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Regional Monetary Coordination in Asia after the Global Financial Crisis: Comparison in Regional Monetary Stability between ASEAN+3 and ASEAN+3+3

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Regional Monetary Coordination in Asia after the Global Financial Crisis: Comparison in Regional Monetary Stability between ASEAN+3 and ASEAN+3+3*

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Abstract

This paper analyzes how much deviation we have among Asian currencies, which include the Indian rupee, the Australian dollar, and the New Zealand dollar, given that we are discussing East Asian Community based on ASEAN+3 (Japan, China, and South Korea)+3 (India, Australia, and New Zealand). We investigate whether the instability or deviation of intra-regional exchange rates would increase when the additional three countries (India, Australia, and New Zealand) join the ASEAN+3. Contribution of each currency to the weighted average of AMU-wide Deviation Indicators shows that movements in the Japanese yen have contributed to those in the weighted average of the AMU-wide Deviation Indicators over time during the sample period from January 2000 to January 2010. Moreover, we use concepts of β and σ convergences in the context of economic growth to statistically analyze convergence or divergence for the ASEAN+3+3 currencies. The addition of the Indian rupee into the ASEAN+3 currencies makes the regional currencies unstable before and during the global financial crisis. Moreover, comparison between ASEAN+3+3 and ASEAN+3+Indian currencies shows that the addition of only the Indian rupee is relatively more stable than the addition of the Australian dollar and the New Zealand dollar as well as the Indian rupee since September 2008. It is worthy to consider that India will join the Chiang Mai Initiative to manage currency crises while the monetary authorities will conduct surveillance over stability of the intra-regional exchange rates in the near future.

1. Introduction

The global financial crisis that began with the subprime mortgage problem in the United States has affected the global economy in monetary and real aspects as well as financial aspects. Especially in the monetary aspect, the global financial crisis has brought about global currency turmoil. The euro and other European currencies depreciated abruptly against the US dollar since summer of 2008 although the financial crisis started from the United States. The Lehman shock accelerated the large depreciation of these currencies. It is the reason why many European financial institutions with subprime mortgage backed securities damaged their own balance sheets because of losses of the subprime mortgage and its related securities.

Some Asian currencies as well as the euro and other European currencies depreciated during the global financial crisis. One of the depreciating Asian currencies is the Korean won. It was overvalued by 20% to 30% against the US dollar and the Japanese yen from 2005 to 2007, however, it had an abrupt and large depreciation immediately after the global financial crisis occurred in the summer of 2007 and the Korean won has been undervalued since then. On one hand, the Chinese yuan appears to be pegged to the US dollar again although the Chinese government made an announcement of its exchange rate system reform that was to change from the dollar peg system to a managed floating exchange rate system with reference to a currency basket on July 21, 2005. On the other hand, only the Japanese yen has a tendency to appreciate against all of the currencies.

This paper has an objective to analyze how much deviation we have among Asian currencies which include the India rupee, the Australian dollar, and the New Zealand dollar, given that we are discussing East Asia Community based on ASEAN+3 (Japan, China, and South Korea)+3 (India, Australia, and New Zealand). We investigate whether the instability or deviation of intra-regional exchange rates would increase when the additional three countries (India, Australia, and New Zealand) join the ASEAN+3. For the purpose, we use measurements of the weighted averages of ASEAN+3 currencies and ASEAN+3+3 currencies and deviation indicators of the currencies based on the weighted averages of the currencies. Also, contribution of the currencies to deviation of the currencies is useful for us to investigate the issue. Moreover, we use concepts of β and σ convergences in the context of economic growth to statistically analyze convergence or divergence for the

ASEAN+3+3 currencies. Also we suppose a case where only the Indian rupee joins the ASEAN+3 currencies to compare β and σ convergences with the case of ASEAN+3+3 currencies.

2. Effects of the Global Financial Crisis on Asian Currencies

We use some measurements that show values of the weighted average of Asian currencies and the position (overvaluation or undervaluation) of each of the Asian currencies based on the weighted average of Asian currencies in order to investigate effects of the global financial crisis on Asian currencies. Here we suppose two kinds of coverage for Asian currencies: one includes ASEAN+3 (Japan, China, and South Korea) while the other includes ASEAN+3+3 (India, Australia, and New Zealand).

Ogawa and Shimizu (2005) created an Asian Monetary Unit (AMU) as a regional common currency unit for East Asia that is a weighted average of the East Asian currencies where the East Asia includes the ASEAN+3 (China, Japan, and South Korea). The weight of each currency in the basket is based both on countries' respective shares of GDP measured at purchasing power parity (PPP), and their trade volumes (the sum of exports and imports) in the total of sampled countries. These two shares are calculated as the average of the three years (2005-2007) for which data is available.

The shares and weights of each currency for AMU are shown in Table 1. A share of China (35.52%) is the largest among the AMU composition currencies, which reflects the largest share in GDP measured at PPP. Japan has the largest share if we use GDP measured at market exchange rates. We chose the GDP measured at PPP because market exchange rates are very much fluctuating over time. Japan has the second share (26.44%) while South Korea has the third share (10.56%).

AMU Deviation Indicators are measured for each East Asian currency's deviation from the AMU. The AMU Deviation Indicators are set at zero during their benchmark period of two years in 2000 and 2001 when trade imbalances of East Asian countries were at their smallest in the period of 1999-2007. Both the AMU and AMU Deviation Indicators are available at a website of the Research Institute of Economy, Trade and Industry (RIETI) (http://www.rieti.go.jp/users/amu/en/index.html).

Also, the same kind of measurements for the ASEAN+3+3 (India, Australia, and New Zealand) are available at the website of RIETI (http://www.rieti.go.jp/users/amu/en/index.html). The calculation methodology of the AMU-wide and AMU-wide Deviation Indicators are same as those of the AMU. The shares and weights of each currency for AMU, that are based both on countries' respective shares of GDP measured at purchasing power parity (PPP), and their trade volumes (the sum of exports and imports) in the total of sampled countries, are shown in Table 2.

The shares of China, Japan, and the others reduce by adding India, Australia, and New Zealand to the AMU-wide. China has still the largest share (29.55%) while Japan has the second largest share (22.21%). The shares of India, Australia, and New Zealand are 9.68%, 5.13%, and 0.84%, respectively. Total shares of the additional three countries amounts 15.65% of the AMU-wide.

The benchmark period is defined as the following: the total trade balance of member countries, the total trade balance of the member countries (excluding Japan) with Japan, and the total trade balance of member countries with the rest of the world should be relatively close to zero. Regarding a benchmark period of the AMU-wide Deviation Indicators, the trade balance of the ASEAN+3+3 between 1990 and 2007 indicates that the figure of intra-regional trade balance was the smallest in 1999, and the second smallest in 2000. The figures of other balances were also not large in these periods. Accordingly, 1999 and 2000 are chosen as the benchmark period of the AMU-wide. The benchmark exchange rates are calculated as the average of daily exchange rates in 1999 and 2000.

Figure 1 shows recent movements in nominal exchange rates of AMU in terms of the US dollar and euro currency basket as well as in terms of the US dollar and the euro separately. The currency basket is composed 65% of the US dollar and 35% of the euro based on trade shares of the East Asian countries with the United States and the euro area in 2001-2003 in order to reflect the value of the AMU in terms of major trading partners' currencies.

The AMU had been gradually depreciating against the currency basket of the US dollar and the euro before June 2003 when the AMU depreciated about 10% compared with the benchmark years of 2000 and 2001. However, it has been reversed its trend to upward direction since then. It has returned to almost the same level as in the benchmark period (2000-2001) before October 2008. The AMU is overvalued by 3% in January, 2010. The value of AMU in terms of the currency basket of the US dollar and the euro has been steadily appreciating even during the global financial crisis.

On one hand, the AMU was gradually appreciating against the US dollar before April 2008. Although it depreciated from April 2008 to April 2009, it has been appreciating against the US dollar since April 2009 again. The AMU was gradually depreciating against the euro before July 2008. It appreciated so much against the euro from July 2008 to October 2008. Both the movements in values of AMU in terms of the US dollar and the euro have reflected those in exchange rates of the euro in terms of the US dollar.

Figure 2 shows recent movements in nominal exchange rates of AMU-wide in terms of the US dollar and euro currency basket as well as in terms of the US dollar and the euro, separately.

The AMU-wide had been gradually depreciating against the currency basket of the US dollar and the euro before June 2003 when the AMU-wide depreciated about 8% compared with the benchmark years of 2000 and 2001. However, it has reversed its trend to upward direction since then. It has returned to almost the same level as in the benchmark period (2000-2001) before March 2008. The AMU-wide is overvalued by 3% in January 2010. The value of AMU-wide in terms of the currency basket of the US dollar and the euro has been steadily appreciating even during the global financial crisis like the AMU.

On one hand, the AMU-wide was gradually appreciating against the US dollar before April 2008. Although it depreciated from April 2008 to March 2009, it has been appreciating against the US dollar since March 2009 again. The AMU was gradually depreciating against the euro before July 2008. It appreciated so much against the euro from July 2008 to October 2008. Both the movements in values of AMU in terms of the US dollar and the euro have reflected those in exchange rates of euro in terms of the US dollar. The movements were very similar with those in the AMU.

Figure 3 shows movements in Deviation Indicators of ASEAN+3+3 currencies against the AMU-wide in terms of nominal exchange rates from the benchmark years of 1999 and 2000. Almost of the Deviation Indicators were fluctuating between -10% and +10% during the earlier period from 2000 to 2002. However, deviation of the currencies have been widening since 2003.

Both the New Zealand dollar and the Australian dollar were overvalued from the beginning of 2003 to July 2008. The New Zealand dollar was overvalued by about 60% in July 2007. On one hand, in July 2008, both the

Australian dollar and the New Zealand dollar were overvalued by about 40%. Both of the currencies dropped very quickly from July 2008 to October 2008 by about 40 % points although they have recovered to about 30% overvalued level. Especially the global financial crisis has fluctuated the both the New Zealand dollar and the Australian dollar.

Also the Korean won has characteristic movements before and after the global financial crisis. The Korean won were overvalued against the AMU-wide or a weighted average of ASEAN+3+3 currencies from the end of 2004 to early 2008. It was overvalued by nearly 20% compared with the benchmark years 1999-2000 especially from early 2006 to early 2007. However, the Korean won has been depreciating quickly since the end of 2007. It reached to a level of 30% of undervaluation in March 2009.

The Indian rupee was stable before 2007. However, it began to depreciate from early 2008 to reach to a level of about 20% of undervaluation at the end of 2008. It has remained undervalued by 20% till now (January 2010). The Indian rupee seems to reflect the global financial crisis to depreciate by about 20% points against the AMU-wide or the weighted average of ASEAN+3+3 currencies.

On the other hand, the Japanese yen has asymmetric movements before and after the global financial crisis against the Korean won. The Japanese yen had been depreciating and undervalued against the AMU-wide from the July 2005 to July 2007. It was undervalued by nearly 15% compared with the benchmark years 1999-2000 especially in July 2007. However, the Japanese yen has been appreciating quickly since July 2007. It reached to a level of 13% of overvaluation in February 2009. The Japanese yen has remained overvalued by about 10% till now (January 2010). The relative appreciation of the Japanese yen against the neighboring currencies worsen the Japanese exports and, in turn, the Japanese economy.

Lastly, the Chinese yuan was appreciating from March 2008 to March 2009 although it had been stable before March 2008. However, it has been depreciated against the AMU-wide or the weighted average of ASEAN+3+3 currencies since March 2008 till now (January 2010). It happens because the Chinese monetary authorities peg the Chinese yuan to the depreciating US dollar although the Chinese government made an announcement of changing its exchange rate system from the dollar peg system to a managed floating exchange rate system with reference to a currency basket which includes not only the US dollar but also the euro, the Japanese yen, and others.

3. Deviations among Asian Currencies

We use a weighted average of absolute values of the above Deviation Indicators for all of the ASEAN+3 currencies (AMU) and ASEAN+3+3 currencies (AMU-wide) to show the degree of deviation for the ASEAN+3+3 currencies before and after the global financial crisis compared with the ASEAN+3 currencies.

Figure 4 shows the comparisons in a weighted average of Deviation Indicators between the AMU and the AMU-wide. Both of the weighted averages of AMU and AMU-wide Deviation Indicators were relatively lower from 2000 to 2004. Averages of them are 3.16% (its standard deviation: 1.38%) for AMU and 4.22% (its standard deviation: 1.12%) for AMU-wide, respectively. Both of them were increasing from the end of 2004 to early 2009. Recently they have decreased a little from 14% to 9% (in January 2010) for AMU-wide and 12% to 6% (in January 2010) for AMU, respectively.

Thus, deviations among Asian currencies began to increase since 2005 before the global financial crisis. They kept increasing during the global financial crisis although they decreased temporarily because the overvalued currencies returned to their benchmark period levels. However, the deviations increased again because they went beyond the benchmark period levels. The global financial crisis was caused by active global capital flows before it occurred. The global financial crisis abruptly shrank the global capital flows and made them flow backward. As the result, active capital inflows overvalued some currencies while the related capital outflows undervalued other currencies. During the global financial crisis, both shrinking capital flows and backward capital flows have reversed upward or downward pressures on the Asian currencies. The global financial crisis has depreciated the overvalued currencies while at the same time they have appreciated the undervalued currencies.

It is clear that the weighted average of the AMU-wide Deviation Indicators has been larger than that of the AMU Deviation Indicators over time since September 2000. The reason is that two of three additional currencies, both the New Zealand dollar and the Australian dollar, have the much larger overvaluation compared with the ASEAN+3 currencies while the Indian rupee has little effects on the differences. Moreover, Figure 4 shows that differentials of AMU-wide minus AMU Deviation Indicators have increased since 2008 when the global financial crisis occurred. The differentials are about 4% points in January 2010 while they were around 2% points before 2008.

Figure 5 shows contribution of each currency to the weighted average of AMU-wide Deviation Indicators [1]. Generally speaking, movements in the Japanese yen have contributed to those in the weighted average of the AMU-wide Deviation Indicators over time during the sample period from January 2000 to January 2010. The contribution was relatively larger from 2005 to 2007 (its contribution reached to a level of 35%).

Movements in the Chinese yuan contributed to those in the weighted average of the AMU-wide Deviation Indicators before mid-2003 (its contribution was larger than 40%). Also they have contributed to those in the weighted average of the AMU-wide Deviation Indicators since May 2008 when the Chinese yuan has returned to the *de facto* dollar peg system (its contribution was about 25%). On the other hand, they had little contribution to movements in the weighted average of the AMU-wide Deviation Indicators while the Chinese monetary authority was revaluing the Chinese yuan against the US dollar from July 2005 to May 2008.

Figure 5 shows that the Australian dollar, the Korean won, and the Indian rupee also made important contributions to the weighted average of AMU Deviation. Movements of the Korean won have large contributions to deviation among the Asian currencies from late 2005 to early 2008 and after September 2008. The Australian dollar has had some contributions to deviation among the Asian currencies since 2004. Also movements of the Indian rupee have had some contributions to movements in the weighted average of the AMU-wide Deviation Indicators. Especially after mid-2008 the contribution of the Indian rupee has increased to 17% in January 2010.

4. Empirical Analysis on Divergences among Asian Currencies

Ogawa and Yoshimi (2009) used the methods of β- and σ-convergences in the context of economic growth to investigate statistically whether deviations among the ASAEN+3 currencies are widening. In this section, the same methods are used to investigate statistically whether deviations among

[1] Ogawa and Yoshimi (2008) analyzed contributions of ASEAN+3 currencies to the AMU Deviation Indicators.

the ASAEN+3+3 currencies are widening. In addition, it is analyzed whether deviations among the ASAEN+3+Indian currencies are widening in order to investigate whether it is possible for the Indian rupee to join regional monetary coordination of the ASEAN+3 and how much the Australian dollar and the New Zealand dollar make the AMU-wide diverge.

Adam *et al.* (2002) proposed β- and σ-convergence measurements in the context of the economic growth literature to investigate whether interbank interest rates among euro area countries relative to the corresponding German rate have reduced or not. The β- and σ-convergence measurements are used to analyze convergence or divergence among Asian currencies. Especially, we can have a situation where currencies converge in terms of σ-convergence while they diverge in terms of β-convergence at the same time because the decrease in the cross-sectional variance among AMU-wide Deviation Indicators does not necessarily imply mean reversion or convergence of AMU-wide Deviation Indicators to its benchmark level. Further, β-convergence does not imply σ-convergence since mean reversion does not imply that the cross-sectional variance decreases over time. In fact, the two tests generated inconsistent results in some of our estimations.

The following equation is estimated in order to analyze whether the AMU-wide Deviation Indicators converge among the Asian currencies (ASEAN+3+3 currencies or ASEAN+3+Indian currencies) during the sample period and how fast they are converging if they are converging.

$$\Delta DI_{i,t} = \mu_i + \beta_i DI_{i,t-1} + \sum_{j=1}^{p_i} \gamma_j \Delta DI_{i,t-j} + \varepsilon_{i,t}, \quad (3)$$

where i and t denote the country and time indices. μ_i reflects an idiosyncratic factor in country i and the error term $\varepsilon_{i,t}$ denotes exogenous shocks to the difference of the AMU-wide Deviation Indicators. p_i is the lag length for country i.

A negative β_i indicates that the deviation of the currency of a relatively large country tends to converge to the average level of sampled currencies more rapidly than that of the currency of a relatively small country. Further, the size of β_i is a direct measure of the speed of convergence. This method is called β-convergence test. Equation (3) can be estimated by panel unit root methods since a negative β_i is equivalent to the stationality of $DI_{i,t}$. We employ two methods developed by Levin, Lin and Chu (2002, LLC hereafter) and Im, Pesaran and Shin (1997, IPS). In the LLC test, the null and alternative hypotheses are $H_0 : \beta_i = \beta = 0$ and $H_1 : \beta < 0$, respectively. It is assumed homogeneity in β_is in the LLC test while β_i is allowed to differ across countries to avoid the heterogeneity bias in the IPS test. In the IPS test, $H_0 : \beta_i = 0$ for all i, against the alternative $H_1 : \beta_i < 0$ for some of i.

To measure the degree of convergence at each point in time and assess whether DI s are converging to their average level during the sample period, the following equation is estimated.

$$\Delta\sigma_{i,t}^2 = \kappa + \eta\sigma_{i,t-1}^2 + \sum_{j=1}^{p_i} \lambda_j \Delta\sigma_{i,t-j}^2 + \nu_{i,t}, \quad (4)$$

where $\sigma_{i,t}^2$ is a variance of the AMU-wide Deviation Indicators in country i at time t and $\nu_{i,t}$ denotes exogenous shocks. A negative η indicates that the deviation among the AMU-wide Deviation Indicators tend to decrease when it is high. Equation (4) can be estimated by Augmented Dickey-Fuller (ADF) unit root test methods as a negative η suggests that the sequence of $\sigma_{i,t}^2$ follows stationary process. Thus, the null and alternative hypotheses are $H_0 : \eta = 0$ and $H_1 : \eta < 0$, respectively. We also employ Phillips-Perron (PP) method to allow the autocorrelation in the stochastic shocks to $\sigma_{i,t}^2$.

In this paper, the global financial crisis is focused on because the crisis is likely to affect movements of the Asian currencies in recent years. We analyze effects of the following events on the Asian currencies. Firstly, it is said that active international capital flows such as the yen carry trades brought about depreciation of the Japanese yen and appreciation of emerging economy country currencies such as the Korean won and the Thai baht during a period from 2005 to 2007. Secondly, the recent subprime mortgage problem, which happened in the summer of 2007, might affect linkages among the East Asian currencies by changing capital flows in international financial markets. In addition, the Lehman shock that happened on September 15, 2008 has increased counterparty risks of financial institutions in inter-bank transaction, which escalate depreciation of the euro and the pound sterling. It might affect movements in Asian currencies which include appreciation of the

Japanese yen and depreciation of the Korean won. We divide the whole sample period into five sub-sample periods based on the above events to investigate any changes in the movements and convergences of Asian currencies.

According to the three events, we divide a whole sample period into the four sub-sample periods: Period 1 (January 3, 2000 to January 13, 2005), Period 2 (January 14, 2005 to August 7, 2007), Period 3 (August 8, 2007 to September 14, 2008), Period 4 (September 15, 2008 to January 21, 2010).

Table 3(a) reports results of the ADF and PP tests for the averaged AMU-wide Deviation Indicators, β-convergence tests (LLC and IPS tests) and σ-convergence test (ADF and PP tests) for the AMU-wide Deviation Indicators of the ASEAN+3+3 currencies during the whole sample period. Lag lengths are selected based on the Schwartz Bayesian Information Criterion (SBIC). We cannot reject the null hypothesis that the averaged AMU-wide Deviation Indicator has unit root in all cases with the full samples (January 3, 2000 to January 21, 2010). Both the LLC and IPS tests have a result that they have no β-convergence among the ASEAN+3+3 currencies. Regarding σ-convergence, we cannot reject the null hypothesis that the AMU-wide Deviation Indicators of ASEAN+3+3 currencies have cross-sectional dispersion. These empirical results suggest that the ASEAN+3+3 currencies are not converged during the whole sample period.

Tables 3(b) to 3(e) also show the same empirical results for each of the sub-sample periods as those during the whole sample period. Only the empirical results during the sub-sample period from September 15, 2008 to January 20, 2010 has one exceptional case where the IPS test have a result that they have β-convergence among the ASEAN+3+3 currencies. All the cases except for the exceptional case show that the ASEAN+3+3 currencies are not converged during all of the sub-sample periods.

The empirical results on divergence in the case of the ASEAN+3+3 are contrast with those in the case of the ASEAN+3 that Ogawa and Yoshimi (2009) obtained. Ogawa and Yoshimi obtained a result that the ASEAN+3 currencies had β-convergence during the period from 2000 to early 2005 in some of the estimations. They could not reject the unit root hypothesis in the ADF and PP tests for both the weighted average of AMU Deviation Indicators and σ-convergence while both of the LLC and IPS tests have a result that they have β-convergence among the ASEAN+3 currencies in few of the estimations. This is because active international capital flows such as the yen carry trades caused the depreciation of the yen and the appreciations of the Korean won and the baht, and pushed the divergence among the sample currencies.

Table 4(a) reports results of the ADF and PP tests for the averaged AMU-wide Deviation Indicators, β-convergence tests (LLC and IPS tests) and σ-convergence test (ADF and PP tests) for the AMU-wide Deviation Indicators of the ASEAN+3+Indian currencies during the whole sample period. Lag lengths are selected based on the SBIC. We cannot reject the null hypothesis that the averaged AMU-wide Deviation Indicator has unit root in all cases with the full samples (January 3, 2000 to January 21, 2010). Both the LLC and IPS tests have a result that they have no β-convergence among the ASEAN+3+Indian currencies. Regarding σ-convergence, we cannot reject the null hypothesis that the AMU-wide Deviation Indicators of the ASEAN+3+Indian currencies have cross-sectional dispersion. These empirical results suggest that the ASEAN+3+Indian currencies are not converged during the whole sample period.

Tables 4(b) to 4(e) show the empirical results for each of the sub-sample periods. Only the empirical results during the sub-sample period from September 15, 2008 to January 20, 2010 has one case where the IPS test have a result that they have β-convergence among the ASEAN+3+Indian currencies and two cases where the ADF and PP tests have a result that they have σ-convergence among the ASEAN+3+Indian currencies. The ASEAN+3+Indian currencies had no convergences in terms of β- and σ-convergences in the other sub-sample period as well as the whole sample period.

Like the case of ASEAN+3+3, the empirical results on divergence in the case of the ASEAN+3+Indian currencies are contrast with those in the case of the ASEAN+3 currencies that Ogawa and Yoshimi (2009) obtained. The addition of the Indian rupee into the ASEAN+3 currencies makes the regional currencies unstable before and during the global financial crisis. Moreover, comparison between the ASEAN+3+3 and ASEAN+3+Indian currencies shows that the addition of only the Indian rupee is relatively more stable than the addition of the Australian dollar and the New Zealand dollar as well as the Indian rupee since September 2008.

5. Conclusion: Regional Monetary Coordination in Asia

Each country in Asia has strong economic relationships with the others in the context of production network and supply chains. The monetary authorities of Asian countries should prevent biased changes in relative prices caused by the US dollar depreciation under their different exchange rate systems and exchange rate policies. Active capital movements in the region have the asymmetric effects on the Asian currencies especially before and after the global financial crisis.

Kawai, Ogawa, and Ito (2004) suggested that first the monetary authorities of Asian countries should discuss the exchange rate issue as a part of their surveillance process. The exchange rates of these currencies against those of neighboring countries are indeed linked by terms of trade and competitive prices. Ogawa and Ito (2002) pointed out possible coordination failure in choosing an exchange rate system and exchange rate policy. For example, if one country chooses the dollar-peg system without coordinating with other countries, this choice may have an adverse effect on the exchange rate systems of other countries through relative price effects[2].

The monetary authorities of ASEAN+3 have already established the Chiang Mai Initiative (CMI) to strengthen regional monetary cooperation in 2000 after they experienced the Asian Currency Crisis in 1997. Under the CMI, a network of bilateral currency swap arrangements was concluded in order to manage currency crises in ASEAN+3 countries. Moreover, the network of bilateral currency swap arrangements has developed to a multilateral currency swap arrangement under a CMI Multilateralization (CMIM) of ASEAN+3 at the end of 2009. However, they have a problem that the currency swap arrangements have a condition that it can be implemented just after the IMF gives a financial support to a country affected by the crisis (so-called IMF Link).

The monetary authorities are supposed to conduct a surveillance process in order that they should prevent future currency crises under the CMIM. However, they have no standing institution for carrying out the surveillance

[2] Ogawa (2007) conducted an empirical analysis on whether the dollar-pegging currencies adversely affected other East Asian countries' choices of exchange rate systems and exchange rate policies. They did not choose a desirable exchange rate system but rather the *de facto* dollar-peg system because the dollar-pegging countries continued to adopt official or *de facto* dollar-peg systems.

process. Instead, they regularly meet as the Economic Review and Policy Dialogue (ERPD) in the ASEAN+3 Finance Deputy Ministers Meeting for surveillance of their macroeconomic performance and they focus only on domestic macroeconomic variables including GDP, inflation, and soundness of the financial sector.

In addition, the Japanese Ministry of Finance has concluded a bilateral currency swap arrangement with the Indian Ministry of Finance in July 2008. Both of the monetary authorities can swap their home currency against the US dollar in order to supply short-term liquidity in terms of the US dollar (It limits US$ 3 billion). The arrangement between Japan and India has the IMF Link like the CMIM. Thus, the Japanese monetary authorities have established currency swap arrangement with ASEAN, China, South Korea, and India.

The monetary authorities have recognized that the currency swap arrangements are important in providing liquidity to avoid further currency depreciation related with abrupt capital outflows as well as managing balance of payment crisis after we experienced the global financial crisis. At the same time, it is necessary to conduct the surveillance over intra-regional exchange rates as well as exchange rates in terms of the US dollar among the monetary authorities of Asian countries.

The empirical analysis in this paper obtained that the addition of only the Indian rupee into the ASEAN+3 currencies has a relatively stronger tendency to converge than the addition of the Australian dollar and the New Zealand dollar as well as the Indian rupee after the global financial crisis in 2008. It is worthy to consider that India will join the CMIM to manage currency crises while the monetary authorities will conduct surveillance over stability of the intra-regional exchange rates in the near future.

References

Adam, Klaus, Tullio Jappeli, Annamaria Menichini, Mario Padula and Marco Pagano, (2002) “Analyse, Compare, and Apply Alternative Indicators and Monitoring Methodologies to Measure the Evolution of Capital Market Integration in the European Union,” Report to European Commissions.

Im, K. S., Pesaran, M. H., Shin, Y., (1997), “Testing for Unit Roots in Heterogeneous Panels,” mimeo, Department of Applied Economics,

University of Cambridge.
Kawai, Masahiro, Eiji Ogawa, and Takatoshi Ito, (2004) "Developing New Regional Financial Architecture: A Proposal," mimeo.
Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu (2002), "Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties," *Journal of Econometrics*, 108(1): 1-24.
Ogawa, Eiji, (2007) "Economic interdependence and international coordination in East Asia," in Takatoshi Ito, ed., *A Basket Currency for Asia*, Routledge, Pub., 99-123.
Ogawa, Eiji and Takatoshi Ito, (2002) "On the desirability of a regional basket currency arrangement," *Journal of the Japanese and International Economies*, Vol. 16, No. 3, 317-334.
Ogawa, Eiji and Junko Shimizu, (2005) "AMU deviation indicator for coordinated exchange rate policies in East Asia," RIETI Discussion Paper, no. 05-E-017.
Ogawa, Eiji and Taiyo Yoshimi, (2008) "Widening Deviation among East Asian Currencies," *RIETI Discussion Paper Series*, 08-E-010.
Ogawa, Eiji and Taiyo Yoshimi, (2009) "Analysis on β and σ Convergences of East Asian Currencies," *RIETI Discussion Paper*, 09-E-018.

Table 1: AMU shares and weights of Asian Currencies

Table 2. AMU shares and weights of East Asian Currencies
(revised in 10/2009****, benchmark year=2000/2001)

	Trade volume* %	GDP measured at PPP** ,%	Arithmetic average shares % (a)	Benchmark exchange rate*** (b)	AMU weights (a)/(b)
Brunei	0.33	0.14	0.23	0.589114	0.0039
Cambodia	0.15	0.17	0.16	0.000270	5.8666
China	26.08	44.97	35.52	0.125109	2.8395
Indonesia	5.27	5.61	5.40	0.000113	477.8761
Japan	23.12	29.76	26.44	0.009065	29.1705
South Korea	13.01	8.12	10.56	0.000859	122.9905
Laos	0.11	0.08	0.10	0.000136	7.0288
Malaysia	7.51	2.40	4.95	0.272534	0.1818
Myanmar	0.33	0.30	0.31	0.159215	0.0198
Philippines	2.37	1.99	2.18	0.021903	0.9964
Singapore	12.80	1.50	7.15	0.589160	0.1213
Thailand	6.59	3.51	5.05	0.024543	2.0580
Vietnam	2.33	1.45	1.89	0.000072	262.4862

* : The trade volume is calculated as the average of total export and import volumes in 2005, 2006 and 2007 taken from DOTS (IMF).

**: GDP measured at PPP is the average of GDP measured at PPP in 2005, 2006 and 2007 taken from the World Development Report, World Bank.

*** : The Benchmark exchange rate ($-euro/Currency) is the average of the daily exchange rate in terms of US$-euro in 2000 and 2001.

**** : AMU shares and weights were reviced in Oct. 2009. This is the 5th version.

Table 2: AMU-wide shares and weights of Asian Currencies

(Benchmark year=1999/2000)

	Trade volume* %	GDP measured at PPP** ,%	Arithmetic average shares % (a)	Benchmark exchange rate*** (b)	AMU weights (a)/(b)
Australia	6.29	3.98	5.13	0.615285	0.0835
Brunei	0.30	0.11	0.20	0.587476	0.0035
Cambodia	0.13	0.13	0.13	0.000264	4.9517
China	23.40	35.70	29.55	0.121326	2.4355
India	3.35	16.01	9.68	0.022829	4.2399
Indonesia	4.71	4.45	4.58	0.000125	367.3403
Japan	20.79	23.63	22.21	0.009100	24.4015
Korea	11.56	6.44	9.00	0.000868	103.7352
Lao PDR	0.09	0.07	0.08	0.000158	4.9820
Malaysia	6.67	1.91	4.29	0.264305	0.1622
Myanmar	0.30	0.23	0.27	0.161891	0.0165
New Zealand	1.05	0.63	0.84	0.494035	0.0170
Philippines	2.03	1.58	1.81	0.024204	0.7462
Singapore	11.43	1.19	6.31	0.587478	0.1074
Thailand	5.82	2.79	4.31	0.025777	1.6703
Vietnam	2.10	1.15	1.63	0.000071	227.4460

* The trade volume is calculated as the average of export and import volumes in 2005, 2006 and 2007 taken from DOTS (IMF).

** GDP measured at PPP is the average of GDP measured at PPP in 2005, 2006 and 2007 taken from the World Development Report, World Bank.

*** The Benchmark exchange rate ($-euro/Currency) is the average of the daily exchange rate in terms of US$-euro in 1999 and 2000.

Table 3: Estimation Results of Convergence among ASEAN+3+3 currencies

(a) Full samples (1/3/2000-1/21/2010)

		Unit root test for averaged AMU-wide DI				
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	2623	-0.30	0.57
		○	0	2623	-1.77	0.40
Phillips-Perron	Nominal	×		2623	-0.31	0.57
		○		2623	-1.80	0.38
		β-convergence test for AMU-wide DI				
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	41956	0.56	0.71
		○	0 to 2	41956	1.49	0.93
Im, Pesaran and Shin	Nominal	○	0 to 2	41956	0.78	0.78
		σ-convergence test for AMU-wide DI				
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	2623	-0.10	0.65
		○	0	2623	-1.48	0.54
Phillips-Perron	Nominal	×		2623	-0.08	0.66
		○		2623	-1.47	0.55

(b) Period1 (1/3/2000-1/13/2005)

		Unit root test for averaged AMU-wide DI				
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	1313	-0.47	0.51
		○	0	1313	-1.76	0.40
Phillips-Perron	Nominal	×		1313	-0.48	0.51
		○		1313	-1.81	0.38
		β-convergence test for AMU-wide DI				
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	21001	-0.65	0.26
		○	0 to 2	21001	1.45	0.93
Im, Pesaran and Shin	Nominal	○	0 to 2	21001	0.13	0.55
		σ-convergence test for AMU-wide DI				
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	1313	1.22	0.94
		○	0	1313	0.06	0.96
Phillips-Perron	Nominal	×		1313	1.36	0.96
		○		1313	0.13	0.97

(c) Period2 (1/14/2005-8/7/2007)

Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Unit root test for averaged AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	667	1.14	0.93
		○	0	667	−0.56	0.88
Phillips-Perron	Nominal	×		667	1.18	0.94
		○		667	−0.50	0.89
β-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	21001	−0.65	0.26
		○	0 to 2	21001	1.45	0.93
Im, Pesaran and Shin	Nominal	○	0 to 2	21001	0.13	0.55
σ-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	667	0.72	0.87
		○	0	667	−1.34	0.61
Phillips-Perron	Nominal	×		667	0.63	0.85
		○		667	−1.55	0.51

(d) Period3 (8/8/2007-9/14/2008)

Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Unit root test for averaged AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	287	−0.38	0.54
		○	0	287	−2.10	0.24
Phillips-Perron	Nominal	×		287	−0.38	0.55
		○		287	−2.18	0.21
β-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	4582	−0.98	0.16
		○	0 to 2	4582	2.67	1.00
Im, Pesaran and Shin	Nominal	○	0 to 2	4582	2.63	1.00
σ-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	287	−1.01	0.28
		○	0	287	−1.61	0.48
Phillips-Perron	Nominal	×		287	−1.00	0.29
		○		287	−1.78	0.39

(e) Period4 (9/15/2008-1/21/2010)

Unit root test for averaged AMU-wide DI							
Method	Data	Constant	Lag length	Obs.	Statistic		Prob.
Augmented Dickey-Fuller	Nominal	×	0	353	-0.32		0.57
		○	0	353	-1.34		0.61
Phillips-Perron	Nominal	×		353	-0.32		0.57
		○		353	-0.32		0.57
β-convergence test for AMUwide DI							
Method	Data	Constant	Lag length	Obs.	Statistic		Prob.
Levin, Lin and Chu	Nominal	×	0 to 3	5638	0.69		0.76
		○	0 to 3	5640	-0.30		0.38
Im, Pesaran and Shin	Nominal	○	0 to 3	5640	-2.44	***	0.00
σ-convergence test for AMU-wide DI							
Method	Data	Constant	Lag length	Obs.	Statistic		Prob.
Augmented Dickey-Fuller	Nominal	×	1	352	0.30		0.77
		○	1	352	-1.04		0.74
Phillips-Perron	Nominal	×		353	0.24		0.76
		○		353	-1.15		0.70

Table 4: Estimation Results of Convergence among ASEAN+3+Indian currencies

(a) Full samples (1/3/2000–1/21/2010)

Unit root test for averaged AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	2623	-0.46	0.52
		○	0	2623	-1.76	0.40
Phillips-Perron	Nominal	×		2623	-0.47	0.51
		○		2623	-1.79	0.38
β-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	36710	0.89	0.81
		○	0 to 2	36710	1.67	0.95
Im, Pesaran and Shin	Nominal	○	0 to 2	36710	0.81	0.79
σ-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	2623	0.60	0.85
		○	0	2623	-1.05	0.74
Phillips-Perron	Nominal	×		2623	0.63	0.85
		○		2623	-1.03	0.74

(b) Period1 (1/3/2000–1/13/2005)

Unit root test for averaged AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	1313	-0.66	0.43
		○	0	1313	-1.62	0.47
Phillips-Perron	Nominal	×		1313	-0.69	0.42
		○		1313	-1.68	0.44
β-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	18375	-1.02	0.15
		○	0 to 2	18375	0.8	0.79
Im, Pesaran and Shin	Nominal	○	0 to 2	18375	-0.72	0.24
σ-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	1313	0.58	0.84
		○	0	1313	-1.63	0.47
Phillips-Perron	Nominal	×		1313	0.73	0.87
		○		1313	-1.46	0.56

(c) Period2 (1/14/2005-8/7/2007)

Unit root test for averaged AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	667	1.00	0.92
		○	0	667	-0.63	0.86
Phillips-Perron	Nominal	×		667	1.00	0.92
		○		667	-0.57	0.88
β-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	9329	0.01	0.50
		○	0 to 2	9329	-0.33	0.37
Im, Pesaran and Shin	Nominal	○	0 to 2	9329	0.85	0.80
σ-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	667	0.72	0.87
		○	0	667	-1.34	0.61
Phillips-Perron	Nominal	×		667	0.63	0.85
		○		667	-1.55	0.51

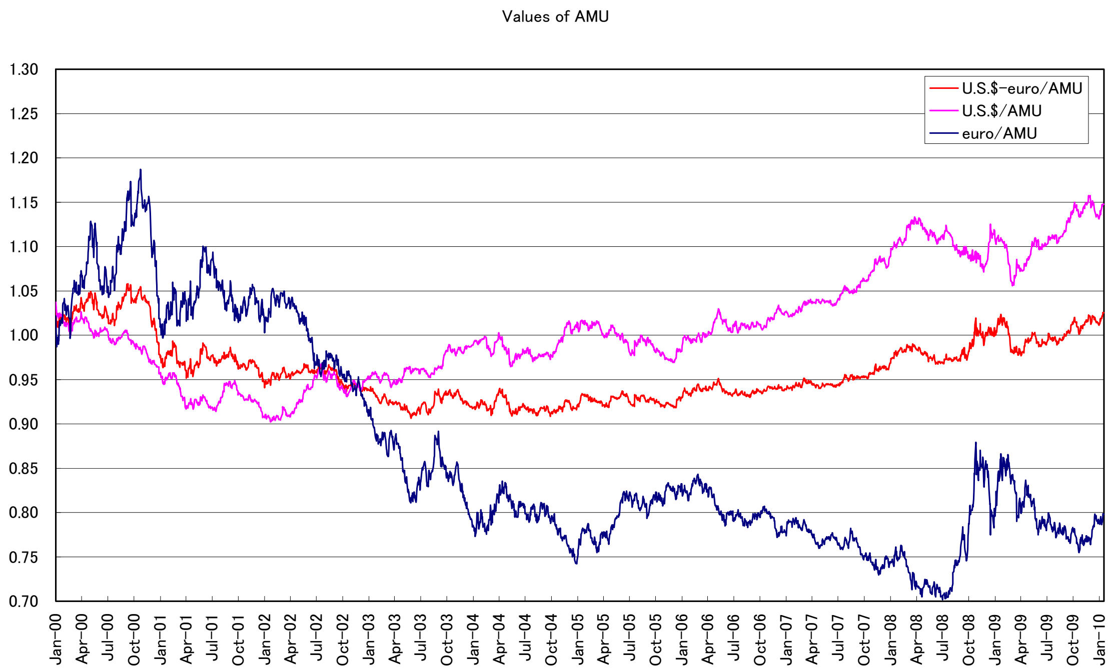
(d) Period3 (8/8/2007-9/14/2008)

Unit root test for averaged AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	1	286	-0.11	0.64
		○	1	286	-1.33	0.62
Phillips-Perron	Nominal	×		287	-0.30	0.58
		○		287	-1.76	0.40
β-convergence test for AMU-wde DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Levin, Lin and Chu	Nominal	×	0 to 2	4007	-0.75	0.23
		○	0 to 2	4008	2.52	0.99
Im, Pesaran and Shin	Nominal	○	0 to 2	4008	2.78	1.00
σ-convergence test for AMU-wide DI						
Method	Data	Constant	Lag length	Obs.	Statistic	Prob.
Augmented Dickey-Fuller	Nominal	×	0	287	-1.18	0.22
		○	0	287	-2.01	0.28
Phillips-Perron	Nominal	×		287	-1.27	0.19
		○		287	-1.98	0.30

(e) Period4 (9/15/2008-1/21/2010)

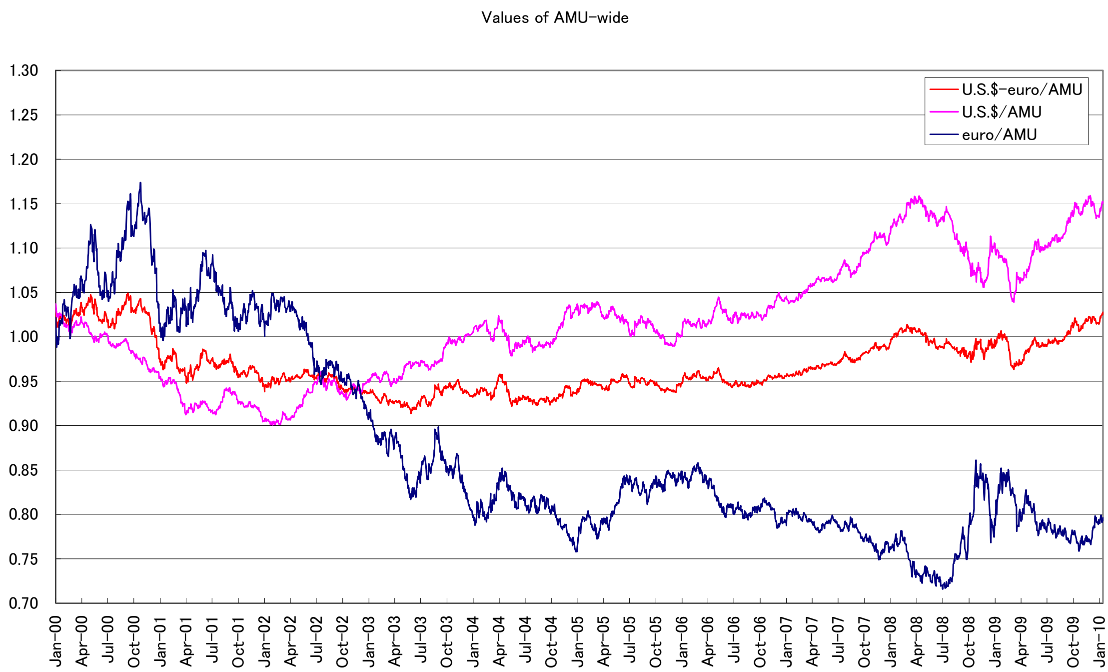
Unit root test for averaged AMU-wide DI							
Method	Data	Constant	Lag length	Obs.	Statistic		Prob.
Augmented Dickey-Fuller	Nominal	×	0	353	-0.37		0.55
		○	0	353	-1.15		0.70
Phillips-Perron	Nominal	×		353	-0.38		0.55
		○		353	-1.2		0.68
β-convergence test for AMU-wide DI							
Method	Data	Constant	Lag length	Obs.	Statistic		Prob.
Levin, Lin and Chu	Nominal	×	0 to 3	4932	0.79		0.79
		○	0 to 3	4932	-0.25		0.40
Im, Pesaran and Shin	Nominal	○	0 to 3	4932	-2.67	***	0.00
σ-convergence test for AMU-wide DI							
	Data	Constant	Lag length	Obs.	Statistic		Prob.
Augmented Dickey-Fuller	Nominal	×	1	353	0.34		0.78
		○	1	353	-2.79	**	0.06
Phillips-Perron	Nominal	×		353	0.34		0.78
		○		353	-2.82	**	0.06

Figure 1: Values of AMU



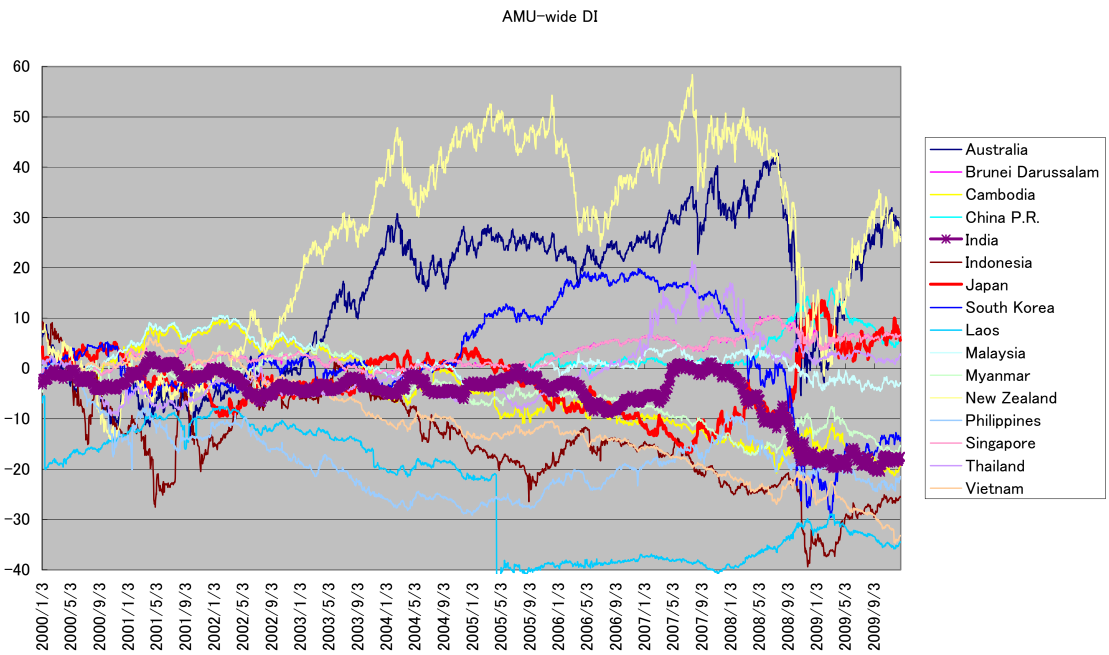
Source: RIETI's website (http://www.rieti.go.jp/users/amu/en/index.html#data)

Figure 2: Values of AMU-wide



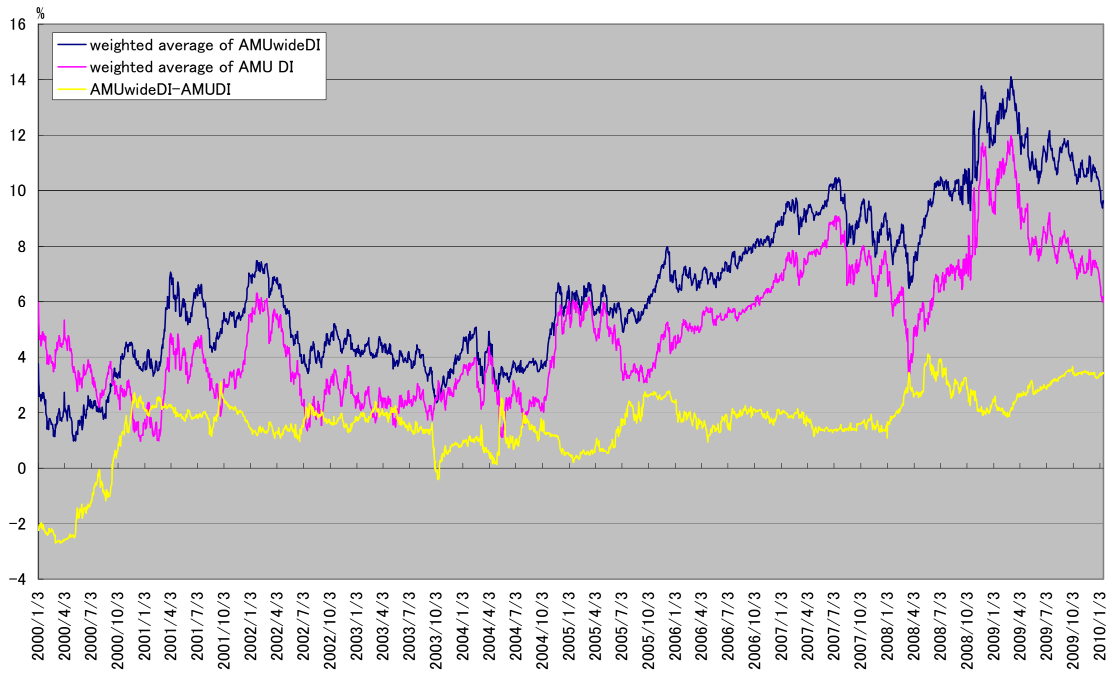
Source: RIETI's website (http://www.rieti.go.jp/users/amu/en/index.html#data)

Figure 3: AMU-wide Deviation Indicators



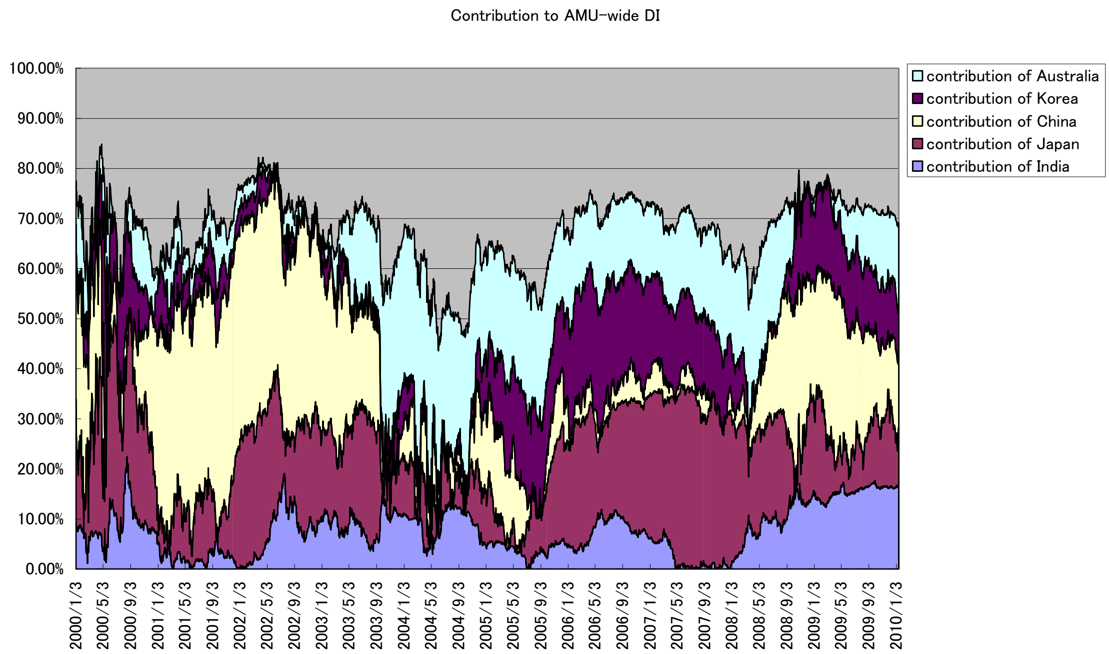
Source: RIETI's website (http://www.rieti.go.jp/users/amu/en/index.html#data)

Figure 4: Weighted averages of AMU and AMU-wide Deviation Indicators



Calculated by the author

Figure 5: Contribution of each currency to weighted average of AMU-wide Deviation Indicators



Calculated by the author