia, Malaysia, the Philippines, Singapore and Thailand (hereafter referred to as ASEAN-5).

In this paper, convergence of real exchange rates is also tested using time series data to determine the suitability of a monetary integration in East Asia. Study by Alesina et al. (2002) evaluate whether natural currency areas emerge across the world based on historical pattern of international trade and of co-movements of prices and outputs (from 1960 to 1997), and found a well-defined dollar and euro areas but no clear yen area. They suggest that the costs of adopting another country's currency as an anchor will be lower if the countries have high co-movements of outputs and prices with potential anchors. In Alesina and Barro's (2002) study, countries that trade more with each other are found to benefit more from adopting the same currency under reasonable assumptions about elasticities of substitution between goods. Alesina et al. suggest that increased trade may also be measured from an increase in the co-movements of outputs and prices. Using the method proposed by Alesina et al., this paper also examines the extent of the price co-movements between each East Asian country with the United States and Japan.

The plan of the paper is as follows. Section 2 outlines both the hierarchical clustering and time series methods used to determine the convergence of currency in the East Asian region. Section 3 examines the exchange rate data for the ten countries. Section 4 presents the test results and some concluding remarks are given in Section 5.

2. Methodology

In this paper, a hierarchical clustering and two different time series methods are used to test the convergence of currencies within the East Asian region. The first method determines the similarity and dissimilarity between the currencies and formed that into differ groups, the second method examines the co-movement of prices, and the third method applies a simple statistical test for converging trends in the real exchange rate series.

2.1 Cluster analysis

Cluster analysis is a useful data analysis tool that groups objects into clusters based on the characteristics that they possess. The objects in the same cluster should be more similar to one another than they are to objects in another cluster. This technique is used to group the exchange rate series of the ASEAN and East Asian countries that exhibit high similarity in the same cluster. The most commonly used measure of similarity is the Euclidean distance between each pair of exchange rate series. Euclidean distance used on raw data is known to be affected by changes in the scale of the variables (see Everitt, 1986). This problem can be overcome by standardized the data values before employing Euclidean distance.

There are two types of hierarchical clustering methods: agglomerative and divisive. The agglomerative clustering method begins with each observation is being considered a separate cluster, and two most similar observations are fused to form a new aggregate cluster. This process is applied repeatedly until all exchange rate series are combined into a single cluster. On the other hand, the divisive hierarchical clustering begins with all

observations belonging to one group, and this group is then split to create separate groups.

In this paper, the hierarchical agglomerative clustering method is used. A number of Euclidean metrics can be used in clustering techniques. Some of the best-known methods are the average and Ward's. According to Stata (2009, p.88), the average-linkage clustering uses the average difference of observations between the variables as the measure between two groups, while Ward's (1963) method joins the two groups that result in the minimum increase in the error sum of square. Mojena (1977) found Ward's method gave a superior performance across all data set. Hence, this paper uses Ward's method of clustering where groups are joined to maximize an error-sum-of-squares objective function. The distance between two clusters is defined as

$$D_{ij} = \sum_{t=1}^{T} (x_{it} - x_{jt})^2 , \tag{1}$$

where x_{it} is the real exchange rate value for country i at time t.

After the hierarchical cluster analysis, the grouping variables are presented in a dendrogram or cluster tree which presents the simplest way of selecting the optimal number of clusters. As discussed in Stata, (2009, p.160), there are many cluster stopping rules and two of the best rules identified were the Duda-Hart index and the Calinski and Harabasz pseudo-F index. This paper uses the simple step-size stopping rule of the Huda-Hart index to determine the number of clusters since the Calinski and Harabasz index is not defined for the degenerate one-group cluster solution. The Duda-Hart (DH) stopping rule index value is given by

$$DH = \frac{Je(2)}{Je(1)}, \tag{2}$$

where $Je(1)$ is the sum of squared errors within the group that is to be divided, and $Je(2)$ is the sum of squared errors in the two resulting subgroups (see Stata, p.165). The DH index requires hierarchical information from the group that is being split and large values of DH stopping-rule index indicate distinct cluster structure.

2.2 *Co-movements of prices*

Alesina et al. (2002) proposed a measure of co-movement of prices between countries *i* and *j* using the following second-order autoregression:

$$\ln\frac{P_{i,t}}{P_{j,t}} = a_0 + a_1 \ln\frac{P_{i,t-1}}{P_{j,t-1}} + a_2 \ln\frac{P_{i,t-2}}{P_{j,t-2}} + \varepsilon_{ij,t}, \tag{3}$$

where $P_{i,t}$ measures how many units of U.S. dollar can be exchanged with one unit of country *i*'s currency at time *t*. By definition, this exchange rate is always one when country *i* is the United States.

The estimated residual from equation (3) is used to compute the following root mean square error:

$$VP_{ij} = \sqrt{\frac{1}{T-3}\sum_{t=1}^{T}\hat{\varepsilon}_{ij,t}^{2}}\ . \tag{4}$$

A higher value of VP_{ij} means less co-movement of prices between countries *i* and *j*.

2.3 *Test for converging trend*

In a time series framework, a simple statistical test for converging or diverging trends of an exchange rate series, as proposed by Verspagen (1994), can be written as follows:

$$W_{i,t} = y_{i,t} - y_t^*, \tag{5}$$

where $y_{i,t}$ is the logarithm of the real exchange rate for country *i* at time *t* and y_t^* is the logarithm of average real exchange rate for *n* countries in the sample ($y_t^* = \left(\sum_{i=1}^{n} y_{i,t}\right)\Big/n$). It is assumed that, for each time period, W_i changes according to the following process:

$$W_{i,t+1} = \Psi W_{i,t} + \eta_{i,t} . \quad (6)$$

If $\Psi > 1$, the currency in country *i* diverges from the sample group; if $\Psi < 1$, convergence of the currency occurs. This paper also examines if the currency of individual country in the sample diverges from the Japanese yen.

3. Data

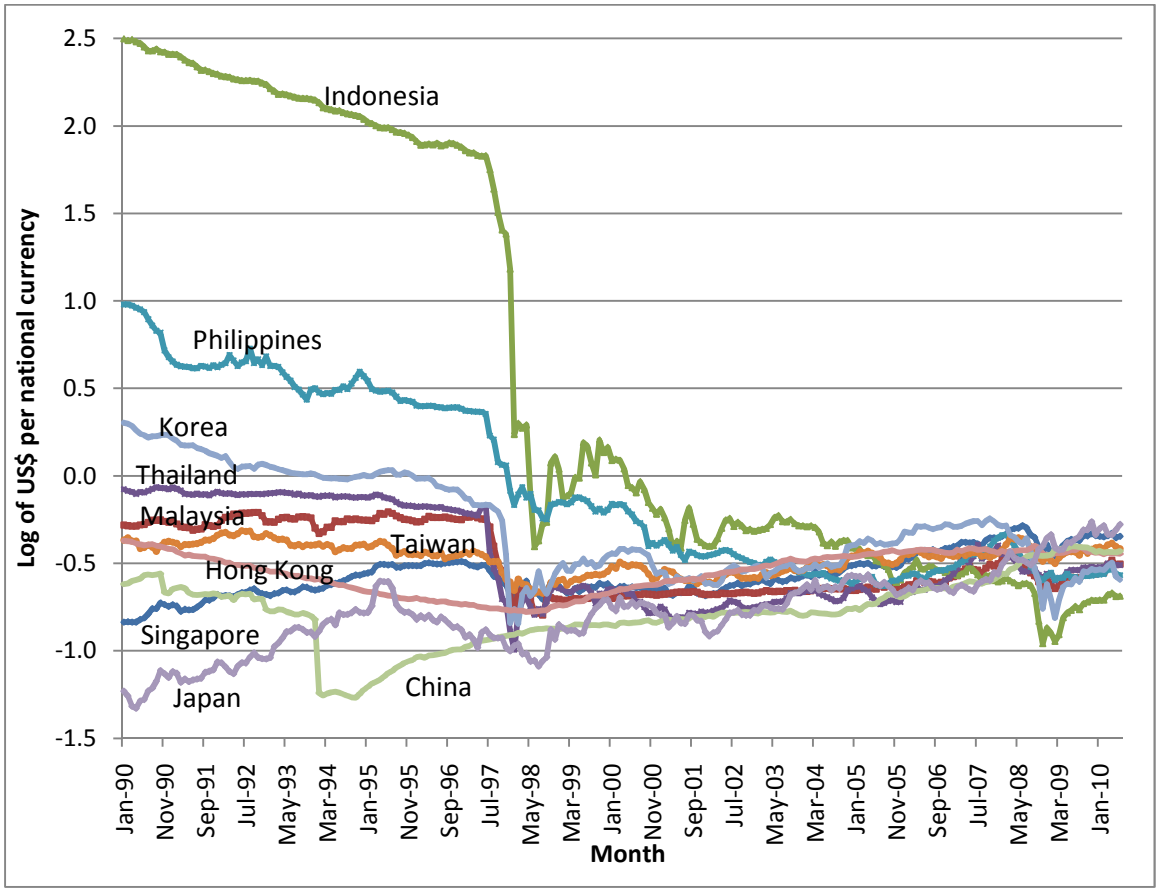
Testing for exchange rate convergence among the ten East Asian countries in a time series framework requires comparative data for these countries over an extended period. As most countries traditionally pegged their currencies against the US dollar, each country's currency is expressed in US dollars. Monthly nominal exchange rates of US$ per national currency for each East Asian country are extracted from the Datastream (and the source is from the International Financial Statistics) over the period January 1990 to June 2010. To examine the effect of the 1997-1998 Asian financial crisis and the GFC of 2007-2009, the whole sampling period was divided into two sub-periods from January 1990 to December 1999 (120 observations) and from January 2000 to June 2010 (126 observations).

Due to vast differences in the values of each East Asian currency, they are redenominated close to the nominal mean value of one Singapore dollar[3] over the last five years to keep the exchange rate disparity from dominating the analysis. Hence, the nominal exchange rates used are US$ per 4 Chinese yuan (CNY), 5 Hong Kong dollar (HKD), 60 Japanese yen (JPY), 700 Korean won (KRW), 20 Taiwan dollar (TWD), 6,000 Indonesian rupiah (IDR), 2 Malaysian ringgit (MYR), 30 Philippine peso (PHP), 1 Singapore dollar (SGD) and 20 Thai baht (THB), for China, Hong Kong, Japan, South Korea, Taiwan Indonesia, Malaysia, the Philippines, Singapore and Thailand, respectively. Real exchange rates of US$ per national currency are derived by multiplying the nominal exchange rates with the relative consumer price index[4] of the national currency to the US$.

[3] The Singapore dollar is chosen among the ten currencies because it has the lower denomination against the US dollar.
[4] The consumer price indices for all East Asian countries and the USA have been converted to a common base year in 1995.

Figure 1 depicts the logarithm of real exchange rates for the ten East Asian countries over the period 1990m1-2010m6. Summary statistics of the ten exchange rate series are given in Table 1. It is evident from Figure 1 that the exchange rates for all countries are fairly stable, apart from the Asian financial crisis which caused a substantial weakening in several currencies. Of the ten East Asian economies, Indonesia, Malaysia, the Philippines, South Korea and Thailand were badly affected by the currency crisis which, to a lesser extent, also affected countries like Japan, Taiwan and Singapore. Among the ten currencies, the Indonesian rupiah suffered the largest drop in value, particularly for 1997m12-1998m10, as a result of political instability. The Malaysian government also chose to fix its exchange rate at ringgit 3.80 per US$ in October 1998. As shown in Figure 1, the GFC had a lesser impact on the East Asian currencies compared to the Asian financial crisis. Of the ten East Asian economies, only Indonesia and South Korea were more severely affected.

Figure 1: Logarithm of Real Exchange Rates for East Asian Countries, 1990m1-2010m6



Source: Datastream.

As shown in Table 1, Indonesia had the highest value of real exchange rate volatility[5] which was more than quadrupled the level of the other sample countries, followed by the Philippine peso. On the other hand, Taiwan dollar had the lowest variability, followed by the Hong Kong dollar and the Singapore dollar. Comparing the two sub-periods, the exchange rate volatilities for all ten currencies were relatively lower after the Asian financial crisis except for the Singapore dollar. However, its level of volatility was still lower than the Indonesia rupiah or the Japanese yen.

Table 1: Summary statistics (log of real exchange rate), 1990m1-2010m6

Country	1990m1-2010m6		1990m1-1999m12		2000m1-2010m6	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Indonesia	0.593	1.243	1.689	0.874	-0.450	0.222
Malaysia	-0.491	0.191	-0.358	0.190	-0.618	0.063
Philippines	-0.058	0.508	0.398	0.332	-0.492	0.107
Singapore	-0.567	0.125	-0.632	0.092	-0.506	0.122
Thailand	-0.459	0.270	-0.266	0.254	-0.643	0.108
China	-0.777	0.201	-0.881	0.199	-0.677	0.146
Hong Kong	-0.551	0.121	-0.618	0.125	-0.488	0.074
Japan	-0.781	0.227	-0.944	0.164	-0.626	0.160
South Korea	-0.286	0.286	-0.096	0.283	-0.468	0.126
Taiwan	-0.470	0.085	-0.446	0.096	-0.493	0.066

Source: Datastream.

4. Empirical results

The paper applies both the hierarchical agglomerative clustering and time series methods to examine the convergence of monthly real exchange rates for ten East Asian countries over the period 1990m1-2010m6. All estimation and test results are derived using the Stata 11.1 statistics/data analysis program and EViews 6 software.

[5] It is calculated as the standard deviation of log of real exchange rate over the sample period.

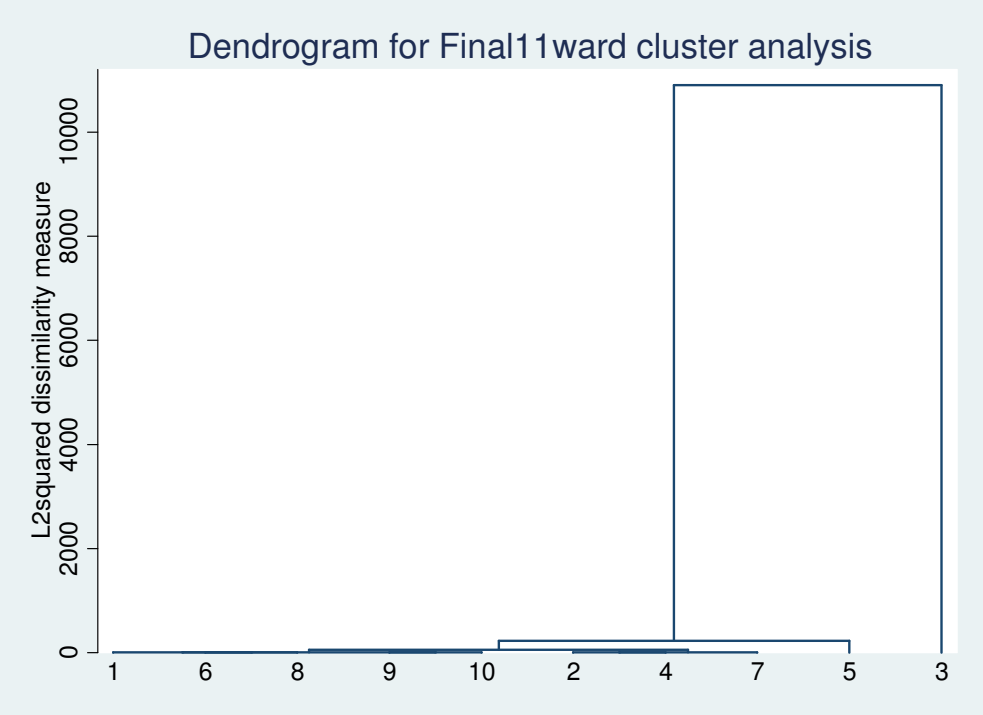
4.1 Cluster analysis

The results of dissimilarity measures or fusion values) are presented in Table 2 and the dendrograms of the hierarchical cluster analyses for three sample periods are shown in Figures 2 to 4. The dissimilarity value increases monotonically as the agglomerative clustering progresses from many to few clusters. It is evident from Figure 2 that the Indonesian rupiah was dissimilar from the rest of the currencies over the sample period 1990m1-2010m6. In addition, the extremely high dissimilarity value for the Indonesia rupiah has made it difficult to view the lower part of the dendrogram. The largest *DH* index value of 0.416 indicates there might be seven distinct groups. Based on a seven-group solution, the clustering would stop at a dissimilarity value of 2.268. As shown in Table 2, the Philippine peso is the second group with a high dissimilarity measure of 227.877. The other five groups in the order of decreasing fusion values were: (i) South Korea (ii) China; (iii) Japan; (iv) Singapore, Taiwan and Hong Kong; and (v) Malaysia and Thailand.

Table 2: Cluster Analysis (dissimilarity measure), 1990m1-2010m6

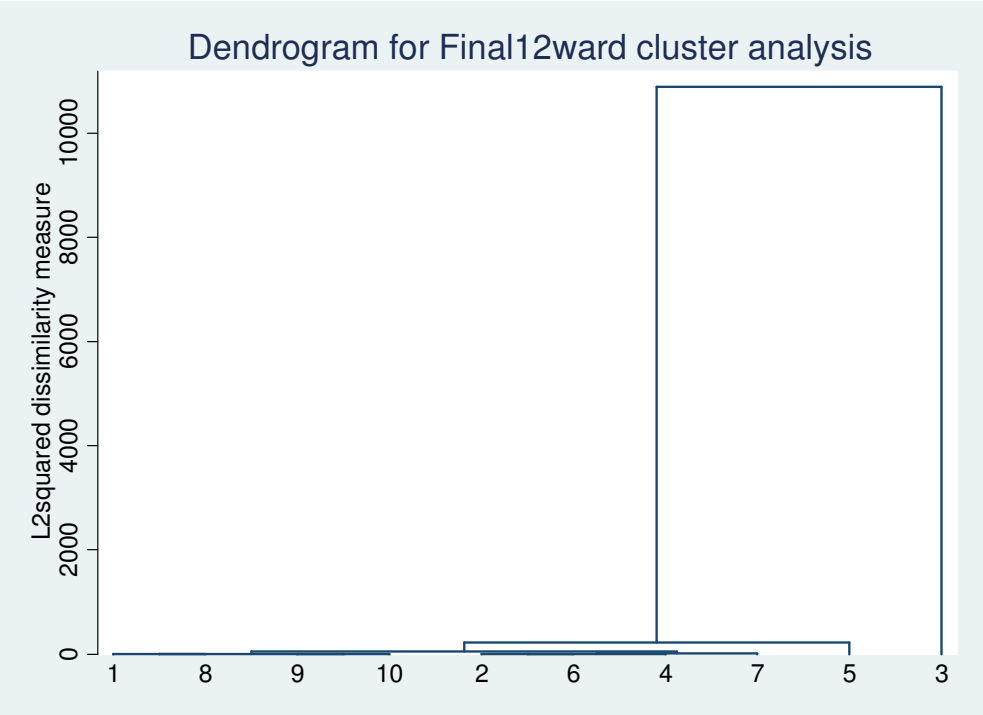
1990m1-2010m6	1990m1-1999m12	2000m1-2010m6
SGD 2.268 TWD 1.617 HKD 11.052 CHY 2.664 JPY 53.177 MYR 1.440 THB 10.660 KRW 227.877 PHP 10,900.297 IDR	SGD 1.494 HKD 4.247 CHY 2.383 JPY 50.419 MYR 1.153 TWD 3.260 THB 12.729 KRW 225.320 PHP 10,891.716 IDR	SGD 0.277 TWD 0.121 HKD 1.072 KRW 4.510 MYR 0.143 THB 0.788 CHY 0.281 JPY 9.358 IDR 1.780 PHP

Figure 2: Clusters of East Asian Currencies, 1990m1-2010m6



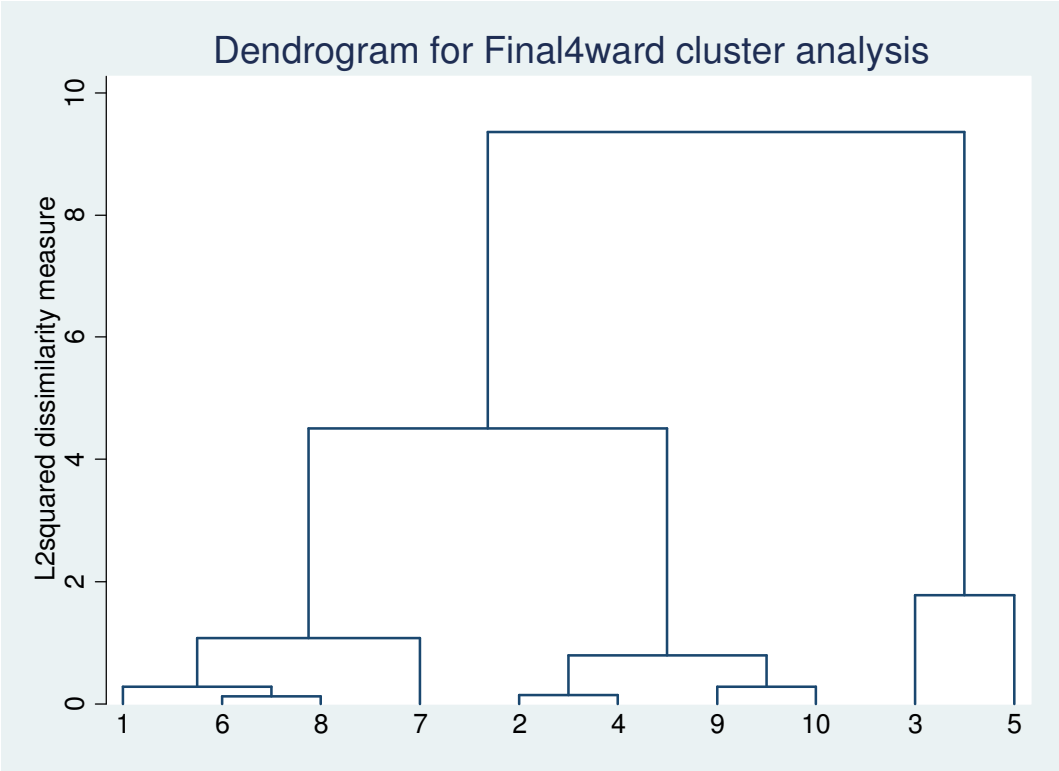
Legend: 1: SGD; 2: MYR; 3: IDR; 4: THB; 5: PHP; 6: TWD; 7: KRW; 8: HKD; 9: CHY; 10: JPY.

Figure 3: Clusters of East Asian Currencies, 1990m1-1999m12



The dendrogram for the sub-period 1990m1-1999m12 in Figure 3 might appear not significantly different from the dendrogram in Figure 2. However, the *DH* index with the largest value of 0.477 suggests a lower grouping of five for the sub-period 1990m1-1999m12. The five distinct groups stopped at a dissimilarity value of 4.247 were: (i) Indonesia; (ii) the Philippines; (iii) South Korea; (iv) Singapore, Hong Kong, China and Japan; and (v) Malaysia, Taiwan and Thailand (see Table 2). The results indicate both the Indonesian Rupiah and the Philippine peso remained two highly distinctive groups that differ from the rest.

Figure 4: Clusters of East Asian Currencies, 2000m1-2010m6



It is noted that the dissimilarities occurred predominantly in the first half of the sample period when comparing the dendrogram in Figure 3 to the dendrogram for the sub-period 2000m1-2010m6 in Figure 4. Both the Indonesian rupiah and the Philippine peso have integrated closer to the other currencies over the last ten years with significantly lower dissimilarity measures (see Table 2). The Korean won also moves closer with the high-performing economies such as Hong Kong, Singapore and Taiwan. The largest *DH* index for the sub-period 2000m1-2010m6 is 0.4895 corresponding to a one-group solution.

This indicates all ten currencies could be agglomerated to form one single group at a dissimilarity value of 9.358.

4.2 Price co-movements

Table 3 presents the estimated VP_{ij}, which measures the price co-movements between each East Asian country with the United States and Japan.[6] The lower the value of VP_{ij}, the higher the co-movement of prices between country *i* and the anchor country. Apart from Indonesia, all countries had higher co-movements of prices with the United States. It is not surprising to find Hong Kong had the lowest estimated *VP* given that its currency is pegged against the US dollar. Overall, all countries had relatively higher co-movement with the US dollar than the Japanese yen, and the Malaysian ringgit is the only currency that did not move closely with the Japanese yen. It is important to note that the value of estimated VP for the Indonesian rupiah against the US dollar and the Malaysian ringgit against the Japanese yen had reduced significantly in the second half of the sample period.

Table 3: Co-movement of Prices with U.S. and Japan, 1990m1-2010m6

	U.S.	Japan
Japan	0.0321	–
China	0.0297	0.0442
Hong Kong	0.0070	0.0319
South Korea	0.0431	0.0451
Taiwan	0.0176	0.0704
Indonesia	0.0823*	0.0582
Malaysia	0.0206	0.1204*
Philippines	0.0284	0.0448
Singapore	0.0164	0.0513
Thailand	0.0327	0.0577

Note: * indicates that the lowest co-movement of price with the US dollar or the Japanese yen.

[6] The values of VP_{ij} computed from higher order autoregressions are similar to the results reported in Table 2.

4.3 Converging trends

Using the simple statistical test of Verspagen (1994) for converging or diverging trends of the exchange rate series (see equations (5) and (6)), estimation results for ten East Asian countries are reported in Table 4. An estimated value of less than one implies convergence of the currency occurs.

Table 4: Test Results for Converging Trends (Ψ), 1990m1-2010m6

	Group Average	Japanese Yen
Japan	0.9895 (0.0027)	–
China	0.9937 (0.0031)	0.9732 (0.0112)
Hong Kong	0.9930 (0.0029)	0.9809 (0.0063)
South Korea	0.9826 (0.0102)	0.9870 (0.0047)
Taiwan	0.9901 (0.0031)	0.9802 (0.0061)
Indonesia	0.9932 (0.0034)	0.9918 (0.0028)
Malaysia	0.9887 (0.0032)	0.9884 (0.0051)
Philippines	0.9836 (0.0099)	0.9894 (0.0026)
Singapore	0.9887 (0.0023)	0.9885 (0.0073)
Thailand	0.9888 (0.0043)	0.9877 (0.0049)

Note: Standard errors are given in parentheses.

It is evident from Table 4 that no exchange rate diverged from the group average or the Japanese yen over the study period. The estimated results also indicate converging trends of each currency with the group average and the Japanese yen for the two sub-periods, 1990m1-1999m12 and 2000m1-2010m6, and hence were not reported here. Similar study

by Lim (2005) found the Japanese yen, the Korean won and the Singapore dollar diverged from the group average over the period 1990m3-2001m12. The different results might be attributed to different sample periods and different mean value of exchange rates. This paper covers longer sample period and includes two additional currencies, namely the Chinese yuan and the Taiwan dollar.

5. Conclusion

This paper used both the clustery analysis and two time series methods to examine the convergence of currencies for ten fast-growing East Asian economies, namely China, Hong Kong, Japan, South Korea, Taiwan and the five founding ASEAN member countries. The stopping-rule statistic (the *DH* index) from the hierarchical cluster analysis indicates there might be seven distinct currency groups over the period from January 1990 to June 2010. An interesting finding is that the dissimilarities occurred predominantly in the 1990s driven by the divergence of the Indonesian rupiah and the Philippine peso from the group. For the sub-period 2000m1-2010m6, a single-group solution was identified which suggests all ten currencies were not that dissimilar in recent years. These results indicate a greater economic integration among the ten East Asian countries over time.

Similarly, there was also evidence of currency convergence for all ten East Asian economies to the group average using the statistical test for converging trends. The test results from co-movements of price showed all ten currencies have a relatively strong tie with the US dollar than the Japanese yen. Among the ten currencies, the Indonesian rupiah had the lowest co-movement with the US dollar, while the Malaysian ringgit had the lowest co-movement with the Japanese yen. However, the extent of divergence has reduced significantly in the second half of the sample period.

Overall, the results of this study lend support for the next monetary union in East Asia using the US dollar as an anchor currency. However, it is important to emphasise that both the cluster analysis and the time series methods used are limited to finding groupings that may exist in the data and testing the time series properties of currency differences, without considering the factors that determine exchange rate movements.

Thus, further research on the suitability of a common currency area should also consider other relevant variables, such as financial markets, financial flows and convergence in the levels of interest rates, inflation rates and outputs that are important for currency adoption.

References

Angresano, J. (2004), European Union Integration Lessons for ASEAN+3: The Importance of Contextual Specificity, *Journal of Asian Economics*, 14, 909-926.

Alesina, A. and R. Barro (2002), Currency Unions, *Quarterly Journal of Economics*, 117(2), 409-436.

Alesina, A., R.J. Barro, and S. Tenreyro (2002), Optimal Currency Areas, Harvard Institute of Economic Research Discussion Paper, No. 1958.

ASEAN (2010), Annual Association of Southeast Asian Nations Statistical Indicators, Retrieved on 6 October 2010, from http://www.aseansec.org.

Cline, W.R. (2010), *Financial Globalization, Economic Growth, and the Crisis of 2007-09*, Peterson Institute for International Economics, Washington, DC.

Durlauf, S.N. and P.A. Johnson (2010), Convergence, in Durlauf, S.N and L.E. Blume (eds.), *Economic Growth*, Macmillan Publishers: New York, pp.16-23.

Everitt, E. (1986), *Cluster Analysis* (2nd Ed.), Halsted Press: New York, 136pp.

Grauwe, P.D. (2007), Economics of Monetary Union (7th ed.), Oxford University Press: New York, 281pp.

Hair, J.F., R.E. Anderson, R.L. Tatham, W.C. Black (1998), *Multivariate Data Analysis* (5th Ed.), Prentice Hall: New Jersey, 730pp.

Krugman, P.R. and M. Obstfeld (2000), *International Economics: Theory and Policy* (5th Ed.), Addison-Wesley: New York., 750pp.

Lim, L.K. (2005), A Dollar or Yen Currency Union in East Asia, *Mathematics and Computers in Simulation*, 68 (5-6), 509-518.

McKinnon, R.I. (1963), Optimum Currency Areas, *American Economic Review*, 52, 717-725.

Mojena, R. (1977), Hierarchical Grouping Methods and Stopping Rules: An Evaluation, *Computer Journal*, 20(4), 359-363.

Mundell, R. (1962), A Theory of Optimum Currency Area, *American Economic Review*, 51, 657-665.

Ruland, J. (2000), ASEAN and Asian Crisis: Theoretical Implications and Practical Consequences for Southeast Asian Regionalism, *The Pacific Review*, 13(3), 421-451.

Stata (2009), *Multivariate Statistics Reference Manual: Release 11*, Stata Press Publication: College Station.

Verspagen, B. (1994), Technology and Growth: The Complex Dynamics of Convergence and Divergence, in G. Silverberg and L. Soete (eds.), *The Economics of Growth and Technical Change: Technologies, Nations, Agents*, Edward Elgar: England, pp. 154-181.

Ward Jr., J.H. (1963), Hierarchical Grouping to Optimize and Objective Function, Journal of the American Statistical Association, 58, 236-244.

Wyplosz, C. (2001), A Monetary Union in Asia? Some European Lessons, in D. Gruen and J. Simon (eds.), *Future Directions for Monetary Policies in East Asia*, Proceedings of a Conference for Financial Studies, Economic Group, Reserve Bank of Australia, pp. 124-155.