

CIRJE-F-181

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Regimes in East Asia**

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November 2002

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Post-crisis Exchange Rate Regimes in East Asia^{*}

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Abstract

More than five 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. Based on high-frequency day-to-day observations, 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. A part of the change was attributable to asymmetric responses to the yen-dollar exchange rate. The change was, however, explained quite well by the strong linkage among the ASEAN countries. This implies that a regime switch in Malaysia had an enormously large impact on the exchange rates of the other ASEAN countries in the post-crisis period.

* An earlier version of this paper was presented at the Ministry of Finance in Japan, ESRI of the Cabinet Office in Japan, the European Central Bank, and Taiwan National University. I would like to thank Masahiro Kawai, William Branson, Chelsea Lin, and other seminar participants for their helpful comments.

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1. Introduction

More than five 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), Goldberg and Klein (1997), and McKinnon (2001)).¹

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 the weights of the U.S. dollar were close to one and those of the Japanese yen were negligible for the Korean won, the Indonesian rupiah, the Philippine peso, and the Thai baht. The weights of U.S. dollar were smaller than 0.9 and those of the Japanese yen were not negligible for the Singapore dollar and the Malaysia ringgit. However, even for these currencies, the weights of U.S. dollar had dominant weights. The results were almost stable from the 1980s to the early 1990s.²

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)) . Several economists have, thus, proposed the desirability of intermediate exchange rate regimes in East Asia that might stabilize their effective exchange rates (see, for example, Bénassy-Quéré (1999), Williamson (1999, 2000), Rajan (2002)).³ The post-crisis experience in East Asia, however, taught us that the road to the intermediate exchange rate regimes in the region is still pretty hard.⁴

¹ Takagi (1996) is an exceptional study that found some significant correlations between the East Asian currencies and the Japanese yen during this period.

² The U.S. dollar had also been dominant in various international transactions in East Asia. See, for example, Ito (1993), Fukuda (1995), and Kawai (1996).

³ The bipolar or two-corner solution view of exchange rates states that intermediate policy regimes between hard pegs and floating are not sustainable. Fischer (2001), however, argued that the proponents of the bipolar view have probably exaggerated their point.

⁴ Bayoumi, Eichengreen, and Mauro (2000, 2001) showed that on economic criteria, ASEAN appears less suited for a regional currency arrangement than Europe before the Maastricht Treaty, although the difference is not large.

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. Hernández and Montiel (2001) have suggested that they are now allowed to float more at low frequencies than before 1997-98. Some other observers, however, have argued that the so-called floating exchange regimes of the countries are not really floating when we look at high-frequency day-to-day observations (Kawai and Akiyama (2000), McKinnon (2001), and McKinnon and Schnabl (2002)). 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.⁵

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 shifted 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.

Based on high-frequency day-to-day observations, we examine how and when three ASEAN currencies, the Malaysia ringgit, the Singapore dollar, and the Thai baht, 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. However, 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.

One possible factor that may explain the structural change is a change of macroeconomic correlations that could alter the 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 experienced a long stagnation. 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

⁵ Calvo and Reinhart (2002) found that many emerging market countries that say they allow their exchange rate to float mostly do not.

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.

The main conclusion of this paper is that a regime switch in Malaysia had an enormously large impact on the exchange rates of the other ASEAN countries in the post-crisis period. A policy change in one country generally has 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. Our empirical studies support this view and suggest that the exchange rate linkage was very important to see why the post-crisis ASEAN countries had a tendency reverting back to *de facto* pegs against the U.S. dollar.

The paper proceeds as follows. Section 2 considers the theoretical determinants of exchange rates under a currency basket regime in East Asia. After reviewing the post-crisis exchange regimes in Malaysia in section 3, sections 4 and 5 investigate how large impacts the regime switch in Malaysia had on the post-crisis exchange regimes in Singapore and Thailand respectively. Section 6 explores how robust our results are when allowing some structural changes in the yen-dollar exchange rate in the late 1990s. Section 7 examines the impacts of the Malaysian regime switch on the post-crisis exchange regimes in Korea and the Philippines. Section 8 summarizes our main results and refers to their implications.

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. All of the exchange rates are denominated by a common numéraire currency such as the Swiss Franc. 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

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

where ΔE_t is the growth rate of an exchange rate E_t , and ε_t is a disturbance term.

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

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

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

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

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

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 with 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.⁶ 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,

⁶ 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.

$b_1=1$, and $b_2=b_3=0$. 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 shifted 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 after the crisis. 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 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

$$(5) \Delta MR_t = \text{constant term} + \alpha_1 * \Delta USD_t + \alpha_2 * \Delta JPY_t + \alpha_3 * \Delta DM_t,$$

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 11 a.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 post-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). This suggests that the Malaysian ringgit had a temporal but drastic increase in the weight of the yen before adapting to the fixed exchange rate in the post-crisis period.

4. Determinants of the Singapore Dollar after the Crisis

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 shifts 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 had a temporary but 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

$$(6) \Delta SD_t = \text{constant term} + \beta_1 \Delta USD_t + \beta_2 \Delta JPY_t + \beta_3 \Delta DM_t,$$

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 shifts 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.

The implication seems supported more strongly when we compare the estimates from July 1998 to August 1998 with those from September 1998 to October 1998. The comparison of the estimates with two short sample periods shows how drastic the change happened around September 1st 1998. That is, the coefficient of the U.S. dollar was only around 0.4 from July to August. But it rose up to about 0.7 from September to October, which is not so different from any other estimates after September 1st 1998. Conversely, the coefficient of the Japanese yen was around 0.6 from July to August, but it dropped below 0.2 from September to October.

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. This implies that a regime switch in Malaysia had an enormously large impact on the Singapore dollar in the post-crisis period.

5. Determinants of Thai Baht after the Crisis

(1) The analytical motivation

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.

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

$$(7) \Delta TB_t = c_1 \Delta USD_t + c_2 \Delta JPY_t + c_3 \Delta SGD_t + c_4 \Delta MYR_t + \mu_t.$$

Substituting (3) and (4) into (7), we obtain

$$(8) \Delta TB_t = (c_1 + c_3 d_1 + c_4 e_1) \Delta USD_t + (c_2 + c_3 d_2 + c_4 e_2) \Delta JPY_t + \lambda_t$$

where $d_1 = \frac{b_1 + a_1 b_3}{1 - a_3 b_3}$, $d_2 = \frac{b_2 + a_2 b_3}{1 - a_3 b_3}$, $e_1 = \frac{b_1 + a_1 b_3}{1 - a_3 b_3}$, $e_2 = \frac{b_2 + a_2 b_3}{1 - a_3 b_3}$, and $\lambda_t = \mu_t + c_3 v_t + c_4 \zeta_t$.

To the extent that ΔSGD_t and ΔMYR_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 .⁷ 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 shifted 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 shifted to the fixed exchange rate regime.

Table 7-(2) reports the calculated theoretical weights after Malaysia shifted to the fixed exchange rate regime, that is, when $b_1=1$, and $b_2=b_3=0$. 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

⁷ 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.

the yen was more conspicuous when we used the trade weights in 1998 and 1999.

(2) The Estimations of the actual weights

We next estimate the actual weights in the Thai baht 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 11 a.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 shift 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. For the sample period 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, for the sample period 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 even before September 1st 1998.

However, the changes of the weights were more drastic after September 1st 1998. That is, for the sample period from September 1998 to October 1998, the coefficient of the U.S. dollar rose up to 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 placed quite different weights on the yen and the US dollar before and after September 1st 1998. The adoption of the fixed exchange rate by the Malaysian government was the only big institutional regime shift around September 1st 1998. The results thus suggest that the regime shift 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. 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 showed different responses to appreciation and depreciation of the Japanese yen in the post-crisis period. We first investigate the existence of asymmetric responses by estimating the following equations:

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

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

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. If the asymmetric responses to the yen/dollar exchange rates were important, the estimated correlations would be similar to those for the post-crisis period before September 1998. Table 10 reports the estimation results with and without ΔDM_t as an explanatory variable. In the case of Singapore, the estimated coefficients are significantly different from those for the post-crisis period before September 1998. Instead, the estimated coefficients are almost similar to those after September 1998 that were reported in Table 5. Even in the case of Thailand, the estimated coefficients are significantly different from those for the post-crisis period before September 1998. However, in the case of Thai baht, 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 2001 when the yen depreciates against the U.S. dollar.

The above overall results show some marginal evidence that the Singapore dollar and the Thai baht had smaller correlations with the U.S. dollar and larger correlations with the yen when the yen depreciates against the U.S. dollar. The results are, however, not so definitive and far from explaining why large structural changes were observed before and after September 1st 1998.

7. The Post-Crisis Exchange Rates in Korea and the Philippines

Concerning the impacts on the exchange rates, Korea and the Philippines also experienced serious devaluations of their currencies during the East Asian crisis. The arrival of the Korean won crisis was late and it was November 1997 when the currency showed a sharp devaluation. In contrast, the Philippine peso had already experienced frequent exchange rate depreciation before the East Asian crisis. However, both the Korean won and the Philippine peso reduced their market values to half of the pre-crisis levels until January 1998. Like the other East Asian currencies, it was after the end of January 1998 when these currencies almost stabilized.

The purpose of this section is to examine what impacts the Malaysian regime switch had on the Korean won and the Philippine peso. Concerning economic interdependence, Malaysia has had smaller linkages with Korea and the Philippines than with Singapore and Thailand. For example, when we look at the trade linkage, we can easily see that the dominant trade partners have been the United States and Japan for Korea and the Philippines. This indicates that intra-regional linkages with the other East Asian

countries, particularly with Malaysia have been less important for Korea and the Philippines. It is thus far from clear what impacts the Malaysian regime switch had on the Korean won and the Philippine peso.

As in the previous sections, we estimate the following equations:

$$(12) \Delta KW_t = \text{constant} + \beta_1 * \Delta USD_t + \beta_2 * \Delta JPY_t + \beta_3 * \Delta DM_t,$$

$$(13) \Delta PP_t = \text{constant} + \gamma_1 * \Delta USD_t + \gamma_2 * \Delta JPY_t + \gamma_3 * \Delta DM_t,$$

where ΔKW_t and ΔPP_t denote the growth rates of the Korean won and the Philippine peso denominated by the Swiss franc respectively.

The sample period of estimations is from the beginning of January 1998 to December 1998. To examine the impacts of the Malaysian regime switch, we split the sample before and after September 1st 1998. Tables 11 and 12 summarize the estimation results for Korea and the Philippines respectively. The tables report the results both with and without ΔDM_t . Throughout the periods, the U.S. dollar had larger weights than the Japanese yen. However, in most of the estimates, the coefficient of the Japanese yen was greater than 0.2 and statistically significant. This indicates that both Korea and the Philippines increased the weight of the Japanese yen in its currency basket after the crisis.

Comparing the coefficients before and after September 1st 1998, the coefficient of the U.S. dollar becomes close to one and that of the Japanese yen drops down after September 1st 1998. This suggests that the currencies had some moderate reversion to *de facto* pegs against the U.S. dollar. However, comparing the estimates from July 1998 to August 1998 with those from September 1998 to October 1998, we can see no such structural change in the Korean Won. In the case of the Philippines Peso, we can see some structural change. The change is, however, less drastic than what we observed for the Singapore dollar and the Thai Baht during the same period. This implies that in the case of the Korean won and the Philippine peso, the moderate reversion to *de facto* pegs against the U.S. dollar are not attributable to the Malaysian regime shift on September 1st 1998.

8. 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 in the post-crisis period. 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.

One possible answer to explain the structural change is a change of macroeconomic correlations that altered correlations of East Asian exchange rates with the U.S. dollar and the Japanese yen. Since East Asian economies had started a sharp recovery from the crisis around the middle of 1998, macroeconomic fundamentals in the East Asian economies may have a 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. Our regression results also showed that a part of the change was attributable to the structural change of the yen-dollar exchange rate.

Our main results, however, suggested that the structural change was explained well by the strong linkage among the ASEAN countries and that a regime switch in Malaysia had an enormously large impact on the exchange rates of the other ASEAN countries in the post-crisis period. This implies the importance of regional cooperation among the East Asian countries. Without regional cooperation, the East Asian countries might come to adopt the exchange rate regime that does not necessarily contribute to economic stability in the region.

In the present period, several East Asian economies adopt different types of exchange rate regimes; 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. The so-called floating exchange regimes of these countries are not really floating. The *de facto* pegs to the U.S. dollar may destabilize the real “effective” exchange rates of these currencies. To avoid another crisis in East Asia, it is an urgent issue to reconsider what is the desirable exchange rate regime in East Asian from a view of regional cooperation.

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Table 1. The Weights 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
Philippine 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 ringgit 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.

**Table 11. The correlations of the Korean Won 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	0.8352 (3.184)	0.3778 (2.054)		0.1126	2.021
	0.6675 (2.326)	0.3590 (1.953)	0.9093 (1.418)	0.1181	2.031
July 1998 - Aug. 1998	1.1521 (3.252)	0.3143 (1.144)		0.3293	1.480
	1.1480 (2.612)	0.3154 (1.102)	0.013 (0.016)	0.3121	1.479

(b) The estimations after September 1st 1998

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Sep. 1998 - Oct. 1998	0.9612 (6.263)	0.2463 (2.832)		0.5379	1.708
	0.7442 (3.844)	0.3411 (3.400)	0.7896 (1.764)	0.5617	1.541
Sep. 1998 - Dec. 1998	1.0369 (9.511)	0.2411 (3.309)		0.5687	1.888
	1.0061 (6.777)	0.2519 (3.100)	0.1101 (0.308)	0.5637	1.876

Note 1) t-values are in parentheses.

**Table 12. The correlations of the Philippine peso 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	0.8462 (4.557)	0.5463 (4.195)		0.2693	2.286
	0.9077 (4.447)	0.5532 (4.231)	-0.3337 (-0.732)	0.2672	2.276
July 1998 - Aug. 1998	0.7133 (3.883)	0.2505 (1.758)		0.4498	1.853
	0.9609 (4.423)	0.1844 (1.303)	-0.7726 (-1.973)	0.4870	1.734

(b) The estimations after September 1st 1998

Sample period	U.S. dollar	Yen	D. Mark	adj.R2	D.W.
Sep. 1998 - Oct. 1998	1.0556 (9.382)	0.1880 (2.949)		0.7065	2.200
	1.3021 (9.751)	0.0804 (1.161)	-0.8970 (-2.905)	0.7535	2.194
Sep. 1998 - Dec. 1998	0.9402 (8.477)	0.2471 (3.334)		0.5194	2.283
	1.0053 (6.670)	0.2243 (2.718)	-0.2326 (-0.640)	0.5158	2.281

Note 1) t-values are in parentheses.

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

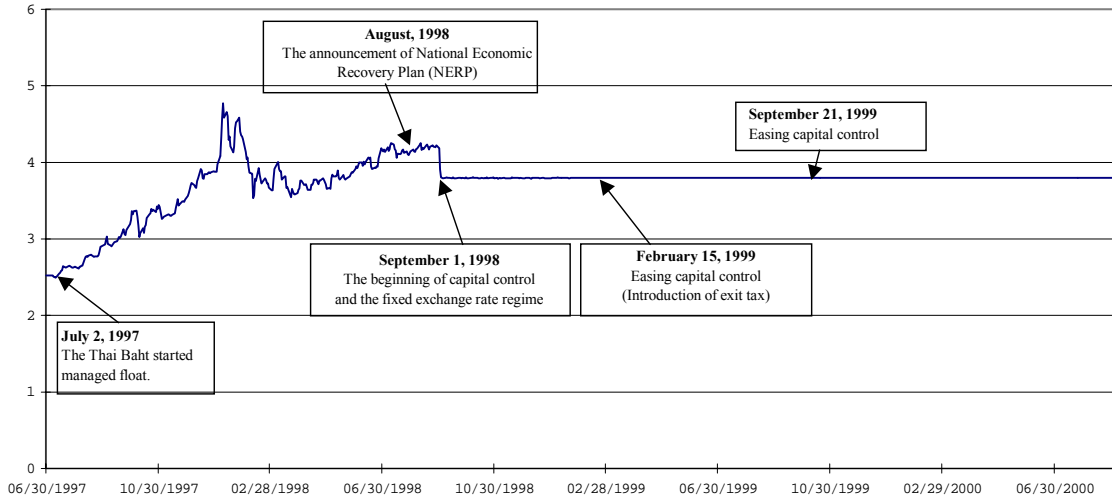


Figure 2. Movements of the Yen/the U.S. Dollar Exchange Rate (Yen/\$)

