To Intervene or Not to Intervene

Exchange Rate Responses to Capital Flows in Selected Asian Economies

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This article stresses the role of the central bank when discussing the response of the exchange rate to net capital flows in selected East Asian countries. We argue that the priority of central banks is the inflation rate, but this priority sometimes becomes obscured by other factors, such as the sources of inflation and economic competitiveness. Low inflation may result from strong productivity in a boom or from weak demand in a recession. Similarly, high inflation may result from strong demand or from a fiscally irresponsible government. Capital inflows would be expected in the former case and outflows would be anticipated in the latter case. The extent of the intervention of central banks and the resulting responses of the exchange rate will therefore vary based on the circumstances. The detailed empirics conducted in this article for selected Asian economies broadly confirm these hypotheses.

I. Introduction

One of the main challenges faced by monetary authorities around the world is the question of how to limit the potential adverse effects of capital inflows on the real exchange rate. Insofar as the appreciation of the real exchange rate could hinder export growth, while greater exchange rate volatility may have negative effects on the tradable goods sector, the impact of capital flows must be of concern to central banks,[1] particularly in developing countries which lack adequate social safety nets. This issue has taken on much greater prominence recently owing to the dramatic boom and bust in East Asia caused by wild swings in capital flows.

Two factors that determine the evolution of the real exchange rate in response to surges in capital inflows have been emphasized in the literature (for instance, see Agénor and Hoffmaister 1998). The first is the macroeconomic policy response. If a central bank chooses not to intervene in response to capital inflows, the real exchange rate appreciates and foreign reserves do not change. By contrast, if a central bank intervenes and purchases the foreign currency brought in by the capital inflows, the real exchange rate does not move, but the increases in the capital account are matched by a rise in official reserves.

The second factor that determines the impact of capital flows on the real exchange rate relates to

the composition of these flows. For instance, Calvo et al. (1994) found that the real exchange rate appreciated in Latin American countries during the capital inflow period, but no change in the real exchange rate occurred in Asian countries. They hypothesized that one reason for this contrasting result was that a large proportion of capital inflows to Latin America took the form of portfolio investment (FPI), whereas foreign direct investment (FDI) dominated inflows in Asian countries.[2] Since FPI is associated mostly with an increase in consumption rather than an increase in investment (as with FDI), the consumption demand for tradable goods pushes up the real exchange rate. (The investment demand will probably induce more imports in the beginning and slow down the real exchange rate, while the rise in exports afterwards will, to some extent, offset the initial impact of FDI on the real exchange rate.)

While the preceding two factors that determine exchange rate responses are certainly important, insufficient attention has been given to the fact that the foreign currency markets in developing countries are thin and imperfect (Bird and Rajan forthcoming).[3] Hence, while market forces are important in the long run, central banks in developing countries are able to deter and/or postpone the general tendency of exchange rate movements at least in the short run. The immediate response of the exchange rate to capital inflows in fact depends on the willingness of central banks to intervene.[4] Therefore, it is important to investigate the circumstances under which central banks intervene. Do factors such as the composition of capital flows systematically influence the behaviour of central banks?

To our surprise, scant attention has been paid to this issue in the academic literature. In one of the few papers that tackled the subject directly, Koenig (1996) attributed the observed fact — that sizeable net capital inflows did not lead to a significant real appreciation in the Asian countries whereas they did in Latin America — to the differing concerns about inflation by central banks in the two regions. During the capital inflow boom period, monetary authorities in Latin America used nominal currency appreciation actively in an effort to bring down double-digit inflation rate. In sharp contrast, monetary authorities in Asian countries, which enjoyed low and stable inflation rates, were more concerned about economic competitiveness, thus keeping their respective nominal exchange rates stable. Koenig's hypothesis, while certainly insightful, was devoid of any statistical support. Accordingly, the purpose of this article is to undertake a detailed empirical investigation into the systematic behaviour of a central bank's intervention, including its response to the composition of capital flows.

The remainder of this article is organized as follows. The next section briefly discusses the hypothesis to be tested. The inflation threshold model to be used in the empirical analysis is the focus of Section III. Sources of data are described in Section IV. The empirical analysis is undertaken in Section V. The final section concludes the paper with a brief summary.

II. Hypotheses Testing

The decision to intervene can be traced back to conventional wisdom regarding growth and macroeconomic stability. Bernanke and Mishkin (1992) have argued that the preferences of central banks in six industrialized countries were "hierarchical" since they focused on economic growth/competitiveness only when the inflation rate was not "problematic" (i.e. above some threshold). This hierarchical behavior may also be called "lexicographic ordering", meaning that central banks have a priority ordering of economic goals.[5] Only if stability (proxied by the inflation rate) is not viewed as problematic by the monetary authorities are they willing to focus on the competitiveness/growth goal. In other words, when the two goals are in conflict, the central bank focuses on the inflation rate before competitiveness. For example, if the inflation rate is in danger, central banks concentrate on the inflation rate target even at the risk of forsaking competitiveness. Only if the inflation rate is within

the tolerance range is the competitiveness goal given priority. Shen and Hakes (1995) have demonstrated this hierarchical behaviour using Taiwanese data, where the hierarchy was dubbed "growth within stability". We borrow this concept in accounting for the central banks' preferences of intervention in the analysis that follows.

While this inflation versus competitiveness hierarchical argument is relatively straightforward, it is an incomplete story as far as central bank intervention is concerned. For instance, the sources of the low inflation rate may be due to either high productivity or weak demand. The response of a central bank to a given inflation rate will vary, to some extent, on its knowledge about the sources of inflation. Accordingly, the impact on the exchange rate to capital inflows will vary. We therefore extend upon the above simple argument by explicitly taking the sources of inflation into account. This extension yields the following four hypotheses/cases.

1. Four Possible Cases

First, when the inflation rate is high and when this high inflation is caused by high government deficit or external debt, capital outflows arise. The high inflation, together with the capital outflows, puts downward pressure on the value of the local currency, which creates two effects on the economy: a further rise in the inflation rate and a possible increase in exports. Because the stability goal takes precedence over that of competitiveness, the central bank tends to intervene to apply the brakes on currency depreciation. This keeps a lid on inflationary pressures but at the cost of an export slowdown. The responses of the exchange rate to capital outflows become less significant.

Second, when high inflation is the result of an economic boom, such as strong demand from abroad, capital typically flows into the country and raises the value of the local currency. While exports may be hurt during the appreciation, the central bank does not intervene. The appreciation of the exchange rate prevents higher inflation. Inflation stability is again the priority over competitiveness.

Third, if the low inflation rate results from strong productivity, capital inflows occur and increase the money supply as well as the value of local currency. The flush of domestic liquidity puts an upward pressure on inflation but the strong local currency slows it down. The low inflation together with the strong productivity implies the economy is experiencing a boom. Some tradable sectors may, however, gradually lose competitiveness due to the currency appreciation. Since inflation is low at the moment, the monetary authority is willing to focus on the competitiveness goal, thus holding back the appreciation. This intervention increases the money supply further, which may lead to the economy "overheating". Thus, an ambivalent attitude towards appreciation probably makes the intervention incomplete. Competitiveness and inflation become equally important at this time. The response of the exchange rate to capital inflow is still negative, but to a lesser extent.

Fourth, when the low inflation rate is due to sluggish demand or simply a recession (we use the term loosely), capital outflows become commonplace. The depreciation of the exchange rate, if it stimulates exports, will push the economic cycle to a "normal stage". The central bank tends not to intervene since the inflation rate is far from reaching crisis levels. Thus, competitiveness appears to be the first goal to pursue, but that is only because macroeconomic stability is not threatened. In addition, the mild inflation, which is within the tolerance of the central bank, may further stimulate the economy. The response of the exchange rate to capital inflows (declining in the case of outflows) becomes negative.

There are two non-intervention and two intervention cases in the above arguments. For the former case, net capital inflows have negative effects on the exchange rate, i.e. when capital inflows increase, the exchange rate appreciates. Alternatively, when net capital inflows decline, the exchange rate depreciates. The first intervention case focuses on preventing a devaluation to ensure

macro stability; the second one focuses on preventing nominal appreciation to foster growth.

2. *Relation to Literature*

The preceding hypothesis matches the observed scenario noted by Koenig (1996) and Calvo et al. (1993). For the former case, because Latin American countries suffered high inflation rates, their central banks chose not to intervene, and the resulting appreciation mitigated the threat of inflation. In other words, they targeted the inflation rate first and tentatively put aside the goal of pursuing competitiveness during the high inflation period. In contrast, Asian central banks selected the opposite strategy since their inflation rate was low. They intervened to enhance their economic competitiveness.[6]

The hypothesis can also account for differing exchange rate responses to the composition of capital flows (Calvo et al. 1993). As the central bank typically sees FPI as "hot money" in contrast to FDI (Claessens et al. 1995), the attitude of central banks to the composition of capital flow varies. The feeling towards FPI is ambivalent since it may be beneficial and detrimental simultaneously (see Wang and Shen 1999 for a detailed discussion). It is beneficial since it increases the liquidity of the stock market and further stimulates the aggregate demand; it is detrimental since it is unstable with the characteristic of sudden stops or sharp reversals (Calvo and Reinhart 1999; Rodrik and Velasco 1999). A central bank thus tends to allow the exchange rate to appreciate, which makes FPI inflows costlier than before so that the inflows slow down. Alternatively, if the capital inflows are in the form of FDI, which is deemed to be "bolted down" and hence stable, a central bank may intervene to fix the exchange rate, which becomes an implicit guarantee for FDI.[7]

We examine our hypothesis for seven Asian economies based on a threshold regression model with inflation rate as the threshold. Country data for seven Asian economies (Indonesia, Japan, Korea, Malaysia, Philippines, Taiwan, and Thailand) are used in the analysis. Except for the Japanese yen, which is "internationalized" and can hardly be influenced by central banks, the remaining six countries' exchange rate policies are basically classified as managed floats (Eichengreen and Bayoumi 1999). We focus on Asian countries for two reasons. First, while there are a few studies focusing on the influences on the real exchange rate of capital inflow in Latin American countries, none have focused on Asian countries.[8] Second, while the causes and consequences of the East Asian crisis has been the subject of much debate, it remains a puzzle in the literature, particularly the question of how the crisis was triggered.

According to our hierarchical hypothesis, capital flows should only have an impact on the real exchange rate when the actual inflation rate is above the inflation threshold. This inflation threshold is unknown *ex ante* but can be estimated. Our threshold regression model draws on Shen and Hakes (1995), which used Tsay's (1989) arranged autoregression method to detect the threshold value and number of thresholds.[9]

III. Capital Inflow Threshold Models

Our hypothesis can be summarized as follows. If S_t denotes the real exchange rate based on direct quotation (amount of the local currency per U.S. dollar) and FA_t denotes the net capital inflow, which will be proxied by financial net inflow, FDI, FPI, and FOI, respectively; the four expected results are:

(a) *Low Inflation*
Case L1: $\partial s/\partial FA \leq 0$ when low inflation is induced by high productivity.
Case L2: $\partial s/\partial FA < 0$ when low inflation is induced by weak demand or a recession.

(b) *High Inflation*
Case H1: $\partial s/\partial FA = 0$ when high inflation is induced by high government deficit or high debt.
Case H2: $\partial s/\partial FA < 0$ when high inflation is induced by strong demand, such as strong exports.

As can be seen, the above four hypotheses are divided by two dimensions: the inflation rate and its sources. However, in view of the acute

difficulties in identifying the sources of inflation and finding suitable proxies, on the one hand, and the fact that sample ranges for Asian countries are typically short, on the other, the actual exact testing of all the possibilities is difficult, to say the least. Furthermore, separating the alternatives by one dimension (the inflation rate) loses the degrees of freedom substantially and separating them by two dimensions (the source of inflation) loses even more.

In view of this, we take only the first dimension, *viz.* the inflation rate, into account when using the following econometric specification. For the next dimension, *viz.* the source of inflation, we employ a descriptive analysis. By adopting annual data, the descriptive analysis is based on the relative size of four variables: government balance/GDP (GB/GDP), banks' credit to the private sector/GDP (Credit/GDP), trade balance/GDP (TB/GDP) and real GDP growth (GDP) to evaluate the sources. While the use of these macroeconomic variables does not mean that the exact source of inflation can be inferred, it does help us verify more successfully the response of central banks' under different considerations.

Accordingly, the threshold regression is based solely on the inflation regime.

$$s_t = \beta_0^{(1)} + \beta_1^{(1)} FA_t + \beta_2^{(1)} \Delta X_t + \beta_3^{(1)} DAsian + \varepsilon_{1t} \quad (1)$$

if $p_t < p_c$

$$s_t = \beta_0^{(2)} + \beta_1^{(2)} FA_t + \beta_2^{(2)} \Delta X_t + \beta_3^{(2)} DAsian + \varepsilon_{2t} \quad (2)$$

if $p_t \geq p_c$

where: p_t is the inflation rate of the local country; p_c is the unknown inflation threshold; X_t are the control variables, including income, M2, long-term interest rate, stock price, and the current account balance; ΔX_t denotes the difference of X between the local country and the US; and *DAsian* is the Asian crisis dummy variable, which is equal to one during the crisis but zero otherwise. This dummy is set differently across each country owing to the time the country is involved in the crisis. Though the choice of the dummy may be *ad hoc*, however, the results are robust irrespective of the different dummy period chosen. (See Table 1 for the details of the dummy.) Parameters $\beta_i^{(j)} (i = 1, 2, 3 \text{ and } j = 1, 2)$ are unknown coefficients; and ε_{jt}, $(j = 1, 2)$ are white noise errors.

The model is separated into two regimes based on the inflation rate. If the inflation rate is below the threshold, it is referred to as the low inflation regime; otherwise, it is the high inflation regime. Coefficients $\beta_1^{(j)}$, $i = 1, 2$, are different across the two regimes and are central to our hypothesis.

Based on the hypothesis of stability before competitiveness, the responses of the real exchange rate to capital flows are determined by $\beta_1^{(j)}$s, which then depend not only on the inflation regime but also the sources of inflation.

1. Estimation Procedure

The estimation procedure uses Tsay's (1989) arranged autoregression which we refer to as the "arranged rolling regression". It has the same concept of the standard rolling regression with a fixed window length but the data is re-ordered using inflation rate as the pivot. That is, inflation is rearranged in an ascending order and all other variables are moved when the inflation rate is re-ordered. We then estimate equation (1) with a fixed sample size and move this fixed sample size one step forward and re-estimate equation (1). Repeating the above procedure creates a sequence of β_1 against the inflation rate. Since the inflation rate is in an ascending order, β_1 is the response of the exchange rate to net capital flows at the different inflation horizon. When the response displays a turning point, the corresponding inflation rate is the threshold. The non-linear test in step two is based on the F-test.

Let $\hat{e}_t$ be the standardized predictive residuals after the above rolling regression, then conduct the regression of $\hat{e}$ on the explanatory variables of (1), yielding residuals $\hat{\mu}_t$. The F-test is

$$F = \frac{\left(\sum \hat{e}^{(2)} - \sum \hat{\mu}^{(2)}\right)/df}{\sum \hat{\mu}^{(2)}/df}$$

where df stands for degrees of freedom. In the

TABLE 1
Data Description

Country	*Sample Period*	*Asian Currency Dummy*	*Initial Sample Size When Period Estimating*
Indonesia	1993:Q1–1999:Q1	1997:Q4–1998:Q4	20
Japan	1980:Q1–1999:Q2	1997:Q4–1998:Q4	20
Korea	1980:Q1–1999:Q1	1997:Q4–1998:Q4	20
Malaysia	1974:A–1998:A	1997:A–1998:A	15
Philippines	1977:Q1–1999:Q1	1997:Q4–1998:Q4	20
Taiwan	1980:Q1–1999:Q3	1997:Q4–1998:Q2	20
Thailand	1993:Q1–1999:Q1	1997:Q4–1998:Q4	15

NOTES: Sample frequency: Q and A denote quarterly and annual data, respectively.
Initial sample size means the sample size in the arranged regression estimation.

numerator, *df* is the number of estimated parameters plus one, and in the denominator, it is the number of predicted residuals generated.

IV. Data Sources

A complete set of exogenous variables in our specification includes income, M2, long-term interest rate, stock price and the current account. In the actual estimation procedure, we use the differences to these variables between the domestic country and the United States. While we would like our specification to be consistent for all seven countries, this is difficult owing to the differences in the availability of data in each country. The separation of the sample into high and low inflation regimes further reduces each sample size. Thus, the exogenous variables used in each country are eliminated based on their significance. Detailed variables employed in each country are available in the estimation tables (Table 4 to Table 10) and are therefore not discussed here.

Except for Taiwan, all the country data used in the article are from the IMF's *International Financial Statistics*. Taiwanese data are from a data tape of ARIMOS of the Ministry of Education. Based on data availability, two data frequencies are used: quarterly data for Korea, Indonesia, Philippines, Taiwan, Thailand, and Japan; annual data for Malaysia. The sample size for each country also varies based on data availability. The sample sizes for Korea, Taiwan, and Japan are from 1980:Q1 to 1999:Q1 with minor variations. The Philippines data uniquely span from 1977:Q1 to 1999:Q1. The sample sizes for Thailand and Indonesia are both from 1993:Q1 to 1999:Q1 only (owing to the unavailability of GDP data). Table 1 provides a detailed sample range of data.

V. Empirical Results

1. Nonlinear Testing

The non-linear F tests for Korea, Indonesia, Japan, Malaysia, Philippines, Taiwan, and Thailand, respectively are: $F(7,51) = 22.06$ ($p = 0{:}000$), $F(4,12) = 16{:}21$ ($p = 0.000$), $F(5,51) = 87.33$ ($p = 0.000$), $F(4,11) = 72.06$ ($p = 0.000$), $F(7,50) = 140.28$ ($p = 0.000$), $F(7,52) = 14.19$ ($p = 0.000$), $F(7,12) = 17.33$ ($p = 0.000$). We observe that the linearity of the models for each country is rejected.

2. Arranged Rolling Regression

Our arranged rolling regressions are plotted in Figures 1 to 7 for each of the seven countries. In each figure, the left hand has four sub-panels which plots the raw data of the real exchange rate and financial flow and its three compositions, FDI, FPI

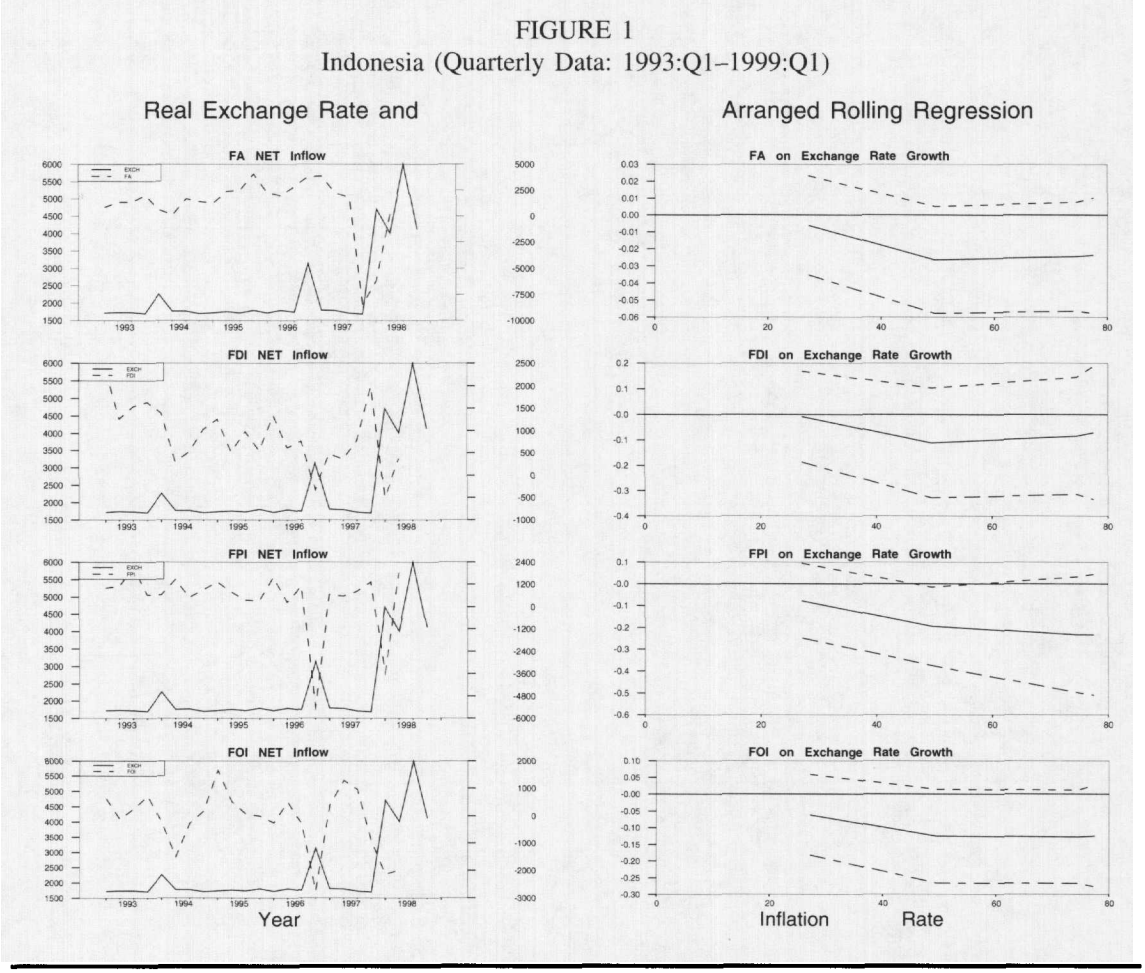
and FOI. Each figure in the right-hand side plots the arranged rolling β_1s, 90 per cent confidence intervals, under different proxies for financial capital flow. It is also worth noting that graphs are the scatterplots with β_1 against the inflation rate. The number of samples in the scatterplot is typically not equally spaced in the horizontal axis. For example, there may be $15\beta_1$s falling into the inflation range 1 to 5 per cent, but only $1\beta_1$ in the inflation range between 30 and 40 per cent. The scatterplots do not reflect this, however. Hence, the plots should be carefully read.

The arranged rolling regressions for each country are summarized below.

Indonesia. The country does not provide quarterly data until 1993:Q1 and missing data are common in the case of capital flows, hence restricting the sample size.[10] Because of the small degrees of freedom, the use of rolling regression is only for reference and may yield big variances due to the small degrees of freedom. Figure 1 shows that the rolling regression displays a downward pattern but the pattern is not significant. Our inflation threshold is not based on the turning point introduced in the previous section owing to the small sample size. Instead, the threshold is simply chosen to be the 75th percentile of the inflation rate. It is 9.7 per cent.

Japan. In Figure 2, the turning point of β_1 appears at 2.7 per cent for all the capital flow measures. The negative response patterns appear in the cases of FDI and FPI, but not in the case of FOI.

FIGURE 1
Indonesia (Quarterly Data: 1993:Q1–1999:Q1)



Korea. In Figure 3, regardless of the financial capital flow measures, the rolling regression of β_1 shows that the turning point is around 7.0 per cent. Below it, the real exchange rate appreciates in response to the capital inflow; above it, the response of real the exchange rate appears to be insignificant.

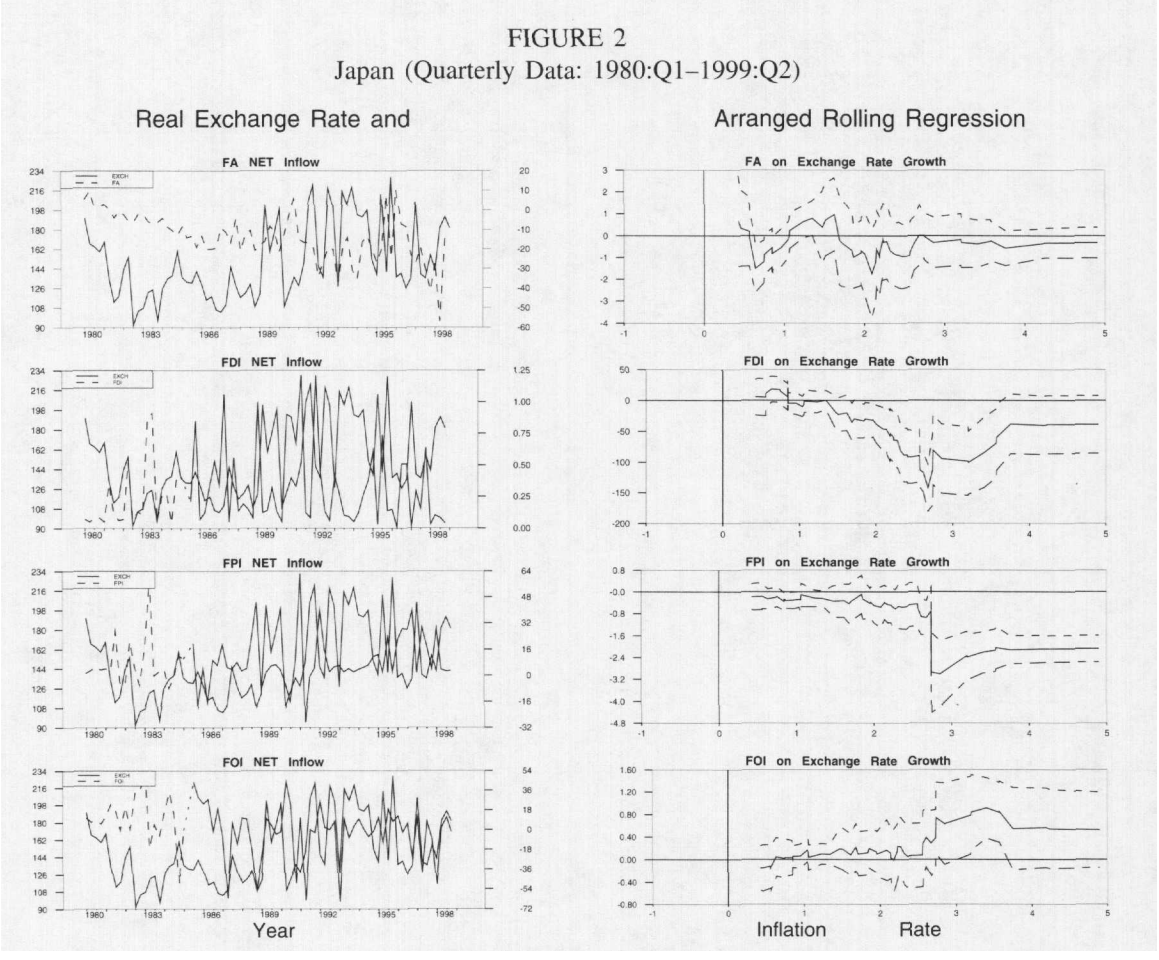
Malaysia. In Figure 4, because only annual data of capital flows are available, the sample size is severely restricted. The inflation threshold cannot be identified by the arranged rolling regression and is managed under the same strategy as that of Indonesia by choosing the 75th percentile of inflation rate, which is 4.9 per cent.

Philippines. In Figure 5, the β_1s fluctuates around an inflation rate between 9.8 and 21.0 per cent. The final threshold is chosen for the lower bound (9.8 per cent) owing to the fact that it offers a larger sample size. The impact appears to show a downward pattern when the inflation rate increases.

Taiwan. In Figure 6, the β_1s fluctuates around an inflation rate of 3.5 and 4.2 per cent. The final threshold is chosen to be 3.9 per cent.

Thailand. In Figure 7, the turning point is chosen to be 6.2 per cent. The responses of real exchange rates to FDI and FPI show no clear pattern, but those to FOI tend to be downward trended.

FIGURE 2
Japan (Quarterly Data: 1980:Q1–1999:Q2)



3. *Economic Background for the Inflation Regimes*

Having measured the inflation threshold of each country, the next step is to determine the four macroeconomic conditions which are employed to identify the inflation sources, in the low and high inflation regimes. This is done in Tables 2 and 3, where only means/averages are reported. The raw data offer several interesting results which we highlight below before proceeding to the individual country analysis.

One, Japan has the lowest GDP growth rates in the low inflation regime, while Philippines has the lowest GDP growth rate in the high inflation regime. Two, Japan is the only country whose GDP growth rate is higher in the high inflation regime than in the low inflation regime. Three, trade balances, relative to GDP, are typically small. Fourth, except for Malaysia, Asian countries have been fairly fiscally conservative. Fifth, credit to GDP ratios are broadly similar across the two regimes for most of the countries. However, the variations across countries are large.

As noted, determination of the sources of inflation is not an easy task. Some countries exhibit strong tendencies to belong to one particular condition (for instance, H1 or H2), but most countries contain mixed features of two or more conditions (for instance, in between H1 and H2). Our descriptive analysis is based on the following rules.

FIGURE 3
Korea (Quarterly Data: 1980:Q1–1999:Q1)

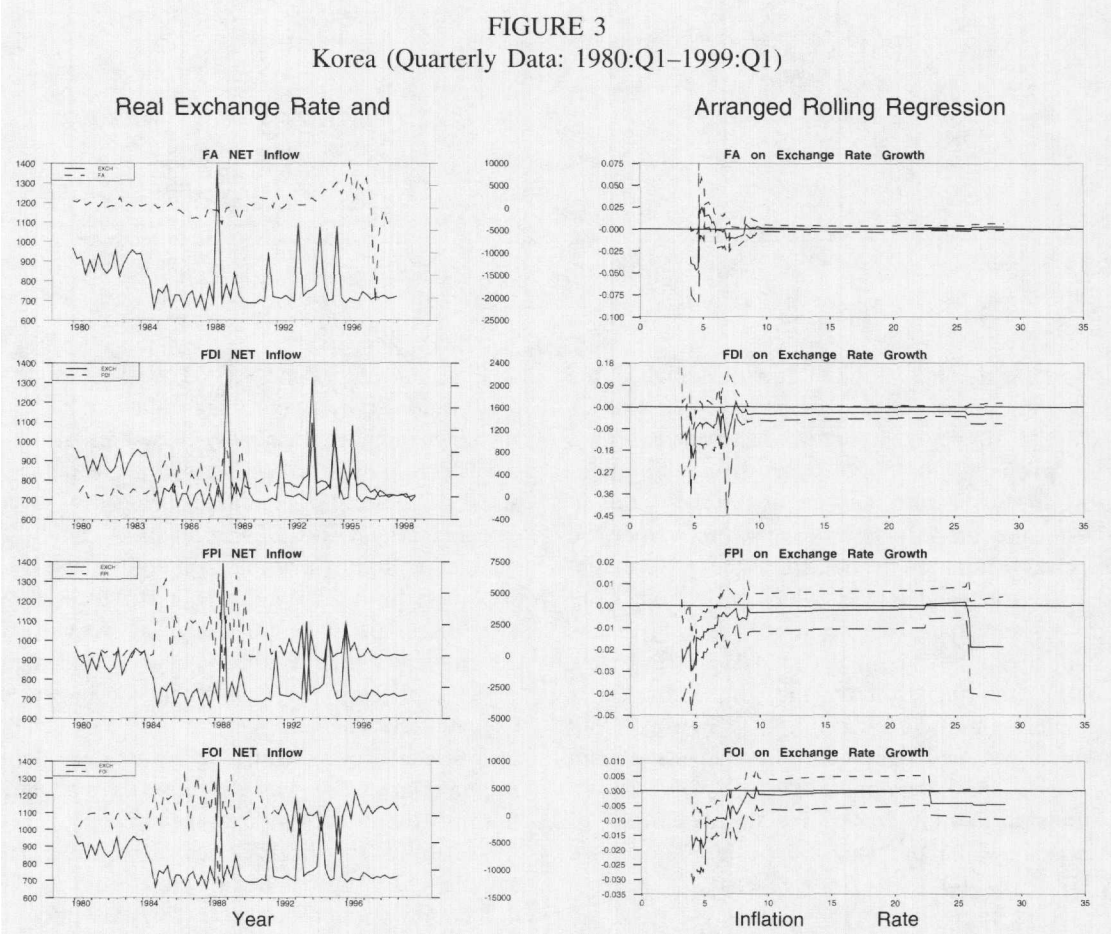
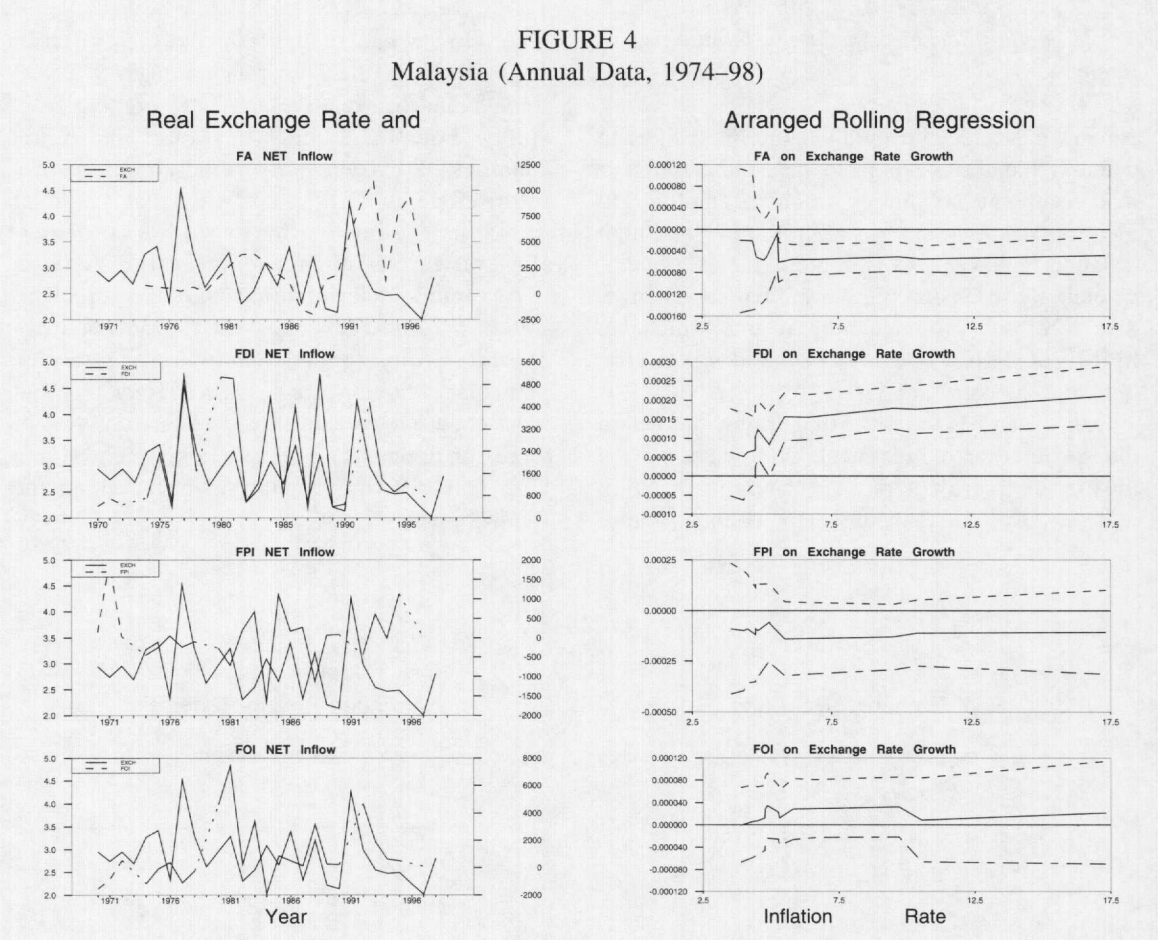


FIGURE 4
Malaysia (Annual Data, 1974–98)

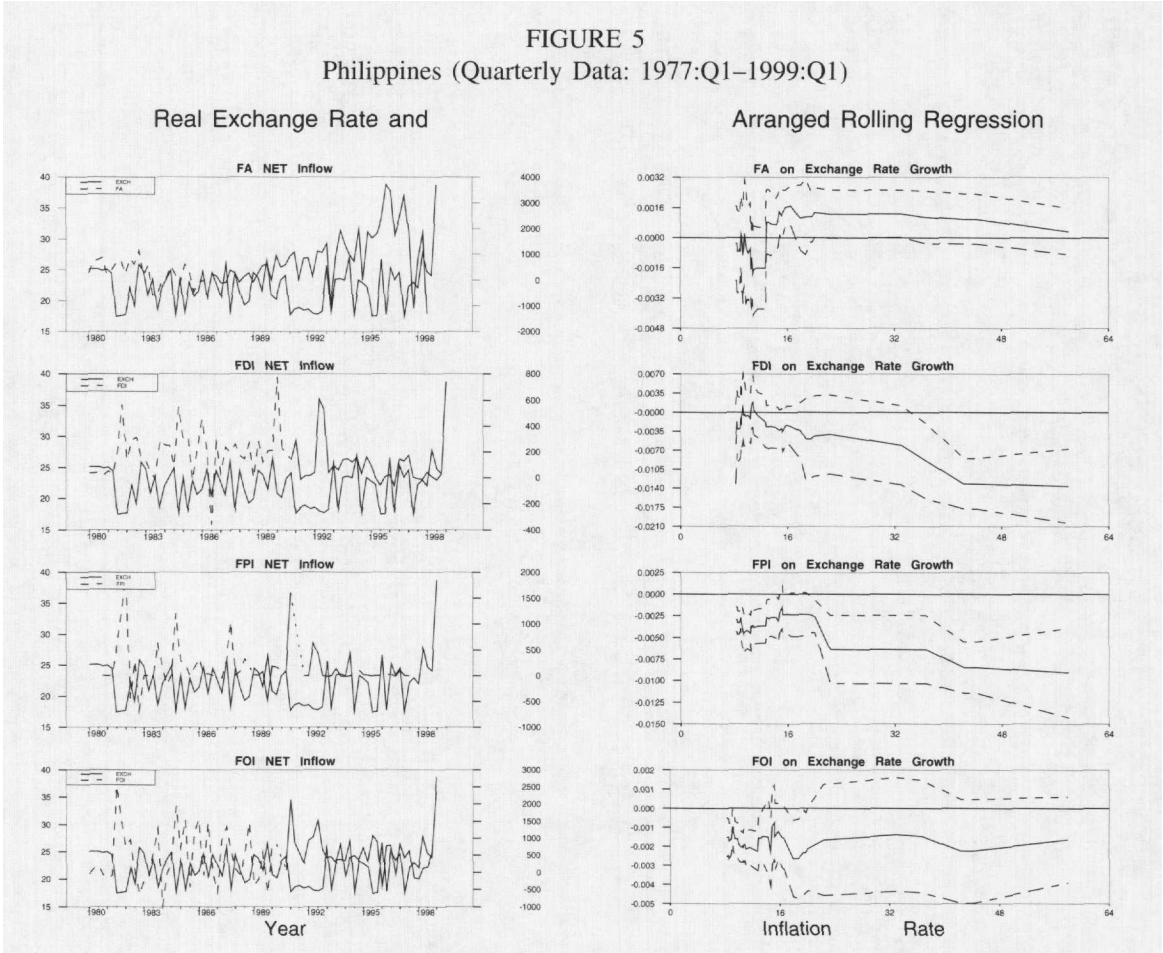


First, if a country's GDP growth is high in the low inflation regime, it is probably in the L1 category. However, before we decide its category, we proceed to check the trade balance, government balance, and credit to GDP ratios to make sure the strong GDP growth is from the private sector and is not from the government deficit. Korea and Taiwan, which have strong GDP growth and trade balance, clearly belong to this group. Second, if a country's GDP growth is low in the low inflation regime, the economy is probably in the L2 category. The weak GDP growth rates of Japan and Philippines make them belong to the L2 group.

It is difficult to determine the categories of Malaysia, Thailand and Indonesia. Indonesia's GDP growth rate is 6.1 per cent in the low inflation regime which is slightly below the median, and it has the second weakest credit to GDP ratio. Both attributes are unfavourable to be included in the L1 category. However, its trade balance is positive and its government deficit is small, suggesting it should be included in the L1 category. Malaysia's GDP growth, in contrast, is the median in this low inflation regime and it has strong credit to GDP ratio, both of which are the attributes of L1 category. However, its government deficit is the highest in this region (−4.102 per cent), which is not the attribute of the L1 category. Thailand has the third fastest GDP growth and strong credit ratio but its trade deficit is high. Thus, we suggest that these three countries fall in-between the two extremes.

Third, in the high inflation regime, if a country's GDP growth and its credit ratio are low, the country is probably in the H1 category.

FIGURE 5
Philippines (Quarterly Data: 1977:Q1–1999:Q1)



Indonesia and the Philippines belong to this category since both their GDP growth rates and credit ratios are the two lowest in this regime.

Alternatively, if a country has strong economic growth in this regime, together with a strong credit ratio and trade balance, it is in the H2 category. Japan's strong GDP growth relative to its low growth in the low inflation regime, together with strong trade balance and credit ratio, suggest it belongs to this category. Taiwan, which has the highest GDP growth in the high inflation regime, also belongs to this group.

It is difficult to classify Korea, Malaysia, and Thailand. Korea has the second highest GDP growth in this regime which is an attribute of H2. However, its government deficit is the third largest, and is higher than its low inflation regime counterpart. These, together with its low credit ratio, make it difficult to decide its category. Malaysia (medium GDP growth with high government deficit) and Thailand (lower GDP growth with medium deficits) also fall in-between the H1 and H2 categories.

4. *Regression Results in Two Regimes*

Employing the inflation thresholds obtained in the last subsection, we estimate the responses of the real exchange rate to the net capital inflows in the two regimes. Also, the whole sample is used as a benchmark.

Indonesia. Since the country belongs somewhere in-between L1 and L2, as well as in the H1 categories, the responses would be both negative but insignificant in the low inflation regime.

FIGURE 6
Taiwan (Quarterly Data: 1980:Q1–1999:Q3)

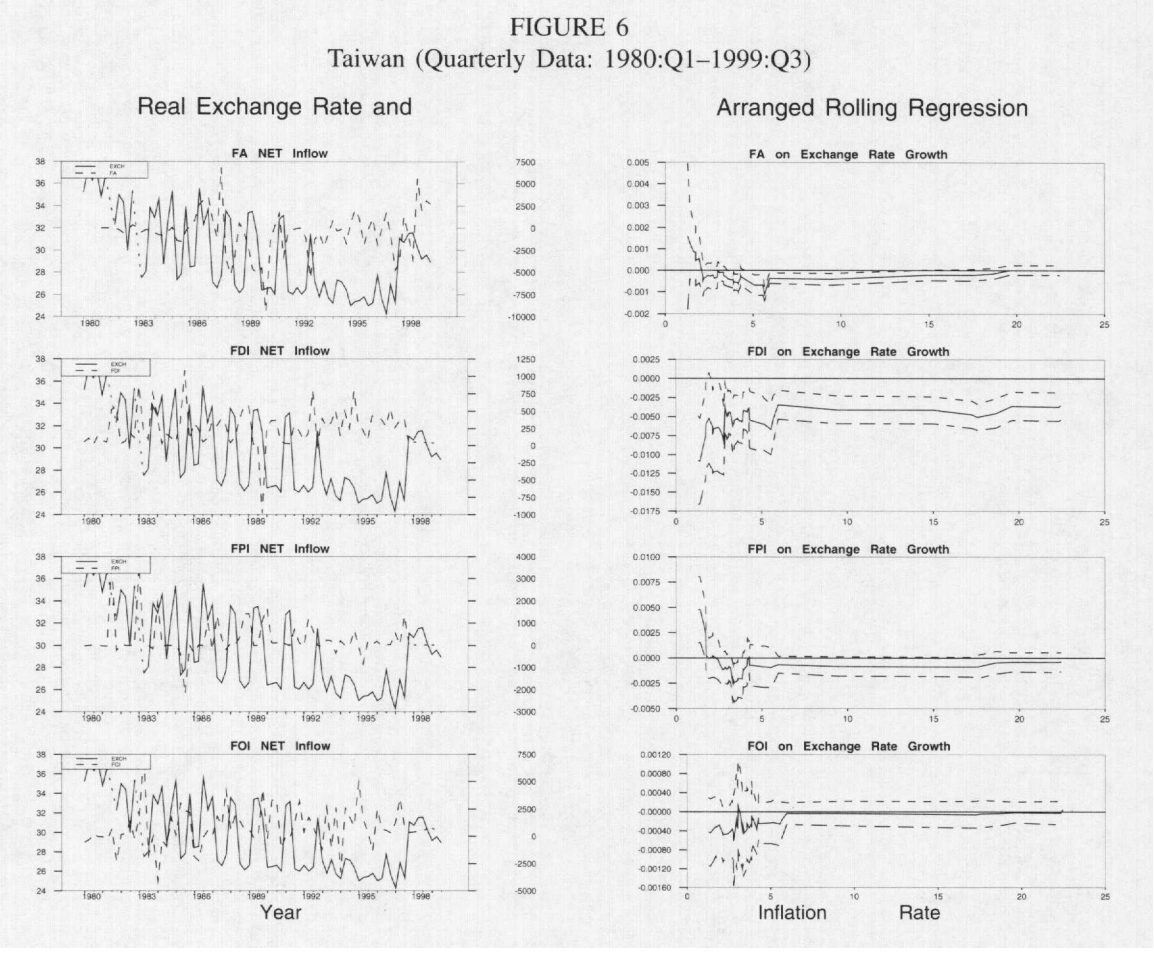


Table 4 reports the estimation results. However, because of few degrees of freedom left in the high inflation regime, the estimation in this regime is skipped. All β_1s are insignificant in the low inflation regime at the conventional level, regardless of the composition of capital flow used. The main reason is that the country intervened continuously (Eichengreen and Bayoumi 1999) which kept the exchange rates intact and the responses insignificant.

Japan. The country's features are L2 and H2 and the responses are expected to be negative in both the regimes, which is also consistent with the fact that intervention makes little use of an internationalized currency. Table 5 demonstrates that FDI and FPI have significantly negative impacts on the real exchange rate irrespective of the regime. The responses to FOI are, however, insignificant in both regimes. The results therefore partially support our conjecture.

Korea. The country is in the category L1 and also falls in-between H1 and H2, both of which are expected to have non-positive effects. However, Table 6 appears to be consistent with our prior expectations. All responses are significantly negative in the low inflation regime but have no impact in the high inflation regime. The negative impact in the low inflation regime is probably because, as we analysed in the previous section, the Korean monetary authority treated competitiveness and inflation as equally important, so the intervention became incomplete.

FIGURE 7
Thailand (Quarterly Data: 1993:Q1–1999:Q1)

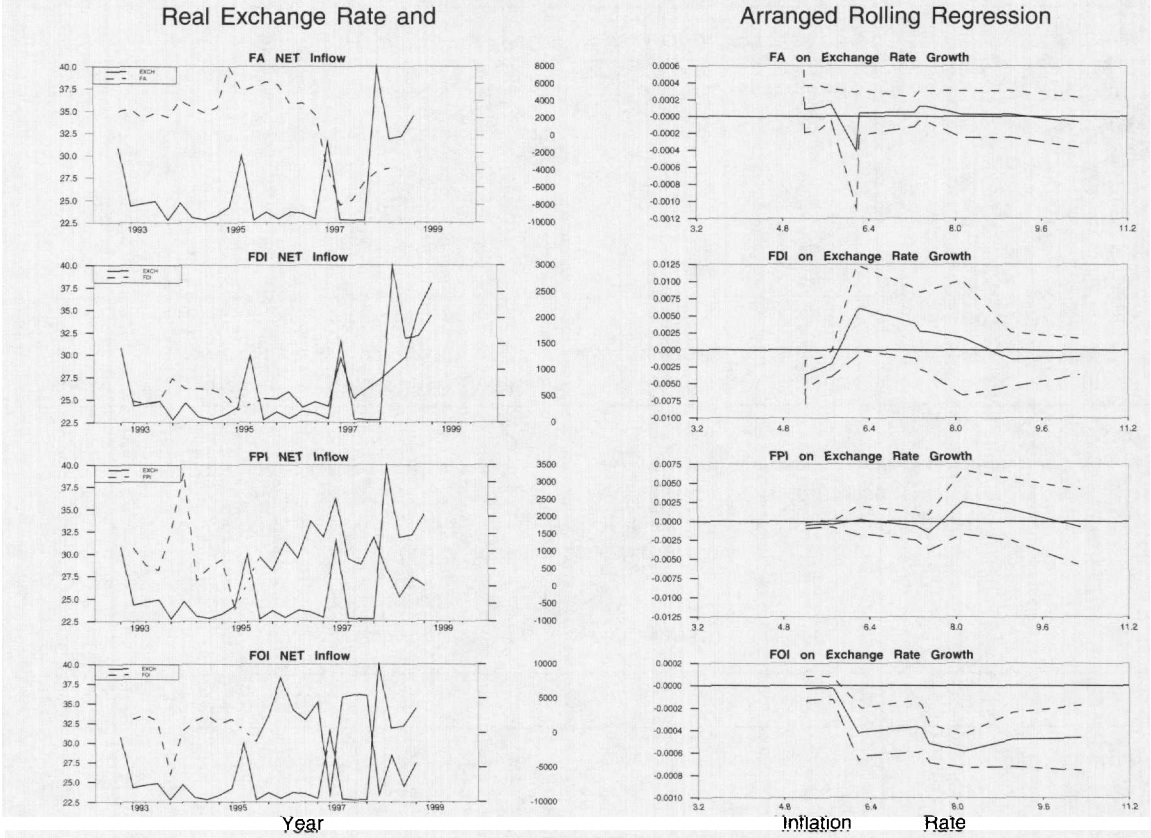


TABLE 2
Basic Macroeconomic Environment (I)

	Inflation	*Low Inflation Regime*				*High Inflation Regime*			
	$\dot{p}_c$	$\frac{TB}{GDP}$	$\dot{GDP}$	$\frac{GB}{GDP}$	$\frac{Credit}{GDP}$	$\frac{TB}{GDP}$	$\dot{GDP}$	$\frac{GB}{GDP}$	$\frac{Credit}{GDP}$
Indonesia	10.28	0.003	6.078	−0.384	36.934	0.005	3.178	−1.611	16.941
Japan	2.36	0.021	2.545	−3.877	109.758	0.009	4.029	−4.549	97.815
Korea	7.02	0.001	8.175	−0.456	53.213	−0.003	5.081	−1.872	48.504
Malaysia	4.86	2.880	7.192	−4.102	67.510	0.796	4.536	−8.034	62.327
Philippines	9.78	−0.285	3.196	−3.169	22.581	−0.430	2.406	−1.744	30.907
Taiwan	3.87	1.35	9.682	NA	68	0.49	6.51	NA	91
Thailand	5.81	−0.132	7.318	0.175	66.183	−0.166	3.751	−1.002	62.210

NOTES:
1. Except for GDP growth, other ratios are not in percentage form.
2. TB is the trading balance, GB is the government balance, and Credit is the banks claim to the private sector.
3. Except for Taiwan, all data are collected from the IMF's *International Financial Statistics*. Annual data from 1980–1999 are used in this table.

TABLE 3
Basic Macroeconomic Environment (II)

Country	*L1*	*In-between*	*L2*	*H1*	*In-between*	*H2*
Indonesia		v		v		
Japan			v			v
Korea	v				v	
Malaysia		v			v	
Philippine			v	v		
Taiwan	v					v
Thailand		v			v	
Expected Responses of Exchange Rate to Capital Flow	Almost insignif. negative	most likely negative	negative	Almost insignif. negative	most likely negative	negative

NOTES:
L1: If the low inflation is induced by high productivity.
L2: If the low inflation is induced by weak demand or recession.
H1: If the high inflation is induced by high government deficit or high debt.
H2: If the high inflation is induced by strong demand, such as strong exports.

TABLE 4
Indonesia (Sample Size: 1993:Q1–1999:Q1)

	Whole Sample			*Low Inflation Regime*		
Cons	1431.98	1074.33	1310.56	1556.55	1486.89	1603.11
	(8.67)	(5.12)	(9.77)	(2.55)	(2.54)	(2.62)
FDI	−0.08			−0.067		
	(−0.76)			(−0.65)		
FPI		−0.19			−0.103	
		(−1.72)			(−1.10)	
FOI			−0.12			−0.04
			(−1.48)			(−0.616)
ΔY	5917.64	4272.71	6895.925	−2307.48	−2576.70	−1869.48
	(3.02)	(2.06)	(3.62)	(−0.83)	(−0.99)	(−0.614)
ΔM2	−1306.38	1817.04	−1721.01	2355.14	3005.51	1593.29
	(−1.14)	(0.83)	(−1.62)	(0.713)	(0.93)	(0.47)
ΔSP	64.151	43.27	39.99	−484.37	−452.78	−407.75
	(0.25)	(0.19)	(0.17)	(−1.911)	(−1.98)	(−1.67)
DAsia	1428.62	387.23	1176.20			
	(4.78)	(0.54)	(3.43)			
DW	1.79	1.89	1.92	1.50	1.39	1.54
R^2	0.96	0.96	0.96	0.34	0.41	0.34

NOTES: *t*-values in parentheses.
There are less than 4 degrees of freedom in the high inflation regime, making the estimation unreliable. Thus, they are not reported.

TABLE 5
Japan (Sample Size: 1980:Q1–1999:Q2)

	Whole Sample			*Low Inflation Regime*			*High Inflation Regime*		
Cons	159.74	152.52	148.58	148.98	141.62	139.01	176.20	201.76	171.78
	(28.52)	(31.86)	(34.47)	(23.50)	(27.65)	(27.78)	(16.43)	(30.42)	(19.38)
FDI	−38.31			−33.02			−38.67		
	(−2.91)			(−2.37)			(−1.72)		
FPI		−0.44			−0.43			−2.07	
		(−1.76)			(−1.67)			(−6.74)	
FOI			−0.04			−0.04			0.52
			(−0.24)			(−0.21)			(1.25)
ΔY	−6.90	−11.56	−14.77	−13.99	−19.31	−21.31	−203.5	85.23	−148.9
	(−0.43)	(−0.71)	(−0.89)	(−0.90)	(−1.22)	(−1.32)	(−1.04)	(0.76)	(−0.69)
ΔM2	−331.8	−343.0	−341.4	−469.5	−485.6	−458.8	−347.4	−332.5	−504.6
	(−3.18)	(−3.17)	(−3.09)	(−3.75)	(−3.74)	(−3.47)	(−1.98)	(−3.83)	(−2.93)
DAsia	9.96	−10.55	−12.45	10.01	−6.39	−8.25			
	(0.54)	(−0.60)	(−0.68)	(0.55)	(−0.37)	(−0.46)			
DW	1.14	1.05	1.13	1.33	1.28	1.22	1.72	1.93	2.10
R^2	0.23	0.18	0.14	0.31	0.27	0.24	0.43	0.84	0.42

NOTE: *t*-values in parentheses.

Malaysia. The country's features are uncertain in both regimes, that is, falling in-between L1 and L2 and in-between H1 and H2. The intervention in Malaysia is known to be episodic (Eichengreen and Bayoumi 1999). Table 7 supports these conjectures. All responses are insignificant in the low inflation regime but significant in the high inflation regime when FDI and FOI are used.

Philippines. Since the country's features are L2 and H1, the responses are expected to be negative in the low inflation regime, but have almost no effect in the high inflation regime. Results in Table 8 confirm these conjectures. Except for FDI, all responses are significantly negative at the 1 per cent level in the low inflation regime. They are, however, insignificantly negative at the 5 per cent level in the high inflation regime.

Taiwan. The country's features are L1 and H2. The results reported in Table 9 are supportive of the prior. In the low inflation regime, the coefficients are significant for FDI and FPI, yet not for FOI. In contrast, in the high inflation regime, the coefficients are found to be significantly different from zero for FDI and FOI.

Thailand. The country's features are similar to those of Malaysia. That is, the attributes fall in-between L1 and L2 (in the low inflation regime) and in-between H1 and H2 (in the high inflation regime). Table 10 shows that FDI and FPI yield significantly negative impacts on the exchange rate in the low inflation regime yet yield insignificant impacts in the high inflation regime; whereas FOI yields a significantly negative impact in the high inflation regime but has an insignificant impact in the low inflation regime. The influences of the composition of capital flow are opposite in the two different inflation regimes. The reasons for the opposite results obtained from each capital flow composition are probably owing to the marginal in-between conditions Thailand experienced in each regime. However, we leave this for future investigation.

TABLE 6
Korea (Sample Size: 1980:Q1–1999:Q1)

	Whole Sample			*Low Inflation Regime*			*High Inflation Regime*		
Cons	874.87	885.80	876.98	888.20	879.72	879.67	704.88	708.65	704.52
	(43.36)	(45.05)	(50.18)	(46.18)	(45.81)	(47.15)	(33.18)	(25.70)	(33.76)
FDI	−0.10			−0.18			−0.02		
	(−2.96)			(−4.46)			(−1.32)		
FPI		−0.017			−1.09			−0.001	
		(−4.00)			(−4.13)			(0.38)	
FOI			−0.02			−0.02			−0.004
			(−5.548)			(−4.49)			(−1.44)
ΔY	431.27	394.35	451.71	482.31	451.66	635.73	−42.55	−29.75	33.48
	(1.69)	(1.62)	(2.05)	(1.72)	(1.57)	(2.28)	(−0.25)	(−0.16)	(0.19)
ΔM2	−758.9	−865.0	−811.2	−689.7	−717.9	−827.9	235.49	180.18	225.74
	(−4.64)	(−5.67)	(−5.79)	(−4.41)	(−4.51)	(−5.36)	(1.66)	(1.72)	(1.67)
ΔLR	85.08	79.58	57.12	171.47	152.86	110.19	53.91	45.95	40.08
	(1.83)	(1.81)	(1.42)	(3.48)	(3.05)	(2.23)	(1.82)	(1.43)	(1.36)
ΔSP	94.48	59.84	62.01	67.50	68.96	66.27	127.10	123.77	113.11
	(2.32)	(1.47)	(1.71)	(1.62)	(1.61)	(1.59)	(5.64)	(4.69)	(5.19)
DAsia	525.54	385.94	305.68	719.04	547.62	404.11	407.55	389.96	376.99
	(9.61)	(7.61)	(5.95)	(11.20)	(8.08)	(4.93)	(9.89)	(8.87)	(10.40)
DW	1.86	1.52	1.65	1.56	1.48	1.71	1.99	2.43	1.83
R^2	0.76	0.8	0.82	0.82	0.81	0.82	0.99	0.99	0.99

NOTE: *t*-values in parentheses.

TABLE 7
Malaysia (Sample Size: 1974:A–1998:A)

	Whole Sample			*Low Inflation Regime*			*High Inflation Regime*		
Cons	2.59	2.8	2.79	2.81	2.93	2.94	2.1	2.46	2.18
	(20.6)	(36.7)	(32.31)	(21.0)	(36.9)	(34.14)	(14.6)	(20.7)	(17.0)
FDI	−0.0001			0.00005			−0.0002		
	(1.99)			(1.17)			(2.86)		
FPI		−0.00006			−0.00003			0.00001	
		(0.51)			(−0.30)			(0.07)	
FOI			8×10^{-8}			−0.000001			0.0001
			(0.002)			(−0.04)			(2.62)
ΔY	3.39	5.51	6.09	4.23	5.36	5.84	−0.20	5.07	−0.45
	(1.6)	(2.62)	(3.29)	(1.91)	(2.25)	(3.13)	(−0.08)	(1.93)	(−0.17)
DAsia	1.34	1.615	1.62	1.34	1.49	1.48			
	(3.64)	(4.34)	(4.2)	(3.96)	(4.53)	(4.39)			
DW	1.00	1.30	1.3	1.76	2.02	2.02	1.37	1.58	1.59
R^2	0.69	0.64	0.63	0.75	0.72	0.72	0.83	0.49	0.81

NOTE: *t*-values in parentheses.

TABLE 8
Philippines (Sample Size: 1977:Q1–1999:Q1)

	Whole Sample			*Low Inflation Regime*			*High Inflation Regime*		
Cons	21.43	21.86	22.05	22.80	23.59	23.30	19.57	15.29	20.86
	(24.8)	(19.86)	(29.05)	(21.90)	(21.92)	(27.21)	(11.15)	(7.30)	(11.09)
FDI	−0.003			−0.001			−0.004		
	(−1.70)			(−0.45)			(−1.18)		
FPI		−0.003			−0.003			−0.002	
		(−5.00)			(−4.46)			(−1.92)	
FOI			−0.001			−0.001			−0.002
			(−4.28)			(−3.72)			(−1.90)
ΔY	−25.74	−13.76	−20.62	−6.10	8.89	−0.88	−26.05	−85.19	−20.18
	(−2.46)	(−0.93)	(−2.31)	(−0.38)	(0.62)	(−0.06)	(−1.80)	(−2.89)	(−1.43)
ΔM2	2.060	2.09	1.41	−9.14	−7.809	−7.18	14.91	32.92	11.50
	(0.49)	(0.42)	(0.40)	(−1.71)	(−1.63)	(−1.76)	(1.87)	(3.25)	(1.50)
DAsia	3.52	1.89	2.49	3.78	2.39	3.05			
	(2.70)	(1.67)	(2.16)	(3.06)	(2.35)	(2.93)			
DW	2.00	2.05	1.82	2.48	2.50	2.36	1.09	1.02	1.53
R^2	0.31	0.52	0.47	0.38	0.63	0.57	0.46	0.76	0.52

NOTE: *t*-values in parentheses.

TABLE 9
Taiwan (Sample Size: 1980:Q1–1999:Q3)

	Whole Sample			*Low Inflation Regime*			*High Inflation Regime*		
Cons	33.85	32.44	32.68	33.54	32.39	32.61	31.27	28.72	27.19
	(32.60)	(30.31)	(29.57)	(27.98)	(26.62)	(25.66)	(22.63)	(25.11)	(24.05)
FDI	−0.006			−0.005			−0.003		
	(−4.93)			(−3.40)			(−2.68)		
FPI		−0.001			−0.001			−0.0006	
		(−2.11)			(−1.92)			(−1.04)	
FOI			−0.0004			−0.0004			0.0005
			(−1.84)			(−1.51)			(2.440)
ΔY	−26.50	−24.63	−22.68	−23.40	−23.55	−21.01	10.98	36.35	54.38
	(−2.24)	(−1.89)	(−1.71)	(−1.68)	(−1.57)	(−1.36)	(0.72)	(2.63)	(3.99)
ΔM2	−14.10	−12.34	−14.02	−9.48	−7.43	−9.56	−25.85	−22.94	−20.92
	(–2.38)	(−1.90)	(−2.10)	(−1.32)	(−0.97)	(−1.19)	(−5.43)	(−4.13)	(−4.31)
ΔStock	5.14	6.60	5.80	3.516	4.51	4.143	5.25	6.09	8.34
	(2.83)	(3.33)	(2.87)	(1.45)	(1.74)	(1.58)	(4.81)	(4.89)	(5.94)
DAsia	5.19	5.42	4.13	4.30	4.30	3.22			
	(2.56)	(2.43)	(1.77)	(1.84)	(1.71)	(1.23)			
DW	1.40	1.43	1.34	1.34	1.43	1.31	2.50	2.48	2.69
R^2	0.39	0.25	0.24	0.29	0.18	0.16	0.86	0.80	0.85

NOTE: *t*-values in parentheses.

TABLE 10
Thailand (Sample Size: 1993:Q1–1999:Q1)

	Whole Sample			*Low Inflation Regime*			*High Inflation Regime*		
Cons	21.07	20.67	21.19	26.78	23.08	22.94	14.69	14.52	19.62
	(9.66)	(10.13)	(12.52)	(17.15)	(64.66)	(42.91)	(2.77)	(2.18)	(4.21)
FDI	−0.0009			−0.007			−0.0009		
	(−0.56)			(−2.51)			(−0.59)		
FPI		0.0003			−0.0006			0.0003	
		(0.32)			(−2.04)			(0.09)	
FOI			−0.0003			0.00002			−0.0004
			(−2.57)			(0.30)			(−2.33)
ΔY	−36.88	−27.71	−11.73	−20.74	−1.35	4.51	−71.93	−62.70	−22.87
	(−2.31)	(−1.24)	(−0.80)	(−1.90)	(−0.28)	(0.72)	(−3.16)	(−1.07)	(−0.90)
ΔM	48.399	39.02	35.71	14.455	5.97	0.65	118.78	106.95	60.70
	(2.15)	(1.24)	(1.89)	(2.53)	(1.09)	(0.09)	(2.42)	(0.94)	(1.36)
DAsia	9.63	9.56	7.94	9.19	8.92	6.50			
	(4.31)	(3.38)	(5.18)	(3.20)	(1.37)	(3.10)			
DW	2.70	2.65	2.21	2.96	1.92	2.94	3.14	3.04	2.34
R^2	0.84	0.84	0.89	0.83	0.78	0.50	0.89	0.89	0.94

NOTE: *t*-values in parentheses.

VI. Conclusion

This article has laid stress on the role of the central bank when discussing the responses of the exchange rate to net capital flows in selected East Asian countries. The role of central banks in these countries is crucial since their foreign exchange markets are thin. It was felt that it would be interesting to determine whether or not there is a systematic way of examining the situations when the interventions are made.

Our hypothesis may be broadly described as one of "stability before competitiveness". We argue that central bank interventions are made for the following two reasons. First, the central bank intervenes to slow down the appreciation of the exchange rate to strengthen competitiveness if the inflation rate is not a cause of concern to policy makers (i.e. within a certain threshold). Second, the central bank intervenes to put a brake on currency depreciation to prevent further depreciation when a rise in inflation in the future is possible. Thus, the goals of intervention revolve around inflation and competitiveness, and in that order. To further enhance the realism of the model, we also consider the source of inflation. For example, low inflation may result from strong productivity during a boom time or from weak demand during a recession. Similarly, high inflation may result from strong demand or from a fiscally irresponsible government. We expect capital inflows in the former case but outflows in the latter. As such, the extent of the intervention of central banks and the resulting responses of the exchange rate will vary based on the circumstances. Simply focusing on the inflation rate without identifying the sources of it may make the analysis void.[11]

The empirical results in this article can be summarized as follows: the results with respect to Malaysia, the Philippines, Indonesia, and Taiwan fully support our conjectures, although due to insufficient degree of freedom in the high inflation regime in Indonesia, we skipped the estimation in this part for Indonesia. In Korea, the central bank intervened in the high inflation regime (when caused by the economic boom) to prevent the Korean won's appreciation. The

results in the low inflation regime show that the Korean monetary authority treated competitiveness and inflation as equally important goals, which resulted in making its intervention incomplete. Finally, the evidence of Japan and Thailand are partially supportive of our conjectures, where different compositions of capital flows obtained mixed results.

NOTES

1. The terms "monetary authority" and "central bank" are used interchangeably in this article. The terms "preferences", "decisions", "behaviour", or "objectives" of the monetary authority/central bank are also used interchangeably in this article.
2. However, Kaminsky and Reinhart (1998) stressed that this generalization regarding different types of capital flows to Latin America and Asia was not valid for more recent data (from the mid-1990s). The other element, besides FPI and FDI, in the IMF financial capital account, is foreign other investment (FOI), which will be mentioned in the following section.
3. "Thinness" implies that the trading volume and/or turnover rate is low. Imperfect exchange market implies a restriction of foreign capital, taxes on capital flows, and such.
4. We assume that the ability of central banks to intervene is not in question (i.e. adequate international reserves).
5. In other words, we are abstracting from the case where the central bank is completely/strictly independent and inflation stability is the sole goal.
6. We abstract from the possibility of monetary sterilization of capital inflows.
7. While Fernandez-Arias and Hausmann (2000) have argued that the bolted down nature of FDI may be exaggerated, it is typically thought of as being stable by central banks. Also see Bird and Rajan (2000) who have discussed the issue with particular reference to the Malaysian experience during the East Asian crisis of 1997–98.
8. For example, see Calvo et al. (1993), Edwards (2000), and Agénor and Hoffmaister (1998).
9. There are, of course, other types of threshold regressions. For details of the maximum likelihood method of threshold regression, see Terasvirta and Anderson (1992). Details of the threshold vector autoregressive model can be found in Shen and Chiang (1999). See Shen and Wang (2000) for a discussion of the threshold cointegration method. Also see Shen and Wang (2000) and Shen (2000) for the panel threshold model.
10. The econometric computer software RATS is used in this study. RATS automatically skips all observations in the period when there is a missing observation in that period. Thus, missing data do not create a problem in the testing.
11. There are certainly additional factors that could be considered in our analysis. These include, but are not limited to, expectation effects, feedback of the exchange rate on capital flows, the effectiveness of intervention, the impact of sterilization/non-sterilization, various types of fiscal and monetary policies, political pressure, independence of the central bank, and the like.

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