Kicking the Habit and Turning Over A New Leaf: Monetary Policy in East Asia After the Currency Crisis

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EXECUTIVE SUMMARY

1 The paper investigates the impact of the switch in the exchange rate regimes after the East Asian financial crisis on the conduct of monetary policy in Korea, Indonesia, Malaysia, and Thailand. Korea, Indonesia, and Thailand, which came under the IMF-supported programmes during the crisis, have adopted a more flexible post-crisis exchange rate regime and a monetary policy framework that explicitly targets inflation. Malaysia, on the other hand, has adopted a fixed exchange rate peg coupled with a system of exchange controls that aims at reducing currency volatility while allowing the authorities to secure greater autonomy in the conduct of monetary policy.

2 The study commences with an evaluation of the role of the pre-crisis quasi-US Dollar peg system, in which these countries were on, as a nominal anchor of domestic price level. The analysis suggests that the relatively low and stable inflation rates experienced in these countries during the early 1990s cannot be attributed to the monetary discipline imposed on the authorities by the quasi-fixed exchange rate system. The ability of the authorities to pursue tight monetary policy was often frustrated by the large capital inflows. The exchange rate system's contribution to price stability came from allowing the arbitrage of tradable goods to take place under stable exchange rates while the relatively open current account channelled the excess domestic demand to imports from abroad.

3 After stability in the financial markets was restored, Korea, Indonesia, and Thailand have redesigned the monetary policy framework to one of targeting inflation in order to provide a new nominal anchor under a more flexible exchange rate regime. Under the new framework the authorities have adopted interest rate as the key operating instrument. The analysis focuses on (i) how far the new exchange rate regimes have enabled the domestic money market interest rates to diverge independently from the US interest rate, and (ii) the degree to which the authorities have secured more effective control over the money market rates through their money

market intervention activities. Estimates from a model of short-term interest rate dynamics indicate that the spread between the domestic and the US interest rates exhibited slower mean-reversion and the volatility of the interest rate differential has diminished during the post-crisis period.

4 The paper analyses the provisions of the revised Bank of Korea Act and the Bank of Indonesia Act together with the policy pronouncements of Bank of Thailand to assess the degree of legal independence that these central banks can enjoy in pursuit of the inflation targeting objective. The ultimate degree of credibility that the authorities will gain, however, will depend on the actual conduct of the monetary policy. Estimates from a forward-looking interest rate reaction function suggest that the authorities have placed greater weight on inflation objective following the outbreak of the currency crisis and are more willing to raise the nominal interest rates in face of expectation of high inflation. The post-crisis policy credibility is evident from the quick decline in the persistence of domestic inflation rates.

I INTRODUCTION

1.1 One major liberating effect an economy enjoys after it has unshackled the commitment to a fixed exchange rate peg is that it allows the authorities greater autonomy to design monetary policy aimed at offsetting domestic and foreign shocks. This paper is a study of the comparative experience of the four East Asian economies – Indonesia, Korea, Malaysia, and Thailand in their quest for greater monetary autonomy in the aftermath of the East Asian currency crisis of 1997-1998. Indonesia, Korea, and Thailand have transited to a more flexible post-crisis exchange rate regime, at the same time having adopted an inflation-targeting monetary policy framework to provide a nominal anchor for their economies. Malaysia, on the other hand, has introduced a system of capital controls to insulate its economy against financial market shocks from abroad and to attain the desired degree of monetary independence.

1.2 Section II of the paper examines the role of the pre-crisis quasi-Dollar peg regime as a nominal anchor for these economies during the 1990s. The analysis provides a background to the subsequent shift in the monetary policy regime after the outbreak of the currency crisis. Section III evaluates the degree of monetary independence and monetary control the authorities of these countries actually exercise in the recent period when the exchange rates are managed more flexibly. Section IV examines the institutional arrangements that aim at providing legal independence to the central banks so as to strengthen their mandate of achieving price stability. Section V analyses the actual conduct of monetary policy using a forward looking interest rate reaction function and provides a preliminary assessment of the credibility of the monetary policy regimes that operate under a more flexible institutional environment. Section VI concludes the paper.

II QUASI-DOLLAR PEG AS A NOMINAL ANCHOR OF MONETARY POLICY

2.1 Before the outbreak of the currency crisis, the exchange rate system of the East Asian economies had been characterised as a quasi-US Dollar peg [Ito, Ogawa, and Sasaki (1998), Edwards (1999)], in which the currencies had been tied to the US Dollar [Frankel and Wei (1994), Kwan (1995), Gan (2000a)].

2.2 From the monetary policy framework perspective, a fixed exchange rate system, with an explicit band around a central rate, represents a commitment mechanism to restrain the monetary authorities from undertaking any time-inconsistent policies [Kydland and Prescott (1977), Barro and Gordon (1983)]. The fixed exchange rate commitment, if it is credible among the participants of the goods, labour, and the foreign exchange market, would provide a clear and directly observable nominal anchor for the domestic price level, thereby reducing the inflation expectations toward the level of inflation of the anchor country whose currency the exchange rate has been pegged to. Cole and Philippopoulous (1997) have shown that the credibility effect of the fixed exchange rate commitment mechanism also holds for the exchange rate target zone model with broader bands.

2.3 While the East Asian quasi-Dollar peg is much less transparent than the traditional fixed exchange rate regime in the sense that there was no publicly announced central parity and the band around it, and it has been managed with some degree of flexibility[1], its record as a nominal anchor for domestic prices has been impressive. As Figure 1 shows, the inflation differential of the four countries relative to the United States had been relatively stable since the late 1980s until the outbreak of the crisis in 1997,

[1] In fact, according to the IMF Exchange Arrangements and Exchange Restrictions Annual Report for 1997, the exchange rate arrangements for Indonesia, Korea, and Malaysia were classified as a "managed float system" while those of Thailand was described as a "basket peg system".

despite the fact that during this period the economies had experienced unprecedented continuous economic boom. Korea and Malaysia had the lowest inflation differential while in Indonesia, the differential was relatively large.

2.4 The tendency of the inflation rate of these four countries to be tied to the US inflation rate in the longer run is evidenced by the absence of unit root in the inflation differential data. Table 1 reports the result of the Augmented Dickey-Fuller and the Phillips-Perron tests of the inflation differential employing monthly sample for each country from January 1990 to January 1997. The test results uniformly reject the null hypothesis that unit root is present in the inflation differential series at 5 percent level of confidence. The rejection of unit root in the inflation differential series implies that a given shock will not cause a persistent deviation of inflation from its long-run mean.

2.5 We complement the unit root test of the inflation rate differential with a variance ratio test that was proposed by Cochrane (1988) to determine the proportion of shocks that cause the domestic inflation rate to depart from the US inflation rate is transitory. Cochrane has shown that any first difference stationary series can be considered as a combination of a stationary and a random walk components. A measure of the persistence to shock (random walk) can be obtained by examining the variance of its k-differences, for different values of k:

$$V(k) = \frac{1}{k}\{\,[Var(x_t - x_{t-k})] \,/\, [Var(x_t - x_{t-1})]\,\} \qquad (1)$$

If the variable x follows a random walk process then $V(k)$ is equal to one. In the case where x has both permanent (random walk) and temporary (stationary) component, $V(k)$ will converge to the ratio of the variance of the permanent shock to the total variance of x. Thus, the closer $V(k)$ is to zero, the higher is the relative importance of temporary shocks.

2.6 The estimated variance ratios for inflation differential for the four countries during the period the quasi-Dollar peg was in existence are presented in Figure 2. The variance ratios are calculated for k=1,3,…..,18 using monthly sample from January 1990 to January 1997. The V(k) shows that shocks that are likely to cause persistent deviations of the domestic inflation rate from the US inflation constitute around 9 to 17 percent of the variance of inflation differential over the twelve month horizon. Therefore the transitory nature of the shocks and the relatively rapid convergence of the domestic inflation rates to the long run inflation differential implies that these economies have avoided a prolonged period of appreciation in the real exchange rate whenever there are shocks to the domestic inflationary process.

2.7 There are two possible channels through which the quasi-Dollar peg ensures that inflation is low and follow a stationary process. One is that it imposes on the government a disciplined fiscal policy stance. A country that runs a persistent fiscal deficit would have to resort to seignorage or borrowing (drawing down of reserves). These alternative methods of financing the fiscal deficit would lead to the depletion of reserves holding. As the first-generation models of speculative attacks developed by Krugman (1979) and Flood and Garber (1984) have shown, unsustainable fiscal policies would trigger off an attack on the fixed peg well before the monetary authorities run out of reserves. Therefore, in order to conserve its reserves holdings and to avoid a costly devaluation of the currency, the authorities are

constrained to maintain a disciplined fiscal policy stance.[2] The credibility of the fixed exchange rate commitment in turn serves to anchor the domestic inflationary expectation to the inflation rate of the country to which the exchange rate is pegged to.

2.8 In addition, the continuous arbitrage among tradable goods produced by different countries under the fixed exchange rate system constrains the domestic inflation rate of a small open economy to that of the international inflation rate. The monetary approach to the transmission of international inflation posits that an expansionary monetary policy in one country would lead to a stock disequilibrium between the desired demand for and the supply of money balances. Under a fixed exchange rate system, the excess supply of money balances would be eliminated mainly in the long run through spending on imported tradable goods (which serves to hold down the domestic price to the international price level), although in the short-run the domestic inflation rate may rise above world inflation. The speed at which the domestic inflation rate will converge to that of the international rate, and the excess money supply that will be eliminated through the balance of payments would depend on such factors as the existing barriers to trade, the share of tradable goods in national output [Swoboda (1977), Frankel and Mussa (1985)].

2.9 To the extent that the domestic inflation is constrained by the international arbitrage process as, posited by the monetary approach to

[2] Tornell and Velasco (1998) have however argued that a flexible exchange rate regime, rather than the fixed exchange rate regime, provides the governments with greater incentive to maintain fiscal discipline. They pointed out that policymakers who have limited term of office and know that the public abhors inflation tax that would inevitably be imposed to finance the persistent deficit. Therefore policymakers would like to defer as much as possible the imposition of inflation tax until they are no longer in office. When the public anticipates higher monetary growth in future, the current exchange rate, under the flexible exchange rate regime, will depreciate thereby generating the immediate inflationary pressure. Hence under the flexible exchange rate regime, the cost of financing a given fiscal deficit through inflation tax is partly paid up-front and is spread over a period of time. On the other hand, under the fixed exchange rate regime the inflation tax can be postponed until the time when the actual increase in the money supply takes place. Hence under a flexible exchange rate regime, policymakers who wish to avoid spreading the inflation tax over time would tend to adopt a more prudent budgetary stance.

world-wide inflation rather than a result of the fiscal and monetary discipline, than the case for the pegged exchange rate system as a nominal anchor would be much diminished.

2.10 The fiscal position of the government in the four countries from 1990 to 1996, a year before the outbreak of the currency crisis, is consistent with the view that the quasi-Dollar peg regime imposed certain fiscal discipline on the governments. As Figure 3 shows, the central government budget were in surplus for most of the time during that period. Even in the years when the central government incurred a budget deficit, as in the case of Malaysia between 1990-1991 and Korea between 1990 to 1992, the size of the deficit was rather small.[3]

2.11 While the quasi-peg system has provided some form of restraint on the fiscal positions in the four countries, it was not able to restrain the strong private sector investment spending, leading to large current account deficits in these countries since 1989 (Figure 4). Had these countries not have access to the international capital market for financing the large external imbalances, the progressive depletion of the stock of international reserves would have forced the authorities to adopt tighter monetary policy to keep the domestic spending in check. Such response would be in consonance with the conventional view of the fixed exchange rate as a device for restraining excessive monetary growth.

2.12 The surge of capital inflows into these countries since the late 1980's funded the current account deficits and thereby helped to relieve the balance-of-payment constraint imposed by the quasi-fixed peg.[4] In Malaysia the net private capital flows reached a peak of 23 percent of GDP in 1993, while in Thailand the private capital flows amounted to 12.3 percent of GDP

[3] Gavin and Perotti (1998) found that countries in Latin America that adopted the fixed exchange rate arrangement had experienced lower fiscal surplus than countries that had adopted the flexible exchange rate regime.

[4] For analysis of the capital inflows into the East Asian economies, see Schadler et al (1993), Koenig (1996), the World Bank (1997).

for two consecutive years in 1990 to 1991. As Table 2 shows, the cumulative capital inflows, as a percentage of GDP, were substantial for all the four countries. In Thailand and Malaysia, the capital inflows in some years were well in excess of the current account deficits, resulting in substantial build-up in the stock of international reserves as the central banks in these countries intervened in the foreign exchange market to relieve the appreciation pressure on the currencies.

2.13 Large-scale exchange market interventions, by increasing the monetary base, could potentially impede the monetary authorities' ability to control the domestic money supply, unless they are effectively sterilised. Recent studies have shown that the central banks in East Asia were successful to various degrees in sterilising the impact of reserves inflows on the monetary base or broad money supply [Takagi and Esaka (2000), Gan (2000b)]. However, the 'quasi-fiscal' costs of the sterilisation measure, as the central banks continuously swap the high-yielding domestic-currency denominated liabilities for foreign-currency denominated assets that typically pay lower nominal yields, tend to limit sterilisation to periods of large surges in the capital inflows.[5] Partly in response to the relatively high cost of sterilisation, the East Asian monetary authorities had instituted a range of 'non-standard' sterilisation measures and capital controls.[6]

2.14 Despite the effort by the central banks to exercise greater control over domestic money supply, broad monetary aggregate and banking system credit continued to expand rapidly in the four countries [Figure 5], indicating that in economies with an open capital account, the fixed exchange rate system has failed to function as a disciplinary device in restraining monetary expansion and domestic spending. Recent critics of

[5] Estimates by Kletzer and Spiegel (1998) on the quasi-fiscal costs of sterilisation measure for selected East Asian countries indicate that the costs tend to be lower than those estimated for the Latin American countries, although much larger estimates were found during periods of sharp surges in the capital inflows.

[6] See Villanueva and Lim (1999) for a survey of different 'non-standard' sterilisation measures adopted by the East Asian monetary authorities during the first-half of 1990s.

the fixed exchange rate system have gone further to argue that the currency regime not only led to loss of monetary autonomy but has also resulted in the domestic money supply and interest rates of economies with liberalised capital account moving in a pro-cyclical manner. Capital flows tend to surge into economies during the period of robust economic booms in response to strong demand for funds and rising asset prices. To the extent that the monetary authorities are unable to sterilise the monetary effects of the foreign exchange intervention adequately, money supply and interest rate will tend to exhibit pro-cyclical movement, thereby serving to amplify the magnitude of the business cycle fluctuations [Hausman et al (1999)].

2.15 To test this proposition, we estimate the following relationship between excess money supply and the cyclical position of the economy:

$$exm2_t = l_0 + l_1 gap_t + u_t \qquad (2)$$

where $exm2_t$ is the excess supply of real M2 and gap_t is the output gap. The evidence that the quasi-Dollar peg tends to lead to pro-cyclical excess money supply would require that $l_1 > 0$.

2.16 The measure of excess money supply is the difference between the actual outstanding stock of real M2 and the long-run equilibrium level of money demand. The long-run demand for real money balances is specified as depending on the level of economic activity and the ex-post real interest rate and the function is estimated over a monthly sample from January 1990 to January 1997. The results of estimating the cointegrating regression for the real money demand by the Johansen maximum likelihood procedure is given in the Appendix I.

2.17 Table 3 presents the estimates of the parameters of equation (2). The output gap is measured as the difference between the logarithm of the index of industrial production and its Hodrick-Prescott trend. The

coefficients of the output gap are all negative, rather than positive, but none of these coefficients are statistically significant from zero.

2.18 The coexistence of relative price stability with rapid growth in money and credit during the 1990s would indicate that the convergence of the inflation rates of these economies towards the steady state inflation differential was achieved primarily through channelling the excess demand pressure into the current account of the balance of payments. To validate this view on the role of fixed exchange rate in the inflation convergence process would require one to show that the inflation differential in the long-run is independent of the domestic monetary growth, as predicted by the monetary theories of international inflation, and that the excess real money balances in the economy is eliminated mainly through the movement in the trade balance.

2.19 To evaluate the monetarist proposition that the differences in inflation rates among countries are independent on national monetary growth, we estimate the following equation:

$$p_t - p_t^{us} = a + (p - p^{us})_{t-1} + \sum_{i=0}^{p} b_i \Delta m2_{t-i} + \sum_{i=0}^{q} g_i (\Delta y - \Delta y^{us})_{t-i} + e_t \qquad (3)$$

where p_t is the domestic inflation rate, as measured by the percentage change in the consumer price index, of the home country, p_t^{us} is the inflation rate in the United States, $\Delta m2_t$ is the growth in nominal M2, Δy_t is the real output growth of the home country, and Δy_t^{us} is the output growth in the United States. The differential output growth between the home country and the United States is included to proxy for differential productivity growth between the two countries that could cause systematic deviations in the relative purchasing power parity relationship.[7] Output growth is measured

[7] See Edwards and Losada (1994).

by the index of industrial production. Equation (2) is estimated over a monthly sample from January 1990 to January 1997.

2.20 Table 4 shows the estimated values of the coefficients of the monetary growth variable summed over the current and five lags and the results of the likelihood ratio test of the null hypothesis that the coefficients are jointly zero. The sum of coefficients of the money growth variable is negative for Thailand and Indonesia and is positive for Korea and Malaysia. However, in none of countries are the coefficients (jointly) significantly different from zero at five percent. An additional test using twelve lags of monetary growth variable also failed to reject the null hypothesis. The results therefore suggest that the inflation differentials in the four countries are not systematically influenced by contemporary and past movements of money supply.

2.21 We next tested the hypothesis that the excess money supply significantly impact on the economy's trade balance by estimating the following equation:

$$tb_t = \delta_0 + \sum_{i=1}^{z} J_i tb_{t-i} + \sum_{i=0}^{p} \theta_i exm2_{t-i} + \nu_t \qquad (4)$$

where tb_t is the nominal trade balance (exports less imports) normalised by the stock of reserves, and $exm2_t$ is, as previously, the excess stock of real M2 balances.

2.22 The estimates of equation (4) are presented in Table 5. The sum of the excess real money balance coefficients are negative, as predicted by the monetary approach to the balance of payments theory, and the coefficients are, jointly, statistically different from zero. The p-values of the likelihood ratio test are zero for three out of the four countries. The results indicate that the stock disequilibrium between the demand for and the supply of real money balances in these economies led to increased

spending on imported goods and services, thereby resulting in a reduction in the existing trade surplus or an increase in the trade deficit.

2.23 Overall, the empirical assessment of the role of the quasi-Dollar exchange rate peg as the nominal anchor for economy suggests that price stability and inflation convergence emanate less from the disciplinary role of the exchange rate regime in constraining excessive monetary growth and more from the fact that the excess monetary expansion was absorbed through larger current account deficit.

2.24 To the extent that the pegged exchange rate serves as a form of implicit guarantee against exchange rate risk and the credibility of the quasi-fixed exchange rate tends to be weaker the longer the time horizon, the exchange rate tends to encourage the use of short-term foreign currency borrowing to finance the large current account deficit [Eichengreen and Hausmann (1999)]. The reversal of the short-term capital flows has been the major source of the collapse of the quasi-fixed exchange rate regime in these countries.

III EXCHANGE RATE FLEXIBILITY AND MONETARY AUTONOMY

3.1 With the outbreak of the currency crisis, Korea, Indonesia, and Thailand came under the IMF-supported programmes which focused on the nominal interest rate as the operating target of monetary policy. During the initial phase of the crisis, monetary policy was aimed at securing the stability of the nominal exchange rates and this was to be achieved through maintaining sufficiently high level of interest rate rather than through the foreign exchange market intervention.[8] "… The essential task of monetary policy was to counter the slide of the exchange rate … the nominal interest rate – rather than credit or monetary aggregates – was adopted as the defacto gauge and instrument of monetary policy tightening … "[Ghosh and Phillips (1999)].

3.2 In order for the central banks of the three countries to set interest rates without being constrained by its foreign exchange market intervention and its liquidity support activities to the distressed financial institutions, the programmes imposed quarterly floors on the central banks' net international reserves and ceilings for their net domestic assets.

3.3 As these economies continued to recover from the crisis and stability is restored in the financial market, the authorities in Korea, Indonesia, and Thailand have redesigned the monetary policy framework to one of targeting inflation in order to provide a new nominal anchor under a more flexible exchange rate regime. Under the inflation targeting framework, the authorities adopted the interest rates as the key operating instrument.[9]

[8] Much controversy has gone by on the efficacy of maintaining high interest rates to stabilise the exchange rates during East Asian currency crisis. For alternative views, see Furman and Stiglitz (1998), Radelet and Sachs (1998), Mussa and Savastano (1999).

[9] See Bank of Thailand, *Inflation Report*, July 2000, Alamsyah et al (2000).

3.4 In Malaysia, after pursuing tight monetary policy since the outbreak of the crisis, the central bank on 1 September 1998, introduced a system of capital controls and fixed the Ringgit exchange rate to the US Dollar in order "to gain greater independence in the conduct of the domestic monetary policy as well as to insulate the economy from the potential risks and vulnerabilities of external developments in the international financial markets". [Bank Negara Malaysia Annual Report 1999, p.93].

3.5 By the beginning of 1999, two different monetary policy frameworks have been evolved, both aiming at securing greater discretion in the conduct of domestic monetary policy without being encumbered by the commitment to the exchange rate peg. In one group of countries consisting of Korea, Indonesia, and Thailand, monetary independence is secured through the adoption of a more flexible exchange rate arrangement, while in Malaysia the conflict between the maintenance of a fixed exchange rate system and monetary autonomy is resolved through a system of tight exchange controls.

3.6 Besides allowing for greater exchange rate flexibility, new measures were undertaken to enhance the "instrument independence" of the new monetary policy framework. The open market operations (OMO) and the reverse repo facilities were improved upon in these countries to facilitate better management of the supply of reserves, and thereby increase the ability of the central banks to influence more closely the short-term interest rates.

3.7 Before proceeding to evaluate the degree of monetary independence under the new exchange rate regimes, we first need to establish how far, since the return of tranquillity to the foreign exchange market, have the Baht, Rupiah, and the Won "kicked the habit" [Eichengreen (1999)] or overcome the "fear of floating" [Calvo and Reinhart (2000)], i.e., these currencies actually exited from the quasi-Dollar peg arrangement to a regime of greater exchange rate flexibility. These currencies were classified

as "independently floating" by the IMF 1999 Report on Exchange Arrangements and Exchange Restrictions.

3.8 We calculate the standard deviations of the daily percentage change in the Rupiah, Baht and the Won against the US Dollar for the period January 2 1999 to September 22 2000 and compare them against the daily volatility during the period January 2 1995 to January 2 1997. Table 6 presents the sample standard deviations for the two periods. There has been an increase in the standard deviation of the daily movement of the three currencies from the pre-crisis sample period to the post-crisis period, with the largest increase in the volatility being recorded for the Rupiah. Increasing exchange rate flexibility can also be inferred from the calculated probability that daily absolute percentage change in the exchange rate exceeds the one percent band. As indicated in Table 6, the probability increases substantially from the period under the quasi-Dollar peg to the post-crisis "independently floating" regime. Hence the declaration that there are greater flexibility in the three currencies are not "merely words but also deeds".

3.9 We next examine how the greater exchange rate flexibility in Indonesia, Korea, and Thailand, and the fixed exchange rate-cum-capital control affect the linkage between the foreign and the domestic money market interest rates in these countries.

3.10 Under a completely flexible exchange rate regime without capital controls, the relationship between the nominal interest rate on a domestic asset with maturity t and the foreign interest rate of similar maturity and identical default risk is governed by the uncovered interest parity adjusted for exchange rate risk premium:

$$r_t - r_t^f = E_t(s_{t+t} - s_t) + h_t^t \qquad (5)$$

where r_t and r_t^f are the domestic and foreign currency denominated interest rates respectively in period t (measured as the log of one plus the interest rate), s_t is the log of the exchange rate (measured as the number of domestic currency per unit of foreign currency), h_t^t is the currency risk premium over the t - maturity period, E_t is the conditional expectations operator based on information at time t.

3.11 Under the fixed exchange rate regime that is fully credible, in the sense that the market expectation of the change in the central parity is zero and the exchange rate risk premium is small, the domestic interest rate equals the foreign interest rate:

$$r_t = r_t^f \tag{6}$$

3.12 The monetary authorities, under such condition, is completely powerless to influence the domestic interest rate. Under a flexible exchange rate regime, the central bank's control over the domestic interest rate arises from the fact that the exchange rate is allowed to adjust for the interest rate differential so as to make investors indifferent to holding either the domestic or foreign currency denominated assets. When the central bank lowers the domestic interest rate, the resulting capital outflows would cause the exchange rate to depreciate, creating the expectation of a future appreciation. The spot exchange rate will depreciate to a level such that the expected rate of appreciation over the t -holding period would just offset the initial fall in the domestic interest rate relative to the international interest rate.

3.13 Svensson (1994) has shown that monetary independence can also be attained for an exchange rate regime that is managed with a relatively narrow band. For an exchange rate band that is viewed as credible, the central bank can exploit the tendency of the spot rate to revert back to its central parity to influence the domestic interest rate.

3.14 The above discussion points to two empirical implications on the relationship between exchange rate flexibility and interest rate differential. First, there exists a trade-off between interest rate variability and exchange rate volatility. Exchange rate flexibility allows the domestic interest rate to be insulated from a foreign interest rate shock, and this enables the central bank to smoothen the domestic interest rate and reduces its volatility. The more flexible the exchange rate regime is, the more effective would be the ability of the authorities to smoothen interest rate, and hence the smaller would be the variability of the interest rate.[10] Second, the ability to smoothen the domestic interest rate leads to a slower reversion back to the mean following a given shock.

3.15 We employ a model of short-term interest rate adjustment that was formulated by Chan, Karolyi, Longstaff, and Sanders (1992) [CKLS] to evaluate the relationship between interest rate differential and the flexibility of the exchange rate arrangement. The continuous time specification of the model can be written as:

$$dr = (a + b)dt + j r^{l} dw \tag{7}$$

where r is the level of the short-term interest rate, w is the Brownian motion. As CKLS have shown, this general model can nest most of the popular continuous time term structure of interest rate models. Following CKLS, the discrete time approximation to the continuous time model (7) yields:

$$r_t - r_{t-1} = a + b\, r_{t-1} + \in_t \tag{8}$$

$$E(\in_t | \Omega_{t-1}) = 0, \quad E(\in_t^2 | \Omega_{t-1}) \equiv s_t^2 = j^2 r_{t-1}^{2l} \tag{9}$$

[10] See Svensson (1994) for a formal model of the volatility trade-off. Flood and Rose (1999) have cast the Mundell's "Incompatible Trinity" of fixed exchange rate, monetary independence, and open capital account in terms of the trade-off between the volatility of the exchange rate and the variability of the interest rate.

where Ω_{t-1} is the information set at time *t-1* and s_t^2 is the conditional variance of interest rate changes.

3.16 The parameters of the model provide us with two sets of information that allow us to make a quantitative assessment of the degree of monetary independence. First, the parameter b measures the speed of the mean reversion towards the long-run mean following a given shock. Second, the parameter l, which is the elasticity of the variance of interest rate with respect to the level of interest rate, indicates the magnitude to which a given shock would cause the interest rate to vary around, say, the foreign interest rate.

3.17 In the actual empirical model, we have employed a specification where the conditional volatility of the interest rate, instead of depending on the level of the previous period interest rate, follows a GARCH (1,1) specification[11]:

$$s_t^2 = a_0 + a_1 \in_{t-1}^2 + b_1 s_{t-1}^2 \qquad (10)$$

3.18 We estimate the GARCH (1,1) model for a differential between the domestic and US Dollar interbank interest rates for the four countries. We split the daily sample observations into the pre-crisis period from January 2 1995 to June 1 1997, and the post-crisis period from January 2 1999 to September 22 2000. The money market interest rates for Indonesia, Malaysia, and Thailand are the 3-month interbank offer rates, namely the Jakarta interbank offer rate (JIBOR), Kuala Lumpur interbank offer rate (KLIBOR), and the Bangkok interbank offer rate (BIBOR). For Korea, we use the 3-month NCD rate. The US interest rate is represented by the 3-month interbank US Dollar SIBOR rate.

[11] Empirical evidence has generallly shown that a GARCH-type of model of the short-term interest rate dynamics tend to dominate the level specification. See Brenner, Harjes, and Kraner (1996); Koutmos (2000).

3.19 Table 7 shows the results of the quasi-maximum likelihood estimates of the parameters of the conditional mean and variance of the interest rate differential model. While the quasi-maximum likelihood estimates of the parameters are consistent and asymptotically normally distributed when the residuals are not normally distributed, the standard errors are biased downward. Bollerslev and Wooldridge (1992) have provided a method of computing standard errors that is robust to departures from normality. The figures in parentheses in Table 7 that are below the estimated parameters are t-values obtained from the Bollerslev and Wooldridge standard errors.

3.20 The diagnostic test carried out on the standardised residuals of the estimated equation indicate that the GARCH (1,1) model fitted the daily data on the interest rate spread well. The Box-Pierce Q statistic at twelve lags [Q(12)] and the squared standardised residuals statistic [Q^2(12)] indicate that the conditional mean and the conditional variance equation are adequately specified for the two sample periods. The ARCH-LM test also found no ARCH effect on the standardised residuals.

3.21 The estimates of the mean reversion parameter b fell sharply for Thailand and Indonesia after the crisis. In the case of Korea, the post-crisis coefficient was not statistically significant. The results therefore indicate that the domestic interest rate tend to adjust much more slowly or not at all to movement in the US interest rate, in which case the money market equilibrium is restored, under the more flexible exchange rate regime, through larger adjustment in the nominal exchange rate. The small value of b in Malaysia and its non-significance indicates that the capital control regime has effectively severed the linkage between the domestic and foreign interest rates, despite the fact that the exchange rate was fixed against the US Dollar.

3.22 We calculate the unconditional variance of the innovations to the interest rate differential, i.e. the expected variance of the interest rate differential as the forecast horizon lengthens considerably. In the limit, as the forecast horizon, T, tends towards infinity, the unconditional variance is given by:

$$\lim_{T \to \infty} E(\in_{t+T}^{2} | \Omega_t) = a_0 \Big/ 1 - a_1 - b_1 \qquad (11)$$

Equation (11) indicates that the more persistent the volatility shock, as measured by a_1+b_1, the larger is the unconditional variance of the interest rate differential to a given shock.

3.23 There is a marked shift downward in the unconditional variance of interest rate differential from the pre- to the post-crisis period. The estimated value of a_0 fell for all the countries while the persistence to the interest rate differential volatility shock also declined in the three countries except in Indonesia. The half-life[12] of the volatility shock declines from 5.2 days to 2 days in Thailand while in Malaysia it falls from 6.7 days to 3.7 days. Half-life measures the duration of time, in number of days, over which a shock to volatility falls to half of its original size. Hence the results indicate the existence of a trade-off between exchange rate variability and interest rate differential in Indonesia, Korea, and Thailand. Under the pre-crisis quasi-Dollar peg regime where the nominal exchange rate variability was smaller, the volatility in the interest rate was considerably larger.

3.24 Next, we evaluate the ability of the monetary authorities to control the domestic money market interest rate given that the latter is less tied to the foreign interest rate either due to a more flexible exchange rate arrangement or the existence of capital controls. We look at the volatility and persistence of divergences of the short-term money market rates from

[12] The half-life of the volatility shock is calculated as $HL=1-log2/log(a_1+b_1)$ [Lamoureux and Lastrapes (1990)].

the central bank intervention or policy rates. We estimate the same model of interest rate dynamics as given by equations (8) - (10). The dependent variable is the deviation of the 3-month money market rate from the policy rate of each individual country. The policy rates for Indonesia, Malaysia, Korea, and Thailand are the 90-day SBI rate, Bank Negara Malaysia 3-month intervention rate, Bank of Korea overnight call rate, and the Bank of Thailand 14-day Repo rate respectively.

3.25 Table 8 shows the estimates of the parameters of the model. The residual diagnostics indicate that a GARCH (1,1) fits the interest rate spread sufficiently well. The estimates of the $\acute{a}$ parameter indicated that the long-run average spread between the money market rate and the official policy rate are lower for Thailand and Indonesia after the crisis. On the other hand, the estimates for Korea indicate that the long-run spread has actually increased since the crisis. In the case of Malaysia, no estimate was made for the pre-crisis period as the central bank did not announce its intervention rate prior to 1998. However, the estimates from the post-crisis period indicate that the long-run mean is –1.8 percent, with the interbank interest rate being lower than the official intervention rate.

3.26 The estimated mean reversion parameter increases only in Indonesia during the post-crisis period. A more rapid mean reverting process would be indicative of an enhanced degree of control by the central bank over the short-term interbank rates. The parameters of the conditional variance equation indicate that the volatility of the money market rate around the policy rate declines sharply after the crisis in the case of Korea and Thailand while the volatility rises in the case of Indonesia.

3.27 Overall, the estimates indicate that while the potential for the exercise of independent monetary policy has increased due to greater exchange rate flexibility, there is no unambiguous evidence to indicate that the central banks have been able to exercise greater control over the money market interest rates.

IV INSTITUTION BUILDING AND THE NEW MONETARY POLICY FRAMEWORK

4.1 After the collapse of the quasi-Dollar exchange rate peg, Indonesia, Korea, and Thailand have adopted inflation targeting as the new monetary policy framework. Inflation targeting, rather than targeting monetary aggregate, appears to be a natural replacement for the exchange rate targeting that has become no longer viable, given that the demand for money in these countries are likely to be unstable following the rupture in the banking system during the crisis and the surge in the domestic inflation arising from the sharp depreciation of the currencies. Inflation targeting regimes are able to accommodate shocks in the demand for money and they tend to have a more direct influence of inflation expectation than monetary targets.[13]

4.2 At a more general level, the inflation targeting framework seeks to reconcile the conflict between credibility and flexibility that is inherent in the choice of the exchange rate/monetary regime [Frankel (1995), Edwards and Savastano (1999)]. The framework provides adequate "constrained discretion" to prevent the pursuit of time inconsistent policy under a flexible exchange rate regime while enabling the policymakers to conduct monetary policy that is not narrowly centred on inflation control but also places some weights on output stabilisation.

4.3 The institutional framework for inflation targeting had been enacted in Korea and Indonesia with the passage of the revised Bank of Korea Act in December 1997 and the new Bank of Indonesia Act in May 1999 respectively. Bank of Thailand has announced the formal adoption of inflation targeting in May 2000 and has appointed a Monetary Policy Board to implement the new monetary policy framework. The proposed amendment to the Bank of Thailand Act will confer the Monetary Policy

[13] See Bernanke et al (1999) for discussions on the relative merits of inflation versus monetary targeting.

Board its official status and its operational independence in the conduct of monetary policy.

4.4 The legislative enactment that seek to implement the inflation targetting framework appears to have incorporated the three key considerations that are considered to be necessary for the formulation and conduct of effective monetary policy under the new regime, namely (1) price stability being established as the dominant goal of monetary policy, (2) sufficient independence being conferred to the central bank to choose freely the instruments to achieve the goal of price stability, (3) the accountability of the central bank for achieving the monetary policy goal [Leiderman and Svensson (1995)].

4.5 In general, central banks that set price stability as the single or dominant objective of monetary policy is more likely to be able to achieve the inflation target than central banks in which monetary policy has other multiple objectives that may potentially conflict with the price stability goal.

4.6 Bank of Korea Act is specific in stating that price stability is the sole objective of monetary policy. In the case of Thailand, the Monetary Policy Board is entrusted to achieve price stability by taking into consideration the development in the external account, exchange rate, economic growth and other factors. In Indonesia, the objective of Bank Indonesia is to achieve the "stability of the Rupiah value" through the conduct of monetary policy, safeguarding the payment system, and regulation and supervision of the banks. The Elucidation of the Bank of Indonesia Act defines the stability of the Rupiah value both in terms of goods and services (domestic purchasing power) "as well as against foreign currencies". Some observers have argued that a major requirement of a successful inflation targetting policy is that the authorities should not seek to target another nominal variable like the exchange rate, especially in economies with open capital account where capital inflows could cause a conflict between the exchange rate and inflation targets [Masson, Savastano, and Sharma (1997)]. A compromise solution is for authorities to

indicate clearly that inflation target has priority when a conflict situation arises [Leiderman and Svensson (1995].

4.7 Cukierman (1992) has identified three dimensions for evaluating the degree of independence of a central bank that seek to achieve price stability as its primary objective, namely (1) the provisions for appointment, dismissal, and term of office of the chief executive officer of the central bank and the members of the executive board, (2) provisions governing the resolution of conflicts between the government and the central bank and the degree of participation of the central bank in the formulation of monetary policy and the budgetary process, (3) the legal restrictions on the central bank in financing the public sector borrowing requirements.

4.8 On the question of appointment and the tenure of the chief executive and the members of the executive board, both in Korea and Indonesia, the Governor of the central bank is appointed by the President of the country. In Indonesia, the appointment by the President is subject to the approval by the House of Representative while in Korea, the appointment is made after consultation with the State Council. Previously, the appointment of the Governor of the Bank of Korea was made in consultation with the Minister of Finance. The members of the Board of Governors in Indonesia are appointed for an initial five years and are eligible for appointment for another five-year term whereas in Korea, the members of the Monetary Policy committee are appointed for a four-year term and are eligible for reappointment. The literature on central bank independence has emphasised the need for sufficiently long-term tenure for policymakers in order for the long-term benefit of price stability to become apparent during the tenure of their terms [Romer and Romer (1997)]. In both countries, the legislations are specific on the circumstances under which the members of the Board of Governors or the Monetary Policy Committee can be dismissed.

4.9 In Indonesia, the Board of Governors is solely responsible for the conduct of monetary policy. A government minister may be invited to attend the meeting of the Board, but he has no voting right. In Korea, the

conduct of monetary policy is entrusted to the Monetary Policy Committee of which the Governor is the chairman. The Ministry of Finance has the right to nominate one voting member to the Committee. In the case where the decision of the committee is at variance with the thrust of the Government's economic policy, the Minister of Finance may request that the committee reconsider its decision, in which case the Minister must publicise the request. Article 92 of the Bank of Korea Act provides a role for the President of the country to make the final decision in the event of an impasse between the central bank and the Ministry.

4.10 To enhance the independence of decision making, the Bank of Indonesia Act vests the authority to supervise and approve the budget of the central bank to the House of Representative. In Korea, the budget allocation of the central bank operating expenses needs to secure the approval of the Minister of Finance.

4.11 The central bank legislation in Indonesia requires that the government holds prior consultation with the central bank and the House of Representative before it issues any state debt securities. The Act explicitly prohibits the Bank from making any direct purchase of state debt securities (except in the secondary market) or provide any other form of credit to the government. In Korea, the central bank is allowed to extend credit to the government and subscribe directly to the government debt securities. However, the total lending to the government is limited by the ceiling authorised by the National Assembly.

4.12 The legislation provides for greater accountability on the part of the central banks to the public in recognition of the fact that ultimately policy makers in a democratic country must be responsible to the public. Where the public and their elected representatives do not have a clear understanding of the policy of the central bank or misunderstand the policy initiative, there exists a possibility that such problems could lead to legislative action that would hamper the work of the central bank [Romer and Romer (1997)].

4.13 Article 58 of the Bank of Indonesia Act mandates that the central bank explain to the public media at the beginning of its fiscal year the conduct of monetary policy in the previous year and the proposed policy initiatives in the current year. This policy announcement has also to be communicated in writing to the President of the country and to the House of Representatives. In addition, the central bank must submit to the House a report every three months a report on "the implementation of its tasks and authority."

4.14 The Bank of Korea Act requires the central bank to publish its annual report within three months after the end of the fiscal year in which the Bank would discuss the implementation of its monetary policy in achieving the inflation target. The central bank has to submit a report at least once a year to the National Assembly and the Governor can be summoned to explain the policy decisions of the bank before the Assembly.

4.15 The preceding discussion on the institutional arrangement indicates that the central banks have the legislative mandate to formulate and implement monetary policy more independently. The ultimate degree of credibility the authorities will gain in the pursuit of price stability will depend on the actual conduct of monetary policy, which is the focus of the following section of the paper.

V EVALUATING MONETARY POLICY OBJECTIVES OF THE EAST ASIAN CENTRAL BANKS

5.1 We present a quantitative assessment of the policy objectives of the central banks of the four countries before the outbreak of the financial crisis and evaluate how much monetary policy goals have shifted since the onset of the crisis. We focus on the commitment of the central banks to bring inflation under control and the relative trade-off the authorities have to face in deciding between the policy goals of controlling inflation and output stabilisation.

5.2 A quantitative appraisal of the manner in which the central banks conduct their monetary policy can be made by estimating an interest rate rule or reaction function that relates interest rate setting by a central bank to the objectives of controlling inflation and stabilising the fluctuation of output around its trend. An interest rate rule, as Taylor (1999) and Clarida and Gertler (1997) have shown, is a general characterisation of the monetary policy decision making process that is consistent with either interest rate or money targeting policy regimes.

5.3 Clarida, Gali and Gertler (1998, 1999) have specified an econometrically tractable forward-looking interest rate reaction function of the form:

$$i_t^* = \bar{i} + b\left[E_t(p_{t+k}) - p_{t+k}^*\right] + g\left[E_t(y_{t+p}) - y_{t+p}^*\right] \qquad (12)$$

A central bank is assumed to set the nominal interest rate target i^* in period t as a function of the expected deviation of inflation and output gap from their target levels. p_{t+k} denotes the percentage change in the price level from t to $t+k$ (expressed in annual rates) and y_{t+p} is the average output gap (in percent) between period t and $t+p$. E_t is the expectation operator conditional on information available at time t. Equation (12) shows that when the output level, on an average, remains at the potential level and there is no

expectation of rising inflationary pressure over the relevant horizon, the nominal rate that is targeted by the central bank will gravitate towards the long run equilibrium rate $\bar{i}$.

5.4 The linear interest rate policy rule such as that given in equation (12) can be derived from a symmetric quadratic loss function in which the authorities place weights on both achieving inflation as well as output objectives. Svensson (1999) has characterised such policy optimisation as "flexible inflation targeting" and it is viewed as a more realistic description of the real world monetary policy decision making than the "strict inflation targeting" in which only inflation enters into the loss function.

5.5 The manner in which a central bank responds to the expected inflation rate by raising the nominal interest rate will determine the magnitude of the increase in the ex ante real interest rate, $ii_t \equiv i_t - E_t(\pi_{t+k})$. If $\beta > 1$, the nominal rate will be raised by an amount that is in excess of the expected rate of inflation, thereby increasing the ex ante real rate to the level that the authorities feel would be sufficient to dampen inflationary pressure. If $\beta < 1$, the ex ante real rate actually falls, even if the nominal rate is being raised. This moderate policy stance can be interpreted as accommodating inflationary expectation [Clarida, Gali, and Gertler (1998)].

5.6 Given that in practice, monetary authorities tend to smooth interest rate movement by making relatively small changes in each period of time towards the target rate [Rudebusch (1995), Goodfriend (1991)], the actual adjustment of the interest rate towards the target rate can be characterised as:

$$i_t = (1-\rho) i_t^* + \rho\, i_{t-1} + \nu_t \qquad (13)$$

Substituting (12) into (13), one gets:

$$i_t = (1-r)a + (1-r)E_t(p_{t+k}) + (1-r)gE_t(y_{t+p}) + r\,i_{t-1} + v_t \qquad (14)$$

5.7 Assuming that the monetary authorities form their expectation rationally, the unobservable forecast variables can be replaced by their actual values:

$$i_t = (1-r)a + (1-r)\,bp_{t+k} + (1-r)g\,y_{t+p} + r\,i_{t-1} + e_t \qquad (15)$$

While equation (14) is expressed all in observable variables, using OLS to estimate it will result in inconsistent parameter estimates as the error term e_t will be correlated with p_{t+k} and y_{t+p}. The Generalised Method of Movements (GMM) procedure can be used to obtain consistent estimates of (15) by exploiting the set of orthogonality conditions:

$$E_t(e_t \mid Z_t) = 0 \qquad (16)$$

where Z is a set of variables within the central bank information set that can be used as instruments for p_{t+k} and y_{t+p}. In addition, the GMM is also an asymptotically efficient class of estimator in light of the fact that the composite disturbance term e_t has an *MA(k-1)* representation as the forecast period exceeded the observation period.

5.8 We initially estimate equation (15) for the four countries using the pre-crisis monthly sample observations from January 1990 to June 1997[14]. The dependent variable is the policy rate of the authorities. Inflation is measured using the CPI and output is proxied by the (log) of the index of industrial production (IIP). The log of IIP is detrended using the Hodrick-Prescott filter to obtain a measure of the output gap. The instruments used include a constant term, six lags of inflation, output gap, interest rate, and the real exchange rate of the domestic currency against the US Dollar. We

[14] See Gerlach and Schnabel (1999) and Dolado et al (2000) for estimates of similar interest rate rule for other countries.

experimented with the choice of k and p at three and six months. The limited sample observations for the recent post-crisis period constrained the choice of a longer horizon for k and p.

5.9 Table 9 reports the GMM estimates of equation (15) for the four countries. The pre-crisis sample estimates for both inflation and output gap are statistically significant from zero for the four countries at the 5 percent level, indicating that the monetary authorities responded to the anticipated inflation and output gap deviating from their targeted levels by changing the nominal interest rates. However, the estimates on the degree to which the central banks are willing to raise the nominal interest rates to bring inflation in line with the target levels differ considerably among the central banks. The implied long-run estimate of b is highest in Thailand where it is 1.4 while the lowest estimate is obtained in Malaysia[15]. The estimates suggest that it was only in Thailand that the authorities were willing to raise the nominal interest rate to the level that is required to ensure a corresponding increase in the real rate. In Korea, the estimated value of b indicates that, on an average, a 1 percent increase in the expected inflation rate leads to an increase in the nominal rate of a similar magnitude, thereby leaving the real rate unchanged. In Indonesia, a 1 percent increase

[15] One possible explanation for the relatively low estimates of b for Malaysia was the concern by the Central Bank that a tight monetary policy that widen the interest rate differential significantly would induce large inflows of short-term capital. For example, between the end of 1993 and mid-1994, the influx of capital inflows raised the external liabilities of the banking system from RM 19.2 billion at the beginning of 1993 to RM 35 billion by May 1994. The dilemma of the Central Bank was summarised as follows:

"In managing the excess liquidity situation during 1994, the Central Bank was, therefore confronted with the conflicting objectives of controlling inflation, a policy objective pursued since 1989, and the need to discourage the inflow of speculative funds. The Central Bank's restrictive monetary policy stance had widened interest rate differentials in favour of Malaysia which contributed towards further short-term capital inflows….. Therefore, as part of the strategy to curb speculative inflows, domestic interest rates were allowed to drift downwards, narrowing the interest rate differentials….. This move created market concerns over the policy stance of the Central Bank as the downward adjustment in interest rates were viewed as inconsistent with the stated objective of monetary policy to combat inflation." [Bank Negara Annual Report 1994, pages 36-37].

in the expected inflation would cause the nominal interest rate to rise by only 55 basis points.

5.10 In Korea and Thailand, interest rate changes are also more aggressively used to stabilise output around its trend. In both countries, a 1 percent increase in the output gap, without inducing an expected increase in expected inflation, would cause the authorities in these two countries to raise the nominal rate by 77 basis points. In Indonesia, the interest rate increased on an average by 56 basis points, while in Malaysia it averaged around 36 basis points.

5.11 The p-values of the J-test [Hansen (1982)] statistic indicate that we cannot reject the overidentifying restrictions of the estimated equations. The satisfaction of the null hypothesis implies that the estimated equations correctly characterise the interest rate setting behaviour and that the variables used to forecast future inflation and output gap are adequate to ensure that e_t is orthogonal to Z_t.

5.12 We included next the real exchange rate against the US Dollar into the interest rate equation to determine the extent to which the authorities take into consideration, before the advent of the currency crisis, the movement in the real exchange rate in setting the interest rates.

5.13 The real exchange rate variable that we include directly into the interest rate equation is the deviation of the real exchange rate from its Hodrick-Prescott trend. With the exception of the Bank of Korea's reaction function, the estimates in Table 9 show that the deviation of the real exchange rate from its trend, for an unchanging inflationary expectation and output gap position, did not bring about significant interest rate response from the three other central banks. The finding is not surprising since the indirect impact of real exchange rate movement on inflation and the level of economic activity has already been taken into account by the inclusion of the changes in the real exchange rate as one of the instruments used for

predicting inflation and the output gap. Even in the case of the Korean reaction function, the addition of the detrended real exchange rate reduces substantially the size of the inflation coefficient and renders it statistically insignificant. This indicates that the influence that the real exchange rate has on interest rate setting is primarily via its pass-through to domestic inflation. In addition, the non-significance of the real exchange rate is consistent with the attempts by the authorities to use sterilised intervention to manage the exchange rate, while leaving monetary policy to be aimed at achieving domestic price and output stability.

5.14 We next extended the sample to include the period of the East Asia currency crisis and the subsequent economic recovery, i.e. from January 1990 to April 2000. Table 10 presents the estimates of the interest rate reaction function using the extended sample. The first noticeable change in the parameter estimates is the large increase in the value of b for Malaysia, Korea, and Thailand. The estimates indicate that the authorities in these countries are currently more vigilant and are more willing to act aggressively in raising the nominal interest rate to dampen the expected inflationary pressure. The sharp depreciation of the regional currencies would have generated strong and persistent inflationary pressure in these economies, despite the contraction in aggregate demand, had the central banks pursued a more accommodative monetary policy. The quick disinflation process that we have noted in Section II can be attributed to the willingness of the authorities to tighten monetary policy in face of the expected surge in inflation following the currency depreciation. The estimates for the three countries indicate that a 1 percent increase in expected inflation, will on an average, lead the authorities to increase the nominal interest rate by 2 percent. In other words, a 1 percent rise in the inflationary expectation over a six-month horizon will lead to an increase in the ex ante real interest rate by 1 percent.

5.15 The second noticeable change in the estimated equation is the significance of the real exchange rate. A depreciation of the real exchange

rate below its trend would trigger the central banks to raise the nominal interest rate. The response of the authorities to the exchange rate movement that is independent of its impact on inflation could be attributed to the concern of the authorities on the effect of large exchange rate depreciation on the real burden of the foreign currency denominated debt held with these countries. A debt deflation process triggered off by currency depreciation has been identified as one of the major sources of collapse in the financial system and economic activity following a currency crisis in the emerging market economies [Mishkin (1998)].

5.16 In the case of Indonesia, the inclusion of sample observations from the crisis period had resulted in the reduction of the explanatory power of expected inflation and output gap in the setting of the SBI rate by Bank Indonesia. Given the political uncertainty, the social disruption, and the extensive collapse of the financial system in the country, it is not surprising that interest rate movements have failed to track the conventional macroeconomic objectives. As Bank Indonesia stated in its 1998/99 Annual Report "… given the complexity of the problems and constraints on the economic and political fronts, the measures have failed at the implementation level to perform the expected outcome. Evidently, the effectiveness of macroeconomic policies is blunted to resolve the crisis under such environment" (p.1).

5.17 While the tight monetary policy imposed in the four countries since the onset of the currency crisis was deemed necessary to bring down the overall level of inflation, an interesting issue from the viewpoint of assessing the credibility of the tight monetary policy is whether it affect the persistence of the inflationary process. Theoretical models of inflationary persistence indicate that inertia in the inflationary process would depend on the perception of the public on the degree to which the authorities would accommodate future inflationary pressure so as not to sacrifice too much losses in output and employment. When the market participants believe that the authorities would tighten monetary policy in response to aggressive wage and price increases, a shock to inflation brought about by a currency

devaluation would not persist into the future for many periods. The degree of persistence in inflationary expectation lies at the heart of the controversy on whether conferring greater independence to central banks and adoption of inflationary targeting would improve the output/inflation volatility trade-off[16].

5.18 To investigate the degree of persistence in the domestic inflation, we fitted an ARMA model for the inflation differential between each of the four countries and the United States. Preliminary diagnostic tests of the residuals of the estimated models indicate that a parsimonious AR(1) model of the following form fits the data well for the four countries:

$$(p - p^{us})_t = j_0 + j_1(p - p^{us})_{t-1} + h_t \qquad (17)$$

The degree of persistence in the inflationary process is measured by the size of the parameter j_1. To the extent that j_1 lies within the unit circle, the mean of the inflation differential series will converge to $\frac{j_0}{1-j_1}$. The estimates of the AR(1) model for the entire monthly sample from Jan 1990 to September 2000 are shown in Table 11.

5.19 Figure 6 shows the evolution of the recursive least squares estimates of the j_1 coefficient over time together with its two standard errors band. The persistence parameter in the four countries rose significantly during the early months of 1998. For Indonesia, Malaysia, and Thailand, the increase in persistence lasted until the early months of 1999, after which the estimates gradually decline, although by the middle of 2000 the level of persistence is slightly higher than the average pre-crisis level of persistence. In the case of Korea, the decline in persistence is slower.

[16] See Debelle and Fischer (1994) and Cecchetti and Ehrmann (2000) for conflicting evidence.

5.20 Once the level and the degree of persistence in the inflationary pressure had declined from the early 1999 and the credibility of the stabilisation policies established, the authorities began to place greater weight on the output stabilisation side of the inflation/output variability trade-off. For example the inflation target of the Bank of Korea shifted from 9 ± 1 percent in 1998 to 3 ± 1 percent in 1999 and to 2.5 ± 1 percent for year 2000.

VI SUMMARY AND CONCLUSIONS

6.1 The paper examined the impact of the shift in the exchange rate regimes on the conduct of monetary policy in four East Asian economies. The findings indicate that in the post-crisis period, the adoption of a more flexible exchange rate regime in Indonesia, Korea, and Thailand have indeed enabled the authorities of these countries to exercise greater monetary autonomy and the greater flexibility in the exchange rate arrangement has not exacted cost in terms of loss of credibility in policy making.

6.2 The empirical analysis indicates that the authorities in the four countries have adopted a more aggressive approach towards inflation and have shown greater willingness to undertake pre-emptive tight monetary policy in anticipation of future inflationary pressure. One consequence of this is that inflation differential in these countries have not shown greater persistence despite the large nominal depreciation of the exchange rates during the currency crisis.

Appendix

The appendix provides the results of cointegration test of the long-run demand for real money balances that was described in Section II.

Table A1
Unit Roots and Cointegration Tests

	Indonesia	Korea	Malaysia	Thailand
Augmented Dickey Fuller Test				
log M2	-0.9963	-0.0842	-0.9121	-2.8497
log Y	-0.8456	-0.2166	-0.2002	-1.1502
RR	-2.5678	-2.4481	-2.6154	-2.3261
Johansen Cointegration test				
LR(0)	41.0527**	44.7983**	39.9462**	52.1263**
LR(1)	13.5261	9.3352	13.4148	18.0926*
LR(2)	0.9186	0.0367	0.3392	6.6015*

Notes: LR(0), LR(1). LR(2) refer to the trace statistics testing the null hypotheses that there is no cointegrating relationship, there is one cointegrating relationship, and there is two cointegrating relationships respectively. ** denotes the rejection of the null hypothesis at 1 percent significant level, * denotes the rejection at 5 percent significant level. M2 is nominal monetary aggregate deflated by the consumer price index, Y is the index of industrial production, and RR is the nominal money market interest rate minus the CPI inflation rate.

Table A2
Johansen Cointegrating Equation for the Long-run Demand for Real M2

	Indonesia	Korea	Malaysia	Thailand
Constant	0.2598	-0.3373	-3.6618	-2.2281
log Y	0.7286 (0.0375)	1.0589 (0.0363)	1.4662 (0.1319)	1.3612 (0.0266)
RR	-0.0076 (0.0017)	-0.0138 (0.0035)	0.0727 (0.0476)	-0.0084 (0.0017)
log likelihood	154.875	199.374	216.011	242.867

Notes: The number in parentheses are asymptotic standard errors.

Table 1
Unit Root Tests on Inflation Differential

	Augmented Dickey-Fuller Statistic	Phillips-Perron Statistic
Indonesia	-5.3023	-6.6776
Korea	-4.5604	-7.0268
Malaysia	-4.7256	-8.0576
Thailand	-5.2437	-8.2431

Notes: The Mackinon 5 percent critical values for ADF and the Phillips-Perron tests are –2.8972 and –2.8963 respectively.

Table 2
Net Private Capital Inflows (Percentage of GDP)

	Inflow Episode	1988	1989	1990	1991	1992	1993	1994	1995	Cumulative flows as percentage of GDP at end of episode
Indonesia	1990-1995	-	-	2.5	1.9	1.3	0.2	1.1	3.6	8.3
Korea	1991-1995	-	-	-	2.6	2.5	0.6	2.4	3.5	9.3
Malaysia	1989-1995	-	2.9	5.7	11.1	15.3	23.2	1.2	6.6	45.8
Thailand	1988-1995	7.4	10.4	12.3	12.3	8.6	7.7	8.3	12.1	51.5

Source: World Bank (1977) and Villanueva and Lim (1999)

Table 3
Testing the Pro-Cyclicality of Excess Money Supply

	l_0	l_1
Indonesia	-0.0275 (-4.5172)	-0.6002 (-1.6891)
Korea	0.0028 (0.4011)	-0.4908 (-0.7303)
Malaysia	0.03447 (1.4679)	-0.6643 (-0.6144)
Thailand	0.0105 (2.1607)	-0.8626 (-1.3789)

Notes: Figures in parentheses are t-values

Table 4
Testing the Impact of Monetary Growth on Inflation Differential

	$\sum b_i$	**Likelihood ratio test statistic**	**p-value**
Indonesia	-0.0518	3.1121	0.6827
Korea	0.1075	3.1224	0.6811
Malaysia	0.0375	7.3967	0.1927
Thailand	-0.4351	3.2411	0.6628

Notes: Likelihood ratio test refers to the test of the null hypothesis that the b_i coefficients are jointly zero.

Table 5
Impact of Excess Money Stock on Trade Balance

	$\sum f_i$	Likelihood ratio test statistic	p-value
Indonesia	-0.0485	35.7662	0.0000
Korea	-0.4150	92.2641	0.0000
Malaysia	-0.1393	98.105	0.0000
Thailand	-0.5507	29.3831	0.0000

Notes: Likelihood ratio test refers to the test of the null hypothesis that the f_i coefficients are jointly zero.

Table 6
Daily Exchange Rate Volatility

	Standard deviation of daily percentage change		Probability that the absolute Percentage change exceeds 1 percent band	
	January 2 1995-January 2 1997	January 2 1999-September 22 2000	January 2 1995-January 2 1997	January 2 1999-September 22 2000
Indonesia	0.2061	1.8791	0.19	43.36
Korea	0.2528	0.4016	0.76	4.36
Thailand	0.2223	0.5474	0.38	6.32

Table 7a
Deviation of the Domestic Interbank Interest Rate from the US Interest Rate: January 2 1995 – January 2 1997

	Indonesia	Korea	Malaysia	Thailand
a	0.1012 (1.9385)	0.0518 (1.5236)	0.0054 (1.7685)	0.2321 (3.2501)
b	-0.0107 (-1.9570)	-0.0090 (-1.9449)	-0.0065 (-1.8037)	-0.03634 (-2.9471)
a_0	0.0291 (10.5159)	0.0005 (1.6967)	0.0025 (7.3241)	0.0226 (0.3844)
a_1	0.0772 (3.3981)	0.0497 (1.9761)	0.8932 (1.1736)	0.0456 (2.8161)
b_1	0.0125 (0.1372)	0.9265 (31.5024)	0.0091 (0.2655)	0.8015 (13.9448)
$-a/b$	9.4577 (0.0000)	5.7555 (0.0000)	0.8307 (0.1034)	6.3869 (0.0000)
L	202.362	311.006	832.257	-256.516
$Q(12)$	8.3374	19.306	10.884	7.3136
$Q^2(12)$	0.6600	9.043	5.091	0.4595
ARCH-LM	0.0166	1.1297	0.006	0.0065
$a_0 / 1-a_1-b_1$	0.0319	0.2100	0.0255	0.1478
a_1+b_1	0.0897	0.9762	0.9023	0.8471
HL	1.2875	29.7792	6.7419	5.1775

Notes: HL denotes the half-life of a volatility shock. Figures in parentheses are the Bollerslev and Wooldridge t-values.

Table 7b
Deviation of the Domestic Interbank Interest Rate from the US Interest Rate: January 2 1999 – September 22 2000

	Indonesia	Korea	Malaysia	Thailand
a	0.0205 (2.7731)	0.0116 (1.0809)	-0.0058 (-1.9523)	-0.0213 (-2.9174)
b	-0.0038 (-4.0215)	-0.0206 (-1.4685)	-0.00045 (-0.0391)	-0.0088 (-2.4737)
a_0	0.0011 (1.6976)	0.0003 (0.8124)	0.0007 (0.7636)	0.0073 (2.53018)
a_1	0.2431 (2.5773)	0.0417 (2.0964)	0.1578 (1.3319)	0.0265 (12.2408)
b_1	0.6825 (11.0283)	0.9171 (35.7210)	0.6710 (2.2506)	0.4531
$-a/b$	5.3947 (0.0000)	0.5631 (0.0016)	-12.888 (0.0000)	-2.4204 (0.0000)
L		649.191	655.587	355.467
$Q(12)$	12.620	16.187	18.949	14.058
$Q^2(12)$	9.682	3.855	1.4695	6.086
ARCH-LM	1.0195	0.0071	0.0136	0.4081
$a_0 / 1-a_1-b_1$	0.0147	0.0073	0.0041	0.0140
a_1+b_1	0.9256	0.9588	0.8288	0.4796
HL	9.9672	17.4767	3.6913	1.9433

Notes: HL denotes the half-life of a volatility shock. Figures in parentheses are the Bollerslev and Wooldridge t-values.

Table 8a
Deviation of the Domestic Interbank Interest Rate from the Policy Rate: January 2 1995 – January 2 1997

	Indonesia	Korea	Thailand
a	0.0158 (1.7661)	0.0968 (2.7076)	0.2955 (4.1135)
b	-0.0115 (-1.8271)	-0.0958 (-3.2223)	-0.1191 (-4.3623)
a_0	0.0048 (1.4121)	0.0091 (1.545)	0.0023 (0.7751)
a_1	0.1491 (1.158)	0.0937 (1.6791)	0.0446 (1.9876)
b_1	0.6747 (6.4301)	0.8791 (15.4082)	0.9381 (21.1039)
$-a/b$	1.3739 (0.0000)	1.0104 (0.0000)	2.4811 (0.000)
L	332.561	-459.559	-165.917
$Q(12)$	11.860	42.802	9.6922
$Q^2(12)$	0.3209	42.802	3.4899
ARCH-LM	0.0095	35.4708	0.4294
$a_0 / 1-a_1-b_1$	0.0272	0.3345	0.1329
a_1+b_1	0.8238	0.9728	0.9827

Notes: Figures in parentheses are the Bollerslev and Wooldridge t-values.

Table 8b
Deviation of the Domestic Interbank Interest Rate from the Policy Rate: January 2 1999 – September 22 2000

	Indonesia	Korea	Malaysia	Thailand
a	-0.01323 (-1.0427)	0.0461 (2.8284)	-0.0042 (-1.6396)	0.0628 (2.0313)
b	-0.0236 (-1.7159)	-0.0229 (-2.7907)	-0.0023 (-1.8411)	-0.0260 (-2.3071)
a_0	0.0372 (1.3936)	0.0003 (1.2289)	8.24E-05 (10.7954)	0.0028 (1.7703)
a_1	-0.006 (1.5489)	0.0643 (1.8929)	0.1768 (9.5031)	0.2031 (1.8233)
b_1	0.6717 (1.8446)	0.8899 (14.2627)	0.8071 (97.494)	0.5445 (2.9046)
$-a/b$	-0.5635 (0.3977)	2.0131 (0.0000)	-1.8261 (0.0538)	2.4153 (0.0000)
L	-48.272	484.3643	768.6317	288.8009
$Q(12)$	6.4273	24.991	2.9252	5.2846
$Q^2(12)$	0.1045	10.644	1.4364	7.3186
ARCH-LM	8.50E-05	0.4672	0.0056	0.3632
$a_0 / 1-a_1-b_1$	0.1133	0.0065	0.0051	0.0111
a_1+b_1	0.6657	0.9542	0.9839	0.7476

Notes: Figures in parentheses are the Bollerslev and Wooldridge t-values.

Table 9
Estimates of Central Banks' Interest Rate Reaction Functions: January 1990 - June 1997

	Indonesia		Korea		Malaysia		Thailand	
Constant	-1.168 (-2.5841)	-1.1736 (-2.5937)	1.2991 (1.8827)	3.4668 (3.0553)	0.4447 (4.4882)	0.4325 (4.2137)	0.4688 (0.5405)	0.2088 (0.2398)
p_{t+6}	0.0536 (1.9829)	0.0535 (1.9714)	0.1761 (1.793)	0.0002 (0.001)	0.0281 (2.1887)	0.0244 (1.5846)	0.3607 (1.9109)	0.3866 (2.0521)
y_{t+3}	0.0551 (3.6474)	0.0551 (2.7096)	0.1371 (2.0994)	0.4101 (3.4311)	0.0280 (3.3521)	0.0301 (3.3775)	0.1761 (2.4547)	0.1381 (1.2636)
i_{t-1}	0.9002 (45.0481)	0.9003 (44.5661)	0.8220 (21.3867)	0.7352 (14.6571)	0.9000 (60.3550)	0.9126 (56.1638)	0.7504 (19.6363)	0.7587 (19.0711)
Real Exchange Rate		-0.0002 (-0.0064)		0.2399 (3.4856)		0.0017 (0.4656)		-0.0191 (-0.3967)
b	0.5513	0.5371	0.9903	0.0007	0.3614	0.2801	1.4455	1.6030
g	0.5661	0.5522	0.7707	1.5491	0.2813	0.3449	0.7057	0.5726
r	0.1487	0.1486	0.1737	0.1149	0.1539	0.1564	0.1696	0.1642

Notes: Figures in parentheses are t-values. $\tilde{n}$ is the p-value of the J-test for overidentifying restrictions.

Table 10
Estimates of Central Banks' Interest Rate Reaction Functions: January 1990 - April 2000

	Indonesia	Korea	Malaysia	Thailand
Constant	0.0281 (0.2113)	0.1937 (0.3884)	0.0282 (0.1221)	-0.1318 (-0.4924)
p_{t+6}	0.0008 (0.1866)	0.3948 (1.6769)	0.0991 (3.2478)	0.1256 (1.8901)
y_{t+3}	-0.0096 (-0.8441)	0.2339 (5.2991)	0.0283 (2.2442)	0.1255 (1.4476)
i_{t-1}	0.9853	0.8413 (9.5691)	0.9521 (33.7856)	0.9375 (30.9931)
Real Exchange Rate	-0.0062 (-0.1380)	0.2171 (3.9580)	0.01589 (2.8799)	0.0289 (1.9963)
b	0.0544	2.4845	2.0686	2.0096
g	-0.6523	1.4738	0.5914	2.0080
r	0.0912	0.1130	0.1660	0.1289

Notes: (a) The sample for Malaysia was January 1990 to August 1998.
(b) Figures in parentheses are t-values. $\tilde{n}$ is the p-value of the J-test for overidentifying restrictions.

Table 11
AR(1) Estimates of Inflation Differential

	Indonesia	Korea	Malaysia	Thailand
j_0	4.1148 (4.4586)	1.2878 (2.5775)	0.5245 (1.5288)	1.1736 (2.3155)
j_1	0.2058 (1.93310	0.4181 (5.0706)	0.1931 (2.1701)	0.2688 (3.0738)
Q(6)	2.1083 (0.909)	3.0620 (0.8010	1.6603 (0.948)	4.9294 (0.553)
F	0.1117 (0.8943)	0.2166 (0.6131)	0.2771 (0.7001)	0.3305 (0.7191)

Notes: Figures in parentheses below the coefficient estimates are t-values. *Q(6)* is the Ljung-Box Statistic testing the null hypothesis of no auto-correlation in the residuals up to 6 lags. *F* is the White test of the null hypothesis of no heteroskedasticity in the residuals. The figures in parentheses below the *Q(6)* and *F* are p-value.

Figure 1
Inflation Differential against the United States

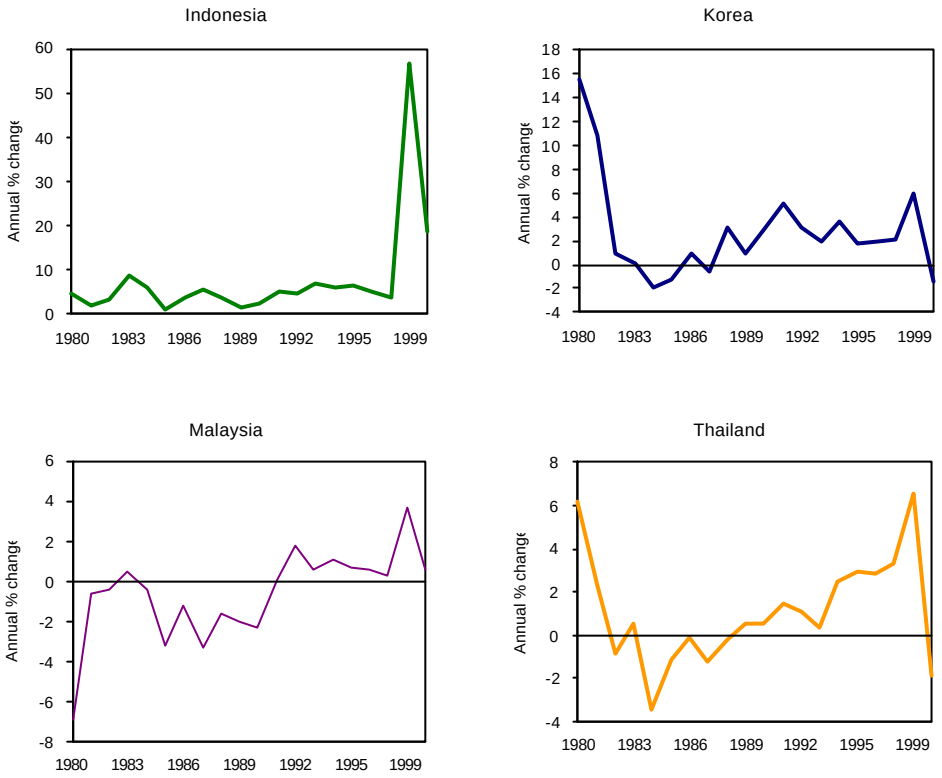
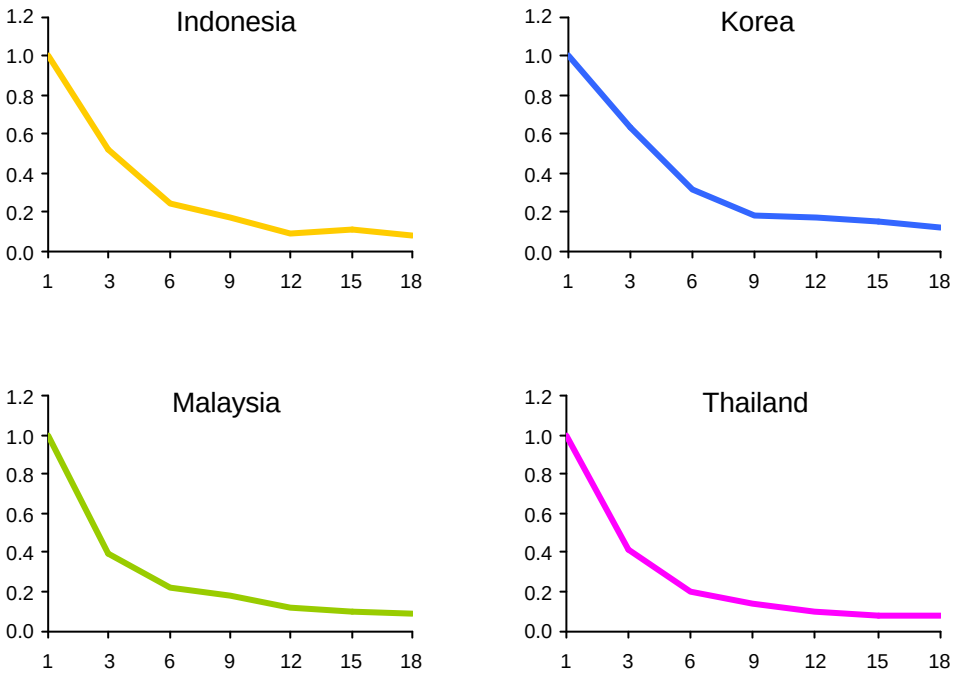


Figure 2
Variance Ratios of Inflation Differential



Notes: The variance ratios are adjusted for degrees of freedom

Figure 3
Central Government Deficit (-) / Surplus as % of GDP

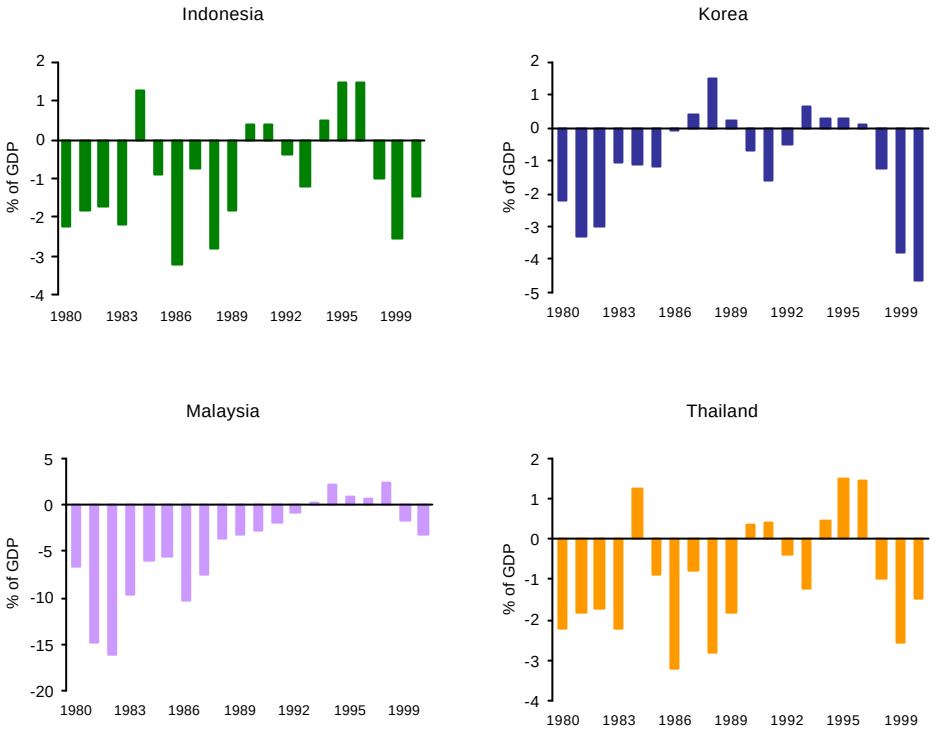


Figure 4
Current Account, Capital Flows, and Reserves Accumulation

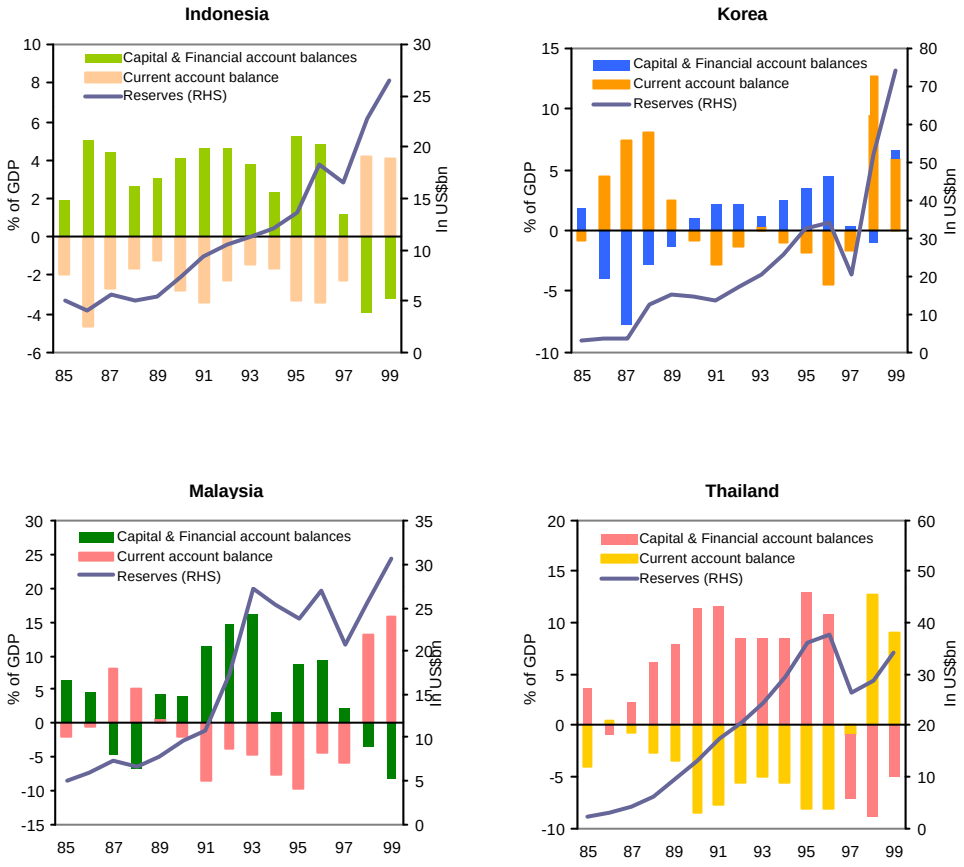


Figure 5
Money Supply and Loan Growth

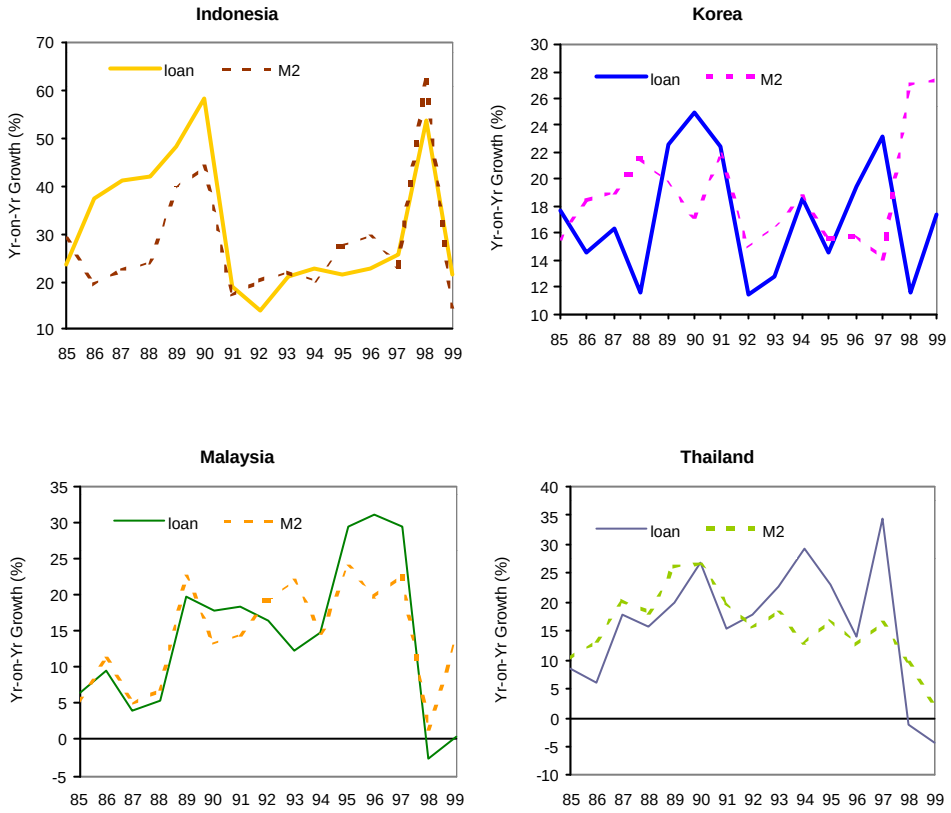
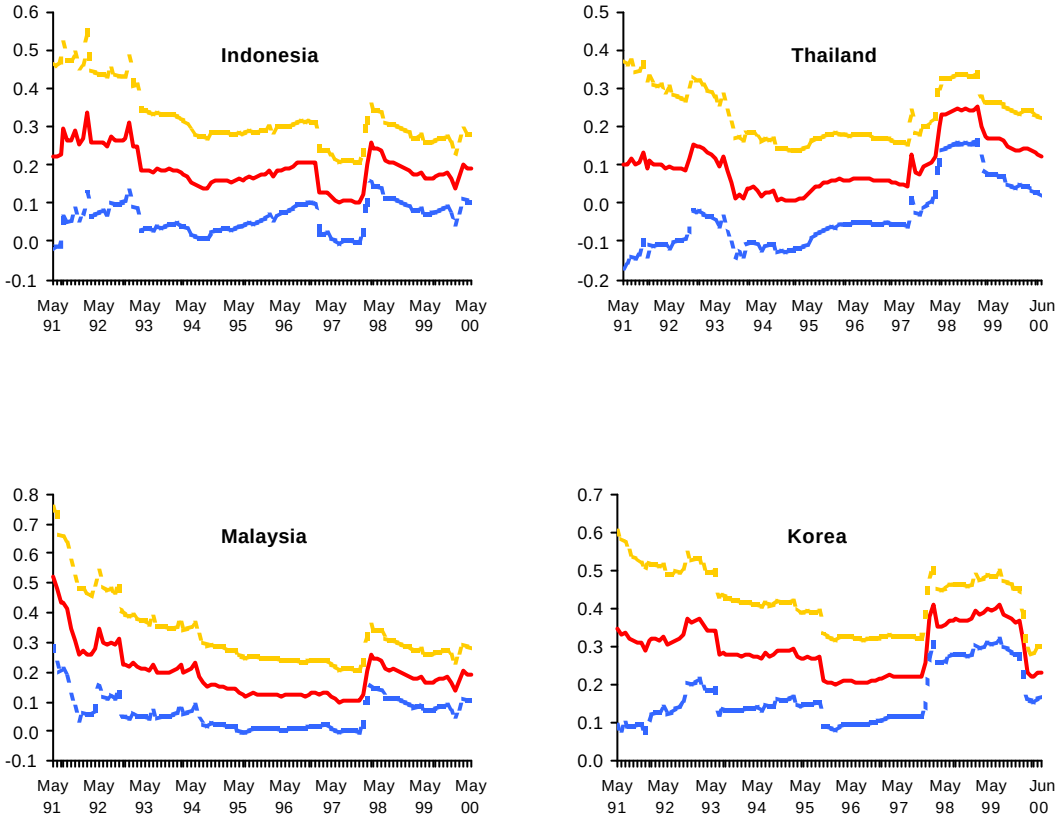


Figure 6
Recursive Estimates of the Coefficient of Lagged Inflation



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