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Fear of Floating in East Asia [+]

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Abstract

We examine the de facto exchange rate arrangements in East Asia by applying the methods suggested by Calvo and Reinhart (2002) and Kim (2004). Estimation results suggest that three East Asian countries in our sample adopted a hard peg or a peg with capital account restrictions in the post-crisis period. Five East Asian countries in our sample moved toward a more flexible exchange rate arrangement in the post-crisis period. At least three of these five countries (Korea, Indonesia and Thailand) achieved the level of exchange rate flexibility that is close to the level accomplished in the free floater such as Australia. These results suggest that "Fear of Floating" of East Asian countries is not prevalent in the post-crisis period and that the bi-polar view has some support in East Asian samples.

Key words: Bi-polar View, De Facto Exchange Rate Arrangements, De Jure Exchange Rate Arrangements, East Asia, Fear of Floating.

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1. Introduction

The choice of an appropriate exchange rate regime has been at the core of economic policy debate since the Asian currency crisis, because the soft-peg exchange rates of East Asian currencies have been blamed for inviting crises. A number of relatively fixed-rate countries have been forced to abandon their pegs and bands. Accordingly, the so-called bi-polar view—greater flexibility (free floating) or credible institutional assurance (hard pegs such as currency board or dollarization)—is gaining wide support (Fischer 2001; Mussa et al. 2000). A general consensus is that as long as developing countries maintain open capital accounts, they can choose only either a hard peg and a passive monetary policy, or a flexible exchange rate and an independent monetary policy (Frankel, 1999).[1]

The recent transition of exchange rate arrangements, based on what government of each country claims ("de jure"), appears to confirm the bi-polar view as many countries move to the bi-polar regimes. However, as suggested by Calvo and Reinhart (2002), what government of each country claims is often different from what they actually do ("de facto"). Many developing countries claiming that they adopt de jure free floating exchange rate regimes have attempted to reduce exchange rate fluctuations through foreign exchange interventions (i.e., in the case of Korea, see Park et al., 2001). Calvo and Reinhart (2002) call this "Fear of Floating" in their explanation of why exchange rate rigidity is conspicuous in the case of developing countries.

The East Asian countries experienced one of the most devastating crises in the

[1] This alleged incompatibility of a hard peg, an open capital account, and an independent monetary policy is known as the "Impossible Trinity Hypothesis."

world economic history. These countries are well known to have adopted a soft peg when the Asian crisis occurred. Many East Asian countries claimed to have a free-floating regime with free capital mobility. However, most East Asian countries, except for a few that feel comfortable with a hard peg, might not be fearless floaters. Some recent observers, such as Mussa (2000) have noted that after the crises, several countries returned to the exchange rate policy similar to that in the pre-crisis period. They argue that reverting to the old exchange rate policy may make these countries vulnerable to another crisis.

This paper examines the exchange rate arrangements in the East Asian countries during the post-crisis period and investigate how the exchange rate arrangements have changed in the post-crisis period, in particular, whether the exchange rate arrangements in the post-crisis period are reverting to those in the pre-crisis period, and whether the exchange rate arrangements in the post-crisis are close to a free float. More generally, we evaluate the "Fear of Floating" in the post-crisis exchange rate arrangements of East Asian countries, whether the bi-polar view is empirically supported in the East Asian countries, and which hypothesis, "Fear of Floating" or the bi-polar view, is a more compelling description of exchange rate arrangements in East Asia.[2]

To investigate the de facto exchange rate arrangements in the East Asian countries, we first apply the methodology developed by Calvo and Reinhart (2002), which basically exploits the volatility of the exchange rate and policy instruments (such as foreign reserves and interest rate). Then, we apply the methodology revised by Kim (2004), which uses structural VAR models to infer the explicit policy reaction functions. Kim's

[2] See Kim (2004) for a study on more samples of countries including non-Asian countries.

method resolves some shortcomings in the Calvo and Reinhart's measure, in particular the endogeneity of the policy variables.

The rest of the paper is organized as follows. Section 2 explains the empirical methodologies developed by Calvo and Reinhart (2002) and Kim (2004) for identifying de facto exchange rate arrangements. Section 3 presents and discusses the empirical results. Section 4 concludes with a summary of findings.

2. Methodology

In order to identify de facto exchange rate arrangements, Calvo and Reinhart (2002) and many subsequent studies such as Baig (2001), Hernandez and Montiel (2003), and Levy-Yeyati and Sturzenegger (2003), rely on the volatility of exchange rate changes (in percentage) and policy instruments changes such as interest rate changes and foreign exchange reserve changes (in percentage).[3] If the policy authority actively stabilizes the exchange rate movements by adjusting the policy instruments, the exchange rate movements would be small while the policy instrument movements would be large. In a fixed exchange rate regime, the volatility of the exchange rate changes would be very small but that of policy instruments would be very high since the policy authority would actively use its policy instruments to intervene in the foreign exchange market and fix the exchange rate. On the other hand, in a free float system, the volatility of the exchange rate changes would be high but that of the policy instruments would be small since the policy authority would rarely use its policy instrument and exchange rate movements would not

[3] Rogoff and Reinhart (2002) develop a novel system of re-classifying exchange rate regime, based on the market determined exchange rates.

be much stabilized. Based on this idea, past studies often classified the regime with smaller exchange rate changes and larger policy instruments changes as a less flexible exchange rate arrangement and the regime with larger exchange rate changes and smaller policy instrument changes as a more flexible exchange rate arrangement.

To measure the volatility of changes in each variable, Calvo and Reinhart (2002) used the probability that the absolute value of the percentage changes in each variable is higher (or lower) than some threshold values. As discussed by Calvo and Reinhart (2002), the probability measure is better than other volatility measures such as the variance of each variable changes, because it avoids the problem of outliers that can distort variances. Following Calvo and Reinhart (2002), we use the probability measures with 1% and 2.5% as threshold values. We calculate the probabilities that percentage changes in the exchange rate, percentage changes in the foreign exchange reserves, and changes in the interest rate are smaller than the threshold values.

In addition to the probability measures, Calvo and Reinhart (2002) constructed an exchange rate flexibility index. The index is defined as the ratio of variance of the percentage changes in exchange rate to the sum of variance of the percentage change in foreign exchange reserves and the change in interest rate. This index calculates the ratio of the volatility of the exchange rate to the volatility of the policy instruments. A higher number is observed when the exchange rate is relatively more volatile than the policy instruments. Therefore, a higher number suggests a more flexible exchange rate arrangement. We use this exchange rate flexibility index to infer the exchange rate arrangements in the East Asian countries.

Calvo and Reinhart's measures are intuitively appealing, but their method has

some drawbacks. The policy instruments may change in the absence of the policy authority's intention to stabilize the exchange rate. Foreign exchange reserves may change owing to fluctuations in valuation and the accrual of interest earnings. Interest rate may change as the policy authority pursues other policy objectives than the exchange rate stabilization. In turn, this change in policy instruments would affect the exchange rate and generate some extra volatility in the exchange rate. Such changes in policy instruments and the exchange rate should be excluded in inferring de facto exchange rate arrangements since they may not be related to the exchange rate stabilization. However, Calvo and Reinhart (2002)'s measures do not. This problem arises from using *unconditional* data that comprises both the movements originated from shocks to the exchange rate (that policy instruments react to) and the movements originated from shocks to the instruments (that affect the exchange rate), although only the former contains the relevant information.

To separate the two types of shocks, Kim (2004) imposes sign restrictions on impulse responses. The two types of shocks imply different sign restrictions on the exchange rate and the policy instruments. For example, an exchange rate depreciation would lead to a decrease in the foreign exchange reserves (or an increase in the interest rate) when the policy authority stabilizes the exchange rate, while a decrease in the foreign exchange reserves (or an increase in the interest rate) would lead to an exchange rate appreciation. Based on the estimated impulse responses to the shocks to the exchange rate, Kim (2004) formally recovers dynamic policy reaction functions, which describe the exchange rate stabilization policy, and infer the exchange rate arrangement in each country. Detailed methodology can be summarized as follows.

Two variable VAR models, which can be easily estimated over a short sample, are constructed. Each model includes the percentage changes in the exchange rate and a policy instrument; one model includes the percentage changes in the foreign exchange reserves as the policy instrument while the other model includes the changes in the interest rate. As usual in structural VAR analysis, the structural form representation is identified from the estimated reduced form representation by imposing some restrictions.

For the first model, the two variable reduced form VAR equations are:

$$(1)\quad \begin{bmatrix} \Delta E_t \\ \Delta FR_t \end{bmatrix} = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \begin{bmatrix} \Delta E_{t-1} \\ \Delta FR_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{E,t} \\ \varepsilon_{P,t} \end{bmatrix}$$

where E is the log of the exchange rate, FR is the log of foreign exchange reserves, $A(L)$'s are polynomials in lag operator L, ε_E and ε_{FR} are the residuals in each equation, ε is 2 by 1 vector of residuals, that is, $\varepsilon = (\varepsilon_E \ \varepsilon_{FR})'$, and $var(\varepsilon)=\Sigma$. For simplicity, the constant term in equation (1) is dropped.

To identify the (structural) shocks to the exchange rate (that foreign exchange reserves reacts to stabilize the exchange rate) and the (structural) shocks to foreign exchange reserves (that affects the exchange rate), sign restrictions on impulse responses are imposed. First, a positive shock to foreign exchange reserves would lead to an exchange rate depreciation (or an increase in the exchange rate); buying foreign currency, selling domestic currency and building up foreign exchange reserves would lead to exchange rate depreciation. Second, a positive shock to the exchange rate (or exchange rate depreciation) would lead to a decrease in the foreign exchange reserves when the policy authority stabilizes the exchange rate since a decrease in the foreign exchange

reserves would appreciate the exchange rate and offset the initial depreciation. That is, we define the shocks that move the two variables in the same direction as the structural shocks to the foreign exchange reserves (that affects the exchange rate) and the shocks that move the two variables in opposite directions as the structural shocks to the exchange rate (that foreign exchange reserves react to). To implement such identification, we modify the sign-restriction method developed by Uhlig (1999).[4]

The resulting structural form equations are:

$$(2)\quad \begin{bmatrix} B_{0,11} & B_{0,12} \\ B_{0,21} & B_{0,22} \end{bmatrix} \begin{bmatrix} \Delta E_t \\ \Delta FR_t \end{bmatrix} = \begin{bmatrix} B_{11}(L) & B_{12}(L) \\ B_{21}(L) & B_{22}(L) \end{bmatrix} \begin{bmatrix} \Delta E_{t-1} \\ \Delta FR_{t-1} \end{bmatrix} + \begin{bmatrix} e_{E,t} \\ e_{FR,t} \end{bmatrix}$$

where B_0's are constants, $B(L)$'s are polynomials in lag operator L, e_E and e_{FR} are the structural shock to the exchange rate and the structural shocks to foreign exchange reserves, respectively, e is two by one vector of structural shocks, that is, $e = (e_E, e_{FR})'$, $var(e)=\Omega$, and Ω is a diagonal matrix. The sign restrictions on impulse responses give some sign restrictions on contemporaneous structural parameters, $B_{11}(0) \geq 0$, $B_{12}(0) \geq 0$, $B_{21}(0) \leq 0$, and $B_{22}(0) \geq 0$. Such restrictions on the contemporaneous structural parameters B are natural. We can interpret the first equation as the foreign exchange market equation and the second equation as the policy reaction function. The implications for the restrictions are: the policy authority decreases the foreign exchange reserves in reaction to the exchange rate depreciation in order to stabilize the exchange rate while an

[4] We impose such restrictions only on the impact responses since it is more difficult to justify the signs of the lagged responses. For example, a positive foreign exchange reserve shock depreciates the exchange rate. Next period, the foreign exchange reserve might decrease if the policy authority tries to offset the exchange rate depreciation.

increase in the foreign exchange reserves depreciates the exchange rate in the foreign exchange market.

To infer the degree of stabilization, we can interpret the coefficients on the foreign exchange policy reaction function (equation (2)). That is,

$$(3)\ B_{0,22}\Delta FR_t = -B_{0,21}\Delta E_t + B_{21}(L)\Delta E_{t-1} + B_{22}(L)\Delta FR_{t-1} + e_{FR,t}$$

Equation (3) has both the exchange rate and foreign exchange reserve on the right hand side, so the interpretation is complicated. Therefore, equation (3) can be rewritten as:

$$(4)\ \Delta FR_t = \left(B_{0,22} - B_{22}(L)L\right)^{-1}\left[\left(B_{0,21} - B_{21}(L)L\right)\Delta E_t + e_{FR,t}\right]$$

By tracing coefficients on ΔE_t, ΔE_{t-1}, ΔE_{t-2},… in equation (4), we can examine how many percentages the foreign exchange reserves changes over time in reaction to 1 percentage depreciation of the exchange rate.[5] In practice, such dynamic policy reaction function in this two variable model can be obtained by combining the impulse responses of the exchange rate and foreign exchange reserves to the shocks to the exchange rate.[6]

To infer the interest rate reactions to the exchange rate, we also construct a two variable model that includes the log of exchange rate changes and the interest rate changes. For the interest rate, we use the difference form, following Calvo and Reinhart (2002). In the model that the interest rate changes, instead of the log of foreign exchange reserve changes, are included, we impose the restriction that a positive shock to the

[5] Refer to Kim (2002) and Kim (2003) for such ways of recovering policy reaction functions.
[6] See Kim (2004) for details.

interest rate decreases the exchange rate (since an increase in the interest rate makes the domestic currency asset more attractive), while a positive shock to the exchange rate increases the interest rate (since the policy authority tries to stabilize the exchange rate).

Although we constructed two variable models that include only one policy instrument, we also expect that there are some interactions between two policy instruments. To consider interactions between two policy instruments, a three variable model that includes both policy instruments is needed. In this regard, Kim (2004) constructed a three variable model that includes both policy instruments, and found that the results are qualitatively similar.

3. Exchange Rate Arrangements in East Asian Countries

3.1. De Jure Classification

Table 1 shows the de jure exchange rate regime of nine East Asian countries reported in IMF's *Exchange Arrangements and Exchange Restrictions*. Among them five countries experienced severe crisis in 1997: Korea, Indonesia, the Philippines, Malaysia, and Thailand. Except for the Philippines, these countries reported changes in the exchange rate arrangements during the crisis. Out of total nine East Asian countries in our sample, five countries changed the exchange rate arrangements during the Asian crisis. Three countries (Korea, Indonesia and Thailand) changed from intermediate regimes like managed float to a free floating. China moved from managed floating to a peg.[7] Malaysia

[7] This is based on IMF's *Exchange Arrangements and Exchange Restrictions*. However, moving out of a dual exchange rate system, Chinese exchange rate was fixed in 1994 (US$1 = 8.72 RMB). In 1994, the official exchange rate and market swap rate were merged to a single rate. During the two years between

changed from a managed float to a peg with capital controls in September 1998. Although Indonesia and Thailand reverted back to a managed float, the bi-polar view has some supports based on the de jure regime classification. However, each country may behave differently from what they say as suggested by Calvo and Reinhart (2002). In the next section, de facto exchange rate arrangements are inferred from the data by applying the methods discussed in Section 2.

3.2. De Facto Exchange Rate Arrangements: Calvo and Reinhart (2002)

In order to infer de facto exchange rate arrangements, we first apply Calvo and Reinhart's methods. Their method is primarily based on the volatility of exchange rate and policy instruments. Therefore, we first plot the exchange rate and policy instruments of East Asian countries to see the visual difference in the two variables across the countries and between the pre-crisis and post-crisis periods.

Figure 1 shows the log of the exchange rate of the East Asian countries (and Australia as a benchmark for a free floater) against U.S. dollar from 1992 to 2003 in which the value of December 2003 is normalized to 100. Exchange rate becomes less volatile for China and Malaysia that announced a fixed exchange rate regime. The exchange rate in Hong Kong over the whole sample period is almost fixed, to be consistent with its claim. On the other hand, in three countries that announced a free float during the crisis (Korea, Indonesia and Thailand), the exchange rates tend to be more volatile after the crisis, to be consistent with their claim of adopting a more flexible exchange rate regime. Also in the Philippines and Singapore, the exchange rate becomes

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August 1995 and end-1997, the value of the RMB (Renminbi) rose by 5 percent, but since the Asian crisis, the rate has been actually pegged to 8.27 RMB to the U.S. dollar.

more volatile after the crisis, although they did not report any changes in the exchange rate regime. Overall, the exchange rate movements are not inconsistent with the transition in de jure exchange rate arrangements.

Figure 2 shows the foreign exchange reserves (in terms of US dollar) in which the value of December 2003 is normalized to 100. In Korea and Indonesia, the foreign exchange reserves tend to be less volatile in the post crisis period than they were in the pre crisis period, while they tend to be more volatile in Singapore and Thailand. Figure 3 reports the interest rate. In Korea, Malaysia, the Philippines and Thailand, the interest rate tends to be less volatile after the crisis.

Although we can learn some features of de facto exchange rate arrangements from the graphs to some extent, it is not so easy to infer the exact arrangements. Therefore, to infer the de facto exchange rate arrangements more precisely, we calculate the probability measures and the exchange rate flexibility index suggested by Calvo and Reinhart (2002). During the periods around the crisis, abnormal behaviors of these variables are observed as apparent from Figures 1, 2, and 3. Therefore, some months before and after the Asian crisis were dropped. For the post crisis-period, we use the sample period from 1999 while for the pre-crisis period, we cut the sample at the end of 1996. To be more comparable to the sample size of the post crisis period, we start the sample as early as 1992. The exact estimation periods are summarized in Table 2. For all countries, the exchange rate against US dollar is used. The foreign exchange reserves in terms of US dollar are used because the exchange rate variations would change foreign exchange reserves in terms of domestic currency without any policy reactions.[8]

[8] All data is from IMF's International Financial Statistics (IFS).

The benchmark cases for free floaters are Japan and Australia. Both countries are generally regarded as free floaters, and Japan is a good example of a free floater in East Asia. However, Japan's currency is a world's reserve currency. In addition, Japan is hard to be regarded as a small open economy that characterizes the countries in the sample. Therefore, following Calvo and Reinhart (2002), Australia is considered as a benchmark since Australia can be regarded as a small open economy and its currency is not usually used as international reserves. Estimation periods are 1983.1-2003.12 for Japan and 1984.1-2003.12 for Australia, when they adopted a free float.[9]

The results are shown in Table 2. The first column shows the country name, the second estimation periods, the third de jure exchange rate arrangements, the fourth to the ninth the probability that the percentage changes in exchange rate, the percentage change in foreign exchange reserves, and the changes in interest rate are smaller than the threshold values of 2.5% and 1% respectively, and the last the exchange rate flexibility index (EFI).

In the two benchmark cases, Japan and Australia, the probability measures for the exchange rate and the interest rate are similar. The exchange rate changes less than 2.5% with 66~69% probability and less than 1% with 31~34% probability, while the interest rate changes less than 2.5% with 99~100% probability and less than 1% with 93~100% probability. The percent changes in foreign exchange reserves are more volatile in Australia than in Japan; the probabilities that the foreign exchange reserve changes less than 2.5% and 1% are 47.3% and 23.8% in Australia, while they are 80.5% and 55.0% in Japan. Since the volatility of the percentage changes in foreign exchange reserves is

[9] The estimation periods are chosen based on IMF's *Exchange Arrangements and Exchange Restrictions*.

higher in Australia while the volatility of the other two variables is similar, Australia seems to have a less flexible exchange rate arrangement than Japan. The exchange rate flexibility index is consistent with this observation. Japan has a higher value (0.80) than Australia (0.14), which suggests that the ratio of the volatility of the exchange rate to the policy instruments is higher in Japan than in Australia. This result might imply that a small open economy like Australia needed to implement a stronger magnitude of intervention to maintain a similar degree of volatility of exchange rate as Japan. Alternatively, it may be related to the fact that Japan's currency has been used as an international reserve currency.

In the three countries that announced a fixed exchange rate regime in the post crisis period (Malaysia, Hong Kong, and China), the percentage changes in the exchange rate tend to be less volatile but the policy instrument changes tend to be more volatile. In general, their exchange rates are clearly fixed in the post crisis period and there is no further ambiguity on the exchange rate arrangements regardless of the volatility of the policy instruments. The EFI also drops from 0.37 to 0.00 in China and from 0.03 to 0.00 in Malaysia, indicating the decrease in the exchange rate flexibility.

In the other five countries, the percentage changes in the exchange rate tend to be more volatile and the policy instruments changes tend to be less volatile in the post-crisis period than in the pre-crisis period. In Korea, Thailand, Singapore, and the Philippines, the probability for the exchange rate falls but the probability for the policy instruments increases. This implies that the volatility of the exchange rate changes increases, but the volatility of the policy instruments changes decreases, which in turn suggests more flexible exchange rate arrangements. In Indonesia, the inference is less clear because the

probability for both exchange rate and interest rate decreases. On the other hand, based on the exchange rate flexibility index, the number increases in all countries in the post-crisis regime, suggesting a more flexible exchange rate arrangement.

Overall, the exchange rate arrangements of the five East Asian countries that do not announce a fixed exchange rate regime in the post-crisis period tend to change toward a more flexible exchange rate regime in the post-crisis period. However, one important issue is whether there is "Fear of Floating," that is, whether these countries, especially those that announced the flexible exchange rate regime in the post-crisis period, actually achieved the flexibility level which is close to a free float. In this regard, we compare the statistics of these countries with those of the two benchmark cases, Japan and Australia.

Based on the exchange rate flexibility index, all of these five countries achieved the level of the exchange rate flexibility of Australia, and some of them achieved the level of the exchange rate flexibility of Japan. The level of Australia is 0.14 and for the level of these six countries ranges from 0.26 to 2.82. In addition, Korea (1.37) and Indonesia (1.10~2.82) have even higher level than Japan (0.8). Singapore and Thailand (for 1999.1-2001.6) also achieved a similar level; the figures are 0.68 and 0.88, respectively.

The probability measures are difficult to interpret since the results are often mixed in the sense that both the volatility of the exchange rate and the volatility of policy instruments are higher (or lower) than that of Japan and/or Australia. In the case of the Philippines, Malaysia, and Thailand, the exchange rate changes are less volatile than those in Japan but the policy instrument changes are more volatile than those of Japan. This suggests that the exchange rate flexibility is lower in these three countries than in

Japan. On the other hand, the exchange rate flexibility of the Philippines is higher than that of Japan, based on the probability measures. For the other cases, results are mixed. In general, we cannot find clear evidence against the conclusion based on the exchange rate flexibility index: these five countries achieved the level of exchange rate flexibility comparable to that of Australia. This result also suggests that there is no case of clear "Fear of Floating" of East Asian countries in the post-crisis period, since they indeed achieved the level of exchange rate flexibility that is close to a free float.

Although the above results and inference are reasonable to some extent, there are a few cases suggesting that some of the results and inference might be misleading. For example, the managed float often shows higher exchange rate flexibility than the benchmark free float case: the exchange rate flexibility indexes for Singapore both in the pre-crisis and post-crisis periods, China in the pre-crisis period, Thailand in the post-crisis period and Indonesia in the pre-crisis period are higher than Australia. When we use the probability measures, such cases are found in several cases. Although we cannot fully dismiss the evidence based on Calvo and Reinhart (2002)'s measures based on this observation, some caution is needed. To confirm the main results in this section, we further investigate the issues, using the measures suggested by Kim (2004), which solves some drawbacks of Calvo and Reinhart (2002)'s method.

3.3. De Facto Exchange Rate Arrangements: Kim (2004).

In this section, we construct the measures developed by Kim (2004). In reporting the results, two types of estimates are constructed for the model with the exchange rate and the foreign exchange reserves; One is how many percentages of the foreign exchange

reserve decrease (to stabilize the exchange rate) in reaction to one percent depreciation, and the other is how many percentages of the foreign exchange reserve "as a fraction of the average monetary base during the sample period" decrease in reaction to one percent depreciation.[10] This measure corrects a possible shortcoming of using simple percentage changes of reserves across different times and countries because the level of reserves may change over time and countries. For example, as apparent from Figure 2, East Asian countries accumulated a substantial amount of foreign exchange reserves over time, and the level of reserves are far higher in the post-crisis period than that was in the pre-crisis period. In that case, one percent change in foreign exchange reserves may have smaller effects on stabilizing the exchange rate in the post-crisis period than in the pre-crisis period, because one percent change in foreign exchange reserves implies smaller changes in the level of reserves in the post-crisis period than in the pre-crisis period. To correct such a bias, we calculate the reserve reactions as a ratio to monetary base.

The results are shown in Table 3. The first column shows the country name, the second estimation periods, the third de jure classification reported to IMF, the fourth to the sixth the reaction function of the foreign exchange reserves to the exchange rate (the first month, the third month, and the sixth month), the seventh to the ninth the reaction function of the foreign exchange reserves as a fraction of average monetary base and the tenth to the twelfth the reaction function of the interest rate to the exchange rate. Note that all the numbers of reaction functions are cumulative numbers over time. There are three cases in which the numbers are not reported; in two cases (Malaysia and China in the post crisis period), the exchange rate is literally fixed and the reaction functions

[10] It is calculated by multiplying the original measure by the ratio of the average foreign exchange reserve to the average monetary base.

cannot be estimated and in one case (Hong Kong), the data is not available.

First, we examine the benchmark countries. Japan's foreign exchange reserve reactions show that the foreign exchange reserve decreases by 0.89% in the first month and by 0.86% at the end of the third and sixth months, in reaction to 1% exchange rate depreciation. The modified reactions (as a fraction of average monetary base) are about one-third of the actual foreign exchange reserve reactions, about 0.32~0.33%. The interest rate reactions show that the interest rate increases by 0.07~0.08% in reaction to 1% exchange rate depreciation. Australia's reaction function implies that more stabilizing policies were implemented, which is consistent with the results based on Calvo and Reinhart (2002)'s measures. The foreign exchange reaction as a fraction of average monetary base is about shows 1.7~1.88%, while the interest rate reactions are 0.19~0.29%.

In one fixed exchange rate regime case (Hong Kong in the post-crisis period) that we could estimate the model, the policy reaction is huge; the foreign exchange reserve reaction ranges form –16.50 to –28.10%, the foreign exchange reserve reaction as a percentage of average monetary base ranges from –59.99 to –102.2%, and the interest rate reaction ranges from 5.27 to 6.25%. The result in general supports the method since we find far larger policy reactions in the fixed exchange rate regime than in the floating exchange rate regime, as expected.

Then, we examine the five countries that did not adopt the fixed exchange rate regime in the post-crisis period. For all five countries, a dramatic fall in the interest rate reactions is found after the crisis. In Korea, it is over 1% before the crisis but less than 0.1% after the crisis. In Indonesia, it is over 3.5% but less than 0.5%. In the Philippines, it

is over 1.3% but less than 0.4%. In Thailand, it is over 6.9% but less than 0.25%. In Singapore, it is over 0.55% but not larger than 0.2%. For Thailand and Indonesia, the foreign exchange reserve reaction also falls substantially; the size of the reactions falls to about one-third after the crisis in Thailand while it falls dramatically (to one tenth ~ one fiftieth) in Indonesia. For Korea and the Philippines, the reserve reaction falls substantially but the reserve reaction as a fraction of average monetary base does not change much. This reflects the substantial build-up of foreign exchange reserves after the crisis. An increase in foreign exchange reserves after the crisis is quite considerable, and in these two countries, it affects the inference on the relative size of the foreign exchange reserve reactions before and after the crisis. That is, based on the reserve reaction per se, the substantial decreases in the size of foreign exchange reserve reaction is found but based on the reserve reaction as a fraction of average monetary base, the size of reaction does not change much; the fall in the percentage of foreign exchange reserve reaction after the crisis is mostly due to an increase in the level of foreign exchange reserves instead of a decrease in the reaction of the foreign exchange reserve level. Finally, the reserve reactions do not change much in Singapore.

To summarize, these five countries actually took a more flexible exchange rate arrangement than they did before the crisis, to be consistent with the results in the previous section. Indonesia and Thailand decreased reactions of both foreign exchange reserves and the interest rate. In Korea, Indonesia, and Singapore, the foreign exchange reserve reaction shows mixed results but the interest rate reactions fall substantially.

Next, we compare the policy reactions of these five countries and the benchmark cases to infer whether these countries actually achieved the exchange rate flexibility that

is close to a free float. All five countries' reaction is stronger than Japan. Now we compare these countries with Australia in more details since the comparison result with Japan is trivial and so Australia may be a better benchmark for these countries as discussed previously. At least some countries should have achieved a similar degree of exchange rate flexibility to that of Australia. Korea has a lower degree of reserve and the interest rate reactions but a slightly higher degree of reserve reaction as a fraction of average monetary base. Indonesia has a lower degree of reserve reactions but a higher degree of interest rate reactions. Thailand also has a similar degree of reactions. In these countries, the size of reactions is not significantly different from that of Australia. On the other hand, the size of reactions of the Philippines is slightly higher than that of Australia, in terms of both the size of the foreign exchange reserve reactions as a fraction of monetary base and the size of interest rate reactions. In the case of Singapore, the size of the foreign exchange reserve reactions as a fraction of monetary base is substantially higher than that of Australia. Overall, at least three countries (Korea, Indonesia and Thailand) achieved a similar level of exchange rate flexibility to that of Australia.

When we compare the results of this section with those in the previous section using Calvo and Reinhart (2002)'s measure, many results are similar. One important discrepancy is how much degree of flexibility is achieved by the five Asian countries that did not adopt the fixed exchange rate regime in the post-crisis period (and mostly adopted the free float). The results based on Calvo and Reinhart (2002)'s method suggest that all these countries achieved as high degree of exchange rate flexibility as Australia and that some countries even achieved the level of Japan, while this section's results suggest that all these countries did not achieve the level of Japan and that most countries achieved the

level of Australia. That is, the results in this section are more conservative in terms of these five countries' exchange rate flexibility. As one way of checking which methods and results are more convincing, we examine the level of reactions in the managed floating regimes, which Calvo and Reinhart (2002)'s method does not deliver convincing results. Contrary to the results using Calvo and Reinhart (2002)'s methods, the results using Kim (2004)'s methods seems to be more convincing in this aspect; based on Kim (2004)'s method, most countries that adopted a managed float have the larger size of policy reactions than the benchmark cases of a free float.

4. Conclusion

We investigate the transition of the de facto exchange rate arrangements in East Asian countries and try to address various questions such as whether East Asian countries adopted more flexible exchange rate arrangements after the crisis, whether East Asian countries moved to the bi-polar regimes, and whether the level of exchange rate flexibility achieved by East Asian countries in the post-crisis period, especially those who announced a free float, are close to a free floater, by applying two methodologies, one suggested by Calvo and Reinhart (2002) and the other suggested by Kim (2004).

The results based on both methodologies present that East Asian countries (that did not adopt a peg in the post-crisis period) adopted a more flexible exchange rate arrangement after the crisis. Moreover many of these countries achieved the exchange rate flexibility close to a free floater such as Australia. In particular, the countries that announced a free float actually behave very closely to a free floater, dismissing the case

of the “Fear of Floating” in the post crisis period. As they claim, East Asian countries tend to move to bi-polar regimes. Three out of the eight countries maintained a hard peg (currency board) or a peg with capital control while three or four countries moved to a free float.

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Table 1. De Jure Exchange Rate Regime Classification

Country	De Jure Exchange Rate Regime Classification
Korea	1980.3-1997.12.15: Managed Floating 1997.12.16 - : Independently Floating
Indonesia	1978.11-1997.8.13: Managed Floating 1997.8.14 – 2001.6.29: Independently Floating 2001.6.30-: Managed Floating
Philippines	1988.1 - : Independently Floating
Malaysia	1992.12-1998.9.1: Managed Floating 1998.9.2.-: Fixed
Thailand	1970.1.-1997.7.1: Fixed 1997.7.2.-2001.6.29: Independently Floating 2001.6.30-: Managed Floating
Hong Kong	1983.10.17-: Currency Board
Singapore	1987 -: Managed Floating
China	1987.8-1998.8: Managed Floating 1998.9-: Fixed
Japan	1982-: Independently Floating

Source: International Monetary Fund, *Exchange Arrangements and Exchange Restrictions.*

Table 2. Probability Measures and Exchange Rate Flexibility Index

Country	Estimation Periods	De Jure	Prob (< 2.5%)			Prob (< 1%)			EFI
			E	FR	R	E	FR	R	
Japan	83.1-03.12	IF	66.9	80.5	100	33.1	55.0	99.2	0.80
Australia	84.1-03.12	IF	68.2	47.3	99.2	31.0	23.8	93.3	0.14
Korea	92.1-96.12	MF	100	55.9	93.2	88.1	27.1	61.0	0.05
	99.1-03.12	IF	81.4	62.7	100	42.4	33.9	100	1.37
Indonesia	92.1-96.12	MF	100	61.0	98.3	98.3	40.7	69.5	0.01
	99.1-01.6	IF	30.0	60.0	66.7	13.3	30.0	50.0	1.10
	01.7-03.12	MF	62.1	86.2	79.3	34.5	48.3	41.4	2.82
Philippines	92.1-96.12	IF	89.8	32.2	66.1	62.7	11.9	42.4	0.03
	99.1-03.12	IF	86.4	66.1	98.3	57.6	27.1	88.1	0.26
Malaysia	92.12-96.12	MF	91.7	50.0	100	72.9	27.1	100	0.03
	99.1-03.12	F	100	61.7	100	100	32.2	98.3	0.00
Thailand	92.1-96.12	F	100	72.9	78.0	98.3	30.5	30.5	0.02
	99.1-01.6	IF	74.3	80.0	97.1	37.1	42.9	88.6	0.88
	01.7-03.12	MF	96.6	75.9	100	51.7	20.7	100	0.30
Hong Kong	92.1-96.12	MF	91.5	---	100	72.9	---	100	---
	99.1-03.12	F	100	91.5	100	100	37.3	98.3	0.00
Singapore	92.1-96.12	MF	100	83.1	100	76.3	37.3	91.5	0.35
	99.1-03.12	MF	93.2	84.7	100	52.5	45.8	100	0.68
China	92.1-96.12	MF	96.6	35.6	100	91.5	11.9	94.9	0.37
	99.1-03.12	F	100	66.1	100	100	37.3	98.3	0.00

* F: Fixed, IF: Independently Floating, MF: Managed Floating

* Monthly foreign exchange reserve data of Hong King is only available from 93.12

* Monthly interest rate data of Hong Kong is not available for the pre-crisis period.

Table 3. Policy Reaction Function (De Facto Classification)

Country	Estimation Periods	De Jure (IMF)	Reserve Reaction			Reserve Reaction (/MB)			Interest Rate Reactions		
			1 mo	3 mo	6 mo	1 mo	3 mo	6 mo	1 mo	3 mo	6 mo
Japan	1983.1-2003.12	IF	-0.89	-0.86	-0.86	-0.33	-0.32	-0.32	0.08	0.07	0.07
Australia	1984.1-2003.12	IF	-2.23	-2.02	-2.01	-1.88	-1.70	-1.70	0.19	0.27	0.29
Korea	1992.1-1996.12	MF	-3.74	-3.17	-3.16	-3.30	-2.80	-2.79	1.68	1.12	1.06
	1999.1-2003.12	IF	-0.67	-0.91	-0.92	-2.62	-3.56	-3.62	0.07	0.09	0.10
Indonesia	1992.1-1996.12	MF	-15.29	-19.14	-19.45	-19.62	-24.56	-24.96	4.06	3.71	3.70
	1999.1-2001.6	IF	-0.34	-0.26	-0.26	-0.74	-0.49	-0.48	0.48	0.46	0.46
	2001.7-2003.12	MF	-0.52	-0.60	-0.60	-0.95	-1.08	-1.08	0.55	0.38	0.33
Philippines	1992.1-1996.12	IF	-4.85	-4.19	-4.17	-3.57	-3.09	-3.06	2.70	1.53	1.36
	1999.1-2003.12	IF	-1.55	-1.39	-1.39	-2.55	-2.29	-2.28	0.28	0.35	0.36
Malaysia	1992.12-1996.12	MF	-9.22	-18.08	-22.65	-14.29	-28.05	-35.13	1.56	1.06	1.02
	1999.1-2003.12	F	---	---	---	---	---	---	---	---	---

IF: Independently Floating, MF: Managed Floating, F: Fixed

Table 3. Continues

Country	Estimation Periods	De Jure (IMF)	Reserve Reaction			Reserve Reaction (/MB)			Interest Rate Reactions		
			1 mo	3 mo	6 mo	1 mo	3 mo	6 mo	1 mo	3 mo	6 mo
Thailand	1992.1-1996.12	F	-4.39	-3.95	-3.93	-10.01	-9.01	-8.96	6.99	8.21	8.21
	1999.1-2001.6	IF	-0.97	-0.60	-0.54	-2.05	-1.26	-1.13	0.22	0.24	0.24
	2001.7-2003.12	MF	-1.56	-1.46	-1.46	-3.25	-3.04	-3.05	0.14	0.09	0.07
Hong Kong	1992.1-1996.12	MF	---	---	---	---	---	---	---	---	---
	1999.1-2003.12	F	-16.50	-26.52	-28.10	-59.99	-96.44	-102.2	6.25	5.39	5.27
Singapore	1992.1-1996.12	MF	-1.42	-1.28	-1.27	-7.57	-6.83	-6.79	0.60	0.57	0.57
	1999.1-2003.12	MF	-0.95	-1.20	-1.21	-7.07	-8.88	-8.96	0.20	0.18	0.18
China	1992.12-1996.12	MF	-2.13	-2.58	-2.60	-0.52	-0.64	-0.64	0.06	0.06	0.06
	1999.1-2003.12	F	---	---	---	---	---	---	---	---	---

IF: Independently Floating, MF: Managed Floating, F: Fixed

Figure 1. Exchange Rate

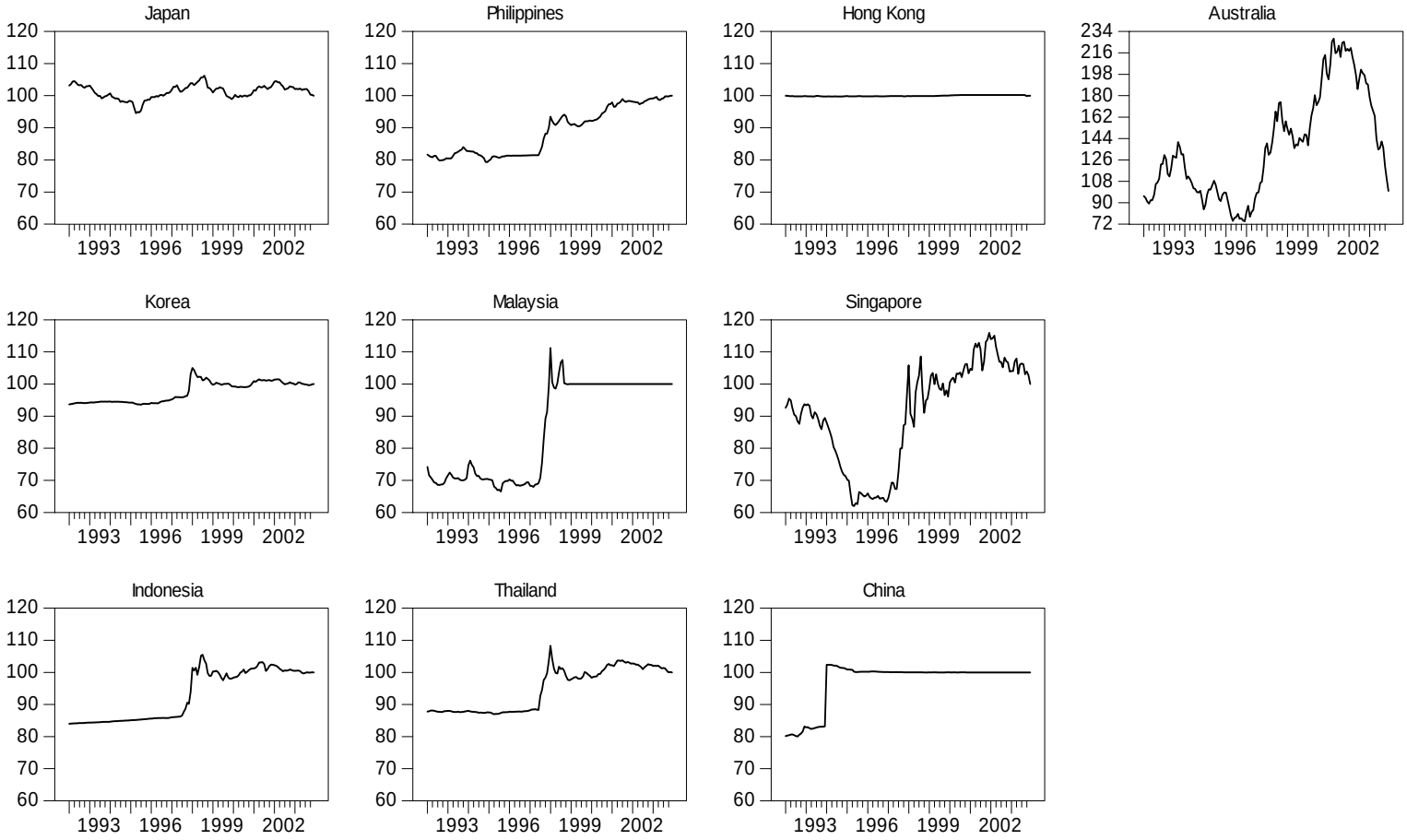


Figure 2. Foreign Exchange Reserve

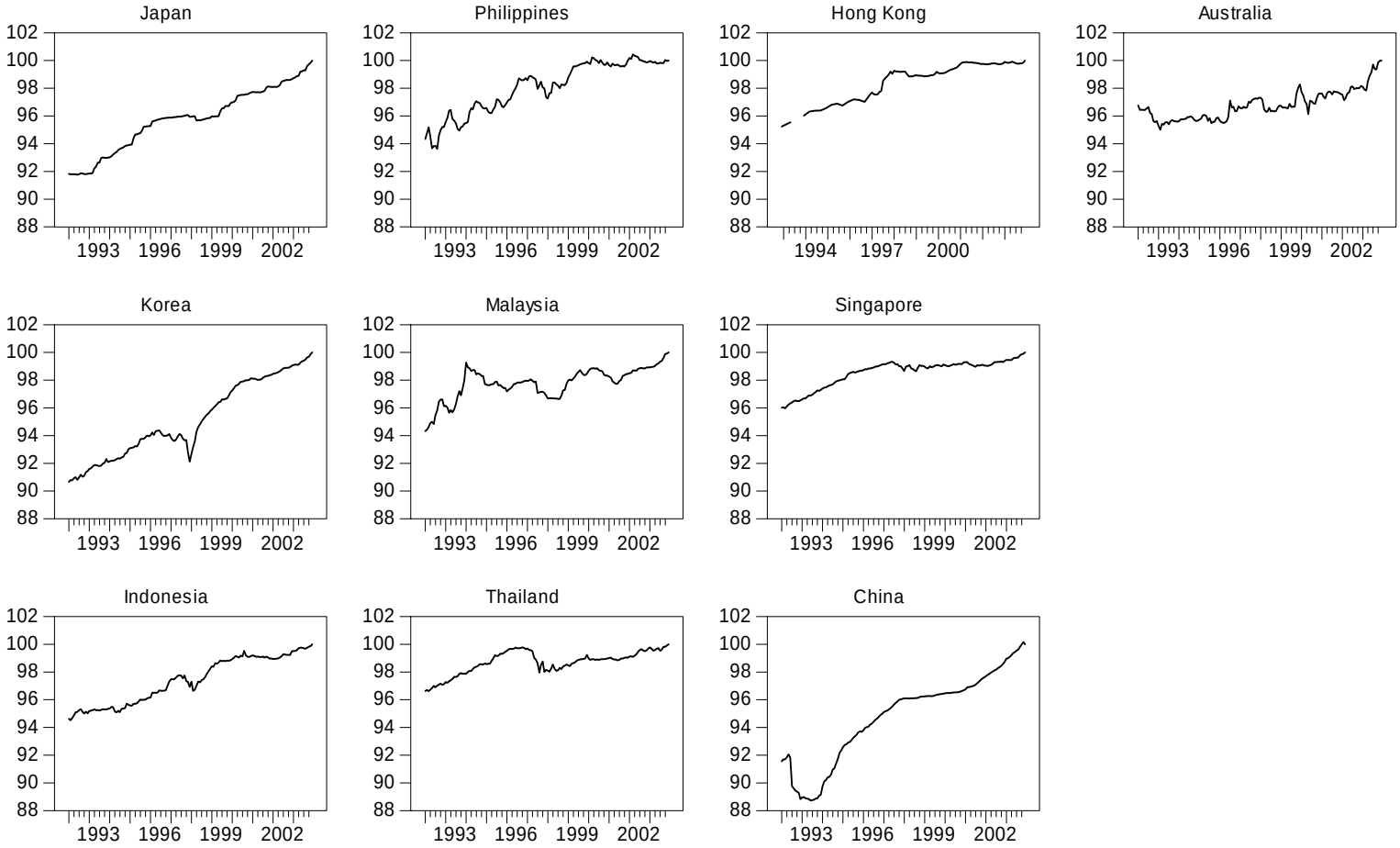
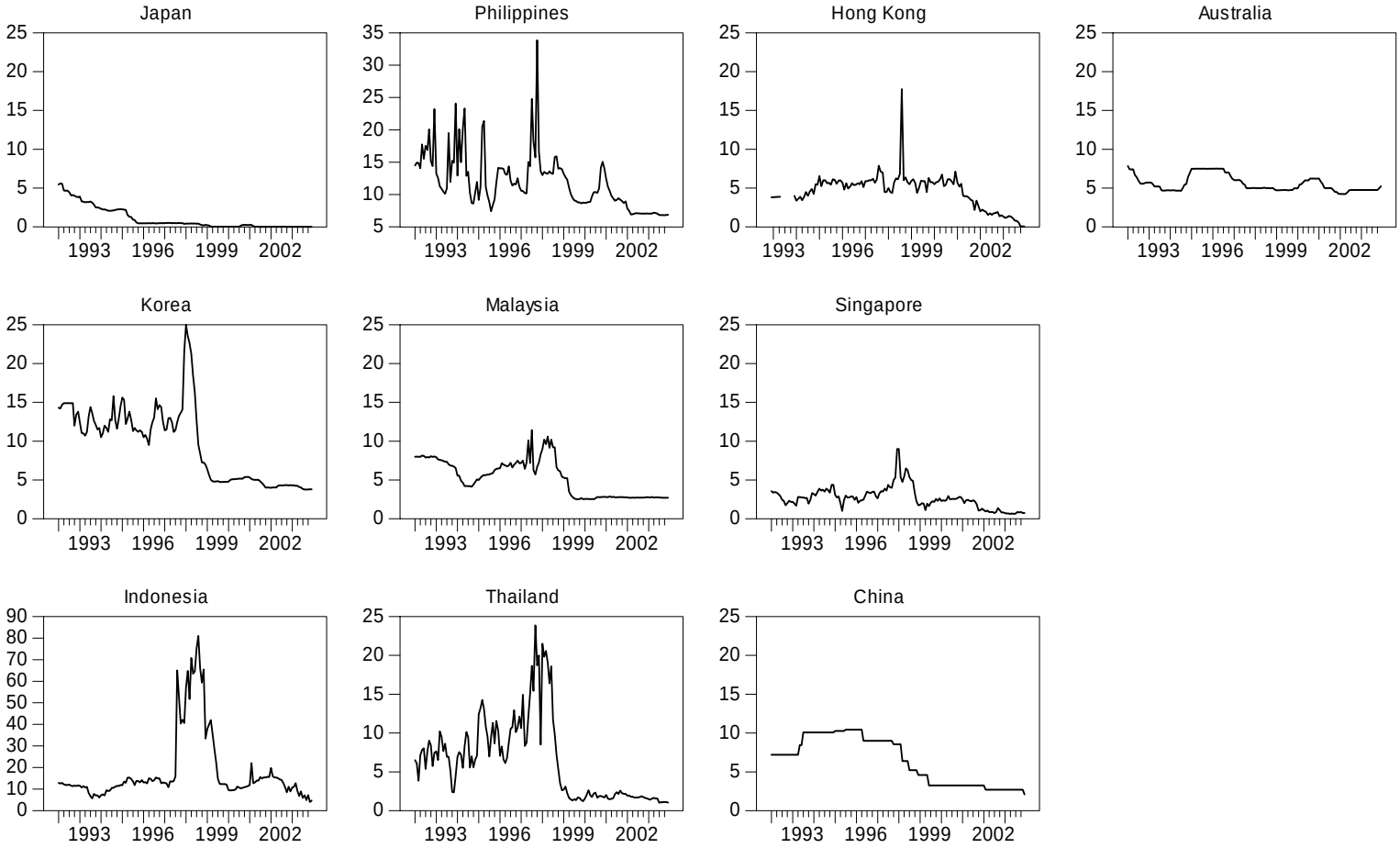


Figure 3. Interest Rate



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