



CHAPTER 4

STATISTICAL ANALYSIS AND MODEL INTERPRETATION

4.1 Theoretical Framework

The study is mainly focus on the theory of optimum currency area, which is employed to analyze a single currency system. The theory of optimum currency areas was first developed in the 1960s by Mundell (1961) and it continues to attract widespread attention by many economists – McKinnon (1963), Kenen (1969) and others. The theory deals with issues at the core of international monetary economics. The optimum currency area refers to the area that is optimal to permanently fixed national currencies among member countries and maintains a flexible exchange rate regime with third countries or the rest of the world. This theory refers to the combination of counties that enjoy net gains by forming a monetary or currency union. This theory can be characterized into 2 approaches: Pre-conditional characteristics of a national economy that desires to participate in a currency union and the costs and benefits to a nation participating in a currency area. The preconditions have been identified as relevant for choosing the likely participants in an optimum currency area. There are many precondition criteria such as similarity of inflation rates, high degree of financial integration, more concentrated trade integration, highly diversified economies, high degree of labor mobility, highly open economies, smaller size of the economy, and high level of fiscal integration, which represent good candidates for currency-area membership. Besides, the major benefit of monetary integration (or participation in a monetary union) is the elimination of exchange rate volatility within the area. By reducing foreign exchange risks, trade and investment are promoted as well as the optimal allocation of resources. In addition, the transaction costs accompanying the exchange of currencies would be reduced. On the other hands, the major cost of joining currency union or monetary integration is the loss of monetary autonomy and fiscal autonomy. Moreover, country loss the sovereignty in conducting independent monetary policy and exchange rate tool.

In this study, the optimum currency area index will be constructed by following the model of Tamim Bayoumi and Barry Eichengreen (1997). They operationalize the theory of optimum currency areas by analyze the determinants of nominal exchange rate variability. They constructed an OCA index that showed the relationship between the pre-conditions of countries, which the OCA theory states. In their study, the

behavior of 15 EU members' exchange rates was observed by using a cross-country data to estimate the OCA index over a period of time and investigate the relationship between economic integration and monetary integration. But here, in this study, 9 East Asian are targeted – China, Indonesia, Japan, South Korea, Malaysia, The Philippines, Singapore, Taiwan, and Thailand.

4.2 Model Specification

The objectives of the study are consisted of three components, namely; to examine the formation of economic integration, to examine the formation of a monetary integration, and analyze the effect of the economic crisis on the formation of an economic and monetary integration. For the formation of economic integration, the study presents through the Trade Matrix, which already stated on chapter 2. For the analysis of the effect of economic crisis on the formation of an economic and monetary integration, it was mentioned in chapter 3 already. Here, in this chapter, the theory of optimum currency area will be concentrated.

The method of this theory is to operationalizing optimum currency area theory. The analysis will be on the determinant of the nominal exchange rate variability. The optimum currency area index will be calculated to represent the measurement of convergence among selected East Asian countries in the currency area. OCA index is used to predict which countries will be best able to support stable exchange rates in the future, and are likely to be best prepared to be among the founding member of the monetary union. The core implications of theory of the OCA are developed in order to find the relationship between the OCA characteristics and the observed behavior of changes in exchange rates. The Theory of Optimum currency area will show the result whether selected country could join the same currency area or not by running the multiple regression and applying the ordinary least square (OLS) method to the OCA estimating equation.

The OCA index is calculated by the standard deviation of the changes in the logarithm of the annual average bilateral nominal exchange rate between 2 countries. And here there will be all together 5 factors that will be emphasized in the OCA index. The effects of the asymmetric shocks to output, the dissimilarities in the structures of economy, trade linkages, size of economy, and asymmetries in price disturbances are hypothesized. The OCA index for 9 selected East Asian countries will be based on the Japanese Yen as a leading currency for the economic and monetary block. Economically, Japan is by far the largest and relatively strong nation in the region. Her share in the world GDP for the year 1990 was 13.5%. Within East Asia, it accounted for

approximately 70% of the region's GDP. If Japan was excluded, East Asia's share in the world GDP will remarkably drop.

The *output related variables* that influence the changes in exchange rates can be calculated by the standard deviation of the differences in the logarithm of real output between two countries, which is used to measure the asymmetric shocks to output. When the standard deviation in output growth between two countries increases; they are likely to have different pattern of business cycle. As a result, bilateral exchange rate of them will be more volatile or it causes fluctuations in their exchange rates. The variable for *dissimilarities* in the structures of the economy is used to identify the asymmetric shocks particularly the industry-specific shock. The sum of absolute differences in shares of agricultural, industrial and service sectors in relative to domestic GDP for two related countries will be used to calculated and represent the economic dissimilarity. As a result, more dissimilarity between countries; the more volatile of bilateral exchanges rate of them. The *trade linkages* are measured by the average ratio of bilateral exports to domestic GDP for two countries, which is used to measure the degree of openness of the countries. As a result, if there is the increasing in trade between two countries, it will strongly encourage exchange rate stability. The country *economic size* is measured by the average of logarithm of the two countries' GDP. For small countries, the benefit of fixing national currency to the large partner country can be the reduction in transaction costs, this will be desirable even though they will lose some control of domestic monetary policy. On the other words, if the size of two countries increase, they are unlikely to gain from having fixed exchange rate together. Simply said, the greater size, the more volatile of bilateral exchange rate of them. Asymmetries in *price disturbances* are measured by the standard deviation of the difference between countries' CPI inflation. Since inflation convergence is one criteria in the precondition approach, the low inflation rate of the countries is expected. As a result, if there is the higher the differences in inflation rate between two countries, the more volatile of bilateral exchange rate of them.

Thus, the estimating equation is

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$$\text{SD}(e_{ij}) = \beta_0 + \beta_1 \text{SD}(\Delta y_i - \Delta y_j) + \beta_2 \text{DISSIM}_{ij} + \beta_3 \text{TRADE}_{ij} + \beta_4 \text{SIZE}_{ij} + \beta_5 \text{SD}(\pi_i - \pi_j)_{ij} + \varepsilon_{ij}$$

where

- $SD(e_{ij})$: the standard deviation of the changes in the logarithm of the annual average bilateral nominal exchange rate between Country i and j This represents the OCA index,
- $SD(\Delta y_i - \Delta y_j)$: the standard deviation of the differences in the logarithm of real output between countries i and j (difference between country i And country j real GDP growth rate),
- $DISSIM_{ij}$: the sum of absolute differences in shares of agricultural, industrial and service sectors in relative to domestic GDP for countries i and j This variable is used to measure the structure of each sector,
- $TRADE_{ij}$: the average ratio of bilateral exports to domestic GDP for the two countries i and j This variable is used to measure the degree of openness,
- $SIZE_{ij}$: the average of logarithm of the two countries' GDP. This variable is used to measure the size of economies of countries,
- $SD(\pi_i - \pi_j)_{ij}$: the standard deviation of the difference between country i and country j CPI inflation,

The variables using in this estimating equation can be written in mathematical terms:

$$SD(e_{ij}) = SD (\Delta \log e^{ij}_t |_{t=1989-1998})$$

$$SD(\Delta y_i - \Delta y_j) = SD \{(\Delta y_i - \Delta y_j)_t\}$$

$$DISSIM_{ij} = | \text{the mean of the share of agricultural sector in GDP of country i} - \text{the mean of the share of agricultural sector in GDP of country j} | + | \text{the mean of the share of manufacturing sector in GDP of country i} - \text{the mean of the share of manufacturing sector in GDP of country j} | + | \text{the mean of the share of service sector in GDP of country i} - \text{the mean of the share of service sector in GDP of country j} |$$

$$TRADE_{ij} = \frac{\sum_{t=1989}^{1998} \left[\frac{GDP_i}{GDP_i + GDP_j} \left(\frac{X_i \rightarrow j}{GDP_i} \right) + \frac{GDP_j}{GDP_i + GDP_j} \left(\frac{X_j \rightarrow i}{GDP_j} \right) \right]}{N}$$

$$SIZE_{ij} = \frac{\sum_{t=1989}^{1998} \left(\frac{\log GDP_i + \log GDP_j}{2} \right)_t}{N}$$

$$SD(\pi_i - \pi_j)_{ij} = SD \{ (\pi_i - \pi_j)_t \}$$

The expected result:

The parameters of $SD(\Delta y_i - \Delta y_j)$, $DISSIM_{ij}$, $SIZE_{ij}$, and $SD(\pi_i - \pi_j)_{ij}$ are expected to be positive in relation to the standard deviation of nominal exchange rates. This can be implied that if

- $SD(\Delta y_i - \Delta y_j)$ or different in output growth in two countries increases; bilateral exchange rate of them will be more volatile.
- $DISSIM_{ij}$, the more dissimilarity between countries; the more volatile of bilateral exchanges rate of them.
- $SIZE_{ij}$, the size of two countries increases; they are unlikely to gain from having fixed exchange rate together. Simply said, the greater size, the more volatile of bilateral exchange rate of them.
- $SD(\pi_i - \pi_j)_{ij}$, the higher the differences in inflation rate between two countries; the more volatile of bilateral exchange rate of them.

The parameter of $TRADE_{ij}$ is expected to be negative in relation to the standard deviation of nominal exchange rates. This can be implied that if

- $TRADE_{ij}$, there is the increasing in trade between two countries, it will strongly encourage exchange rate stability.

4.3 Measurement, data and Description

Cross-country data for selected nine East Asian countries – China, Indonesia, Japan, South Korea, Malaysia, The Philippines, Singapore, Taiwan, and Thailand—are used in this analysis. The data covers 10 years period (1989-1998). Exchange rate is collected quarterly from 1989-1998). GDP, contribution of GDP to major sectors – Agriculture, Industrial, Service sectors, Intra East Asian export, inflation rate are collected annually from 1989-1998. The reason for choosing this period of time is to cover both before and after the economic crisis in order to observed the differences result of them. Every variable are collected and calculated in the same period of time. The result of cross country data will be as shown in Appendix.

Sectoral share of GDP (%), in this study, covers three part. First is Agricultural sector (or Primary industry). Second is Manufacturing sector, which involves processing of primary product comprising with mining and manufacturing part. Third is Service sector, which includes electricity, gas and water, construction, trade, transport and communications, finance, and public administration.

4.4 EMPIRICAL RESULT

The model explains the determinants of nominal exchange rate variability, and this theory focuses on characteristics, which make stable exchange rates and monetary unification more or less desirable.

Finding

From the cross data output, applying the Ordinary Least Square (OLS), then the finding is as shown:

LS // Dependent Variable is SDEIJ

Date: 03/13/00 Time: 06:36

Sample: 1 36

Included observations: 36

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007200	0.008793	0.818838	0.4193
SDGDP	0.009523	0.258291	0.036871	0.9708
SIZE	0.002677	0.001584	1.689289	0.1015
SDDINFLA	0.002635	0.000750	3.514054	0.0014
DISSM	0.002281	0.007670	0.297429	0.7682
TRADE	-0.072611	0.040386	-1.797910	0.0823
R-squared	0.862876	Mean dependent var	0.037569	
Adjusted R-squared	0.840021	S.D. dependent var	0.017667	
S.E. of regression	0.007066	Akaike info criterion	-9.753867	
Sum squared resid	0.001498	Schwarz criterion	-9.489948	
Log likelihood	130.4878	F-statistic	37.75587	
Durbin-Watson stat	1.613103	Prob(F-statistic)	0.000000	

Table 4-1 Finding

The estimation yields the following result with the standard error in parentheses:

$$\begin{aligned}
 SD(e_{ij}) = & 0.0072 + 0.009532 SD(\Delta y_i - \Delta y_j) + 0.002281 DISSIM_{ij} \\
 & (0.008793) \quad (0.258291) \quad (0.007670) \\
 & - 0.072611 TRADE_{ij} + 0.0026766 SIZE_{ij} + 0.0026353 SD(\pi_i - \pi_j)_{ij} + \varepsilon_{ij} \\
 & (0.040386) \quad (0.001584) \quad (0.000750)
 \end{aligned}$$

where $n = 36$, adjusted $R^2 = 0.84$, and $S.E. = 0.007$

F-statistic = 37.75587

Hypothesis testing

The anticipated coefficient sign

The parameter of $SD(\Delta y_i - \Delta y_j)$, $DISSIM_{ij}$, $SIZE_{ij}$, and $SD(\pi_i - \pi_j)_{ij}$ are expected to have positive relationship to the OCA index. Only TRADE variable is expected to have negative relationship to the OCA index.

The result shows that every parameter -- output variable, dissimilarity, trade linkage, economic size, price disturbance -- have anticipated signs. However, if it was considered the estimated coefficients differ from zero at 5 percent confidence level, only price disturbance variable is statistically significant. At 10 percent confidence level, $SD(\pi_i - \pi_j)_{ij}$, $SIZE_{ij}$, and $TRADE_{ij}$ are statistically significant. For $SD(\Delta y_i - \Delta y_j)$, $DISSIM_{ij}$, they can not be explained statistically but they pose the anticipated sign as the expectation.

Significant test

t-test

t statistics for all estimated parameters are significant at 0.90 level except for $SD(\Delta y_i - \Delta y_j)$, $DISSIM_{ij}$. The critical t-value is equal to 1.684 at 10 percent level of significant, and 2.021 at 5 percent level of significant. T-test for estimated output and dissimilarity parameters lead to the conclusion that null hypothesis of β_1 and β_2 can not be rejected. And both of them can not explain the OCA index in statistical term.

Interpretation:

The interpretation of the estimated regression is as follow:

In case of *trade linkage*: If the trade between countries increases by, let's say, 1 percent, the variation on nominal exchange rate or an OCA index is expected to decrease by 0.072611 or about 7.2 percent. This would imply that the more trade between countries, the more openness of the countries' economies, the less volatile of nominal exchange rate among the member countries.

In case of the *size of the countries*: If the size of the countries increased by, say, 1 percent, the variation on nominal exchange rate or an OCA index is expected to increase by 0.00267 or about 0.26 percent. This implied that if the size of two countries increases, they are unlikely to gain from having fixed exchange rate together.

In case of the *differences on inflation rate* between countries: If the differences in inflation rate between two countries higher, let's say, by 1 percent, the variation on nominal exchange rate or an OCA index is

expected to increase by 0.0026353 or about 0.263 percent. Since the inflation rate is one important pre-conditional criteria, the lower rate of inflation is expected to be found among member countries. The difference in inflation rate between countries lower, the OCA index or the variation on nominal exchange rate will be better and more stable.

The R^2 value means that about 84 percent of the variation in OCA index is explained by variation in difference in output growth, the dissimilarity of economic structure, the size of the economy, the differences in inflation rate, and the trade linkage.

f-test

The overall test uses the F-statistic. The calculated F-statistic from the regression is equal to 37.75587, which is far higher than 1% critical value. The F-distributed value is equal to 4.02 at 1% level of significant. Hence, the null hypothesis $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ can be rejected. Every parameter can be used in the model because they are all statistically significant at 1%, which can be used to explain the relationship of the model.

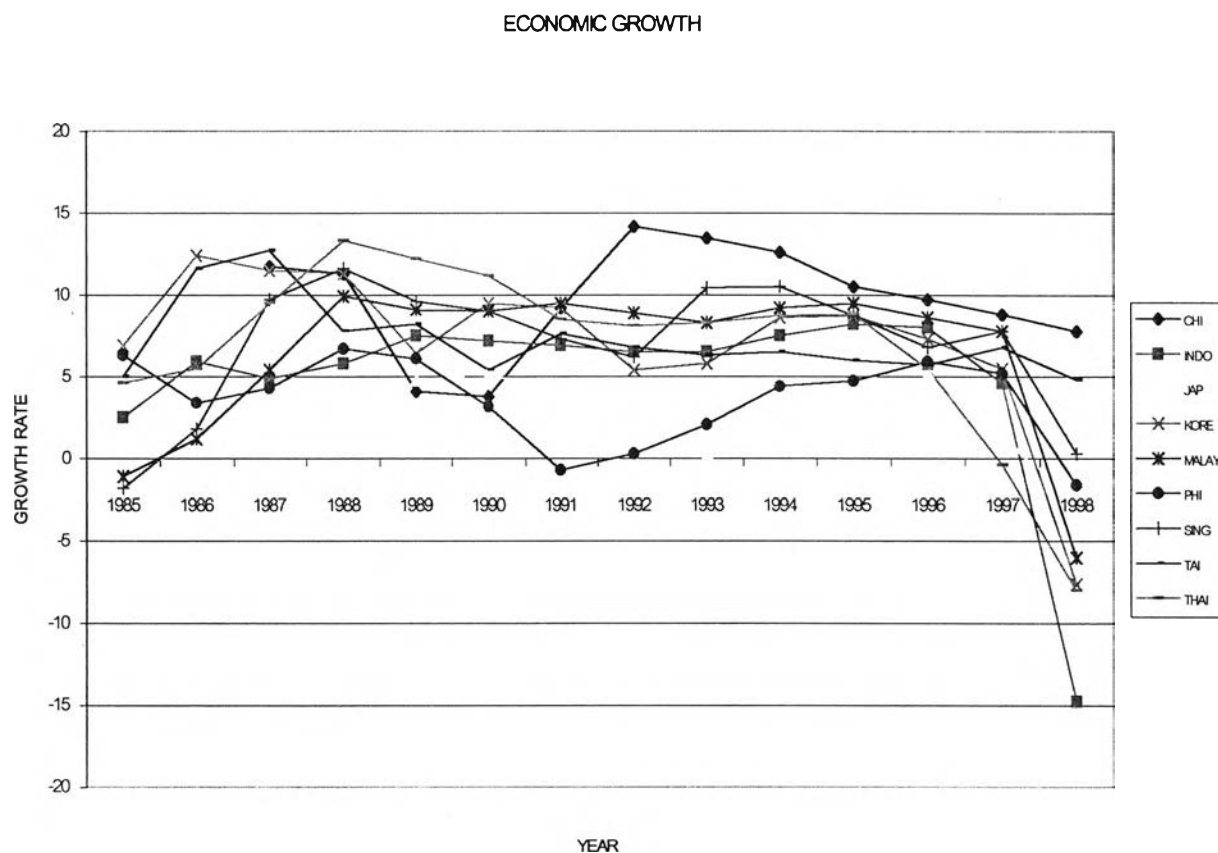


Figure 4-1 East Asian Economic Growth rate

The estimation leads to the question for the output and dissimilarity variables even they have as anticipated sign. The possible explanation of this result is that the pattern of economic growth of selected East Asian countries does not go in the same direction in the same period.

Since the patterns of economic growth of selected East Asian countries are based on high difference in the size of the economies, this caused the cross-country data less effective and it may not well represent the asymmetric shocks to output. Due to both of two variables -- $SD(\Delta y_i - \Delta y_j)$, $DISSIM_{ij}$, are calculated from GDP, the cross-country data of highly differences in GDP of each individual country will be more fluctuated. Additionally, East Asian was hit by currency and economic crises. Their growth of economies was dropped remarkably since 1997, especially Indonesia. Meaning that their GDPs shrunk in real terms, and on top of that their currencies have depreciated, as a result of which their GDPs have contracted 30-40% from their pre-crises levels. Also, because of the

crises, the degree of openness declines. Intra-regional trade is decreases, countries cure themselves in order to recovering their footing. The unemployment was produced by the economic crises. Moreover, the economic crises have also produced major shifts in exchange rate policies, which caused the exchange rate fluctuation.

The interpretation on OCA index:

It can be seen clearly that Indonesia has strongly effects from the currency and economic crises. By comparing the result of before and after crises, the cross-country currency index between pair of Indonesia have no sign of convergence but rather divergence and even more fluctuation.

Country	1994	1996	1998
China	0.0449	0.04387	0.04345
Indonesia	0.02231	0.02606	0.06903
Korea	0.02501	0.02617	0.04501
Malaysia	0.02368	0.02528	0.02747
Philippine	0.03516	0.03632	0.03923
Singapore	0.01886	0.02173	0.02392
Taiwan	0.02609	0.02609	0.02717
Thailand	0.01938	0.02299	0.03413

Table 4-3 OCA index (The construction of the OCA index)

In this study, the OCA index is constructed for 1994, 1996, and 1998 by using Japan as the leader of the economic and monetary block.

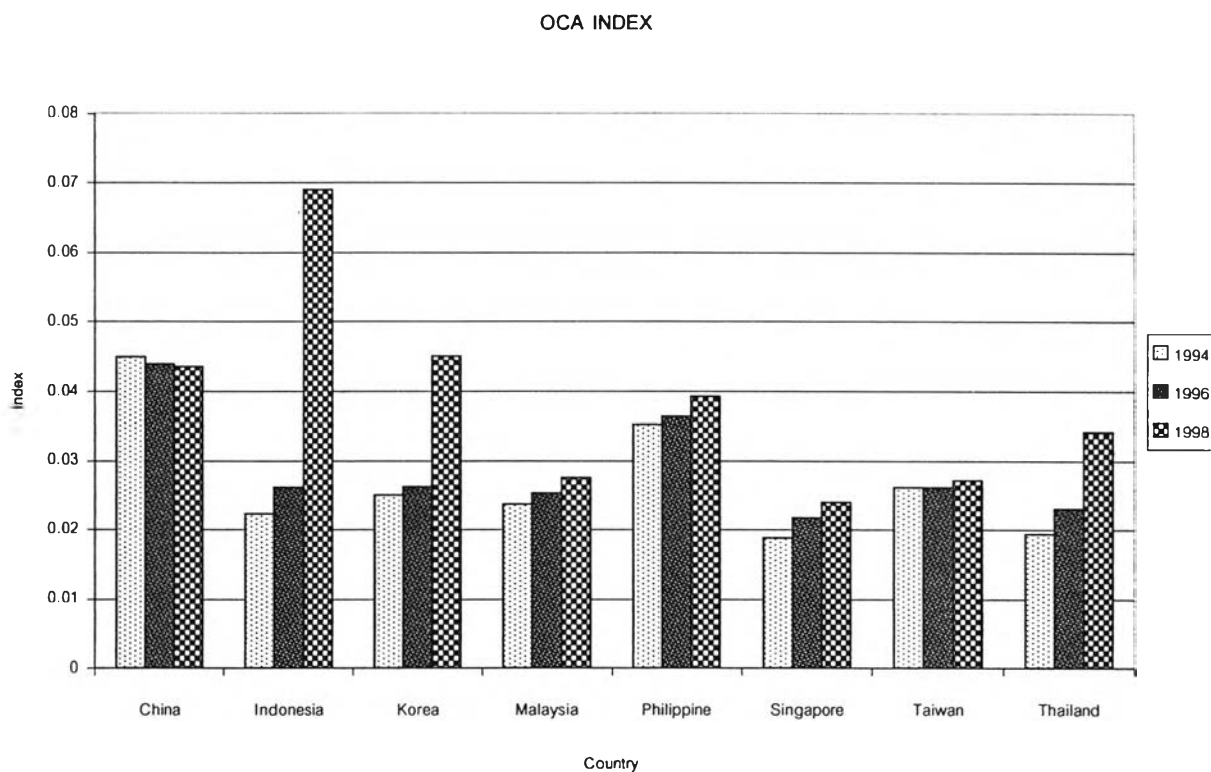


Figure 4-3 Movement of OCA index of 1994,1996, and 1998

Table 4-3 shows computed OCA indexes for 8 East Asian countries versus Japan, and Figure 4-3 shows movements of OCA indexes of 1994, 1996, and 1998.

The OCA index of 1994 was analyzed since the countries' economies were relatively peak, comparing with 1996 (pre-crisis) and 1998 (post-crisis). In case of China, the OCA index shows a convergence towards the exchange rate stability within the Japanese Yen block even after the period of financial and economic crises in 1998. The OCA indexes for Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand have showed that their indexes do not significantly change, the indexes are rather small and can be included in the convergence case, this is for the case of pre-crisis 1996. See the case of Japan-China, its index was 0.044904 in 1994 and 0.043866 in 1996, which do not change much. This also occurred in the case of Japan-Indonesia, Japan-Korea, Japan-Malaysia, Japan-The Philippines, Japan-Singapore, Japan-Taiwan, and Japan-Thailand both in 1994 and 1996. But once there was the financial and economic crises in 1998, many countries' OCA indexes have changed. Especially Indonesia, she has been hit hard with the financial

and economic crises and her indexes shows dramatically change and have no sign of convergence towards the currency union, as OCA index shows the value of 0.069033 in the year of crisis 1998. This result suggests that before the financial and economic crisis; China, Korea, Malaysia, The Philippines, Singapore, Taiwan, and Thailand can be candidates for participating in the currency union vis-à-vis Japanese Yen. However, due to the financial and economic crises, every country except China shows no sign of convergence towards the exchange rate stability within the Japanese Yen block. This is because this crises mainly occurred in the financial sector, which have the strongly effect to the exchange rate stability (one important criteria of convergence condition to the formation of currency union).

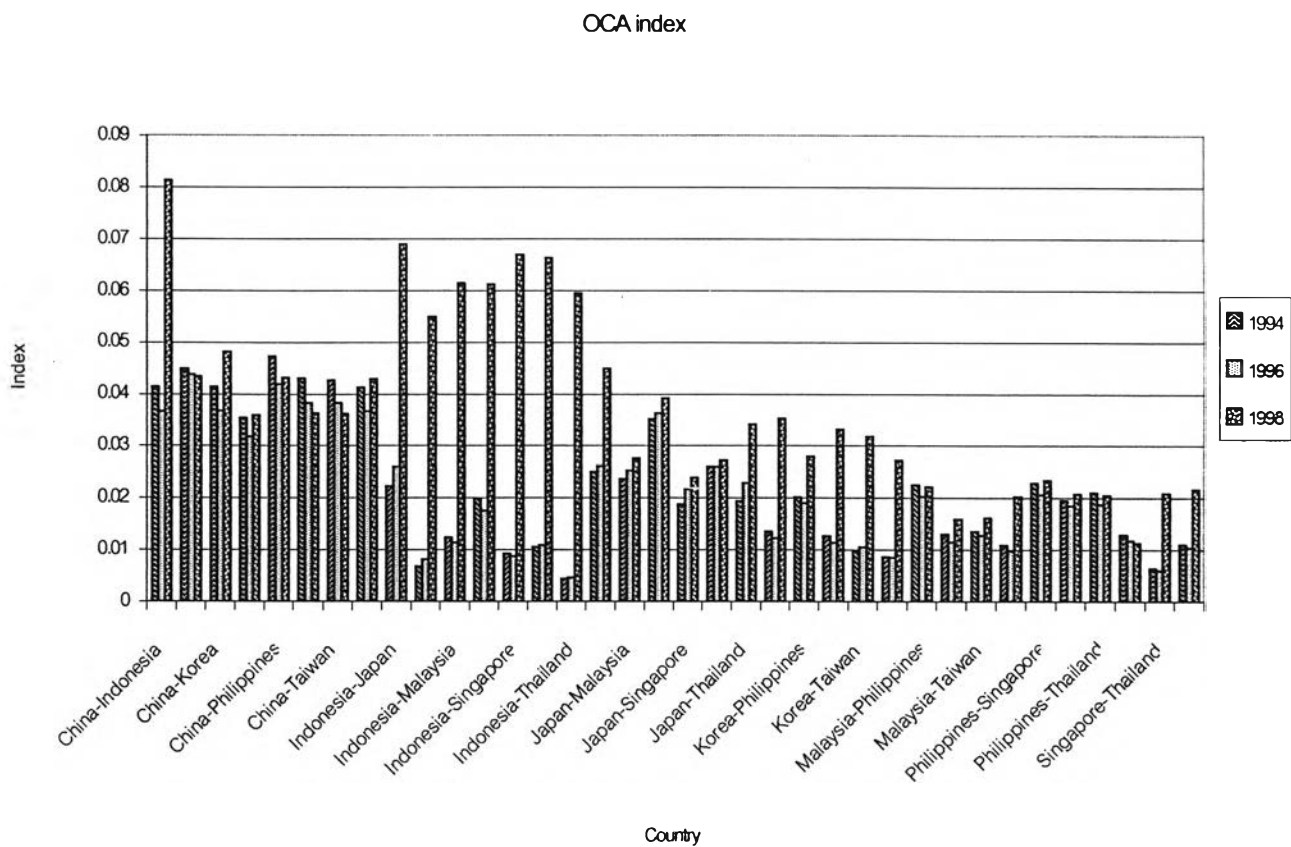
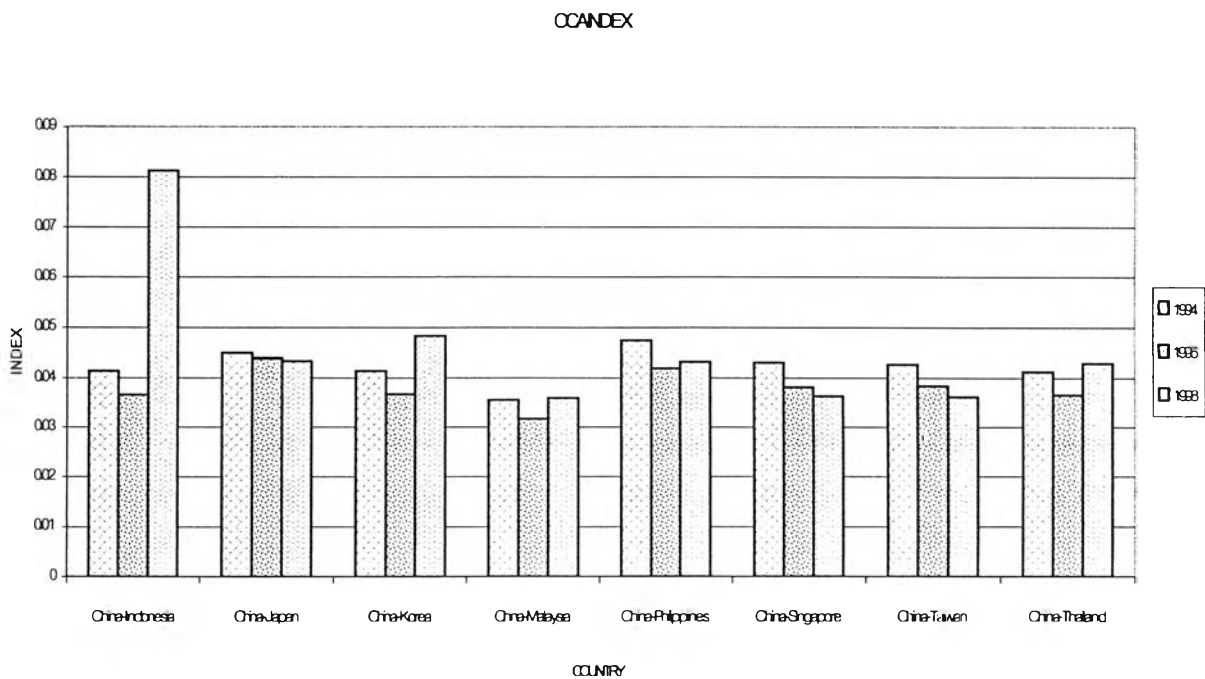
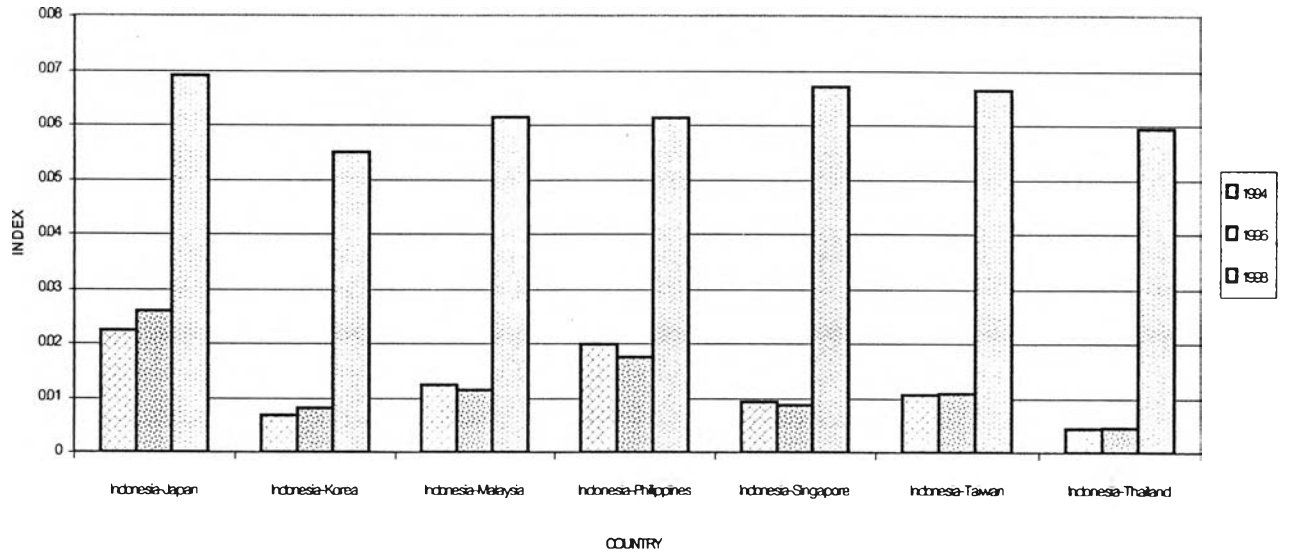


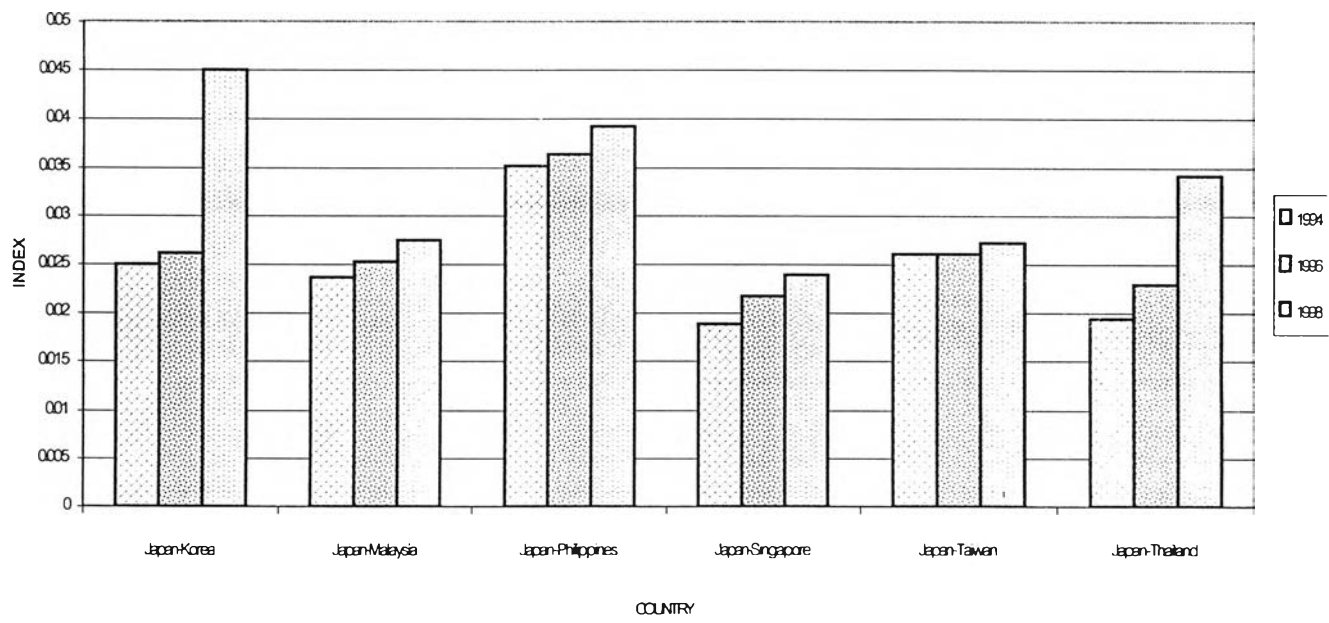
Figure 4-4 OCA index



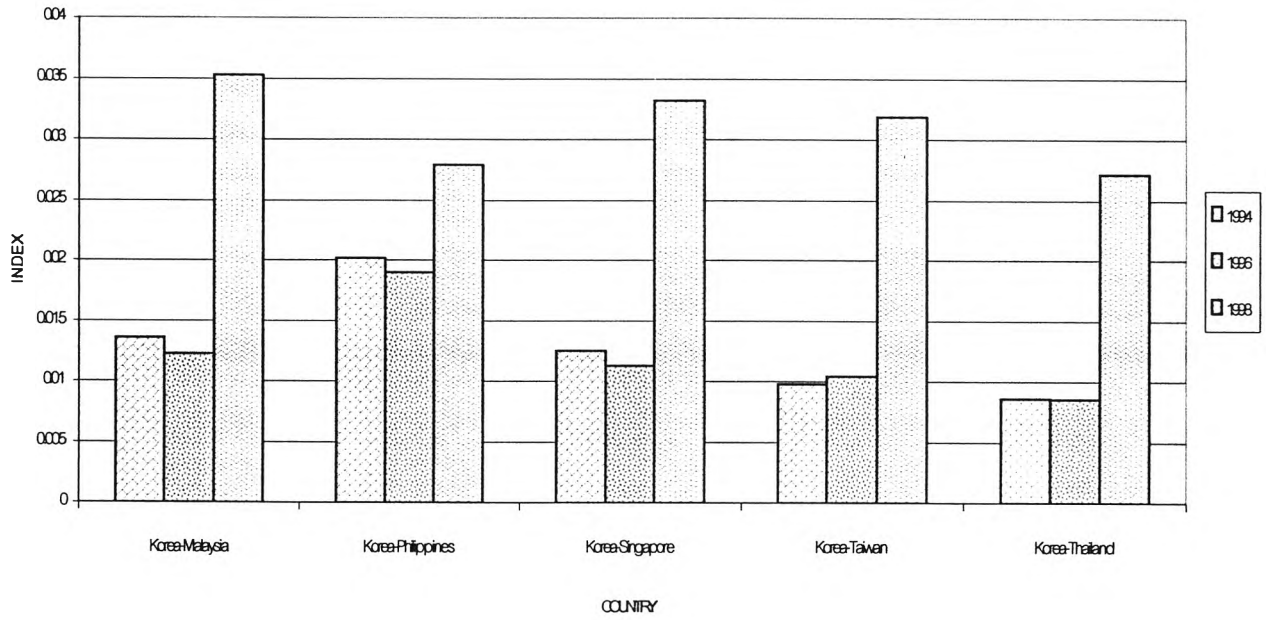
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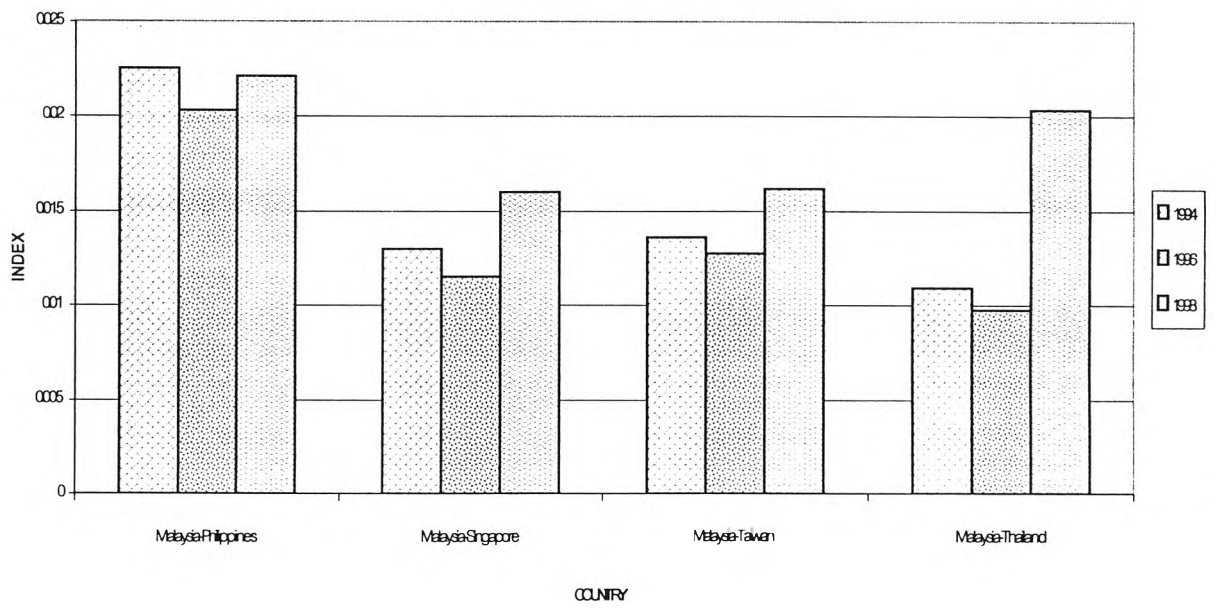
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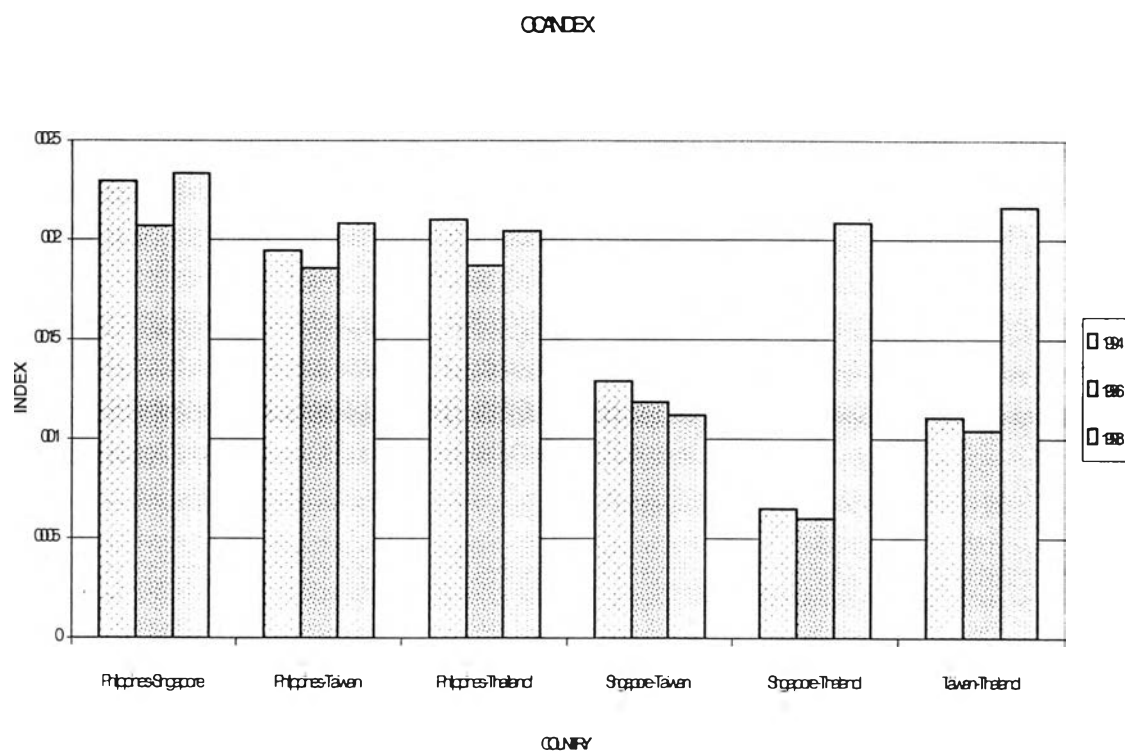


CCANDEX



CCANDEX





ij	1994	1996	1998
China-Japan	0.044904	0.043866	0.043451
China-Singapore	0.043051	0.038268	0.036304
China-Taiwan	0.042685	0.038402	0.036128
Japan-Taiwan	0.026094	0.026089	0.027169
Malaysia-Philippines	0.022567	0.020306	0.022131
Philippines-Singapore	0.022953	0.020714	0.023374
Philippines-Taiwan	0.019484	0.018598	0.020814
Philippines-Thailand	0.021034	0.018721	0.020463
Singapore-Taiwan	0.012924	0.011859	0.011206

Table 4-4 Other bilateral OCA indexes

From above figure, Indonesia shows no sign of convergence towards the currency block with any country since she was hit by financial and economic crises in 1998. The OCA indexes for other bilateral exchange rates are shown in table 4-4.

The individual OCA index, which shows the bilateral relationship suggests that China-Japan, China-Singapore, China-Taiwan, Japan-Taiwan, Malaysia-Philippines, Philippines-Singapore, Philippines-Taiwan, Philippines-Thailand, and Singapore-Taiwan shows significant sign of convergence towards the currency block eventhough they were hit by financial and economic crises in 1998. In case of Indonesia with subject countries, there is no sign of convergence, but rather divergence. Hence, if countries in the region strengthen their bilateral trade linkages, promote free trade policy, open their economies, their exchange rate stability will be higher and they will gain the benefits from the currency area.

4.5 POLICY IMPLICATION

As a result of the study, it is evident that an East Asian Economic and Monetary Integration is an achievable goal, but for the goal to be realized, there are a number of factors that have to be seriously considered and addressed. One of the most important components for Asia is undoubtedly the institutional setting. For the European Union, EU, it could be said that their economic and monetary integration was institutional based. The EU is the most successful of all the economic integration efforts in the world today, and hence their experiences can be valuable for other aspiring regional integration efforts as well. The various institutions such as the European Commission, the Council of Ministers, the European Council, the European Parliament and the Court of Justice reflects EU seriousness and ambition, and it was these institutions, each with their own functions, that played an integral part in the success that the EU is enjoying. The European Commission is the executive body responsible for implementing the treaties and general leadership, as well as managing the commission funds and programs and making policy proposals and presenting them to the Council of Ministers. The Council of Minister if the main law making body of the EU, and is the decision-making unit on all community wide matters, comprising of a single representative from each member states. The Council accepts, rejects or request proposals from the European Commission, but have no power to draft legislation. These are only two of the many important institutions that have contributed to the EU's success, and it could do no harm if Asia could learn from it.

For Asia, the ideas of an Asian Commission, an Asian Council of Ministers or an Asian Central Bank is not a far-fetched fantasy, but an achievable feat, that requires just a little more effort from the potential members. But clearly before that stage can be reached, the potential members for an "Asian Union" has to first be identified. It will be of no use at all to just include all the countries in Asia that are interested in joining the union, a strict screening process should be introduced, because the level of development of each country can be a major obstacle in the integration process. If countries that are not really ready for the integration are included just for the sake of the fact that they are an Asian country, they could hinder the integration process, and damage the effort for good. The EU also started with a small number of countries, and when they were strong enough, extended the memberships to other countries that were also strong enough. This will offer more benefit, because if a country outside the integration want to be included, then they have to work very hard to meet the standard and requirements set by the group. For Asia, a strong leader is needed, this is reflective of the fact that

although ASEAN had been in existence for over two decades, they have not been able to move to a greater and deeper level of integration, and this is often attributed to the lack of strong leadership within ASEAN. So for an Asian Integration, strong countries that possess leadership qualities, and also those that are widely accepted and respected have to be included and take the initiatives. In this first group, the region's powerhouses such as China and Japan should be included, followed closely by South Korea and Singapore. Then, the ring should be expanded to include countries with track records of stable economic performances, such as Thailand, Indonesia, Malaysia and Taiwan. These countries should form the core of the integration effort, and only when the integration is strong enough, membership expansion should be considered. Creation of Institutions such as those of the EU will help strengthen Asia's efforts, but Asia must be careful not to just copy what EU had done. It had been proven time and time again that what works in one environment does not guarantee that it will enjoy the same level of success in another. So Asia can choose what it thinks is the best features of the EU efforts and adapt these institutions to their own needs and ability. Furthermore, the functions that are required of the Asian Institutions may also be vastly different from that of the other institutions in other regional groupings. It is a matter of finding the right combination that will give the highest return for the desired purposes. Institutional based integration seem a much easier way to reach the goal, because when the institutions have been created, they will help to stabilize, as well as assist and strengthen the regional cooperation efforts. These institutions will make sure that all the members stay on the same course, and maintain the members' interests.

With a stable environment, the integration process can experience a surge in regional cooperation, talks and negotiations on abolishing the tariff rates and trade barriers can be seriously addressed. And when these issues are settled, it will result in an increased intra-regional trade, which will further strengthen the integration efforts. Hence, it must be stressed that for an Asian Economic and Monetary Integration to materialize, a number of factors have to be introduced and implemented. These factors have to be supported by the potential members' seriousness in wishing to achieve the goal, and their sincerity in the effort. Regional Integration offer enormous rewards and benefits, and as the world edges closer and closer towards globalization and regionalism, Asia, and other regional groupings for that matter, can no longer afford to waste time and energy, and let the integration process drag on. The longer the process takes, the more benefit will be lost, and if they arrive late on the scene, other regional groupings would have already reap the benefits, and there would almost certainly be nothing left for the late arrivers. It took almost half a century for the EU to reach the pinnacle, so how long will it take Asia?

The answers are in the hands of the leaders of Asia, and they must realize the urgency of the matter. Asia still have a long way to go, and it is going to be a tiring and winding road, but if the members stick together and stick to their goal, and share the same ambition, that is a good start.