Exchange Rate Policy In East Asia After The Fall: How Much Have Things Changed?

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EXECUTIVE SUMMARY

1 While much have been written on the relationship between the exchange rate regimes and the out break of the currency crises in East Asia, there is comparatively little literature on the conduct of the post-crisis exchange rate policies in the region. The paper analyses the following aspects of the post-crisis exchange rate regime:

(i) the shift in the relative weights accorded to the US Dollar and the Yen under the more flexible exchange rate regime;

(ii) the macroeconomic sources of exchange rate variability;

(iii) the process of regaining exchange rate credibility and exchange market stability; and

(iv) the reversion of the exchange rates back to their fundamental values.

1 INTRODUCTION

1.1 It has been almost two and half years since the East Asian currency crisis broke out following the devaluation of the Thai Baht on July 2 1997. Financial market stability has been restored and economic growth has resumed with considerable vigor in most of the East Asian economies. One key aspect of the post-crisis agenda to reform the international financial architecture involves finding an appropriate exchange rate regime for the individual countries that would make it less vulnerable to future devaluation crisis. The quasi-US Dollar peg that was adopted by some of the East Asian countries had been singled out by some observers as a major contributory factor in precipitating the currency crisis. The Dollar peg has been blamed for causing the overvaluation of the currencies [Ito, Ogawa, and Sasaki (1998), Edwards (1999), Eichengreen (1999)] and for encouraging excessive unhedged foreign currency borrowing through provision of implicit guarantee on exchange rate stability [Eichengreen and Hausman (1999)].

1.2 This study is concerned with the conduct of exchange rate policy in the aftermath of the currency crisis and attempts to evaluate how much exchange rate policy has changed in response to the weaknesses of the quasi-Dollar peg system. This paper focuses on the changes in the relative weights of the Yen and the Dollar in the currency baskets of the East Asian economies, the overall degree of exchange rate flexibility in response to the volatility in the underlying macroeconomic fundamentals, and the foreign exchange market perception of the credibility and risk of the post-crisis exchange rate regimes. Analysing how market expectations shift over time is crucial to understanding how the East Asian currencies has been able to achieve relative stability in a comparatively short period of time following the outbreak of one of the most devastating currency crises in the annals of modern economic history.

1.3 The rest of the paper is organised as follows: Section II evaluates how the East Asian exchange rates against the Dollar varied in response to changes in the Yen-Dollar exchange rate before and after the

outbreak of the currency crisis. Section III is concerned with the degree of exchange rate flexibility shown by the East Asian currencies following the exit from the quasi-Dollar peg and how much the variability in the exchange rates reflects attempts by the authorities to cope with the volatility of the underlying macroeconomic fundamentals. Section IV presents evidence on the foreign exchange market perception of the post-crisis exchange rate regime in terms of exchange market expectation of future depreciation and exchange rate uncertainty. Section V seeks an understanding of how the exchange rates moved back to their fundamental values thereby achieving relative stability over a rather short-period of time, even for those currencies that had experienced massive collapse. Section VI provides a summary of our findings and outlines the conclusions.

II THE YEN, US DOLLAR AND THE EXCHANGE RATE POLICY IN EAST ASIA

2.1 It is now part of the conventional wisdom that a major contributory factor to the currency crisis in East Asia was the overvaluation of the regional currencies as a result of being closely pegged to the US Dollar [Ito, Ogawa, and Sasaki (1998), Edwards (1999)]. A study by Frankel and Wei (1994) on the exchange rate policy of nine East Asian countries during the period 1979 to mid-1992 has shown that the weight that was attached to the Dollar in the currency baskets of most East Asian countries ranged from 0.9 to 1.0. The only exception was the Singapore Dollar which was found to assign a significant weight to the Yen, in addition to the Dollar. Kwan (1995) updated the Frankel and Wei study for the period 1991 to 1995 and the author further confirmed the dominant position of the Dollar in the East Asian currency baskets, although he found that the weight given to the Yen in the Korean Won, Thai Baht, Singapore Dollar, and the Malaysian Ringgit had increased during the later part of the sample period.

2.2 The system of defacto peg or quasi peg against the Dollar had conferred competitive advantage to these countries when the Dollar was relatively weak in the international currency market. However, since April 1995 when the Dollar started to appreciate against the Yen, the real effective exchange rates of most of the regional currencies started to appreciate.[1] Since these East Asian economies exported a substantial proportion of their goods to Japan, the loss in export competitiveness had contributed to the deterioration in the current account of the balance of payments. In fact Ito, Ogawa, and Sasaki (1998) have shown that the optimal weight for the Yen in the East Asian currency basket that minimises the variance of the trade balance of these countries is much larger than the implicit weights estimated by Frankel and Wei (1994) and others.[2]

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[1] Chinn (1998), using a monetary model of exchange rate determination, found that the real exchange rates of Thailand, Malaysia, Taiwan, and Singapore, to be overvalued during the early part of 1997.

[2] For example, the optimal weights for the Yen derived by the authors for the Baht ranged from 0.39 to 0.65, Rupiah from 0.52 to 0.60, and the Won was 0.89.

2.3 Our analysis in this section focuses on the response of the seven East Asian currencies to movement in the Yen-Dollar exchange rate following their forced exit from the quasi-Dollar peg regime. The more freely a regional currency is allowed to float against the Dollar, the more responsive the bilateral exchange rate would be to the movement in the Yen-Dollar exchange rate. The currencies analysed are the Baht, Ringgit, Rupiah, Won, the New Taiwan (NT) Dollar, the Philippines Peso, and the Singapore Dollar. The sample consists of daily exchange rate movements from January 2 1995 to September 30 1999.

2.4 The influence of the Yen-Dollar exchange rate on the exchange rate of a specific regional currency against the US Dollar is evaluated by estimating the following regression:

$$\Delta \log e_{kt} = a + b\ \Delta \log e_{¥t} + U_t \qquad (1)$$

where e_k refers to the number of units of a k regional currency to one US Dollar and $e_¥$ is the number of Yen per US Dollar. Where a regional currency is closely pegged to the Dollar, the movement of its exchange rate relative to the Dollar would be independent of the movement of the Yen-Dollar exchange rate, and the estimated value of $\hat{a}$ would approximate zero. Conversely, if a regional currency is closely pegged to the Yen, then its exchange rate against the Dollar would closely mirror the movement in the Yen-Dollar exchange rate, resulting in the estimated value of $\hat{a}$ being close to one. Consequently, the elasticity of the regional currency cross rate with the Yen with respect to the Yen-Dollar movement would be $1 - \hat{a}$.

2.5 Equation (1) was estimated over two sub-periods, namely January 2 1995 to July 1 1997 and from July 2 1997 to September 30 1999 using White's (1980) heterokedasticity-consistent least square estimator in view of the changing volatility of the exchange rates. The first sub-sample would capture the management of the East Asian exchange rates in response to the changes in the Yen-Dollar exchange rate before the

outbreak of the currency crisis while the second sub-sample covers the period of extreme turbulence in the foreign exchange markets as the financial crisis unfolded and the return to relative market tranquillity as the crisis subsided.

2.6 Table 1 presents the estimates of $\hat{a}$ for the seven East Asian currencies. The estimates of the Dollar elasticities for the seven currencies with respect to the Yen-Dollar movement during the period right up to the eve of the crisis indicate that the exchange rates of the East Asian economies were closely linked to the Dollar, the currencies with the strongest link to the Dollar were the Peso, Rupiah, Won, and the NT Dollar. For these currencies, a 1 percent change in the Yen against the Dollar would bring about, on an average, only a 0.05 of a percent change or less in exchange rate of these currencies against the Dollar. On the other hand, the cross rate of these currencies against the Yen would, on an average, move by 0.95 of a percent for every 1 percent change in the Yen-Dollar rate.

Table 1
East Asian Currencies' Linkage with the Yen and the US Dollar

Currency	January 2 1995 – July 1 1997			July 2 1997 – September 30 1999		
	â	R^2	*DW*	â	R^2	*DW*
Thai Baht	0.1095 (2.9791)	0.0159	2.4946	0.3752 (4.6534)	0.049	1.7981
Malaysian Ringgit	0.0972 (7.7707)	0.0954	2.2923	0.5928 (5.1589)	0.0791	1.9639
Philippines Peso	0.0026 (0.1882)	0.0001	2.1293	0.1458 (3.0601)	0.0150	1.8947
Indonesia Rupiah	-5.92E-05 (0.0073)	0.00	2.1664	0.6564 (4.4042)	0.0246	1.8599
Korean Won	0.0179 (1.124)	0.0023	2.2011	0.0190 (0.3074)	0.000	1.6384
NT Dollar	0.0541 (2.7139)	0.0277	2.2184	0.0887 (5.3229)	0.0356	1.7328
Singapore Dollar	0.1685 (12.0037)	0.2445	2.3491	0.3172 (8.5174)	0.2112	2.1411

Note: Figures in parentheses are t-values adjusted for heterokedasticity using the White procedure.

2.7 For the Baht, Ringgit, and the Singapore Dollar, the exchange rate against the Dollar is more sensitive to the movement in the Yen-Dollar rate. The estimated elasticity implies that a 1 percent appreciation in the Yen-Dollar exchange rate resulted in 0.10 to 0.17 percent appreciation of these currencies against the Dollar. The greater sensitivity of the exchange rate of these currencies against the Yen-Dollar movement implies that the monetary authorities sought to stabilise, to a limited extent, the cross rates of these currencies against the Yen.

2.8 The estimated elasticities indicate that since the abandonment of the defacto Dollar peg, the responsiveness of the bilateral exchange rate of these currencies vis-à-vis the Dollar to movement in the Yen-Dollar exchange rate had more than doubled the estimated pre-crisis elasticities. The largest shift towards a closer linkage to the Yen is evident in the Rupiah where the elasticity rose from virtually zero before the currency crisis to 0.65. The estimated elasticity implies that a 1 percent Yen appreciation against the Dollar would lead to a 0.65 percent appreciation of the Rupiah against the Dollar. In the case of the Baht, a 1 percent Yen appreciation against the Dollar would lead to an average of 0.38 percent appreciation in the Baht against the Dollar. The relatively large elasticity estimated for the Ringgit was obtained using the sample period from July 1 1997 to August 30 1998, before the imposition of capital control and fixing of the Ringgit-US Dollar exchange rate at RM3.80 per US Dollar on September 1 1998. The only two currencies that has maintained the close link with the US Dollar since the outbreak of the crisis are the Won and the NT Dollar.

2.9 A formal test of the null hypothesis that there is no structural change in the coefficient vector ($\acute{a}$, $\hat{a}$) of equation (1) before and after the outbreak of the crisis was conducted using a Wald test which allowed for the differences in the residual variance of equation (1) between the two periods. The results of the Wald test are presented in Table 2. The chi-square statistics indicate that the null hypothesis of no structural change cannot be rejected only for the Won and the NT Dollar.

Table 2
Wald Test of Structural Change in Coefficient Vector *(Æ,* â *)*

	Baht	Ringgit	Peso	Rupiah	Won	NT Dollar	Singapore Dollar
Chi-square at 2 d.f.	9.571	8.249	10.212	16.204	0.195	2.896	30.732
p-value	0.007	0.016	0.001	0.000	0.907	0.235	2.121E-07

III EXCHANGE RATE FLEXIBILITY AND MACROECONOMIC SHOCKS

3.1 The exit from the Dollar peg regime has led the monetary authorities to adopt a more flexible exchange rate policy which persisted even after the second half of 1998 when the underlying exchange market pressure had ebbed considerably. Table 3 shows the values of an index of exchange rate flexibility that we have calculated for the seven regional currencies for different sample periods. The index of exchange rate flexibility is constructed as [Glick and Wihlborg (1997) and Bayoumi and Eichengreen (1998)][3]:

$$SDFLEX = \frac{SDEX}{SDEX + SDREV} \qquad (2)$$

where $SDEX$ is the standard deviation of $\Delta log(e_{kt})$, $SDREV$ is the standard deviation of changes in the central bank's foreign exchange holdings divided by lagged stock of monetary base. The denominator of the index indicates the variability of the overall exchange market pressure arising from both the variability of the actual exchange rate movement and the incipient exchange rate changes that are neutralised by the central bank exchange market intervention. In order for an exchange rate regime to be considered flexible, it is not sufficient that the standard deviation of the nominal exchange rate increases but it must increase relative to the underlying exchange market pressure.

3.2 Table 3 presents the values of SDFLEX and its components, SDEX and SDRESV calculated using monthly data for the two sample periods. Before the outbreak of the crisis there were two distinct groups of countries in terms of the degree of exchange rate flexibility. In one group are the Peso, NT Dollar, Won and the Singapore Dollar which exhibited a relatively high degree of flexibility, as measured by the index SDFLEX. In another group, which consists of the Baht, Ringgit, and the Rupiah, the index

shows a relatively low degree of exchange rate flexibility. Among the first group of currencies, the Won, NT Dollar, and the Singapore Dollar had relatively small variability in the actual change in the exchange rate, despite the relatively higher index of exchange rate flexibility. This is explained by the low variability in the overall exchange market pressure experienced by these countries. On the other hand, the high degree of flexibility of the Peso reflected the greater variance in the underlying exchange market pressure and the general disinclination to intervene in response to the pressure.

3.3 On the other hand, the limited flexibility displayed by the Baht, Rupiah, and the Ringgit was mainly the consequence of active intervention in the face of large variability in exchange market pressure. The exchange market intervention had resulted in low exchange rate variability, especially for the Baht and the Rupiah.

3.4 Table 3 shows that even after the peak of the currency market pressure had passed, i.e. during the period after June 1998, the regional currencies had remained more flexible with the exception of the Ringgit and the Baht. In the case of the Ringgit, the imposition of capital control in September 1 1998 had dramatically reduced the degree of exchange market pressure compared to the pressure experienced in Thailand, Indonesia, and Korea. The fixing of the nominal exchange rate at RM3.80 per US Dollar on the same date had reduced the variance of the Ringgit exchange rate to almost zero.

3.5 The increase in volatility in the exchange rates following the currency realignment could be dominated by speculative pressure and "noise-trading" or it could reflect the volatility of the underlying macroeconomic fundamentals.

[3] For other approaches to developing indices of exchange rate flexibility see Holden, and Suss (1979) and Girton and Roper (1977).

Table 3
Indicators of Nominal Exchange Rate Flexibility

Currency	SDEX			SDEX + SDRESV			SDFLEX		
	1990:1 – 1997:6	1997:7 - 1999:6	1998:6 – 1999:6	1990:1 – 1997:6	1997:7 – 1999:6	1998:6 – 1999:6	1990:1 – 1997:6	1997:7 – 1999;6	1998:6 – 1999;6
Baht	0.0051	0.0918	0.0339	0.0595	0.3575	0.1270	0.0859	0.2564	0.2669
Ringgit	0.0125	0.0727	0.0005	0.1652	0.1552	0.0744	0.0756	0.4675	0.0067
Peso	0.0222	0.0568	0.0352	0.0840	0.1712	0.1217	0.2643	0.3317	0.2671
Rupiah	0.0024	0.2296	0.1665	0.0586	0.8982	0.6334	0.0409	0.2556	0.2629
Won	0.0079	0.1057	0.0503	0.0385	0.2716	0.2068	0.2052	0.3888	0.2432
NT Dollar	0.0109	0.0288	0.0195	0.0435	0.0674	0.0466	0.2506	0.4273	0.4185
Singapore Dollar	0.0103	0.0329	0.0255	0.0541	0.0853	0.0940	0.1904	0.3857	0.2713

3.6 An evaluation of the sources of exchange rate volatility is important since it would determine the optimal degree of flexibility at which the exchange rates should be managed in the aftermath of the Asian currency crisis when the underlying macroeconomic fundamentals of the economies have not yet fully stabilised. Where economies are vulnerable to macroeconomic shocks, a more flexible exchange rate regime serves as a shock absorber and prevents the underlying macroeconomic volatility from being transferred to the rest of the economy. On the other hand, if the volatility is mainly attributed to speculative noise, then intervention measure aimed at limiting the variability of the exchange rate would not have volatility consequences elsewhere in the economy.

3.7 To evaluate the relationship between exchange rate volatility and macroeconomic fundamentals, we employ the methodology developed by Rose (1994) and Flood and Rose (1995, 1998). The methodology allows one to ascertain whether the change in the exchange rate volatility brought about from a switch in the exchange rate regime, e.g. from a relatively fixed to a more flexible exchange rate system is followed by a corresponding increase in the variability of the macroeconomic fundamentals. Flood and Rose employed a monetary model of exchange rate determination with flexible as well as sticky prices to identify the underlying fundamentals. The models are useful for investigating the issue at hand since the link (linear)

between the exchange rate and the fundamentals is not dependent on the specific form of exchange rate regime.

3.8 In a flexible-price monetary model, the equilibrium money market condition is specified (in logarithms) as:

$$m_t - p_t = by_t - ai_t + e_t \quad (3)$$

where m denotes the (logarithms) of money stock, p is the price level, y is the real income, i is the nominal interest rate that clears the money market, and $\mathring{a}_t$ is the stationary shock that impinges on the money market.

3.9 Assume that there is a comparable money demand equation for the foreign country and the domestic and foreign elasticities, $\hat{a}$ and $\acute{a}$, are equal:

$$m_t^* - p_t^* = by_t^* - ai_t^* + e_t^* \quad (4)$$

where prices are flexible and the purchasing power parity (PPP) condition holds, subject to a disturbance:

$$(p - p^*)_t = e_t + v_t \quad (5)$$

where e is the nominal exchange rate and v_t is the disturbance in the goods market. Combining (4), (5), and (6), one obtains the familiar exchange rate equation:

$$e_t = (m - m^*)_t - b(y - y^*)_t + a(i - i^*)_t - (e - e^*)_t - v_t \quad (6)$$

Equation (6) highlights the volatility trade-off between exchange rate stability and macroeconomic variability. If the exchange rate is relatively fixed, a given macroeconomic shock (either through $\mathring{a}_t$, $\mathring{a}_t^*$, or v_t) would cause greater volatility in the macroeconomic variables. If the exchange rate is managed

more flexibly, the impact of the shock would be transferred to exchange rate movement, leaving the macroeconomic variables unchanged.

Equation (6) can be re-arranged into:

$$e - a(i - i^*)_t = (m - m^*)_t - b(y - y^*)_t - (e - e^*)_t - v_t \quad (7)$$

3.10 Flood and Rose (1995) called the left hand side of the equation (7) the "virtual fundamentals" (VF):

$$VF \equiv e - a(i - i^*)_t \quad (8)$$

and the first two terms on the right hand side of equation (7) the "traditional fundamentals" (TF):

$$TF \equiv (m - m^*)_t - b(y - y^*)_t \quad (9)$$

3.11 They characterised equation (9) that includes the money market shocks as "augmented traditional fundamentals" (ATF):

$$ATF \equiv (m - m^*)_t - b(y - y^*)_t - (e - e^*)_t \quad (10)$$

Since the money market disturbances are not observable, the ATF can be reformulated as[4]:

$$ATF \equiv (p - p^*)_t - a(i - i^*)_t \quad (11)$$

3.12 We calculate the conditional variance of the first difference of VF, TF, and ATF together with the variance of the change in the logarithm of seven regional currencies against the US Dollar using monthly data for the period January 1990 to September 1999. The consumer price index of each

country is taken as a measure of the price level, M2 represents money supply, index of industrial production proxies for real income, and the money market interest rate is taken to represent the relevant nominal interest rate for the demand for money. All the series, except for the nominal interest rates, are expressed in logarithms. Following Flood and Rose, the parameters $\acute{a}$ and $\hat{a}$ are set at 0.5 and 1 respectively.

3.13 Figures 1 to 7 display the plots of the first difference in the logarithm of the exchange rate against the Dollar and the first difference in the three measures of fundamentals. The figures show that, for each country, the marked increase in volatility of the exchange rates after July 1997 was accompanied by increase in the volatility of the fundamentals, especially the VF and ATF. Table 4 presents the standard deviations of the change in the nominal exchange rates and their fundamentals for two different time periods, i.e. January 1990 to June 1997 and July 1997 to August 1999. A volatility ratio, calculated as the ratio of the standard deviation of each of the variables before the onset of the currency crisis to the standard deviation of the variables during the crisis period is also presented in Table 4.

Table 4
Fundamental Volatility of the East Asian Currencies

Currencies	January 1990 – June 1997				July 1997 – August 1999				Volatility Ratio [(1)]			
	e	VF	TF	ATF	e	VF	TF	ATF	e	VF	TF	ATF
Baht	0.0020	0.0093	0.0127	0.0093	0.0329	0.0270	0.0151	0.0133	16.45*	2.91*	1.19	1.48*
Ringgit	0.0048	0.0049	0.0126	0.0027	0.0255	0.0250	0.0148	0.0035	5.31*	5.10*	1.17	1.84*
Peso	0.0071	0.0099	0.0220	0.0083	0.0200	0.0199	0.0248	0.0113	2.82*	2.01*	1.13	1.38*
Rupiah	0.0012	0.0095	0.0221	0.0100	0.0837	0.0795	0.0333	0.0222	69.75*	8.37*	1.51*	2.22*
Won	0.0033	0.0065	0.0108	0.0063	0.0384	0.0271	0.0172	0.0127	11.64*	4.17*	1.59*	2.02*
NT Dollar	0.0041	0.0072	0.0230	0.0069	0.0103	0.0101	0.0260	0.0044	2.51*	1.40*	1.13	0.68
Singapore Dollar	0.0040	0.0041	0.0255	0.0027	0.0113	0.0083	0.0397	0.0055	2.85*	2.02*	1.56*	2.27*

Note: [(1)] Ratio of sample standard deviation for sub-period July 1997 to August 1999 to sample standard deviation for sub-period January 1990 to June 1997.

* indicates the null hypothesis of equal variance in the two sub-periods is rejected at 0.05 confidence interval. The critical value of F(12, 120) at 0.05 level is 1.83.

4 By subtracting (3) from (4), solving for $(e - e^*)_t$, and substituting into (10).

3.14 The volatility of the VF shows marked increases for almost all currencies from July 1997 onwards, following the sharp increase in the variability of the nominal exchange rates. The volatility ratio indicates that the F-test for the null hypothesis of no significant change in the variance of VF after the outbreak of the crisis is rejected at 5 percent level for the six currencies except the NT Dollar. Similarly, the volatility of the ATF rose substantially after July 1997. In five out of the seven currencies, the variance of the change in ATF increased significantly after July 1997. On the other hand, the shift in the volatility of the TF is much more moderate, compared to the change in the volatility patterns of VF and ATF. The F-test rejects the null hypothesis of equality of variances for the TF only for three currencies. The difference between ATF and TF is that the former incorporates the shocks in the (relative) money demand. The greater volatility of ATF presumably reflects the shocks in money demand following the massive reversal of short-term capital flows following the outbreak of the currency crisis.[5] From mid-1998 onwards, the decline in the exchange rate volatility was accompanied by the reduction in the variability of the exchange rate fundamentals.

3.15 Overall, the analysis indicates that the increase in the exchange rate volatility of the East Asian currencies under the more flexible exchange rate regime was accompanied by an increase in the variability of some macroeconomic fundamentals.

[5] See Kamin and Wood (1998) for an analysis of the impact of capital flows on the demand for money.

IV REGAINING EXCHANGE RATE CREDIBILITY AND MARKET STABILITY

4.1 This section is concerned with how stability in the exchange rates was quickly restored within a period of less than eighteen months after the outbreak of the currency crisis. It has been well established that exchange market expectations are the key factor through which exchange rates are stabilised. Our objective is to characterise how the market expectations changed over the course of the crisis and to assess how far the shifts in the market sentiment can be explained by macroeconomic factors and the authorities' policy response to the crisis.

4.2 A commonly used measure of the expected rate of depreciation of a currency is the differential between the nominal interest rates on the domestic currency-denominated assets and the foreign currency-denominated assets:

$$i_t - i_t^* = E_t(\Delta e_{t+1} \mid I_t) \qquad (12)$$

where $i_t - i_t^*$ is the nominal interest rate differential, $\Delta e_{t+1} \equiv e_{t+1} - e_t$, and E_t is the market expectation conditional on information set I_t. Equation (12) holds only if the investors and speculators are risk neutral, or if the exchange rate risk premium exists, it remains small. However, even if the risk premium is non-negligible, the interest rate differential can still be a valid measure of exchange rate expectation so long as the former does not vary in such a way as to offset the relationship between the size of the interest rate differential and the exchange rate expectation.

4.3 In order to relate the market expectations of future exchange rate movement to the known macroeconomic variables, we follow the reduced-form projection approach that was employed by Chen and Giovannini (1994) and subsequently adopted by Rose and Svensson (1994), Marston (1995) and others.

4.4 The non-structural approach is based on the consideration that under rational expectations, the best estimate of expectations of an economic variable is based on the projection of the variables in the agents' information set at the time when the expectations are formed. Such projection is also closer in spirit to the actual practices of the market participants when they try to predict future movement of the exchange rates. The agents are more likely to use a wide range of macroeconomic variables in their information set when projecting future exchange rate changes than rely on a specific structural model of exchange rate determination.

4.5 The linear projection equation that we estimate is specified as:

$$i_t - i_t^* = Z_t^{'} b + U_{t+1} \qquad (13)$$

where Z_t is a vector of variables in the agents' information set at time t and U_{t+1} is the one-period ahead projection error. Under rational expectations, U_{t+1} should be orthogonal to the variables used to form expectations.

4.6 The set of macroeconomic variables that we employ include those that are considered to be the fundamentals in the monetary models of exchange rate determination such as the relative output growth, relative growth in money supply, and the relative inflation rates in the home and foreign countries. We have also included variables that have been identified in the empirical literature on currency crises as potential determinants of exchange rate vulnerability, such as the size of international reserves and the magnitude of the cumulative external imbalance [Eichengreen et al (1995), Corsetti et al (1998), Tornell (1999)]. In addition, we incorporate a variable that proxies for the credibility of the exchange rate policy. The market's subjective assessment of the extent to which a central bank is able to arrest future depreciation of the currency will, to a large extent, depend on how far the policy environment has been conducive for the exchange rate to recover to its pre-crisis level. The closer the exchange rate is able to regain some of its pre-crisis parity, the more confidence the market has on the

ability of the central bank to resist future downward exchange market pressure on the basis of its past success record. Hence a variable that measures the deviation of the current spot rate from the six-month average value of the exchange rate before the outbreak of the crisis can be expected to be negatively correlated with the nominal interest rate differential.[6]

4.7 Equation (13) was estimated for Thailand, Indonesia, Malaysia, and Singapore using monthly sample observations from January 1990 to September 1999. The four countries were selected on the basis of availability of the relevant macroeconomic data. The dependent variable is the three-month money market interest rate differential between each of the South-East Asian countries and the United States. The relative output growth is proxied by the difference in the monthly percentage change in the index of industrial production, relative money supply growth is measured by the difference between the monthly growth rates of M2. The external balance position is measured as the cumulative trade deficit or surplus of each country relative to the cumulative trade balance of the United States.

4.8 Table 5 presents the estimates of the determinants of the nominal interest rate differential. Each of the information variables is entered with one and two-month lags. The equations are estimated using the Newey-West (1987) heterokedasticity- and autocorrelation-consistent covariance matrix estimator in view of the fact that the three-month projection horizon is longer than the one-month sample observation interval, giving rise to a second-order serial correlation in the error term, U_{t+1}, of the projection equation.

[6] In their study of the expectation of currency realignment under the EMS, Chen and Giovannini (1994) use the length of time since the last exchange rate realignment as a credibility variable.

Table 5
Determinants of Exchange Rate Expectations
Based on Nominal Interest Rate Differential

	Thailand	Malaysia	Indonesia	Singapore
Constant	32.052 (1.358)	-3.844 (-0.956)	38.888 (3.738)	-42.621 (-4.885)
Relative money supply growth (-1)	13.852 (1.068)	-3.464 (-1.287)	13.033 (1.227)	-13.168 (-4.267)
Relative money supply growth (-2)	-1.149 (-0.119)	2.135 (0.904)	-8.705 (-0.802)	3.545 (1.335)
Relative inflation (-1)	179.543 (2.064)	58.301 (1.361)	-4.601 (-0.078)	-33.487 (-1.362)
Relative inflation (-2)	200.614 (2.842)	97.807 (2.481)	140.121 (1.947)	-31.284 (-1.245)
Relative cumulative trade balance (-1)	729.152 (2.818)	-259.902 (-1.373)	254.090 (1.639)	54.837 (2.398)
Relative cumulative trade balance (-2)	-605.001 (-2.510)	471.781 (2.823)	31.265 (0.2157)	-25.251 (-1.255)
Log of relative stock of reserves (-1)	-17.414 (-2.131)	3.528 (1.495)	2.311 (0.347)	1.335 (0.467)
Log of relative stock of reserves (-2)	11.565 (1.811)	-2.753 (-1.044)	-2.725 (-0.332)	5.211 (1.699)
Relative output growth (-1)	-19.269 (-1.930)	-8.458 (-2.575)	8.665 (1.1030	-1.582 (-1.171)
Relative output growth (-2)	-23.633 (-2.609)	-8.593 (-2.472)	20.226 (2.318)	0.112 (0.089)
Deviation of exchange [(a)] Rate from pre-crisis level	-0.698 (-3.202)	-1.087 (-1.647)	-0.004 (-6.325)	-2.613 (-1.449)
R^2	0.591	0.626	0.847	0.733
c^2 (11)	102.003 (0.000)	112.413 (0.000)	162.381 (0.000)	150.687 (0.000)

Notes: Figures in parentheses are t-values. Chi-square is the Wald-statistic that tests the hypothesis that all the information variables are jointly zero. The p-value is given below the statistic in parentheses.

(a) The pre-crisis exchange rate level is taken as the average of monthly values from January to June 1997.

4.9 Inflation differentials are significant determinants of exchange rate expectations in Indonesia, Thailand, and Malaysia, with the estimated coefficients indicating that higher inflation in these countries relative to the US led the market to expect the currencies to depreciate. Stronger growth in industrial production in Thailand and Malaysia tend to be associated with expectation of appreciation of the currencies. The stock of international reserves has a significant influence on the market expectation of the future movement of the Thai Baht, while an improvement in the liquidity of the financial system (as proxied by relative growth in M2) is associated with an expected appreciation of the Singapore Dollar. The estimated coefficients of the variable that measures the deviation of the spot rate from its average pre-crisis level all have the expected negative sign although they are statistically significant only in the case of Thailand and Indonesia. The Rupiah and the Baht had experienced the most drastic depreciation among the four currencies and the ability of the monetary authorities to bring about the necessary correction to the excess depreciation can be expected to have a significant impact on the market expectation. The R^2 of the estimated regressions varies from 0.59 to 0.84 and the Wald test of the null hypothesis that the information variables are jointly zero is rejected for the equations.

4.10 Finally we plot the predicted values of the regressions together with the actual interest rate differentials in Figure 8. The projected interest rate differentials based on the standard macroeconomic variables are able to track the actual interest rate differential fairly well during the turbulent period when the market expected the currencies to depreciate sharply and during the ensuing period of relative calm when it anticipated the exchange rates to correct the excess depreciation. Overall, our analysis has shown that the steady appreciation of the currencies and the stability in the foreign exchange market since the mid-1998 can well be explained by the improvement in the underlying macroeconomic fundamentals of the regional economies. The recovery in economic activities, lowering of inflationary pressure and rising surplus in the trade balance are some of the factors that had enabled the implicit expected rate of depreciation to diminish and eventually reversed.

4.11 The attainment of exchange market stability and the narrowing of interest rate differential following improvements in the underlying macroeconomic variables can be expected to reduce exchange rate uncertainty and consequently the exchange rate risk premium that is attached to the regional currencies. The theoretical models of international asset pricing show that the size of the risk premium depends on the conditional variance of the exchange rate depreciation and the coefficient of relative risk aversion.[7]

4.12 The concept of exchange market uncertainty that we focus on pertains to the variance of the forecast errors, i.e. exchange rate uncertainty increases if the variance of the one-period ahead exchange rate prediction error increases. For the purpose of determining the variance of the exchange rate around its conditional mean, we assume the market uses the following exchange rate prediction equation:

$$\Delta e_{t+1} = a_0 + a_1(f_t - e_t) + h_{t+1} \qquad (14)$$

where e is the logarithm of number of units of a regional currency to one US Dollar and f is the logarithm of the one-period forward rate.

4.13 While there have been numerous empirical studies which reject the hypothesis that the forward rate is an unbiased predictor of the future spot exchange rate, some of these studies have shown that the forward premium contains relevant information for forecasting changes in the spot exchange rate. Accordingly we consider equation (14) as an acceptable forecasting equation, even though the unbiasedness hypothesis is widely rejected in the empirical literature.

[7] For a survey of the models see Frankel and Meese (1987) and Lewis (1995)

4.14 We estimate equation (14) using a GARCH (1,1) model in which the conditional variance of the forecast error, h_{t+1}^2, is specified as:

$$h_{t+1} \mid I_t \sim N(0, h_{t+1}^2)$$
$$h_{t+1}^2 = l_0 + l_1 e_t^2 + l_2 h_t^2 \qquad (15)$$

where I_t represents information available at time t.

4.15 Equations (14) and (15) are jointly estimated for the Baht, Ringgit, Rupiah, and the Singapore Dollar over a monthly sample from January 1995 to September 1999. The non-availability of the forward exchange rate data for the other regional currencies prevents us from estimating the equations for these currencies. Table 6 presents the estimates of the equations using the one-month forward discount as the independent variable in the conditional mean equation. The one-month-ahead conditional variances of the exchange rate forecast error h_{t+1}^2 for each of the currencies are plotted in Figure 9.

4.16 Figure 8 shows that the variance of the forecast error rose sharply following the outbreak of the currency crisis and continued to remain high until the second half of 1998, indicating high exchange market uncertainty regarding the future direction of the currencies. Since then, however, the market uncertainty has diminished sharply and in recent months the variance of the exchange rate forecast has declined to almost the pre-crisis level.

Table 6
GARCH Estimates of Forward Discount Forecasting Equation

	Baht	Ringgit	Rupiah	Singapore Dollar
$á_0$	-0.0036 (-3.8208)	-0.0038 (-2.9700)	0.0105 (3.5522)	-5.76E-05 (-0.0380)
$á_1$	1.3509 (6.0924)	0.1639 (0.3759)	1.2684 (1.5468)	-0.1113 (-0.1201)
$ë_0$	-1.48E-06 (-0.1719)	3.54E-07 (0.0854)	2.28E-05 (0.3972)	2.28E-06 (0.5356)
$ë_1$	3.1298 (3.9555)	1.0543 (3.9776)	2.5305 (1.9466)	0.5781 (2.0719)
$ë_2$	0.1517 (2.0984)	(0.4263) (7.2138)	0.2623 (2.1357)	0.5899 (4.4461)
Q(12)	8.209	6.983	7.436	20.682
ARCH LM	0.025	0.091	0.069	0.318
Jarque-Bera	20.347	30.245	4.309	1.826

Note: Figures in parentheses are t-values.

4.17 Our analysis thus far indicates that the post-crisis exchange rate regimes have shown greater exchange rate flexibility; currencies are allowed to fluctuate more regularly and over a wider interval. However, the more flexible exchange rate arrangements have not, after the most turbulent period of the crisis had passed, resulted in greater exchange rate uncertainty. In this respect, the market has not changed its mind much despite the change in the information set unlocked by the crisis about the East Asian economies.

V LONG RUN REVERSION TO FUNDAMENTAL VALUES

5.1 Some observers like Radelet and Sachs (1998) have pointed out that during the depth of the East Asian currency crisis, the exchange rates of the most severely affected economies had depreciated well below the levels dictated by the underlying fundamentals. In the following analysis, we focus on the extent of fundamental overshooting and the time horizon it takes for the exchange rates to revert back to the values dictated by macroeconomic fundamentals.

5.2 We employ the long-horizon regression approach that was pioneered by Fama and French (1988) to investigate the relationship between the stock returns and dividend yield to evaluate the speed at which the regional currencies adjust back to their fundamental values after an initial under-valuation. Mark (1995) and Chinn and Meese (1995), among others, have used a similar approach to investigate the long-horizon predictability of the OECD currencies. The multi-period long- horizon regression model can be specified as:

$$e_{t+k} - e_t = a_k + b_k (F_t - e_t) + h_{t+k,t} \qquad (16)$$

The equation shows how the k-period ahead change in the logarithm of the exchange rate respond to the current deviation of the exchange rate from its fundamental value, F_t. A positive value of $\hat{a}_{CE}$ would indicate that the exchange rate starts to revert back to its fundamentals at the time $t+k$ at a speed given by the estimated value of $\hat{a}_{CE}$

5.3 Equation (16) is estimated for the seven East Asian currencies over the same monthly sample from January 1990 to September 1999. The equation is fitted over forecast horizons from one to twenty-four months at the intervals of k = 1, 3, 6, 12, 18 and 24 months. Given that the forecast horizons are longer than the sampling interval of monthly observations, this would induce (*k-1*)th-order serial correlation in the error term, ς_{t+CE}. The

Newey-West (1987) covariance matrix estimator is used to obtain a consistent estimate of the regression standard errors.

5.4 Tables 7 and 8 present the estimates of equation (16) for the seven exchange rates, using two alternative representation of the fundamental value, f, namely TF and ATF. In each of the tables, we display the estimates of $\hat{a}_{CE}$ and its serial correlation-consistent standard errors in the round parentheses. The R^2s of the regressions are reported in the square parentheses.

5.5 The estimates of $\hat{a}_{CE}$ indicate that the reversion to fundamental value, when TF is used, as the fundamental, starts as early as one month for the Singapore Dollar. This is followed by the Peso and the NT Dollar where the adjustment back to the fundamental values began to take place three to six months after a depreciation in the spot rate below the fundamental. For the rest of the currencies, the process of fundamental reversion starts from twelve months onward. The increase in the estimated values of $\hat{a}_{CE}$ and the R^2 as k rises is consistent with the findings made by Mark (1995) and Chinn and Meese (1995). The TF has a superior explanatory power over ATF in characterising the process of long run fundamental reversion among the currencies under consideration.

5.6 Finally note that the estimates of $\hat{a}_{CE}$ in the equation in which the TF serves as a measure of the fundamental value, vary inversely with the magnitude of the actual depreciation of the exchange rates that took place during the height of the currency crisis. The estimates for the NT Dollar and the Singapore Dollar are the smallest at, for example, the one-year horizon while the estimate for the Rupiah is the largest. The estimate of $\hat{a}_{12}$ for the Rupiah implies that a one-percent under valuation would lead to an appreciation of one percent over the next twelve months. On the other hand, for the Singapore Dollar and the NT Dollar where the process of fundamental reversion starts earlier, a one-percent under-valuation leads to only 0.25 and 0.17 percent appreciation. The relative large estimates for the Rupiah at longer horizons are suggestive of the considerable initial

undershooting of the exchange rate below its fundamental value when the currency depreciated.

Table 7
Estimates of Reversion to Fundamental Value
Using TF as a Measure of Fundamental

ê	â						
	RM	**SGD**	**RUP**	**BHT**	**PESO**	**WON**	**NTD**
1	0.0291 (0.0171) [0.035]	0.0187 (0.0074)* [0.055]	0.0303 (0.0396) [0.006]	0.0313 (0.0206) [0.024]	0.0309 (0.0173) [0.039]	0.0605 (0.0181) [0.006]	0.0093 (0.0067) [0.018]
3	0.0975 (0.0556) [0.098]	0.0598 (0.0203)* [0.132]	0.1479 (0.1192) [0.035]	0.1166 (0.0663) [0.077]	0.1248 (0.0583)* [0.131]	0.1264 (0.0951) [0.046]	0.0322 (0.0202) [0.049]
6	0.2013 (0.1108) [0.181]	0.1301 (0.0347)* [0.3163]	0.3322 (0.2160) [0.083]	0.2295 (0.1282) [0.139]	0.2706* (0.1097) [0.242]	0.2502 (0.1605) [0.091]	0.0745 (0.0356)* [0.127]
12	0.4188 (0.1496)* [0.351]	0.2551 (0.0564)* [0.4651]	1.009 (0.3646)* [0.319]	0.4572 (0.1845) [0.257]	0.5662 (0.1302)* [0.476]	0.5068 (0.2122)* [0.226]	0.167 (0.0542)* [0.271]
18	0.5999 (0.1243)* [0.513]	0.3803 (0.0591)* [0.583]	1.4816 (0.3908)* [0.427]	0.6623 (0.1678) [0.433]	0.7289 (0.1148)* [0.618]	0.6769 (0.1915)* [0.337]	0.2517 (0.0475)* [0.477]
24	0.7372 (0.1005)* [0.633]	0.4779 (0.0651)* [0.613]	2.1336 (0.3521)* [0.593]	0.7643 (0.1331) [0.549]	0.7853 (0.1027)* [0.657]	0.7081 (0.1837)* [0.327]	0.3024 (0.0397)* [0.653]

Notes: Figures in parentheses are serial correlation consistent standard errors while those in the brackets are the R^2s. * denotes coefficient is significant at 5 percent level.

Table 8
Estimates of Reversion to Fundamental Value
Using ATF as a Measure of Fundamental

ê	â						
	RM	**SGD**	**RUP**	**BHT**	**PESO**	**WON**	**NTD**
1	0.0028 (0.0229) [0.0001]	0.0208 (0.0155) [0.015]	0.0010 (0.0327) [0.000]	0.0074 (0.0446) [0.001]	-0.0041 (0.0162) [0.001]	0.0218 (0.0429) [0.008]	0.0051 (0.022) [0.001]
3	0.0312 (0.0415) [0.005]	0.0857 (0.0416)* [0.0618]	0.0317 (0.0861) [0.005]	0.0647 (0.0956) [0.019]	0.0244 (0.0469) [0.005]	0.1307 (0.0991) [0.059]	0.0281 (0.0570) [0.006]
6	0.0943 (0.0741) [0.021]	0.1476 (0.0761)* [0.092]	0.0722 (0.1247) [0.0126]	0.1567 (0.0819) [0.053]	0.1081 (0.0961) [0.038]	0.2451 (0.0421)* [0.114]	0.0639 (0.0879) [0.014]
12	0.2899 (0.1393)* [0.07]	0.3328 (0.1242)* [0.183]	0.2705 (0.1280) [0.064]	0.3820 (0.1077)* [0.150]	0.3482 (0.1531)* [0.177]	0.4354 (0.0578)* [0.194]	0.2309 (0.0851)* [0.062]
18	0.5549 (0.2828)* [0.103]	0.6290 (0.1549)* [0.347]	0.2186 (0.1997) [0.012]	0.5208 (0.1340)* [0.169]	0.5474 (0.1609)* [0.321]	0.5516 (0.0698)* [0.190]	0.3022 (0.1389)* [0.042]
24	1.8968 (0.6214)* [0.271]	1.011 (0.1687)* [0.563]	0.1228 (1.2380) [0.0002]	1.0032 (0.6871) [0.112]	0.7186 (0.1462)* [0.449]	2.0826 (0.7221)* [0.275]	0.5090 (0.3480) [0.040]

Notes: Figures in parentheses are serial correlation consistent standard errors while those in the brackets are the R^2s. * denotes coefficient is significant at 5 percent level.

VI SUMMARY AND CONCLUSIONS

6.1 The paper set out to investigate how the conduct of the exchange rate policy among the East Asian economies has changed in the aftermath of the currency crisis and the manner in which stability in the exchange market has been restored relatively quickly despite the severity of the crisis.

6.2 Our analysis has shown that since the outbreak of the crisis the East Asian monetary authorities have managed their exchange rate more flexibly and have assigned progressively greater weight to the Yen at the expense of the US Dollar in their currency baskets. The shift towards greater exchange rate flexibility and towards placing greater weight on the Yen has served to redress one of the major weaknesses of the quasi-Dollar peg.

6.3 Our analysis indicates that changes in the exchange rate volatility among the East Asian currencies were followed by shifts in volatility of the fundamentals, and the attainment of exchange market stability since the second half of 1998 can be traced to the improvement in macroeconomic fundamentals and to the greater credibility that has been acquired by the regional monetary authorities. The exchange market stability has resulted in lower exchange rate uncertainty and consequently lower risk premium. Market stability has also allowed the exchange rates to revert back gradually to their fundamental values.

Figure 1
Variations in the Exchange Rate and its Fundamentals: Indonesia Rupiah

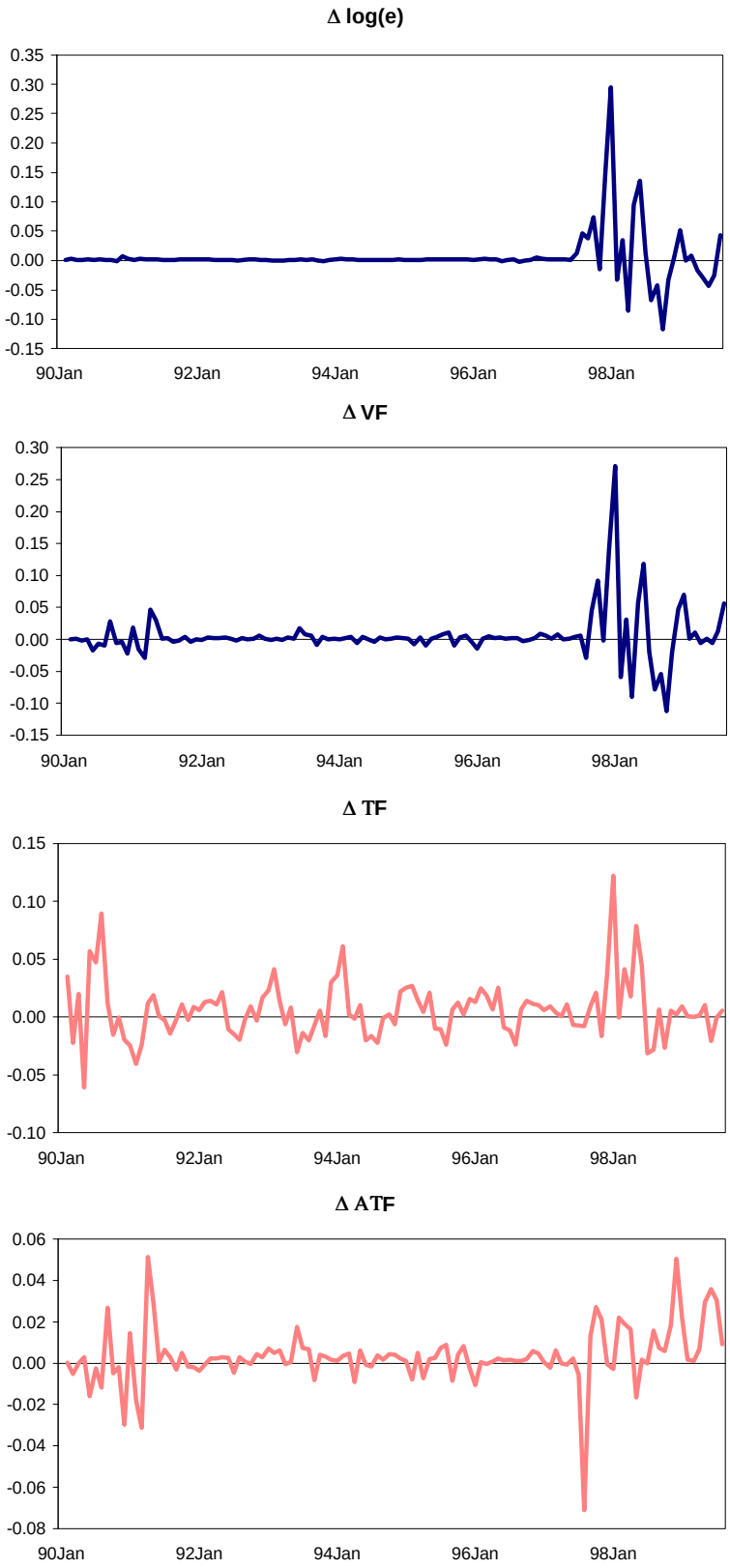


Figure 2
Variations in the Exchange Rate and its Fundamentals: Malaysian Ringgit

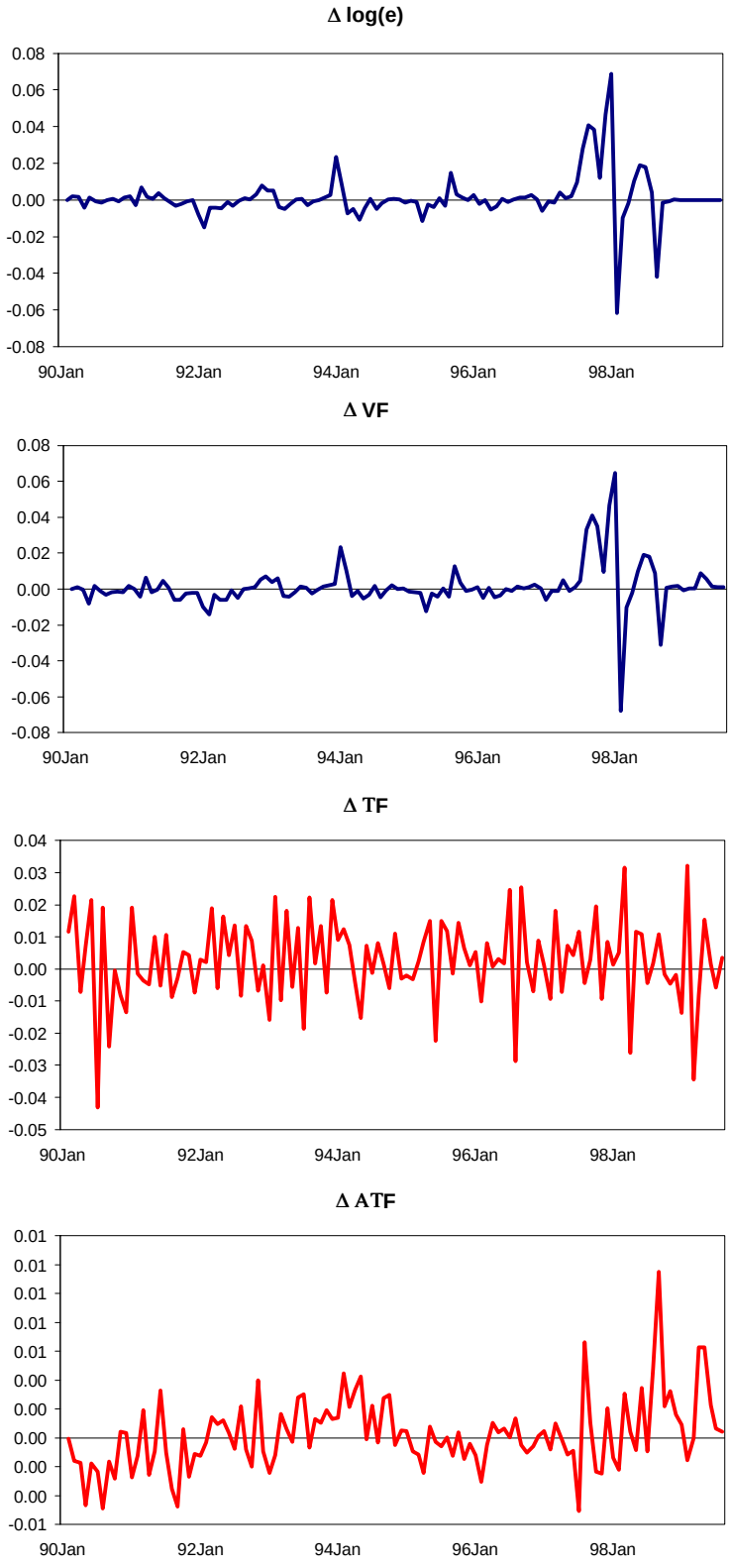


Figure 3
Variations in the Exchange Rate and its Fundamentals: Singapore Dollar

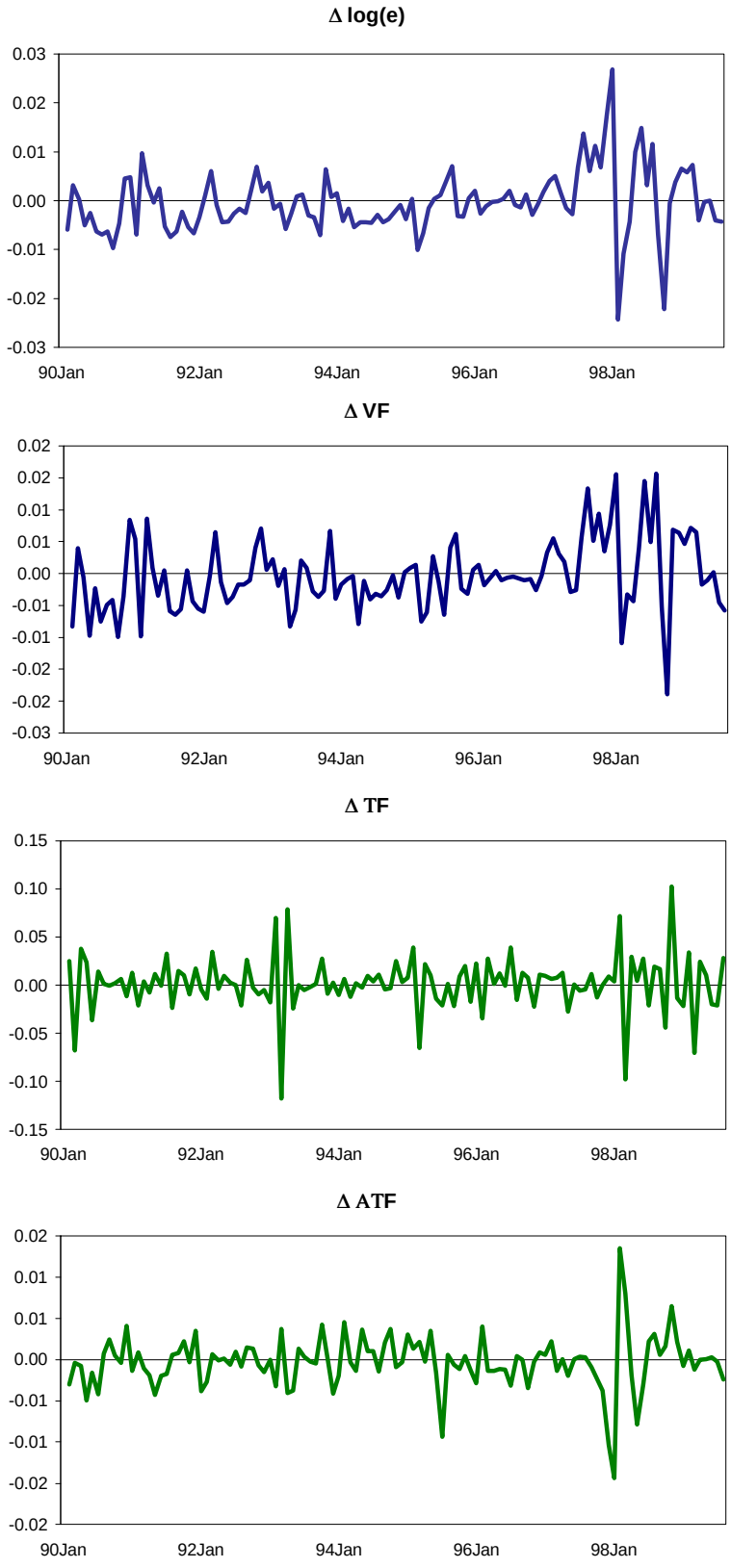


Figure 4
Variations in the Exchange Rate and its Fundamentals: Thai Baht

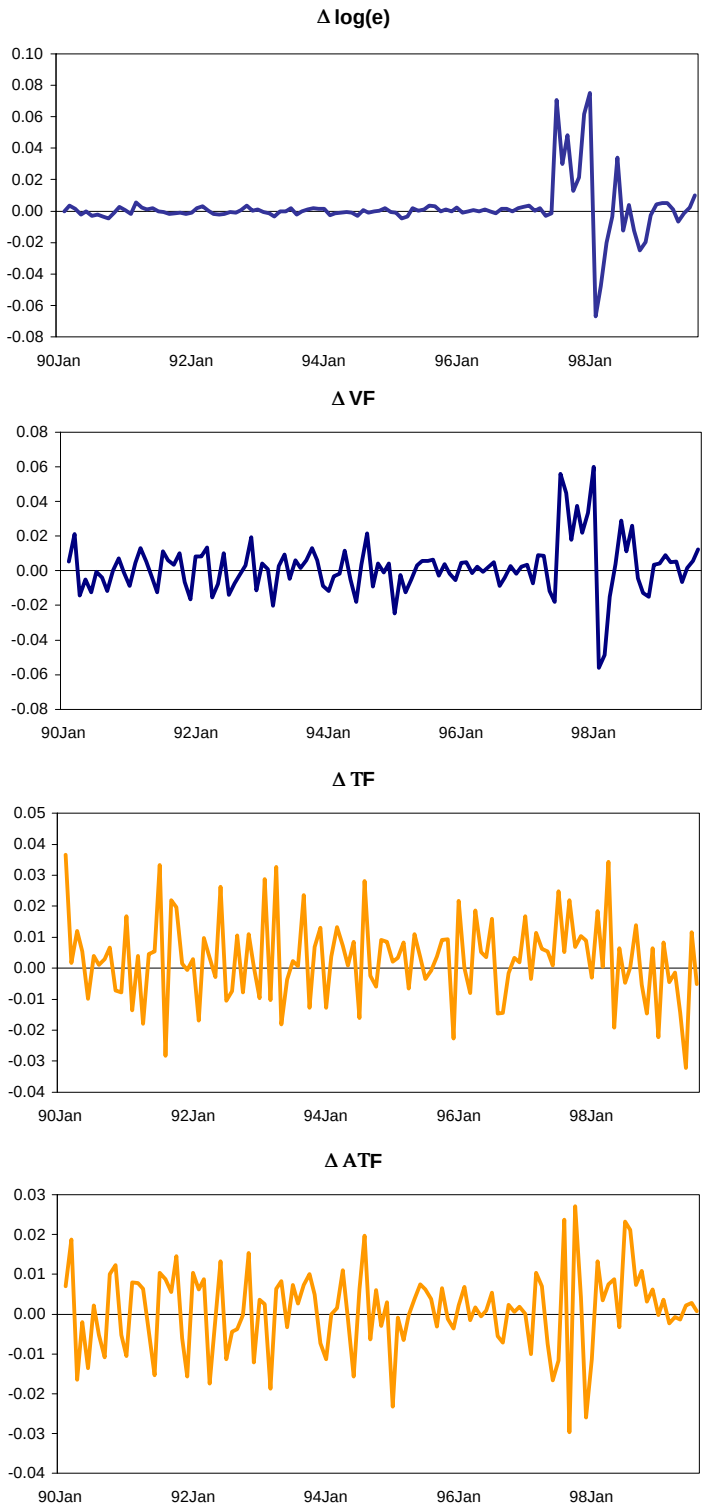


Figure 5
Variations in the Exchange Rate and its Fundamentals: Philippines Peso

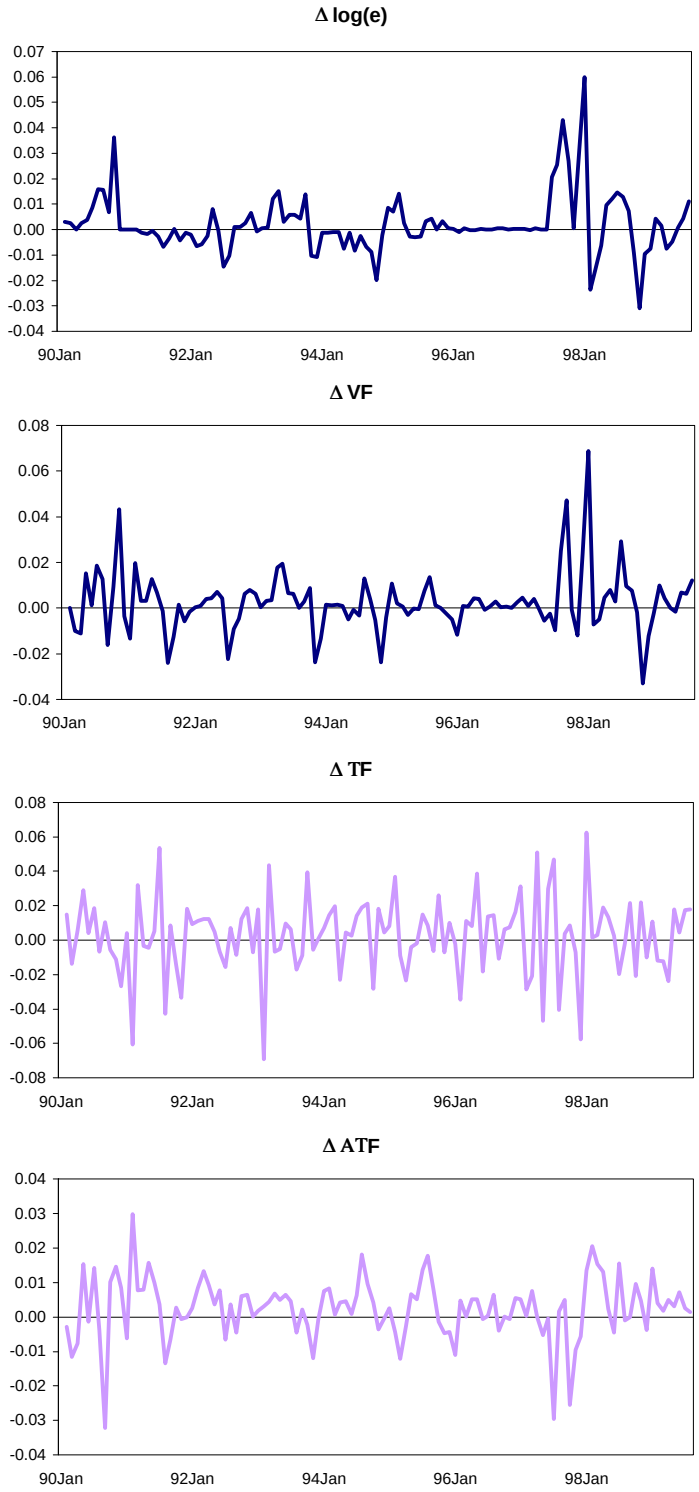


Figure 6
Variations in the Exchange Rate and its Fundamentals: Korean Won

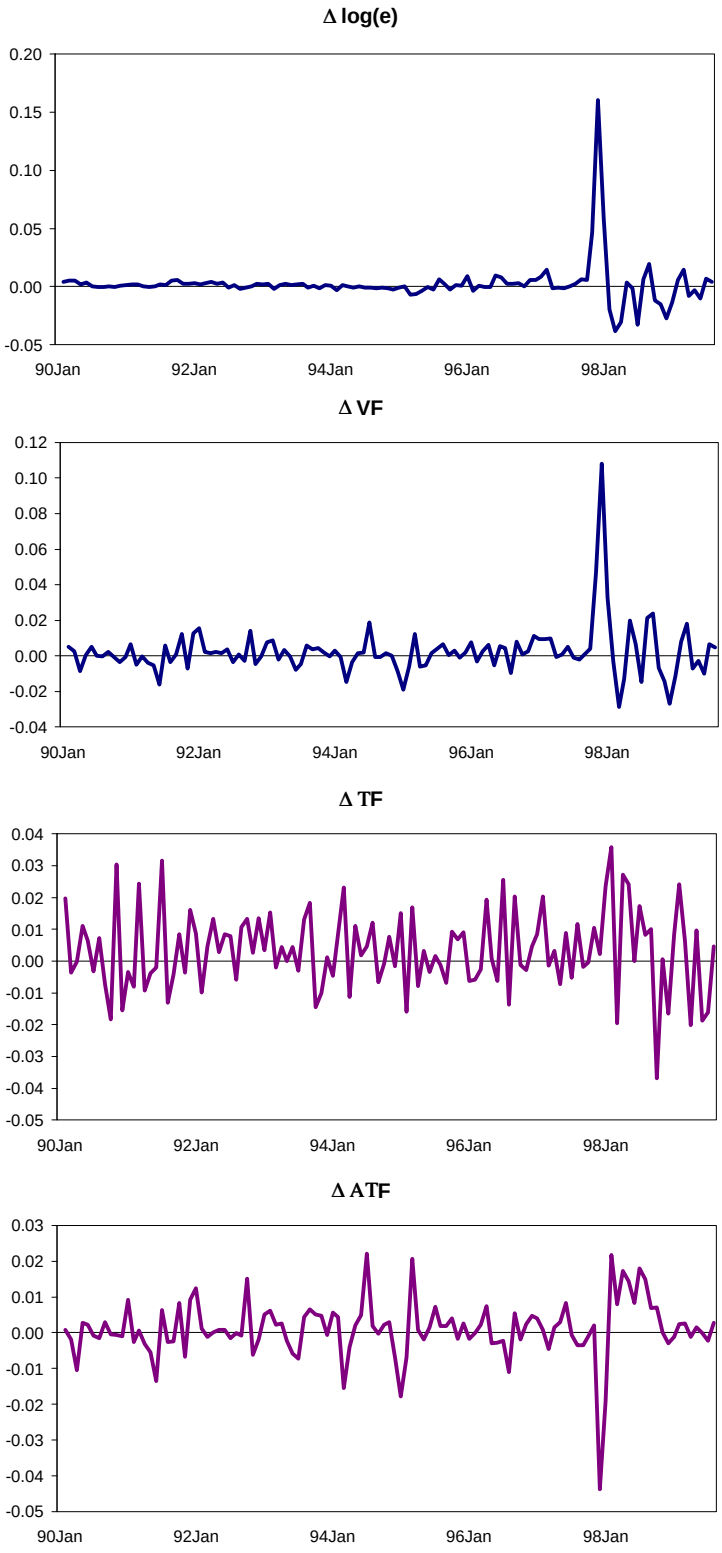


Figure 7
Variations in the Exchange Rate and its Fundamentals: Taiwan Dollar

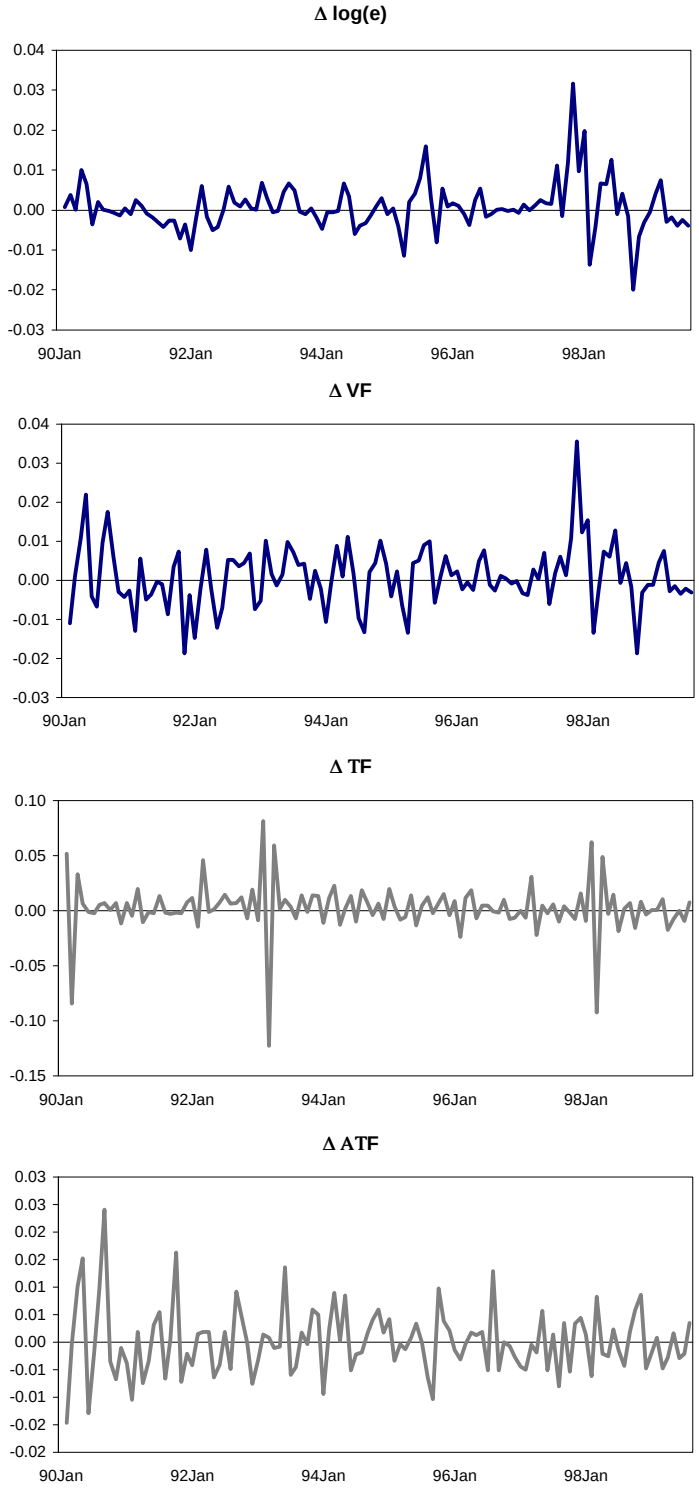
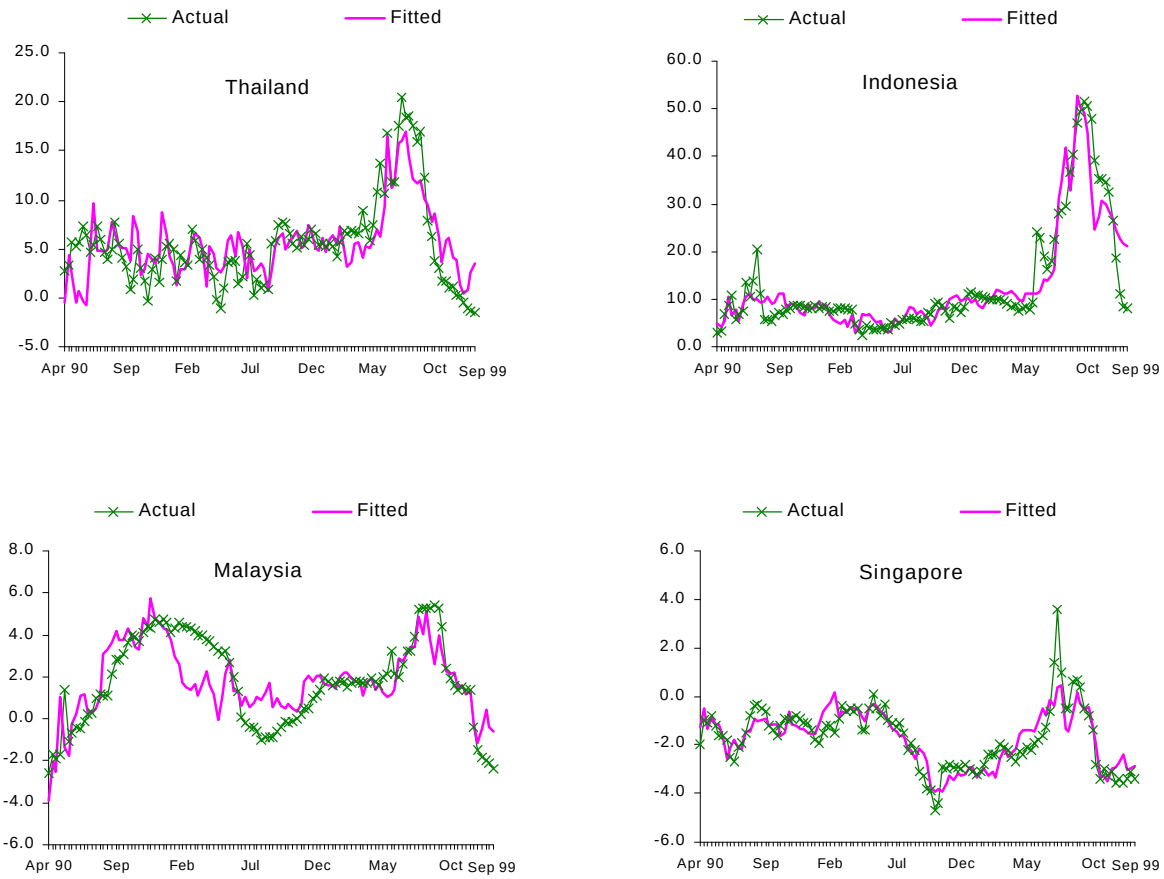


Figure 8
Actual and Projected Nominal Interest Rate Differential



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