February 2002

Post-crisis Exchange Rate Regimes in East Asia*

Shin-ichi Fukuda (University of Tokyo)**

Abstract

More than four years after the onset of the Asian crisis, the characteristics of the exchange rate regimes of East Asian economies remain a topic of considerable discussion. The purpose of this paper is to investigate what affected the values of three ASEAN currencies, the Malaysia ringgit, the Singapore dollar, and the Thai baht after the crisis. The particular interest in our analysis is to explore why the East Asian currencies, which temporarily reduced correlations with the U.S. dollar after the crisis, had a tendency to revert back to *de facto* pegs against the U.S. dollar in the late 1990s. In particular, we examine how and when these three ASEAN currencies changed their correlations with the U.S. dollar and the Japanese yen in the post-crisis period. Before September 1st 1998, these currencies increased correlations with the Japanese yen in the post-crisis period. In particular, the increased correlations were larger than theoretical correlations based on the trade weights. The increase in correlations with the Japanese yen was, however, temporary. After Malaysia adopted the fixed exchange rate, both the Singapore dollar and the Thai baht increased correlations with the U.S. dollar drastically and began reverting back to *de facto* pegs against the U.S. dollar. Some of these changes were attributable to the structural change of the yen-dollar exchange rate. Most of these changes were, however, explained well by the strong linkage among the ASEAN countries.

---

* An earlier version of this paper was presented at the Ministry of Finance and the European Central Bank. I would like to thank the seminar participants for their helpful comments.

** Correspondence: Shin-ichi FUKUDA, Faculty of Economics, University of Tokyo, Hongo Bunkyo-ku Tokyo 113 JAPAN, E-mail: sfukuda@e.u-tokyo.ac.jp, FAX: 81-3-5841-5521.

1. Introduction

More than four years after the onset of the Asian crisis, the characteristics of the exchange rate regimes of East Asian economies remain a topic of considerable discussion. In the pre-crisis period, it was fairly evident that currencies of most East Asian economies maintained *de facto* pegs to the U.S. dollar. Among the East Asian economies, Hong Kong was the only East Asian economy that adopted the fixed exchange rate regime backed by a currency board arrangement. It was, however, well known that currencies in the other East Asian economies had maintained highly stable values against the U.S. dollar since the mid-1980s (see, for example, Frankel and Wei (1994), Kwan (1995), and Goldberg and Klein (1997)).

For example, Table 1 reports the estimated weights of the U.S. dollar and the Japanese yen in the pre-crisis East Asian currencies by Frankel-Wei and Kwan. From the table, we can easily see that in the cases of the Korean won, the Indonesian rupiah, the Philippine peso, and the Thai baht, the weights of the U.S. dollar were close to one and those of the Japanese yen were negligible. In the cases of the Singapore dollar and the Malaysia ringgit, the weights of U.S. dollar were smaller than 0.9 and those of the Japanese yen were not negligible. However, even in these currencies, the weights of U.S. dollar had dominant weights. The results were almost stable from 1980s to the early 1990s.

The *de facto* pegs to the U.S. dollar sometimes destabilized the real “effective” exchange rates of these currencies in the pre-crisis period. In particular, as the Japanese yen depreciated against the U.S. dollar from April 1995 to the summer of 1997, appreciation of the real “effective” exchange rates reduced the export competitiveness and increased current account deficits in the East Asian economies（see, for example, Corsetti, Pesenti, and Roubini (1999), and Ito, Ogawa, and Sasaki (1998)）.

In the post-crisis period, Hong Kong kept its currency board arrangement and the Chinese yuan virtually maintained its peg to the U.S. dollar. After experiencing some transitional regime, Malaysia started pegging to the U.S. dollar on September 1st 1998. In contrast, Thailand, Indonesia, and Korea as well as the Philippines and Taiwan have adopted managed float since the crisis. After going through steep devaluations and high volatility in 1997-98, their currencies have mostly stabilized over the past couple of years. Some observers, however, have argued that the so-called floating exchange regimes of the countries are not really floating (Kawai and Akiyama (2000), McKinnon (2000)). In particular, using a regression framework from Fankel and Wei (1994), they have interpreted that the East Asian currencies are reverting back to *de facto* pegs against the U.S. dollar.

The purpose of this paper is to investigate why the East Asian currencies, which temporarily reduced correlations with the U.S. dollar after the crisis, had a tendency to revert back to *de facto* pegs against the U.S. dollar in the late 1990s. During the crisis, several East Asian economies sifted their exchange rate regimes from *de facto* U.S. Dollar pegs to managed float. However, except for Malaysia, the East Asian economies had no institutional switch of exchange rate regimes in the post-crisis period. It is thus far from clear why the East Asian currencies reverted back to *de facto* pegs against the U.S. dollar in the late 1990s.

One possible answer to explain this tendency is that a change of macroeconomic correlations altered correlations of East Asian exchange rates with the U.S. dollar and the Japanese yen. Throughout the late 1990s, the U.S. economy was booming, while the Japanese economy stagnated. Since East Asian economies had started a sharp recovery from the crisis around the middle of 1998, macroeconomic fundamentals in the East Asian economies thus had a strong positive correlation with those of Japan in the first half of 1998 but with those of the United States after the latter half of 1998. To the extent that macroeconomic fundamentals affect exchange rates, the change of macroeconomic correlations may explain part of exchange rate movements in the East Asian economies in the late 1990s. However, since the change of macroeconomic correlations was gradual, it cannot explain why several ASEAN currencies had drastic structural changes for a short period. We thus need an alternative answer to explain why the East Asian currencies reverted back to *de facto* pegs against the U.S. dollar for a short period.

In deriving the alternative answer, the following analysis focuses on strong interdependence among East Asian economies, particularly among ASEAN countries. Interdependence among East Asian economies increased steadily in various aspects during the past decades. For example, Table 2 reports the weights of foreign trade by country in Malaysia, Singapore, and Thailand. The table implies that both the United States and Japan have been major trade partners for these countries. However, in Singapore and Malaysia, trade between Singapore and Malaysia has almost equal shares to those of the United States and Japan. In the case of Thailand, trades with Singapore and Malaysia have smaller shares to those with the United States and Japan. But, when we sum up trade shares of Singapore and Malaysia, the share becomes more than 20%. These shares indicate that intra-regional trade among the ASEAN countries is far from negligible.

In general, a policy change in one country will have an impact on the exchange rate in the other country when their economic linkage is tight. It is thus highly possible that the regime switch in Malaysia on September 1st 1998 had a strong impact on the exchange rates in its neighboring countries and that the affected exchange rates had another impacts on the exchange rates in another neighboring countries. The empirical studies in the paper imply that this type of exchange rate linkage caused a tendency reverting back to *de facto* pegs against the U.S. dollar in the post-crisis ASEAN countries.

2. The Trade Weighted Currency Basket Regime

In order to analyze the interdependence of exchange rates in East Asian economies, this section theoretically considers the determinants of exchange rates under a currency basket regime. For analytical simplicity, we suppose that the Singapore dollar is determined by a basket of the U.S. dollar, the Japanese yen, and the Malaysia ringgit. Denoting the nominal exchange rates of the U.S. dollar, the Japanese yen, the Singapore dollar, and the Malaysia ringgit by USD_t, JPY_t, SD_t, and MR_t respectively, the growth rate of Singapore dollar is thus written as

$$(1) \quad \Delta SD_t = a1*\Delta USD_t + a2*\Delta JPY_t + a3*\Delta MR_t + \varepsilon_t,$$

where ΔE_t is the growth rate of an exchange rate E_t, and ε_t is a disturbance term. All of the exchange rates are denominated by a common numéraire currency such as the Swiss Franc.

If the growth rate of the Malaysia ringgit (ΔMR_t) is determined by

$$(2) \quad \Delta MR_t = b1*\Delta USD_t + b2*\Delta JPY_t + b3*\Delta SD_t + \eta_t,$$

where η_t is a disturbance term, equations (1) and (2) therefore lead to

$$(3) \quad \Delta SD_t = \frac{a1 + a3*b1}{1 - a3*b3}\Delta USD_t + \frac{a2 + a3*b2}{1 - a3*b3}\Delta JPY_t + \upsilon_t$$

$$(4) \quad \Delta MR_t = \frac{b1 + a1*b3}{1 - a3*b3}\Delta USD_t + \frac{b2 + a2*b3}{1 - a3*b3}\Delta JPY_t + \zeta_t$$

where $\upsilon_t \equiv (\varepsilon_t + a3*\eta_t)/(1-a3*b3)$ and $\zeta_t \equiv (b3*\varepsilon_t + \eta_t)/(1-a3*b3)$.

To the extent that ε_t and η_t are independent of ΔUSD_t and ΔJPY_t, equation (3) indicates that how the Singapore dollar is correlated with the U.S. dollar and the Japanese yen depends not only the basket weights of the Singapore dollar in (1) but also on the basket weights of the Malaysia ringgit in (2). Thus, even if Singapore keeps its basket weights constant, the regime switch of the Malaysian exchange rate policy can have a significant impact on the Singapore dollar, particular when a3 is large.

For example, suppose that the basket weights of the Singapore dollar are based on trade weights among five major trade partners. Then, noting that the Hong Kong dollar is fixed to the U.S. dollar, Singapore's trade weights in 1997 imply the basket weights that a1=0.4131, a2=0.2205, and a3=0.2871. Therefore, if the weights of the Malaysia ringgit are also based on the trade weights among five major trade partners in 1997, that is, b1=0.2896, b2=0.2830, and b3=0.2833, then equations (3) and (4) lead to theoretical correlations. Table 3-(1) summarizes the calculated theoretical correlations among the exchange rates before Malaysia adopted the fixed exchange rate.[1] It indicates that both the Malaysia ringgit and the Singapore dollar have slightly larger correlation with the U.S. dollar than with the Japanese yen. The weights of the Japanese yen, however, amount to more than 0.3 in both currencies, which are much larger than the estimated weights in the pre-crisis period.

In contrast, when the Malaysia ringgit is fixed to the U.S. dollar, it holds that $\Delta MR_t = \Delta USD_t$, that is, b1=1, and b2=b3=0. Thus, substituting the trade weights in 1997, 1998, and 1999 into equations (3) and (4) respectively, we can obtain Table 3-(2). The table summarizes theoretical correlations of the Singapore dollar with the U.S. dollar and the Japanese yen after Malaysia adopted the fixed exchange rate.

Comparing the theoretical correlations in Table 3-(2) with those in Table 3-(1), the weight of the U.S. dollar rose from 0.54 to 0.7, while the weight of the Japanese yen declined from 0.328 to 0.2. This implies that the switch of the Malaysian exchange rate regime had significant impacts on the theoretical correlations of the Singapore dollar. It is noteworthy that these changes occurred even if Singapore did not switch its exchange rate regime. Instead, these changes are attributable to the high degree of interdependence of the Singapore dollar to the Malaysia ringgit.

3. The Post-crisis Exchange Rate Regimes in Malaysia

On September 1st 1998, the Malaysian government sifted its exchange rate regime from managed float to the fix exchange rate. The regime shift was the only drastic regime switch in the post-crisis East Asian economies. However, before shifting the fixed exchange rate regime, Malaysia adopted managed float the post-crisis period. The purpose of this section is to estimate how large correlations the post-crisis Malaysia ringgit had with the U.S. dollar and the Japanese yen before September 1st 1998.

After the Thai crisis in July 1997, Malaysia experienced serious devaluation of its currency. During the crisis, the market value of the Malaysia ringgit had dropped to half of the pre-crisis level until January 1998. It was after the end of January 1998 when the Malaysian ringgit almost stabilized (see Figure 1). After the Malaysian ringgit stabilized, the Malaysian government began to explore a new economic policy, including the stabilization policy of real effective exchange rates of the ringgit. For example, the National Economic Action Council (NEAC), which was established by Prime Minister Mahathir in December 1997, announced the National Economic Recovery Plan (NERP) in August 1998. The plan stressed the importance of stabilizing the real "effective" exchange rates and proposed the adoption of a trade weighted basket system as a

[1] The values of a1 and b1 are calculated by the sum of the trade weights to the U.S.A and those to Hong Kong.

desirable exchange rate regime. The plan is based on the idea that the *de facto* pegs to the U.S. dollar sometimes destabilize the real "effective" exchange rates.

In order to investigate the determinants of the ringgit during this period, we use the method of Frankel-Wei to estimate the weights of the U.S. dollar and the Japanese yen in the Malaysia ringgit before September 1st 1998. In this approach, an independent currency is chosen as an arbitrary numéraire for measuring the exchange variation. The goal here is to estimate the weight a currency assigns to another currency on a given frequency. The regression model, where the local currency's value against the independent currency is regressed against the major world currencies, is

$$(5) \quad \Delta MR_t = \text{constant term} + \alpha 1 * \Delta USD_t + \alpha 2 * \Delta JPY_t + \alpha 3 * \Delta DM_t,$$

where ΔE_t is the growth rate of an exchange rate E_t.

The data of each currency's exchange rate is the daily data at 11a.m. in the Tokyo market. Using the Swiss Franc as a numéraire, we estimated equation (5) by the ordinary least square with and without ΔDM_t. Table 4 reports the estimation results for three alternative sample periods; (i) from the beginning of January 1998 to the end of August 1998, (ii) from the beginning of March 1998 to the end of August 1998, (iii) from the beginning of July 1998 to the end of August 1998. The results clearly show that regardless of the choice of ΔDM_t and the sample period, the Japanese yen had kept much larger weights than the U.S. dollar during this pos-crisis period.

The estimated weight of the yen was largest for the sample period from January 1998 to August 1998. For this period, the estimated weight of the yen was close to 0.9, while the estimated weight of the U.S. dollar was positive but not statistically significant. The adjusted R^2, however, was less than 0.2, implying that the yen and the U.S. dollar explain only small part of the ringgit's fluctuations during this period.

In contrast, the adjusted R^2 rose up to 0.55 for the sample period from July 1998 to August 1998. This implies that during this period, the yen and the U.S. dollar came to explain significant part of the ringgit's fluctuations. For this sample period, the estimated weight of the yen was approximately equal to 0.5, while the estimated weight of the U.S. dollar was approximately equal to 0.3. Compared with the other sample period, the estimated weight of the yen was modest for this period. However, even for this modest period, the estimated weight of the yen was larger than the theoretical weight in Table 3-(i), while that of the U.S. dollar was much smaller than the theoretical weight in Table 3-(i).

4. The Post-crisis Exchange Rates in Singapore

Compared with the other ASEAN countries, Singapore experienced relatively modest devaluation of its currency during the crisis. Singapore thus kept the exchange regime of a basket system before and after the crisis. In the pre-crisis period, the U.S. dollar had a dominant weight in the currency basket of the Singapore dollar, although the weight of the Japanese yen was also significantly positive. The estimated weight of the U.S. dollar in the pre-crisis period was much larger than the theoretical weight calculated by the trade weights. However, in the post-crisis period, the other ASEAN countries shifted their exchange rate regimes from *de facto* U.S. dollar pegs to managed float. It is thus possible that there were some structural changes in the basket weights of the Singapore dollar in the post-crisis period.

The purpose of this section is to investigate how the Singapore dollar changed the weights of the U.S. dollar and the Japanese yen in the post-crisis period. The particular interest of the analysis is to investigate how the regime sifts of the Malaysia ringgit affected the weights of the U.S. dollar and the Japanese yen in the post-crisis Singapore dollar. As we have shown in the last section, the Malaysia ringgit temporarily had a drastic increase in the weight of the Japanese yen in 1998 before adopting the fixed exchange rate on September 1st 1998. Since Malaysia is the second largest trade partner for Singapore, it is highly possible that the changes of the Malaysian exchange rate policy had strong impacts on the movements on the Singapore dollar.

In order to investigate the determinants of the Singapore dollar, we estimate

$$(6) \quad \Delta SD_t = \text{constant term} + \beta 1 * \Delta USD_t + \beta 2 * \Delta JPY_t + \beta 3 * \Delta DM_t,$$

by the ordinary least square. The exchange rates, for which the Swiss Franc is used as a numéraire, are the daily data at 11a.m. in the Tokyo market. The sample periods of estimations are (i) from the beginning of January 1998 to the end of August 1998, (ii) from the beginning of March 1998 to the end of August 1998, (iii) from the beginning of July 1998 to the end of August 1998, (iv) from the beginning of September 1998 to the end of October 1998, (v) from the beginning of September 1998 to the end of December 1998, and (vi) from the beginning of September 1998 to the end of December 1999. The first three sample periods are those before September 1st 1998, while the latter three sample periods are those after September 1st 1998. Comparing the estimation results for two types of sample periods, we can examine how strong impacts the Malaysian regime swift on September 1st 1998 had on the determinants of the Singapore dollar.

Table 5 summarizes the estimation results with and without ΔDM_t in an explanatory variable. For the sample periods before September 1st 1998, we can easily see that the Japanese yen had larger weights than the U.S. dollar. That is, the coefficient of the U.S. dollar was approximately equal to 0.4, while that of the Japanese yen took the values from 0.6 to 0.65. The estimation results are highly stable throughout the sample periods. The results indicate that corresponding the regime sifts of the other ASEAN countries, Singapore increased the weight of the Japanese yen in its currency basket after the crisis.

However, the estimation results for the sample periods after September 1st 1998 show that such a increase of the weight was only temporary. That is, after September 1st 1998, the coefficient of the U.S. dollar took the values from 0.6 to 0.8, while the coefficient of the Japanese yen declined less than 0.2. The coefficients are almost equivalent to those in the pre-crisis period that were reported in Table 1. The results imply that the weights in the currency basket returned to the pre-crisis levels after Malaysia adopted the fixed exchange rate. Comparing the estimates for two months before and after September 1st 1998, we can see how drastically the changes were. That is, the coefficient of the U.S. dollar, which was around 0.4 from July to August, rose up to about 0.7. The coefficient of the Japanese yen, which was around 0.6 from July to August, dropped below 0.2.

It is noteworthy that the estimated weight of the yen (the U.S. dollar) was larger (smaller) than the theoretical weight in Table 3-(i) before September 1st 1998, while that of the yen (the U.S. dollar) was much smaller (larger) than the theoretical weight in Table 3-(ii) after September 1st 1998. The estimated weight of the yen (the U.S. dollar) was larger (smaller) before September 1st 1998 partly because the Malaysia ringgit put higher weight on the yen than its theoretical level. However, even if we calculate the theoretical correlations of the Singapore dollar based on the estimated correlations of the ringgit in Table 4, we can still see that the estimated weight of the yen (the U.S. dollar) was larger (smaller) than the theoretical weight.

For example, Table 6 reports the theoretical weights in the Singapore dollar based on the estimated weights in the ringgit from the beginning of January 1998 to the end of August 1998 and from the beginning of July 1998 to the end of August 1998. In both periods, the theoretical weights were calculated based on the trade weights in 1997 and 1998. The calculated weights show that the U.S. dollar still has larger weight than the Japanese yen in three cases and that the U.S. dollar has marginally smaller weight than the Japanese yen in one case. In all cases, the estimated weight of the yen (the U.S. dollar) in Table 5 was larger (smaller) than its theoretical weight.

5. The Post-crisis Exchange Rates in Thailand

After the speculative attack in July 2nd 1997, Thailand started adopting managed float. Under the managed float, the Thai baht first experienced serious devaluation and its market value had dropped to half of the pre-crisis level until January 1998. After the end of January 1998, the Thai baht, however, stabilized gradually. The purpose of this section is to estimate how large correlations the Thai baht had with the U.S. dollar and the Japanese yen after January 1998. In the analysis, we assume that the Thai baht is determined by the weighted average of major currencies. Strictly speaking, this may not be an appropriate assumption because Thailand did not adopt an explicit currency basket. However, even under managed floats, the exchange rate tends to be affected by exchange rates of major trade partners. The assumption may thus hold as an approximation.

(1) The calculation of theoretical weights

Before estimating the actual correlations, we first calculate the theoretical weights in the Thai baht. Suppose that the Thai baht is determined by the weighted average of the U.S. dollar, the Japanese yen, the Singapore dollar, and the Malaysia ringitt. Then, the growth rate of the Thai baht (ΔTB_t) is written as

$$(7) \quad \Delta TB_t = c1*\Delta USD_t + c2*\Delta JPY_t + c3*\Delta SD_t + c4*\Delta MR_t + \mu_t.$$

Substituting (3) and (4) in section 2 into (7) leads to

$$(8) \quad \Delta TB_t = (c1+c3*d1+c4*e1)*\Delta USD_t + (c2+c3*d2+c4*e2)*\Delta JPY_t + \lambda_t$$

where $d1=\frac{b1+a1*b3}{1-a3*b3}$, $d2=\frac{b2+a2*b3}{1-a3*b3}$, $e1=\frac{b1+a1*b3}{1-a3*b3}$, $e2=\frac{b2+a2*b3}{1-a3*b3}$, $\lambda_t = \mu_t + c3*\upsilon_t + c4*\zeta_t$.

To the extent that ΔSD_t and ΔMR_t are independent of μ_t, it is natural to assume that the disturbance term λ_t is independent of ΔUSD_t and ΔJPY_t.[2] Under this assumption, we can thus obtain the theoretical weights of the U.S. dollar and the Japanese yen in the Thai baht. Table 7-(1) reports the calculated theoretical weights before Malaysia sifted to the fixed exchange rate regime based on the trade weights among five major trade partners in 1997. It shows that the Japanese yen had a slightly higher theoretical weight than the U.S. dollar before Malaysia sifted to the fixed exchange rate regime.

Table 7-(2) reports the calculated theoretical weights after Malaysia sifted to the fixed exchange rate regime, that is, when b1=1、and b2=b3=0. The weights are calculated for three alternative cases based on the trade weights among five major trade partners in 1997, 1998, and 1999 respectively. In all cases, the weight of the Japanese yen became smaller than that of the U.S. dollar. The decline of the weight of the yen was more conspicuous when we used the trade weights in 1998 and 1999.

(2) The Estimations of the actual weights

---

[2] Strictly speaking, this is not an appropriate assumption because Thailand is the fifth largest trade partner for Singapore,. However, since the trade weight is 8%, the bias caused by this assumption will be small.

We next estimate the actual weights in the Thai bath after the crisis. As in the previous sections, we estimate

(9) $\Delta TB_t = \text{constant term} + \gamma 1 * \Delta USD_t + \gamma 2 * \Delta JPY_t + \gamma 3 * \Delta DM_t$,

by the ordinary least square. The exchange rates, for which the Swiss Franc is used as a numéraire, are the daily data at 11a.m. in the Tokyo market. As in the last section, the sample periods of estimations are (i) from the beginning of January 1998 to the end of August 1998, (ii) from the beginning of March 1998 to the end of August 1998, (iii) from the beginning of July 1998 to the end of August 1998, (iv) from the beginning of September 1998 to the end of October 1998, (v) from the beginning of September 1998 to the end of December 1998, and (vi) from the beginning of September 1998 to the end of December 1999. Comparing the estimation results for two types of sample periods, we can examine how strong impacts the Malaysian regime swift on September 1st 1998 had on the determinants of the Thai baht.

Table 8 summarizes the estimation results with and without ΔDM_t in an explanatory variable. When the sample periods are from January 1998 to August 1998 or from March 1998 to August 1998, we can see that the Japanese yen had larger weights than the U.S. dollar. In those cases, the coefficient of the Japanese yen was approximately equal to 0.7, while that of the U.S. dollar was not statistically significant. The estimated weight of the yen (the U.S. dollar) was much larger (smaller) than the theoretical weight in Table 7-(i). The results indicate that the Thai baht drastically increased the weight of the Japanese yen after the crisis.

In contrast, when the sample periods are from July 1998 to August 1998, we can see that the weight of the Japanese yen became slightly smaller than that of the U.S. dollar. In particular, the estimated weight of the yen (the U.S. dollar) became smaller (larger) than the theoretical weight in Table 7-(i). The results indicate that in case of Thailand, the weight of the Japanese yen declined and the weight of the U.S. dollar had risen before September 1st 1998.

However, the changes of the weights were more drastic after September 1st 1998. That is, when the sample period is from September 1998 to October 1998, the coefficient of the U.S. dollar became more than 0.9, while the coefficient of the Japanese yen declined less than 0.1. The coefficients are almost equivalent to those in the pre-crisis period that were reported in Table 1. The results imply that the weights in the currency basket returned to the pre-crisis levels after Malaysia adopted the fixed exchange rate.

6. Asymmetric Impacts of the Yen/Dollar Rate on East Asian Exchange Rates

Until the last sections, we have shown that both the Singapore dollar and the Thai baht before

September 1st 1998 had quite different weights from those after September 1st 1998. Since the adoption of the fixed exchange rate by the Malaysian government is the only big institutional regime swift around September 1st 1998, the results suggest that the regime swift of the Malaysian exchange rate had a strong impact on the determinants of the Singapore dollar and the Thai bath in the post-crisis period.

However, we need to note that in 1998, the Japanese yen/U.S. dollar exchange rate had a big structural break. For example, Figure 2 draws movements of the yen/dollar exchange rates from January 1994 to December 2001. It shows that the yen steadily depreciated against the U.S. dollar and that the rate of depreciation was accelerated after November 1997. The trend of the depreciation had continued until the end of July 1998. However, after August 1998, the yen, in turn, started appreciating against the U.S. dollar and that the appreciation had continued until the end of December 1999. This indicates that if the Singapore dollar and the Thai baht had asymmetric responses to appreciation and depreciation of the yen/dollar exchange rates, they could have had different correlations with the U.S. dollar and the Japanese yen before and after August 1998.

The purpose of this section is to investigate whether the Singapore dollar and the Thai baht responded to appreciation and depreciation of the Japanese yen differently in the post-crisis period. We first investigate this by estimating the following equations:

$$(10) \quad \Delta SD_t = \text{constant} + \beta_1 * \Delta USD_t + \beta_2 * \Delta JPY_t + \beta_{12} * D * \Delta USD_t + \beta_{22} * D * \Delta JPY_t + \beta_3 * \Delta DM_t,$$

$$(11) \quad \Delta TB_t = \text{constant} + \gamma_1 * \Delta USD_t + \gamma_2 * \Delta JPY_t + \gamma_{12} * D * \Delta USD_t + \gamma_{22} * D * \Delta JPY_t + \gamma_3 * \Delta DM_t,$$

where D_t is a dummy variable which takes one when the Japanese yen depreciated against the U.S. dollar but takes zero otherwise.

The sample period of estimations is from September 1998 to December 1999 when the Japanese yen had a tendency to appreciate against the U.S. dollar. Table 9 summarizes the estimation results with and without ΔDM_t. In all cases, variables without the dummy had similar estimated coefficients to those in Tables 5 and 8. In contrast, the U.S. dollar multiplied by the dummy variable had negative sign and the Japanese yen multiplied by the dummy variable had positive sign. This implies that the Singapore dollar and the Thai bath had smaller responses to the U.S. dollar and larger responses to the Japanese yen when the yen depreciates against the U.S. dollar. The estimated coefficients of the U.S. dollar with the dummy variable took the values around –0.3 and were marginally significant. The estimated coefficients of Japanese yen with the dummy variable were, however, very small and were far from significant.

We next estimated equations (6) and (9) for the sample period from January 2000 to December 2001. We chose this sample period because the yen/dollar exchange rates had a tendency to depreciate throughout the period. Table 10 reports the estimation results with and without ΔDM_t as an explanatory variable. In the case of Singapore, we could not find any significant difference from the other estimates after September 1998 that were reported in Table 5. In the case of Thailand, the U.S. dollar had smaller coefficients and the Japanese yen had large coefficients than the other estimates after September 1998 that were reported in Table 8. This implies that the Thai baht had smaller responses to the U.S. dollar and larger to the Japanese yen from January 2000 to December 2001when the yen depreciates against the U.S. dollar.

7. Concluding remarks

In this paper, we investigated the determinants of three ASEAN currencies, the Malaysia ringgit, the Singapore dollar, and the Thai baht after the crisis. In particular, we examined how these three ASEAN currencies had correlations with the U.S. dollar and the Japanese yen in the post-crisis period. We found that before September 1st 1998, these currencies increased correlations with the Japanese yen in the post-crisis period. In particular, the increased correlations were larger than the theoretical correlations that were calculated based on the trade weights. The increased correlations with the Japanese yen were, however, temporary. We found that after Malaysia adopted the fixed exchange rate, both the Singapore dollar and the Thai baht increased correlation with the U.S. dollar drastically and began reverting back to *de facto* pegs against the U.S. dollar.

Our regression results imply that some of these changes were attributable to the structural change of the yen-dollar exchange rate. We, however, found that most of these changes were explained well by the strong linkage among the ASEAN countries.

References

Bénassy-Quéré, A., (1999), "Optimal Peggs for Asian Currencies," Journal of the Japanese and International Economies 13, pp.44-60.

Bayoumi, T., B. Eichengreen, and P. Mauro, (2000), "On Regional Monetary Arrangements for ASEAN," Journal of the Japanese and International Economies 14, pp.121-148.

Black, S.W., (1990) " The International Use of Currencies," in Suzuki, Miyake, and Okabe eds. The Evolution of the International Monetary System, The University of Tokyo Press.

Corsetti, G., P. Pesenti, and N. Roubini, (1999), "What Caused the Asian Currency and Financial Crisis?," Japan and the World Economy 11, pp.305-373.

Frankel, J.A., and Shang-Jin Wei, (1994) " Yen Bloc or Dollar Bloc: Exchange Rate Policies of the East Asian Economies," in T. Ito and A. O. Krueger eds., Macroeconomic Linkage, Chicago: University of Chicago Press.

Fukuda, S., (1995), "The Structural Determinants of Invoice Currencies in Japan: The Case of Foreign Trades with East Asian Countries" in T. Ito and A. O. Krueger eds., Financial Deregulation and Integration in East Asia, Chicago: University of Chicago Press.

Fukuda, S.,and Ji Cong (1994),"On the Choice of Invoice Currency:The PTM Approach," Journal of the Japanese and International Economies 8, pp.511-529.

Goldberg, L., and M. Klein, (1997), "Foreign Direct Investment, Trade and Real Exchange Rate Linkages in Southeast Asia and Latin America," NBER Working Paper #6344.

Hamada, K., and A. Horiuchi, (1987) " Monetary, Financial, and Real Effects of Yen Internationalization," in Arndt and Richardson eds. Real-Financial Linkages among Open Economies, The MIT Press.

Ito, T., (1993) " The Yen and the International Monetary System," in C.F. Bergsten and M. Noland eds. Pacific Dynamism and International Monetary System, Institute of International Economics.

Ito, T., E. Ogawa, and Y. N. Sasaki, (1998), "How Did the Dollar Peg Fail in Asia?" Journal of the Japanese and International Economies 12, pp.256-304.

Kawai, M., (1996), "The Japanese Yen as an International Currency: Performance and Prospects," in R. Sato and H. Hori eds., Organization, Performance, and Equity: Perspectives on the Japanese Economy, Kluwer Academic Publishers, Boston, pp.334-387.

Kawai, M., and S. Akiyama, (1996), "The Role of Nominal Anchor Currencies in Exchange Rate Arrangements," Journal of the Japanese and International Economies 12, pp.256-304.

Kawai, M., and S. Akiyama, (2000), "Implications of the Currency Crisis for Exchange Rate Arrangements in Emerging East Asia," mimeo, World Bank.

Krugman, P., (1980) " Vehicle Currencies and the Structure of International Exchange," Journal of Money, Credit, and Banking, 12, pp.513-526.

Krugman, P., (1998), “What Happened to Asia?” mimeo.

Kwan, C., (1995), Economics of the Yen Block (in Japanese), Nihon Keizai Shimbun Sya.

Matsuyama, K., N. Kiyotaki, and A. Matsui, (1993) “ Toward a Theory of International Currency," Review of Economic Studies, 60, pp.283-307.

McKinnon, R.I., (2000), “After the crisis, the East Asian Dollar Standard Resurrected: An Interpretation of High-Frequency Exchange Rate Pegging,” mimeo, Stanford University.

Radelet, S., and J. Sachs, (1998), “On the Outset of the East Asian Financial Crisis,” NBER Working Paper #6680.

Takagi, S., (1996), “The Yen and Its East Asian Neighbors, 1980-95: Cooperation or Competition?” NBER Working Paper #5720.

Taguchi, Hiroo, (1994) "On the Yen Block," in T. Ito and A. O. Krueger eds., Macroeconomic Linkage, Chicago: University of Chicago Press.

Takeda, Masahiko, and Phillip Turner,(1992), Liberalisation of Japan's Financial Markets: Some Major Themes, BIS Economic Papers No.34.

Tavlas, G.S., and Yuzuru Ozeki, (1992) “The Japanese Yen as an International Currency," International Monetary Fund, Occasional Paper 90.

Table 1. TheWeights of the U.S. Dollar and the Japanese Yen in the Pre-crisis Period

Currencies	Frankel & Wei (1994)		Kwan (1995)			
	weekly data		monthly data		weekly data	
	1979.1 -1992.5		1991.1- 1995.5		1995.1- 1995.8	
	US $	Yen	US $	Yen	US $	Yen
Kora Won	0.96	-0.01	0.94	0.06	0.84	0.17
Singapore Dollar	0.75	0.13	0.69	0.1	0.74	0.18
Malaysia Ringgit	0.78	0.07	0.84	0.04	0.87	0.16
Indonesia Rupia	0.95	0.16	0.99	0	0.97	0.01
Philipphine Peso	1.07	-0.01	1.15	-0.24	1.07	0.02
Thai Baht	0.91	0.05	0.82	0.1	0.86	0.09

Table 2. Trade Weights by Country in Malaysia, Singapore, and Thailand (Top 5)

(1) Malaysia

	1997		1998		1999	
	country	weight	country	weight	country	weight
1st	U.S.A.	28.96%	U.S.A.	35.58%	U.S.A.	34.08%
2nd	Singapore	28.33%	Singapore	26.49%	Japan	26.71%
3rd	Japan	28.30%	Japan	24.98%	Singapore	26.33%
4th	Taiwan	7.45%	Korea	6.55%	Korea	6.72%
5th	Korea	6.95%	Hong Kong	5.96%	Hong Kong	6.17%

(2) Singapore

	1997		1998		1999	
	country	weight	country	weight	country	weight
1st	U.S.A.	31.24%	U.S.A.	34.32%	U.S.A.	32.43%
2nd	Malaysia	28.71%	Malaysia	27.38%	Malaysia	28.65%
3rd	Japan	22.05%	Japan	20.47%	Japan	21.33%
4th	Hong Kong	10.07%	Hong Kong	10.19%	Hong Kong	9.47%
5th	Thailand	7.94%	Thailand	7.65%	Thailand	8.12%

(3) Thailand

	1997		1998		1999	
	country	weight	country	weight	country	weight
1st	Japan	38.78%	U.S.A.	36.08%	Japan	34.54%
2nd	U.S.A.	30.88%	Japan	34.93%	U.S.A.	32.12%
3rd	Singapore	14.88%	Singapore	14.01%	Singapore	17.32%
4th	Malaysia	8.57%	Malaysia	7.87%	Malaysia	8.86%
5th	Taiwan	6.89%	China	7.11%	Hong Kong	7.15%

Sources) IMF, *Direction of Trade Statistics*, Various Issues.
Notes 1)Trade with Taiwan is not included after 1998.
2)Trade with Indonesia is not included in Singapore.

Table 3 Theoretical weights of the exchange rates based on trade weights
- Malaysia and Singapore

(1) Theoretical weights before August 31, 1998

	Malaysia ringit	Singapore dollar
US dollar	0.443	0.540
Yen	0.376	0.328

(2) Theoretical weights after September 1, 1998
- The Case of the Singapore dollar

	case 1	case 2	case 3
US dollar	0.700	0.719	0.705
Yen	0.221	0.205	0.213

Notes 1) The theoretical weights in (1) were calculated based on trade weights in 1997.
2) After September 1st 1998, the theoretical weights in cases 1, 2, and 3 were calculated based on the trade weights in 1997, 98, and 99 respectively.

Table 4. The correlations of the Malaysia ringit with the U.S. dollar and the Yen

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Jan. 1998 - Aug. 1998	0.1997 (0.844)	0.9090 (5.480)		0.1896	1.863
	0.0479 (0.185)	0.8920 (5.380)	0.8226 (1.422)	0.1947	1.853
April 1998 - Aug. 1998	0.5244 (2.504)	0.6332 (5.125)		0.3044	2.426
	0.4255 (1.814)	0.6258 (5.051)	0.4093 (0.939)	0.3036	2.401
July 1998 - Aug. 1998	0.3353 (2.355)	0.5077 (4.599)		0.5562	2.619
	0.2889 (1.641)	0.5201 (4.532)	0.1447 (0.456)	0.5472	2.579

Note 1) t-values are in parentheses.

Table 5. The correlations of the Singapore dollar with the U.S. dollar and the Yen - The estimations before and after September 1st 1998.

(a) The estimations before September 1st 1998

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Jan. 1998 - Aug. 1998	0.4102 (4.255)	0.6547 (9.685)		0.5045	2.302
	0.3620 (3.424)	0.6492 (9.586)	0.2610 (1.105)	0.5052	2.311
April 1998 - Aug. 1998	0.4426 (4.109)	0.6221 (9.790)		0.6049	2.330
	0.3943 (3.268)	0.6185 (9.704)	0.1996 (0.8905)	0.6041	2.344
July 1998 - Aug. 1998	0.3893 (3.822)	0.6220 (7.875)		0.7849	2.212
	0.4398 (3.503)	0.6085 (7.438)	-0.1577 (-0.697)	0.7820	2.252

(b) The estimations after September 1st 1998

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Sep. 1998 - Oct. 1998	0.7959 (7.567)	0.1444 (2.422)		0.6086	2.457
	0.6692 (4.988)	0.1997 (2.873)	0.4610 (1.486)	0.6204	2.411
Sep. 1998 - Dec. 1998	0.7161 (10.857)	0.1619 (3.671)		0.6314	2.198
	0.5973 (6.816)	0.2036 (4.244)	0.4248 (2.012)	0.6451	2.183
Sep. 1998 - Dec. 1999	0.7825 (26.992)	0.1553 (7.537)		0.7755	2.115
	0.7368 (21.741)	0.1658 (7.953)	0.2316 (2.546)	0.7792	2.117

Note 1) t-values are in parentheses.

Table 6. Theoretical weights of the Singapore dollar
- Correlations based on the estimates in Malaysia

(1) Theoretical weights based on the estimates from January 1998 to August 1998

	case 1	case 2
US dollar	0.470	0.500
Yen	0.481	0.454

(2) Theoretical weights based on the estimates from July 1998 to August 1998

	case 1	case 2
US dollar	0.509	0.537
Yen	0.366	0.354

Notes) The theoretical weights in cases 1 and 2 were calculated based on
the trade weights in 1997 and 98 respectively.

Table 7. Theoretical weights of the exchange rates based on trade weights
- The case of Thailand

(1) Theoretical weights before August 31, 1998

US dollar	0.427064344
Yen	0.468909222

(2) Theoretical weights after September 1, 1998

	case 1	case 2	case 3
US dollar	0.498636763	0.540219458	0.532087734
Yen	0.420610829	0.37799448	0.382339891

Notes 1) The theoretical weights in (1) were calculated based on trade weights in 1997.
2) After September 1st 1998, the theoretical weights in cases 1, 2, and 3 were calculated based on the trade weights in 1997, 98, and 99 respectively.

Table 8. The correlations of the Thai baht with the U.S. dollar and the Yen
- The estimations before and after September 1, 1998.

(a) The estimations before September 1st 1998

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Jan. 1998 - Aug. 1998	0.1602 (0.664)	0.7460 (4.408)		0.1279	2.246
	0.0328 (0.124)	0.7317 (4.318)	0.6907 (1.168)	0.1298	2.257
April 1998 - Aug. 1998	0.3715 (1.660)	0.6966 (5.278)		0.2780	2.489
	0.2243 (0.899)	0.6855 (5.202)	0.6089 (1.314)	0.2831	2.495
July 1998 - Aug. 1998	0.5775 (3.385)	0.3615 (2.732)		0.4824	1.974
	0.5403 (2.556)	0.3714 (2.697)	0.1163 (0.305)	0.4704	1.995

(b) The estimations after September 1st 1998

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Sep. 1998 - Oct. 1998	0.9314 (7.074)	0.0833 (1.116)		0.5520	1.890
	0.9715 (5.633)	0.0658 (0.736)	-0.1459 (-0.366)	0.5418	1.863
Sep. 1998 - Dec. 1998	0.8406 (8.510)	0.0871 (1.319)		0.4814	1.912
	0.8181 (6.081)	0.0950 (1.290)	0.0807 (0.249)	0.4752	1.926
Sep. 1998 - Dec. 1999	0.8187 (15.680)	0.1408 (3.794)		0.5277	2.077
	0.7858 (12.767)	0.1483 (3.919)	0.1669 (1.010)	0.5277	2.091

Note 1) t-values are in parentheses.

Table 9. The correlations with the U.S. dollar and the Yen
- The estimations allowing asymmetric responses

(a) The Case of Singapore

Sample period	U.S. dollar	Yen	dummy*dollar	dummy*Yen	D. Mark	adj.R2	D.W.
Sep. 1998 - Dec. 1999	0.8232 (9.560)	0.1525 (2.504)	-0.3208 (-1.861)	0.037 (0.291)		0.6581	2.336
	0.7003 (6.510)	0.2026 (3.087)	-0.2790 (-1.630)	0.003 (0.026)	0.3969 (1.874)	0.6517	2.288

(b) The Case of Thailand

Sample period	U.S. dollar	Yen	dummy*dollar	dummy*Yen	D. Mark	adj.R2	D.W.
Sep. 1998 - Dec. 1999	0.9556 (7.303)	0.0466 (0.504)	-0.3527 (-1.348)	0.1288 (0.670)		0.4801	1.960
	0.9480 (5.677)	0.0496 (0.487)	-0.3501 (-1.318)	0.1267 (0.648)	0.0244 (0.074)	0.4734	1.970

Note 1) t-values are in parentheses.

Table 10. The correlations with the U.S. dollar and the Yen

(a) The Case of Singapore

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Jan. 2000 - Dec. 2001	0.7966 (24.658)	0.2252 (7.832)		0.8827	2.091
	0.7856 (23.291)	0.2309 (7.912)	0.0728 (1.123)	0.8828	2.122

(b) The Case of Thailand

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Jan. 2000 - Dec. 2001	0.7688 (17.785)	0.2886 (7.498)		0.8174	2.400
	0.7667 (16.945)	0.2896 (7.398)	0.0135 (0.156)	0.8166	2.400

Note 1) t-values are in parentheses.

Figure 1. Movements of the Malaysia Ringgit after the Crisis（Ringgit/＄）