What Do They Learn from Currency Crisis, Fear of Floating or Hollow Middle? Identifying Exchange Rate Policy Arrangements in Recent Crisis Countries

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2004

Abstract

Exchange rate arrangements are examined for countries that experienced severe crisis recently and are likely to deliberate on the choice of their exchange rate regimes after crisis. To infer the exchange rate arrangements from the data (that is, de facto arrangements), structural VAR models are employed. By imposing sign restrictions on impulse responses, the structural VAR models identify the shocks to exchange rate that policy instruments react to stabilize the exchange rate. Based on the impulse responses to such shocks, policy reaction functions are derived. This method improves upon previous methodologies that use simple volatility measures of the exchange rate changes and policy instrument changes. The main findings are: (1) The cases that de facto exchange rate arrangements are different from de jure exchange rate arrangements (including the cases of "Fear of Floating") are often found in the pre-crisis period, but not much in the post-crisis period. (2) To be consistent with "Hollow Middle" hypothesis, most countries moved toward hard pegs like dollarization and currency board or more flexible exchange rate arrangements that are close to the free float.

Key Words: De Facto Exchange Rate Regime, structural VAR,
Fear of Floating, Hollow Middle, Crisis

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1. Introduction

In recent years, many countries have experienced currency crisis and economic turbulence, including Europe (1992), Mexico (1994-5), East Asia (1997), Russia (1998), and Argentina (2002). Most of these countries adopted highly managed exchange rate arrangements onset of currency crisis, and thus currency crisis has been thought of as at least partly due to the exchange rate arrangements adopted in each country. As a result, lively discussion on the choice of the exchange rate regime has followed.

Eichengreen (1994) suggests that highly managed exchange rate arrangements are vulnerable to international capital flows and thus intermediate regimes, including a soft peg, would disappear in a world with integrated capital markets, and only viable choices are two extreme exchange rate arrangements: free float and "hard peg" like currency boards, dollarization, and currency union. Such a view is known as "Hollow Middle" (Eichengreen, 1994) or "bipolar view" (Fisher, 2001).[1]

Recent European monetary unification confirms such a view. However, experience of emerging markets is more diversified, and does not uniformly support such a view. Although changes toward the polar regimes are seemingly observed based on what each country claims, or de jure classification of the exchange rate regime (for example, see Fischer, 2001), each country's claim may be different from what it actually does. Calvo and Reinhart (2002) finds that by inferring the exchange rate policies in each country from the data of the exchange rate and policy instruments (that is, de facto arrangements), the countries that say they allow their exchange rate to float mostly do not because of "Fear of Floating".[2] A possible discrepancy between de jure and de facto exchange rate rearmaments has been well reflected in recent discussion on the post-crisis exchange rate arrangements. For example, Mussa (2000) et al and McKinnon (2000) argued that in a few years after crisis, Asian crisis countries reverted back to highly managed exchange rate arrangements (although they claimed free float), and raised concerns on repetition of crisis in the future.

This paper contributes to the literature on transition of the exchange rate arrangements and de facto exchange rate arrangements in two aspects. First, this paper develops a de facto measure of the exchange rate arrangements by using structural VAR model, which resolves a few problems of the previous methods. Second, the method is applied to the countries that recently experienced crisis to investigate how these countries change the exchange rate arrangement after crisis, to shed some lights on various issues on de facto exchange rate

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[1] See also Obstfeld and Rogoff (1995) and Krueger (2000) for such views.

[2] Levy-Yeyati and Sturzenegger (2004) also confirms "Fear of Floating" by classifying de facto exchange rate regime of each country based on the data.

arrangements and the transition of the exchange rate arrangements.

While past studies often investigate not only crisis countries but also non-crisis countries, I focus on the countries that experienced severe crisis recently. These countries are the main victims of the crisis, and they must be the ones that have been deliberating on the exchange rate regime choice and made a choice of the exchange rate regime after realistically considering the possibility of future crisis. On the other hand, other countries' choice is likely to be more superficial. They might simply keep their current exchange rate arrangements or their choice may have more consideration on other aspects (than crisis). In other words, I would like to see what these countries learned about exchange rate arrangements from the experience of severe crisis, for example, whether they moved to polar regimes that are less vulnerable in the world of integrated capital markets and whether they are reluctant to publicly announce their highly managed exchange rate arrangements. We also focus on the recent crisis episodes since various views on the exchange rate regime (such as the vulnerability of the soft peg) become popularly known in recent years. Twelve cases are considered, including five Asian crisis countries.

Following Calvo and Reinhart (2002), a number of recent studies construct de facto regime classifications (e.g., Levy-Yeyati and Sturzenegger (2004), Rogoff and Reinhart (2002), Ghosh, Gulde, Ostry, and Wolf (2003), Bubula and Otker-Robe (2003), Hernandez and Montiel (2003), and Baig (2001))). Many previous studies, including Calvo and Reinhart (2002), rely on the information on the volatility of the exchange rate (changes) and the policy instruments (changes) such as foreign exchange reserves (changes) and the interest rate (changes). If the policy authority actively stabilizes the exchange rate movements by adjusting the policy instruments, the exchange rate changes would be small while the policy instrument changes would be large. Based on this idea, past studies often classified the regime with less volatile exchange rate changes and a more volatile policy instruments changes as less flexible exchange rate arrangement.

However, such classification methods have a drawback. The policy instruments may change in the absence of the policy authority's intention to stabilize the exchange rate. For example, foreign exchange reserves may change owing to fluctuations in valuation and the accrual of interest earnings and the interest rate may change to pursue other policy objectives than stabilizing the exchange rate (i.e., accommodating money demand, stimulating output, and so on). Such changes in policy instruments (and the resulting changes in the exchange rate) are not relevant to exchange rate policy and thus they should be excluded when inferring de facto exchange rate arrangements, but past studies do not. In a sense, the 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. From another perspective, past studies used the information from both policy reaction function (the policy authority's reaction of policy instruments to the exchange rate, to stabilize the exchange rate) and the foreign exchange market equation (that shows how the policy instruments affect the exchange rate), but only the former is relevant.

Structural VAR models are naturally fitted to address the problem since structural VAR models can be used to identify different types of structural shocks and to construct the *conditional* data in the presence of only one type of structural shocks. To separate the two types of shocks, I impose sign restrictions on impulse responses by modifying Uhlig (1999)'s methodology. The two shocks imply different sign restrictions on the responses of 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 rest rate) would lead to an exchange rate appreciation. Based on the estimated impulse responses to the former shocks, I formally recover dynamic policy reaction functions, instead of using simple descriptive statistics as in past studies, in order to infer de facto exchange rate arrangements in each country

The rest of the paper is organized as follows. Section 2 explains the methodology. Section 3 analyzes exchange rate arrangements and discusses various issues on exchange rate arrangements. Section 4 discusses some extended experiments and compares the methodology in this paper with that of Calvo and Reinhart (2002). Section 5 concludes with a summary of findings.

2. The Methodology

I start from the most parsimonious model since the model is applied to a short time-span data. Since the number of parameters to be estimated in VAR models increase geometrically as the number of variables increases, a large VAR model often suffers from a low degree of freedom. The most parsimonious model includes only two variables, the exchange rate changes and changes in one policy instrument. The number of parameters to be estimated in the two variable model is relatively small, and thus the model can be well applied to a short-time span.

As emphasized by Levy-Yeyati and Sturzenegger (2004), the textbook definition of the fixed exchange rate regime is the regime in which foreign exchange reserves changes are aimed at reducing the volatility of the exchange rate while the flexible exchange rate regimes are characterized by substantial volatility in the exchange rate with relatively stable reserves. Therefore, the exchange rate and foreign exchange reserves are included in the model to infer

the exchange rate arrangements.

Although the foreign exchange reserve is the most important policy instrument to control the exchange rate, another important policy instrument, the interest rate, is also often used to control the exchange rate. Consequently, past studies such as Calvo and Reinhart (2001) also examined the interest rate changes. Therefore, I also construct the two variable model with the exchange rate and the interest rate to complement the first model. In the next section, the three variable model, which includes the exchange rate and both policy instruments, is constructed to examine the robustness of the results of the basic two variable models.

As usual in structural VAR analysis, the structural representation is identified by imposing some restrictions on the estimated reduced form. The reduced form VAR equations (for the model that includes the exchange rate and the foreign exchange reserve) are:

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

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, $\varepsilon = (\varepsilon_E \ \ \varepsilon_P)'$, and $var(\varepsilon)=\Sigma$. For simplicity of exposition, the constant term is dropped in equation (1). I use the log-difference of each variable (instead of log-level) for the following reasons. First, most past studies, for example Calvo and Reinhart (2002), Levy-Yeyati and Sturzenegger (2004), Hernandez and Montiel (2003), Baig (2001), and Reinhart and Rogoff (2003), used the percentage changes instead of level or log-level, and I would like to have the results more comparable to past studies. Second, in most countries, the hypothesis of a unit root in log of the exchange rate and log of foreign exchange reserve is not rejected at conventional significance level based on unit root tests like ADF and PP tests. Third, in the case of continuously falling and rising exchange rate like that in crawling peg regime, log-difference of the exchange rate (or the percentage changes) may be more appropriate than log-level or level.

In this model with the exchange rate and the foreign exchange reserve, the task is to separately identify two orthogonal structural shocks, 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). Popular identification methods that impose zero restrictions on the contemporaneous structural parameters (developed by Sims (1980, 1986), Bernanke (1996), and Blanchard and Watson (1996)) and that impose zero restrictions on the long run effects (developed by Blanchard and Quah (1989)) are difficult to be applied in this case. Both structural shocks are likely to affect both variables contemporaneously,

so that imposing zero restrictions on contemporaneous parameters does not seem to be feasible.[3] In addition, any long run zero restrictions do not seem to be firmly supported by theories, when separating the two types of shocks.

To separately identify the two types of structural shocks, sign restrictions are imposed on impulse responses. 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 an exchange rate depreciation. Second, a positive shock to the exchange rate (or an 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 to offset the initial depreciation. That is, shocks to foreign exchange reserves move the exchange rate and the foreign exchange reserves in the same direction while shocks to the exchange rate move two variables in opposite directions. I impose such restrictions only on the impact responses since it is more difficult to justify the signs of the lagged responses.[4] To implement such identification, I modify the method developed by Uhlig (1999).[5] See Appendix for details.

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)=Ω, and Ω is a diagonal matrix. In moving average form,

$$(3)\quad \begin{bmatrix} \Delta E_t \\ \Delta FR_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{bmatrix} \begin{bmatrix} e_{E,t} \\ e_{FR,t} \end{bmatrix}$$

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[3] In the large-scale model that is estimated over the long sample period, the two types of shocks can be separated with short-run zero restrictions by using other variables as instruments. For example, see Kim (2003) and Kim (2004).

[4] For example, a positive foreign exchange reserve shock would depreciate the exchange rate on impact. However, the foreign exchange reserve might decrease in the next period if the policy authority tries to offset the initial exchange rate depreciation.

[5] Some related studies are Faust (1998) and Canova and Nicolo (2002).

where C(L)'s are polynomials in lag operator L, and $C(L) = (B_0 - B(L)L)^{-1}$. The sign restrictions imposed on the model are $C_{11}(0) \geq 0$, $C_{12}(0) \geq 0$, $C_{21}(0) \leq 0$, and $C_{22}(0) \geq 0$. These restrictions also give some sign restrictions on contemporaneous structural parameters, which are $B_{0,11} \geq 0$, $B_{0,12} \leq 0$, $B_{0,21} \geq 0$, and $B_{0,22} \geq 0$. Such restrictions on the contemporaneous structural parameters B can be easily interpreted. We can interpret the first equation in (1) as the foreign exchange market equation and the second equation as policy reaction function. The implications for the restrictions are natural; an increase in the foreign exchange reserves depreciates the exchange rate (in the foreign exchange market) while the policy authority decreases the foreign exchange reserves in reaction to the exchange rate depreciation to stabilize the exchange rate (in the policy reaction function).

To infer the degree of stabilization, the dynamic policy reaction function is calculated that shows the reaction of the foreign exchange reserves to the exchange rate over time in the presence of shocks to the exchange rate. From equation (3), the impulse responses of the exchange rate and foreign exchange reserves to the shocks to the exchange rate are

(5) $\Delta E_t(e_E) = C_{11}(L)e_{E,t}$

(6) $\Delta FR_t(e_E) = C_{21}(L)e_{E,t}$

where $\Delta E_t(e_E)$ and $\Delta FR_t(e_E)$ are defined as the exchange rate and foreign exchange reserve changes in the presence of the shocks to exchange rate only. By combining (5) and (6),

(7) $$\Delta FR_t(e_E) = \frac{C_{21}(L)}{C_{11}(L)}\Delta E_t(e_E)$$

The coefficients on $\Delta E_t(e_E)$, $\Delta E_{t-1}(e_E)$, $\Delta E_{t-2}(e_E)$,… in (7) show how many percentages foreign exchange reserves changes over time in reaction to 1% depreciation of the exchange rate in the presence of the shocks to the exchange rate.

These measures are equivalent to the coefficients on foreign exchange policy reaction function (the second equation in (2)) in this two variable model. From the second equation in (2),

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

By reorganizing equation (8),

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

By tracing coefficients on ΔE_t, ΔE_{t-1}, ΔE_{t-2},… in (9), we can examine how many percentages foreign exchange reserves changes over time in reaction to 1% depreciation of the exchange rate. In this two variable model, we can show that the coefficients in equations (7) and (9) are the same, that is, $\frac{B_{0,21}-B_{21}(L)L}{B_{0,22}-B_{22}(L)L} = \frac{C_{21}(L)}{C_{11}(L)}$, using the relation $C(L) = (B_0 - B(L)L)^{-1}$. That is, by exploiting the impulse responses to the shocks to the exchange rate that policy reacts to, the policy reaction function can be recovered.

To infer the interest rate reactions to the exchange rate, a two variable model is constructed that includes the log of exchange rate changes and the interest rate changes. For the interest rate, the difference form is used following past studies, although mixed evidence is found on the hypothesis of a unit root in the interest rate. In this model, I impose the restriction that a positive shock to the 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). That is, in moving average form,

(10) $\begin{bmatrix}\Delta E_t \\ \Delta R_t\end{bmatrix} = \begin{bmatrix}C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L)\end{bmatrix}\begin{bmatrix}e_{E,t} \\ e_{R,t}\end{bmatrix}$

where R is the interest rate, e_E and e_R are the structural shock to the exchange rate and the structural shocks to interest rate, respectively, and the sign restrictions imposed on the model are $C_{11}(0) \geq 0$, $C_{12}(0) \leq 0$, $C_{21}(0) \geq 0$, and $C_{22}(0) \geq 0$. These restrictions also give some sign restrictions on contemporaneous parameters in the structural equation like equation (2), which are $B_{11}(0) \geq 0$, $B_{12}(0) \geq 0$, $B_{21}(0) \leq 0$, and $B_{22}(0) \geq 0$. The policy reaction functions are constructed based on impulse responses to shocks to exchange rate as in the first model.

3. Exchange Rate Arrangements

3.1. De Jure Exchange Rate Arrangements

Quite a few countries experienced severe currency crisis in recent years. These include five Asian crisis countries (Korea, Indonesia, Philippines, Malaysia, and Thailand), Mexico, Brazil, Russia, Ecuador, Bulgaria, Argentina, and Turkey. These countries mostly announced

changes in the exchange rate regime after the crisis. Table 1 reports the rough date of the currency crisis and de jure exchange rate regime that each country reports to IMF, found in IMF's *Exchange Arrangements and Exchange Restrictions*.

Eight countries (out of twelve countries under consideration) announced a free float (independently floating) within one and a half years after the onset of the crisis. Among them, five countries (Korea, Indonesia, Mexico, Brazil, Russia) changed from a managed float, Thailand changed from the fixed exchange rate regime, Turkey changed from a crawling peg and Philippines continued to be a free floater. Among these nine countries, Indonesia, Thailand, and Russia eventually announced a managed float. Three countries (out of total twelve countries) adopted the fixed exchange rate regime within one and a half years after the onset of the crisis. Malaysia changed from a managed float to a peg with capital account restrictions. Bulgaria changed from the independent float to a fixed exchange rate regime, and eventually announced a hard peg (currency board). Ecuador changed from managed float/free float to a hard peg (dollarization). Finally, Argentina changed from a hard peg (currency board) to a managed float.

Pre-crisis regimes may be described as intermediate regimes like managed float and soft peg. There are eight or nine such cases.[6] On the other hand, post-crisis regimes are more toward to polar regimes like currency board, dollarization, and free float. There are at least ten such cases, although three of them further changed from a free float to a managed float in a few years.[7] Overall, based on de jure regime classification, the bi-polar view has some supports.

3.2. De Facto Exchange Rate Arrangements

Although some supports for the bi-polar view were found based on de jure classifications, each country may act differently from what they say as suggested by Calvo and Reinhart (2002). To infer de facto exchange rate arrangements in each country, the methodology developed in Section 2 is applied in this section.

During the periods around the crisis date, abnormal behaviors of the exchange rate and the policy instruments are observed. Therefore, some months before and after the crisis dates are dropped from the estimation.[8] Also, in each country, the sample size of the pre-crisis period is adjusted to be roughly equal to the sample size of the post-crisis period, to make a better comparison between pre- and post-crisis periods. The estimation periods are summarized in

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[6] The case of Ecuador may not be clearly categorized. Ecuador announced a managed float from 1995, but announced a free float from early 1999, and then the crisis occurred in late 1999.

[7] If Malaysia (a peg with capital control) is regarded as a hard peg, there are eleven cases.

[8] In this regard, there are some claims that the effects of policy on the exchange rate are dramatically different during the crisis period. For example, Radelet and Sachs (1998), Stiglitz (1999), and Wade (1998) suggest that a high interest rate policy further depreciated the currency during currency crisis.

Table 2. Argentina is excluded since the post-crisis period is too short.

The benchmarks of free floaters are Japan and Australia. Both countries are generally regarded as free floaters. Japan might be a better example of a free floater but Japan's currencies are world's reserve currencies. In addition, Japan is hard to be regarded as a small open economy that characterizes the countries in the sample. Therefore, exchange rate stabilizing actions of Japan may not be directly comparable to that of the countries in the sample. To make a better comparison with the countries in the sample, Australia is also considered as an important benchmark, following Calvo and Reinhart (2002). Australia can be regarded as a small open economy and its currency is not usually used as international reserves, which describes the characteristics of the countries in the sample. Estimation periods are 1983.1-2003.12 for Japan and 1984.1-2003.12 for Australia, when they have been a free floater.[9][10]

Verifying a fixed exchange rate regime from actual data is relatively easy since the exchange rate is mostly fixed in the fixed exchange rate regime, but it is still interesting to have the benchmark case of tightly managed exchange rate (although not literally fixed) in order to have some idea on the size of reactions of a tightly managed exchange rate regime and to check the validity of the current methodology. Denmark is used as a benchmark. From 1979, Denmark was in the ERM, and from 1998, the Danish Krone has been pegged to Euro within an official band of +/-2.25%. The ERM period may be regarded as the case in which the exchange rate arrangement is somewhat less flexible than usual managed float (with discretion) while the latter period as the case for the fixed exchange rate arrangements within a narrow band. An ERM country is chosen since the ERM is a good example of tightly managed exchange rate arrangements, and Denmark among ERM countries is chosen since Denmark is one of very few countries that has been within the ERM without much trouble.[11] Estimation periods for Denmark are 1979:3-1998:12 and 1999:1-2003:12.

First, the two-variable models are estimated using monthly data.[12] For European countries, the exchange rate against the DM (before 1999) or Euro (from 1999) is used. For all

[9] The estimation dates are chosen based on IMF's *Exchange Arrangements and Exchange Restrictions*.
[10] The other two G-3 countries, Germany and the US, may also be regarded as good examples of free floaters. However, Germany is not used as the benchmark since now Germany adopted Euro and went through European monetary unification and German unification. On the other hand, it is less clear that the U.S. is interested in stabilizing the exchange rate against only one currency; official foreign exchange intervention data suggests that foreign exchange intervention of the US involves with transactions of German Mark (or Euro), Japanese Yen, and other currencies. In contrast, Japan has been more interested in the exchange rate against US dollars (than the exchange rate against other currencies); official foreign exchange intervention data shows that most interventions are transactions on the U.S. dollars. Therefore, Japan seems to be a better benchmark than the US and Germany. At any rate, G-3 countries, including Japan, are difficult to be regarded as small open economies, and also their currencies are used as international reserves, so the comparison with the countries in the sample may not be the most appropriate.
[11] See Eichengreen and Wyplozs (1993).
[12] In all estimations, one lag is chosen based on Schwartz Criterion. A constant term is included in all estimations.

other countries, the exchange rate against the US dollar is used. The foreign exchange reserves in terms of foreign currency are used (that is, for European countries, foreign exchange reserves in terms of DM or Euro, and for other countries, foreign exchange reserves in terms of US dollars) because the exchange rate variations would change foreign exchange reserves in terms of domestic currency without any foreign exchange policy actions.[13]

In reporting the results, two types of numbers are constructed for the model with the exchange rate and foreign exchange reserves. As discussed in Section 2, the size of the percentage changes in foreign exchange reserves in reaction to one percent depreciation is constructed based on impulse responses. In addition, the size of the changes in foreign exchange reserves as percentage of the average monetary base during the sample period in reaction to one percent depreciation is also constructed.[14] The level of foreign exchange reserves may change over time and countries. For example, Asian crisis countries accumulated a substantial amount of foreign exchange reserves after crisis and the accumulation of foreign exchange reserves was far faster than development in the general economic activities or monetary environment. In that case, one percent change in foreign exchange reserves may have smaller effects on the exchange rate in the post-crisis period than in the pre-crisis period since one percent change in foreign exchange reserves implies a far smaller change in the level of foreign exchange reserves in the post-crisis period than in the pre-crisis period, even after considering development in general economic activity level or monetary environment. To correct this problem, the responses of reserve changes are calculated as percent of the average monetary base during the sample period since the size of monetary base may be a reasonable proxy for development in monetary environment.

Table 2 reports the results. The first column shows the country name, the base foreign currency (in parenthesis, "DM" indicates German Mark or Euro), and the crisis date (below the country name), the second the estimation period, the third the 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 foreign exchange reserves as a percentage of the average monetary base, the tenth to the twelfth the reaction function of the interest rate. Note that all numbers of the reaction functions are cumulative numbers over time. There are three cases in which the numbers are not reported because the exchange rate is literally fixed and the reaction functions cannot be calculated.

First, I examine the benchmark countries. Japan's foreign exchange reserve reactions

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[13] All data is from *International Financial Statistics*.

[14] It is calculated by multiplying the original impulse responses by the ratio of the average foreign exchange reserve to the average monetary base for each sample period.

show that foreign exchange reserves decrease by 0.89% in the first month and by 0.86% up to the third and sixth months, in reaction to a 1% exchange rate depreciation. The modified reactions (as percentage of average monetary base) are about one-third, which implies that the foreign exchange reserve to monetary base ratio is about one-third during the sample period. 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 suggests a stronger exchange rate stabilization. The foreign exchange reserve reactions as a percentage of the average monetary base shows –1.88~-1.70% while the interest rate reactions show 0.19~0.29%. Japan is a larger economy the currency of which is used as international reserves, and Japan may not really need to intervene the foreign exchange market as much as Australia. On the other hand, the reaction function of Denmark shows a far stronger exchange rate stabilization. During the ERM period, foreign exchange reserve reactions are –12.22~-13.21%, foreign exchange reserve reactions as percentage of the average monetary base is –17.00~-18.37%, interest rate reactions are 1.39~2.07%. For the post-ERM period, the reactions, especially foreign exchange reserve reactions, are even stronger; foreign exchange reactions are -50.30~-70.73%, foreign exchange reserve reactions as a percentage of the average monetary base are –119.2~-168.6%, and interest rate reactions are 1.72~2.82%. Overall, the size of reactions based on the current methodology well describe the relative rankings on the degree of exchange rate stabilization among a free float, a tight exchange rate management like ERM, and a peg.

I examine the eight countries that announced a free float within a short period after the crisis. As discussed, these countries mostly announced less flexible exchange rate arrangements such as a managed float and a fixed exchange rate regime just before the crisis, and I analyze whether they indeed moved to a more flexible exchange rate regime after the crisis. Regarding the four Asian crisis countries, a dramatic fall in the size of interest rate reactions is found after the crisis. It changes from over 1% in the pre-crisis period to below 0.1% in the post crisis period in Korea, from over 3.5% to below 0.6% in Indonesia, from over 1.3% to below 0.4% in Philippines, and from over 6.9% to below 0.25% in Thailand. For Thailand and Indonesia, the foreign exchange reserve reactions (both the original percentage reaction and the reaction as a percentage of the average monetary base) also fall 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. The foreign exchange reserve reactions also fall substantially in Korea and Philippines. However, the reserve reactions as percent of average monetary base decrease only by about 1% in Philippines and do not change much in Korea. This reflects the substantial build-up of foreign exchange reserves after the crisis. The accumulation in foreign exchange reserves after the crisis was substantial in most Asian countries, which was far larger than the increase in the monetary base. For Korea, it may affect the inference on the relative size of the

foreign exchange reserve reactions in the pre and post crisis periods. That is, based on the percentage foreign exchange reserve reaction per se, a substantial decrease in the size of foreign exchange reserve reaction is found but based on the foreign exchange reserve reaction as a percent of the average monetary base, the size of reaction does not change much; the fall in the percentage foreign exchange rate reaction after the crisis is mostly due to the fast build up in the level of foreign exchange reserves (that was far lager than the changes in monetary base). In four non-Asian countries, the sizes of both interest rate reactions and foreign exchange reserve reaction fall substantially after the crisis. In Mexico and Russia, the decreases are huge; they fall to the level that is less then one-tenth of the pre-crisis level in many cases. The decreases are also substantial in Brazil and Turkey. Overall, these countries that announced a free float in the post-crisis period actually adopted a more flexible exchange rate arrangement than in the pre-crisis period. Indonesia, Thailand, Philippines, Brazil, Turkey, Mexico, and Russia decreased reactions of both foreign exchange reserves and the interest rate. In Korea, the foreign exchange reserve reaction shows somewhat mixed results but at least the size of interest rate reactions fall substantially.

Although the above result is consistent with the claim of these countries that report more flexible exchange rate arrangements in the post crisis period, one important issue is whether these countries' post-crisis exchange rate arrangements are indeed close to free float. That is, although more flexible in the post-crisis period than in the pre-crisis period, the arrangements might not be flexible enough to be called a free float. In this regard, I compare the reaction functions of these countries in the post-crisis period with those of the benchmark countries.

All eight countries' reactions in the post-crisis period are stronger than Japan, but below I compare these countries with Australia in more details since the comparison with Japan is trivial and Australia may be a better benchmark for these countries as discussed previously. Many countries achieved a similar degree of exchange rate flexibility to that of Australia. Brazil, Turkey, and Thailand (especially for the 1999-2000 period) have a similar degree of all reactions. In these countries, the size of reactions is not much stronger than those of Australia. Indonesia has about 1% weaker degree of reserve reactions (both own percentage and percentage of average monetary base terms) but a bit stronger (about 0.04-0.36%) interest rate reactions. Mexico has 0.62-0.73% stronger interest rate reactions but at least 1% weaker reserve reactions and 0.15-0.16% weaker reserve reactions as a percentage of the average monetary base. Korea has 0.12-0.19% weaker interest rate reactions and 1.09-1.56% weaker reserve reactions but 1.09-1.42% stronger reserve reactions as a percentage of the average monetary base. The Philippines has 0.62-0.68% weaker reserve reactions but 0.58-0.68% stronger reserve reactions as percent of average monetary base and 0.07-0.09% stronger interest rate reactions. In

theses countries, the reactions are not much stronger than those in Australia. Russia achieved substantial flexibility of exchange rate in the post-crisis period of 1999:10-2000.11, although the size of the interest rate reactions is quite stronger than that of Australia, and then move to a more tightly managed exchange rate regime (during the period of 2000:12-2003:12). Overall, all countries except for Russia achieved a similar or slightly lower level of exchange rate flexibility of the exchange rate, compared to Australia.

Regarding the issue of "Fear of Floating," there are not many such cases in the post-crisis period. Although the sizes of the reactions of Russia during the period 2000.12-2003.12 are clearly stronger than those of Australia, the period was reported as a managed float. The closest case of "Fear of Floating" is Russia during the period 1999.10-2000.11 in which the size of interest rate reactions is substantially higher than that of Australia. To further check the issue of "Fear of Floating," I examine the cases that are reported as independent floating in the pre-crisis period. There are two cases (Philippines and Bulgaria) in the sample. These two cases, especially Philippines, tend to show stronger reactions in general, and can be regarded as the case of "Fear of Floating." Although there are only two cases reporting independent float in the sample, it seems that "Fear of Floating" becomes less prevalent in the post-crisis period.

By comparing with Denmark, I also examine whether there are some countries that say a managed float or a free float but actually act closely to a peg.[15] The size of reactions in pre-crisis Russia, pre-crisis Mexico, pre-crisis Malaysia, and pre-crisis Indonesia (that reported discretionary managed float) is also as strong as the size of reactions of Denmark during the ERM period, suggesting that these countries managed the exchange rate very tightly. But we don't find such cases in the post crisis period. That is, in the pre-crisis period, quite a few countries that say managed float (with discretion) actually control the exchange rate as tightly as the arrangements of the ERM. Together with the previous finding that "Fear of Floating" is more prevalent in the pre-crisis period than in the post-crisis period, we may conclude that in the post crisis period, there are less cases of discrepancy between the claim and the actual behavior in exchange rate managements (or between de jure and de facto classifications).

To summarize, "Fear of Floating" is found in pre-crisis period, but not much in post-crisis period. Also, the results are consistent with the bi-polar view or "Hollow Middle;" the countries tend to move toward two bi-polar regimes. There are two countries that adopted hard peg like dollarization and currency board and one country that adopted a peg with capital account restrictions. Eight countries moved toward a more flexible exchange rate arrangements, and among them, the policy reactions of seven countries in the pre-crisis period is as weak as or

[15] Levy-Yeyati and Sturzenegger (2004) call this phenomenon as "Fear of Pegging," which might be also called as "Fear of saying Pegging" (since some countries are afraid of "saying" pegging even though they actually pegging), to be more comparable to "Fear of Floating" (some countries are afraid of freely floating even though they say freely floating).

only slightly stronger than that of Australia. Although there is one country that gave up the hard peg after crisis (Argentina) and one country that move towards to a more flexible but not enough to be compared with a true free floater (Russia), at least nine countries in the sample move closely to bi-polar regimes.

4. Extended Experiments

4.1. Three Variable Model

In this section, the three variable model is constructed that includes two policy instruments changes and the exchange rate changes, to further confirm the robustness of the main results. The reduced from VAR equations are:

$$(11)\quad \begin{bmatrix} \Delta E_t \\ \Delta FR_t \\ \Delta R_t \end{bmatrix} = \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{bmatrix} \begin{bmatrix} \Delta E_t \\ \Delta FR_t \\ \Delta R_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{E,t} \\ \varepsilon_{FR,t} \\ \varepsilon_{R,t} \end{bmatrix}.$$

where ε_R is the residual in the interest rate equation.

In this three variable model, three orthogonal structural shocks, the (structural) shocks to the exchange rate (that foreign exchange reserves and the interest rate react to stabilize the exchange rate), the (structural) shocks to foreign exchange reserves (that affects the exchange rate), and the (structural) shocks to the interest rate (that affects the exchange rate). As in the two variable model, sign restrictions on impulse responses are imposed. First, the same restrictions as those in the two variable model of the exchange rate and foreign exchange reserves are imposed. That is, a positive shock to foreign exchange reserve lead to an increase in the foreign exchange reserves and an exchange rate depreciation while a positive shock to exchange rate leads to an exchange rate depreciation and a decrease in the foreign exchange reserves. Second, the same restrictions as those in the two variable model of the exchange rate and the interest rate are imposed. That is, a positive shock to the interest rate leads to an interest rate increase and an exchange rate appreciation while a positive shock to the exchange rate leads to an exchange rate depreciation and an interest rate increase. As in the two variable models, the restrictions are imposed only on the impact responses.

The resulting structural form equations in moving average form are:

$$(12)\quad \begin{bmatrix} \Delta E_t \\ \Delta FR_t \\ \Delta R_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) & C_{13}(L) \\ C_{21}(L) & C_{22}(L) & C_{23}(L) \\ C_{31}(L) & C_{32}(L) & C_{33}(L) \end{bmatrix} \begin{bmatrix} e_{E,t} \\ e_{FR,t} \\ e_{R,t} \end{bmatrix}.$$

The sign restrictions imposed on the model are $C_{11}(0) \geq 0$, $C_{12} \geq (0)\ 0$, $C_{21}(0) \leq 0$, and $C_{22}(0) \geq 0$, $C_{13}(0) \leq 0$, and $C_{31}(0) \geq 0$.

As in the two variable models, the measures that trace the reaction of policy instruments to the exchange rate in the presence of exchange rate shocks are constructed.

$$(13)\quad \frac{C_{21}(L)}{C_{11}(L)},\ \frac{C_{31}(L)}{C_{11}(L)}$$

Table 4 reports the reaction functions in the first month ("Reaction Function"). The main conclusions remain unchanged. Australia's reactions tend to be stronger than Japan, but weaker than Denmark. All countries that claim independently floating in the post crisis period weaken the size of the reaction in the post-crisis, and except for Russia, the size of their reactions is not much stronger than that of Australia. There are more cases that de jure exchange rate arrangement classifications are different from de facto exchange rate arrangement classifications in the pre-crisis period than in the post-crisis period.

4.2. Comparison with Methodology of Calvo and Reinhart

In this section, I discuss the results based on Calvo and Reinhart (2002)'s methodology in order to examine the robustness of the main results and to compare the methodology in this paper and that of Calvo and Reinhart (2002). Calvo and Reinhart (2002) basically used two methods. First, they used the probabilities that the percentage changes in the exchange rate and foreign exchange rate reserve and the changes in the interest rate are lower (or higher) than a threshold value, for example, 2.5%. Then, a lower probability for the exchange rate (that is, more volatile exchange rate changes) and higher probabilities for the policy instruments (that is, less volatile policy instrument changes) are regarded as indicating a more flexible exchange rate arrangement. Second, they used the exchange rate flexibility index, the ratio of the variance of the percentage changes in the exchange rate to the sum of the variances of the interest rate changes and the variance of the percentage changes in foreign exchange reserves, and inferred that a larger number suggests a more flexible exchange rate arrangements since a larger number should be related to a larger variation in the exchange rate and lower variations in the policy instruments.

Table 3 reports the probability that each variable changes less than 1% and the

exchange rate flexibility index ("EFI").[16] The index reasonably explains the relative degree of exchange rate flexibility for the benchmark cases; Japan has a higher number than Australia and Australia has a higher number than Denmark. It is also found that the index number for all countries that did not adopt the fixed exchange rate regime in the post crisis period is larger in the post crisis period than that in the pre crisis period, which implies that those countries move toward more flexible exchange rate arrangements in the post crisis period, to be consistent with the previous results. The index numbers in these countries in the post crisis period are higher than Australia, except for Russia. In four cases (Korea, Indonesia, Thailand for the period of 1999-2001.6, and Turkey), the number is even higher than that of Japan. Generally speaking, this result is consistent with previous conclusion that those countries achieved the level of exchange rate flexibility comparable to the benchmark free floater, Australia. However, the index numbers seem to be too small for the benchmark cases (when they are compared to the numbers in these countries); it is hard to believe that the degree of exchange rate flexibility in the seven countries is higher than that of Australia and the degree in the four countries is even higher than that of Japan. The problem also arises for some cases in the pre-crisis period. For example, the number for Ecuador in the pre-crisis period is 0.13, which is similar to that of Australia (0.14), but it is hard to believe that the pre-crisis exchange rate arrangement of Ecuador was as flexible as that of Australia.

Next, the probability measures are examined. For benchmark cases, Australia seems to have a less flexible arrangements than Japan; while the probability that the percentage exchange rate changes are lower than 1% is similar in the two countries, the probability that the percent changes in foreign exchange reserve are lower than 1% is far lower in Australia than in Japan and the probability that the changes in the interest rate are lower than 1% is also lower in Australia than Japan, which implies policy instruments have higher volatilities in Australia than in Japan. Denmark has a lower exchange rate volatility and higher volatilities of policy instruments than Japan and Australia, as expected.

When the pre-crisis and the post-crisis periods are compared, the countries that did not announce the fixed exchange rate regime tend to have more flexible exchange rate arrangements in the post-crisis. In Korea, Indonesia (1999-2001.6), Philippines, Thailand (1999-2001.6), Mexico, and Brazil, the exchange rate volatility increases (that is, the probability for the exchange rate drops) and the policy instrument volatility decreases (that is, the probabilities for both policy instruments rise); these countries moved to a more flexible exchange rate arrangements. However, more ambiguities are found in other cases since probabilities for not only policy instruments but also the exchange rate increase (or decrease) together. For example,

[16] When different threshold values are used, the main conclusion remains unchanged.

all probabilities does not decrease in Russia, and both probabilities for the exchange rate and foreign exchange reserves decrease in Thailand when the pre-crisis period and the period of 2001.7-2003 are compared. When the post-crisis periods of these countries are compared to Australia, it is difficult to make a clear conclusion based on the three probability measures in many cases. For example, in the cases of post-crisis Korea and Malaysia, all probabilities are higher in Korea and the Philippines than those in Australia, and in the case of post crisis Indonesia (2001.7-2003), the Philippines, Thailand (1999-2001.6), and Mexico, probabilities for both foreign exchange reserves and the exchange rate are higher in these countries than those in Australia. The difficulty on the comparison arises mostly because three numbers should be compared and it is not so easy to have clear conclusions with all three numbers that have possibly different implications on the size of policy actions.[17]

To summarize, although the probability measures developed by Calvo and Reinhart (2002) provide useful information, they are often difficult to be used to make a comparison across different sample periods and countries. On the other hand, the exchange rate flexibility measures developed by Calvo and Reinhart (2002) sometimes provide the results that seem unreasonable, although it is a good summary measure that can be easily compared across different countries and sample periods. Finally, although these measures have some drawbacks, the main conclusion that is inferred from the method developed in this paper is not clearly at odds with the results based on these measures.

5. Conclusion

This paper first develops a method to identify the de facto exchange rate arrangements using structural VAR model. The method improves upon the previous methodologies in that it uses only relevant information for inferring exchange rate stabilization and in that it formally derives the policy reaction function. Some advantages of the current methodology are shown by comparing it to Calvo and Reinhart (2002)'s methodology.

By applying the method to the countries that experienced severe crisis recently, the exchange rate arrangement transition around the crisis period is examined. A large fraction of these countries tends to move to bi-polar regimes, either hard pegs such as currency board and dollarization or more flexible exchange arrangements that are close to a free float, to be consistent with the bi-polar view. In the pre-crisis period, countries often claimed their exchange rate arrangements differently from what they actually did. However, in the post-crisis period, such a tendency becomes far weaker. In particular, the countries that claim a free float tend to

[17] For example, suppose that all three numbers are 20% higher in one case than the other case. Then, it is difficult to interpret the results because 20% higher probabilities of each variable is not clearly related to policy actions and it is difficult to judge whether it implies more flexible exchange rate arrangements.

act closely to free float; the case of “Fear of Floating” is very rare in these countries that experienced severe crisis recently. Indeed, the countries seem to have learned from crisis. By moving toward polar regimes, they seem to try to lower the possibility of future crisis in the world of integrated capital markets. They may have also learned that saying is not enough since crisis visited them regardless of what they said.

Appendix.

This appendix explains details on the implementation of the sign restrictions discussed in the main text. The reduced form VAR equations can be written as $Y_t = A(L)\varepsilon_t$, where Y_t is a n×1 data vector, A(L) is an n×n matrix polynomial in lag operator L, ε_t is a serially uncorrelated n×1 vector of residuals in reduced form equation, and $var(\varepsilon)=\Sigma$. Finding the structural form amounts to finding an n×n matrix K such that $\varepsilon_t = K e_t$ where $var(e_t) = I_n$. Cholesky Factorization of Σ is one example of finding a structural form. That is, a Cholesky factor P can be used as K, where $\Sigma=PP'$ and P is a Cholesky factor. Also note that PN where N is an n×n orthonormal matrix, that is, $NN' = I_n$, can be regarded as K. As discussed in Uhlig (1999) and Uhlig and Mountford (1999), the space of K is spanned by N given P. A(L) and Σ are drawn from normal Wishart distribution. To draw N, some elements of N are drawn from standard normal distribution and use restrictions implied by $NN' = I_n$.

For the two variable model, I draw each element in the first row of N from standard normal distribution and normalized to have the norm to be 1 (which is implied by $NN' = I_n$). The second row of N is derived from the restriction $NN' = I_n$ given the drawn two elements of the first row of N. For the three variable model, I draw each element in the first row of N from standard normal distribution and normalized to have the norm to be 1. In the case of three variable model, another element in N is still needed to recover all elements of N, so I draw each element in the second row of N from standard normal distribution and normalized to have the norm to be 1. Since only one element is needed, I only use the first element of the second row, and discard other elements. The remaining five elements are drawn from the restriction $NN' = I_n$ given four drawn elements.

I generate 10000 draws and keep the draws that satisfy the sign restrictions but discard the draws that do not, and calculate the median impulse responses. For the two variable model of the exchange rate and the foreign exchange reserve, I discard the draws that both shocks move two variables in the same direction or in opposite directions, but keep the draws that one shock moves two variables in the same direction and the other shock moves two variables in opposite directions and define the former as the shocks to the foreign exchange reserves and the latter as the shocks to the exchange rate. For other models, a similar procedure is used.

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Table 1. De Jure Exchange Rate Regime Classification

Country	Crisis Date	De Jure Exchange Rate Regime Classification
Korea	1997.9.	1980.3-1997.12.15: Managed Floating 1997.12.16 - : Independently Floating
Indonesia	1997.6	1978.11-1997.8.13: Managed Floating 1997.8.14 – 2001.6.29: Independently Floating 2001.6.30-: Managed Floating
Philippines	1997.6	1988.1 - : Independently Floating
Malaysia	1997.6	1990.3.-1992.11: Fixed 1992.12-1998.9.1: Managed Floating 1998.9.2.-: Fixed
Thailand	1997.7	1970.1.-1997.7.1: Fixed 1997.7.2.-2001.6.29: Independently Floating 2001.6.30: Managed Floating
Mexico	1994.11	1982-1994.12.21: Managed Floating 1993.12.22 - : Independently Floating
Brazil	1998.12	1994.7.1.-1999.1.17: Managed Floating 1999.1.18: Independently Floating
Russia	1998.7	1995.7.6-1998.9.1: Managed Floating (band) 1998.9.2.-1999.9.29: Managed Floating 1999.9.30-2000.11.30: Independently Floating 2000.12.1-: Managed Floating
Ecuador	1999.12	1995.10.27-1999.2.11: Managed Floating (band) 1999.2.12-2000.3.12: Independently Floating 2000.3.13-: Dollarization
Bulgaria	1996.12	1991.2.8-1997.6.30: Independently Floating 1997.7.1-1998.12.31: Fixed (pegged to DM) 1999.1.1 -: Currency Board
Turkey	2001.1	1975 – 1998.6.29: Managed Floating 1998.6.30-2001.2.21: Crawling Peg 2001.2.22-: Independently Floating
Argentina	2002.1	1991.3.19-2001.11.31: Currency Board 2002.2.11-: Managed Floating

Table 2. Estimation Results (De Facto Classification): Two Variable Model

Country (vs.) Crisis Date	Estimation Period	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
Denmark (DM)	1979:3-1998:12	ERM	-13.21	-12.23	-12.22	-18.37	-17.02	-17.00	2.07	1.41	1.39
	1999:1-2003:12	F	-50.30	-70.48	-70.73	-119.2	-168.0	-168.6	1.72	2.76	2.82
Korea ($)	1992.1-1996.12	MF	-3.74	-3.17	-3.16	-3.30	-2.80	-2.79	1.68	1.12	1.06
1997.9	1999.1-2003.12	IF	-0.67	-0.91	-0.92	-2.62	-3.56	-3.62	0.07	0.09	0.10
Indonesia ($)	1992.1-1996.12	MF	-15.29	-19.14	-19.45	-19.62	-24.56	-24.96	4.06	3.71	3.70
1997.6	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 ($)	1992.1-1996.12	IF	-4.85	-4.19	-4.17	-3.57	-3.09	-3.06	2.70	1.53	1.36
1997.6	1999.1-2003.12	IF	-1.55	-1.39	-1.39	-2.55	-2.29	-2.28	0.28	0.35	0.36
Malaysia ($)	1992.12-1996.12	MF	-9.22	-18.08	-22.65	-14.29	-28.05	-35.13	1.56	1.06	1.02
1997.6	1999.1-2003.12	F	---	---	---	---	---	---	---	---	---
Thailand ($)	1992.1-1996.12	F	-4.39	-3.95	-3.93	-10.01	-9.01	-8.96	6.99	8.21	8.21
1997.7	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

IF: Independently Floating, MF: Managed Floating, F: Fixed, CP: Crawling Peg, F(D): Dollarization, F(C): Currency Board, ERM: Exchange Rate Mechanism

* The numbers show the cumulative reaction functions.

Table 2. Estimation Results (De Facto Classification): Two Variable Model

Country (vs.)	**Estimation Period**	**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
Mexico ($)	1989.1-1993.12	MF	-18.44	-7.14	-6.07	-23.66	-9.17	-7.78	4.45	3.13	2.99
1994.11	1997.1-2003.12	IF	-1.16	-0.76	-0.75	-1.71	-1.11	-1.10	0.92	0.91	0.91
Brazil ($)	1994.7-1997.12	MF	-4.05	-3.02	-2.87	-5.02	-3.74	-3.55	4.08	2.58	2.58
1998.12	2000.1-2003.12	IF	-1.76	-1.10	-1.08	-1.80	-1.12	-1.10	0.10	0.24	0.37
Russia ($)	1995.8-1997.12	MF	-43.27	-13.44	-8.96	-19.61	-6.09	-4.06	59.40	11.36	9.28
1998.7	1999.10-2000.11	IF	-2.34	-1.43	-1.21	-1.70	-1.04	-0.88	1.47	0.46	0.47
	2000.12-2003.12	MF	-6.15	-3.77	-3.62	-7.12	-4.38	-4.20	5.06	2.43	2.17
Ecuador ($)	1995.11-1998.12	MF	-2.30	-1.60	-1.44	-3.94	-2.74	-2.37	0.99	1.33	1.36
1999.12	2001.1-2003.12	F(D)	---	---	---	---	---	---	---	---	---
Bulgaria (DM)	1993.12-1995.12	IF	-3.10	-0.72	-0.57	-2.28	-0.53	-0.42	0.46	0.50	0.51
1996.12	1997.7-1998.12	F	-34.06	-52.79	-52.69	-65.54	-101.57	-101.37	1.95	3.21	3.21
	1999.1-2003.12	F(C)	---	---	---	---	---	---	---	---	---
Turkey (DM)	1993.7-1998.6	MF	-1.58	-1.25	-1.26	-2.32	-1.84	-1.85	7.60	4.85	3.40
2001.1	1999.1-2000.6	CP	-2.48	-3.27	-3.31	-4.63	-6.09	-6.17	5.92	4.23	0.35
	2002.1-2003.12	IF	-0.96	-0.65	-0.64	-1.81	-1.21	-1.20	0.22	0.36	0.37

IF: Independently Floating, MF: Managed Floating, F: Fixed, CP: Crawling Peg, F(D): Dollarization, F(C): Currency Board, ERM: Exchange Rate Mechanism

* The numbers show the cumulative reaction functions.

Table 3. Three Variable Model, Probability Measure, and Exchange Rate Flexibility Index

Country (vs.)	**Estimation Period**	**De Jure**	**Reaction Function**			**Probability (<1%)**			**EFI**
			FR	FRM	R	E	FR	R	
Japan ($)	83.1-03.12	IF	-2.0	-0.7	0.2	33.1	55.0	99.2	0.80
Australia ($)	84.1-03.12	IF	-5.0	-4.2	0.4	31.0	23.8	93.3	0.14
Denmark (DM)	79:3-98:12	ERM	-27	-37	4.4	92.4	13.5	78.5	0.00
	99:1-03:12	F	-71	-169	3.9	100.0	15.3	100.0	0.00
Korea ($)	92.1-96.12	MF	-7.5	-6.7	3.8	88.1	27.1	61.0	0.05
1997.9	99.1-03.12	IF	-1.4	-5.6	0.1	42.4	33.9	100.0	1.37
Indonesia ($)	92.1-96.12	MF	-19	-24	11	98.3	40.7	69.5	0.01
1997.6	99.1-01.6	IF	-0.7	-1.5	1.7	13.3	30.0	50.0	1.10
	01.7-03.12	MF	-0.9	-1.7	1.2	34.5	48.3	41.4	2.82
Philippines ($)	92.1-96.12	IF	-9.0	-6.6	6.5	62.7	11.9	42.4	0.03
1997.6	99.1-03.12	IF	-3.1	-5.1	0.6	57.6	27.1	88.1	0.26
Malaysia ($)	92.12-96.12	MF	-7.3	-11	0.6	72.9	27.1	100.0	0.03
1997.6	99.1-03.12	F	---	---	---	100.0	32.2	98.3	0.00
Thailand ($)	92.1-96.12	F	-10.2	-23	7.1	98.3	30.5	30.5	0.02
1997.7	99.1-01.6	IF	-1.7	-2.4	0.5	37.1	42.9	88.6	0.88
	01.7-03.12	MF	-3.6	-7.4	0.2	51.7	20.7	100.0	0.30
Mexico ($)	89.1-93.12	MF	-34	-44	10	67.8	18.6	30.5	0.00
1994.11	97.1-03.12	IF	-1.7	-1.3	1.6	50.0	33.3	52.8	0.29
Brazil ($)	94.7-97.12	MF	-7.2	-8.9	7.1	75.6	26.8	41.5	0.01
1998.12	00.1-03.12	IF	-2.9	-3.0	0.3	17.0	27.7	76.6	0.42
Russia ($)	95.8-97.12	MF	-60	-27	98	53.6	0.0	10.7	0.00
1998.7	99.10-00.11	IF	-4.6	-3.4	2.9	61.5	0.0	15.4	0.09
	00.12-03.12	MF	-12	-14	18	80.6	16.7	27.8	0.01
Ecuador ($)	95.11-98.12	MF	-5.0	-8.6	2.2	18.9	8.1	32.4	0.13
1999.12	01.1-03.12	F(D)	---	---	---	100.0	39.1	100.0	0.00
Bulgaria (DM)	93.12-95.12	IF	-3.9	-2.9	1.0	20.8	4.2	58.3	0.11
1996.12	97.7-98.12	F	-47	-89	4.2	100.0	17.6	94.1	0.00
	99.1-03.12	F(C)	-41	-80	9.7	98.3	11.9	64.4	0.00
Turkey (DM)	93.7-98.6	MF	-2.5	-3.7	18	6.8	11.9	10.2	0.02
2001.1	99.1-00.6	CP	-4.3	-8.1	10	23.5	17.6	35.3	0.02
	02.1-03.12	IF	-1.8	-3.3	0.4	17.4	26.1	47.8	0.85

FR: Foreign Exchange Reserve, FRM: Foreign Exchange Reserve as a Fraction of Average Monetary Base, R: Interest Rate, E: Exchange Rate, EFI: Exchange Rate Flexibility Index, ratio of variance of the percentage changes in the exchange rate to the sum of variance of the percentage changes in foreign exchange reserve and the variance of the interest rate changes.

IF: Independently Floating, MF: Managed Floating, F: Fixed, CP: Crawling Peg, F(D): Dollarization, F(C): Currency Board, ERM: Exchange Rate Mechanism