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EXCHANGE RATE MISALIGNMENTS IN ASEAN-5 COUNTRIES

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Abstract

The purpose of this paper is to estimate the exchange rate misalignments for Indonesia, Malaysia, Philippines, Singapore and Thailand before the currency crisis. By employing the sticky-price monetary exchange rate model in the environment of vector error-correction, the results indicate that the Indonesia rupiah, Malaysian ringgit, Philippines peso and Singapore dollar were overvalued before the currency crisis while Thai baht was undervalued on the eve of the crisis. However, they suffered modest misalignment. Therefore, little evidence of exchange misalignment is found to exist in the second quarter of 1997. In particular, Indonesia rupiah, Malaysia ringgit, Philippines peso and Singapore dollar were only overvalued about 1 to 4 percent against US dollar while the Thai baht was only 2 percent undervalued against US dollar.

Keywords: Bounds Exchange Rate Misalignment; Monetary Model; Vector Error-Correction

1. Introduction

During the 1980s and early 1990s, the Southeast Asia's enjoyed rates of growth of nearly 8% a year. However, the impressive growth had dramatically changed in 1997. Massive attacks on Thai baht took place on 14 and 15 May 1997, forcing the Bank of Thailand to float baht on 2 July 1997. At first, the economic crisis was limited to Thailand's financial sector, but it quickly grew to engulf Malaysia and Indonesia as well.

Many studies have tried to figure out the causes of Asian currency crisis. The "fundamentalist" view of Corsetti *et al.* (1998) suggests that the crisis was due to the structural weaknesses prevalent in the domestic financial institutions together with unsound macroeconomic policies. A view put forward by Radelet *et al.* (1998) tells the story of "financial panic". One of the principal policy mistakes in the region, which is highlighted by a few observers (Hill, 1998; Nidhiprabha, 1998; Sadli, 1998

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and Athukorala, 1998), was the commitment to a rigidly fixed exchange rate or quasi-fixed exchange rates, in which the effective weight of the US dollar in the basket was so high that it could be characterized as an implicit peg to the US currency. It is believed that the pegged to US dollar would help to ensure their currencies stability, however, a robust US economy in recent years had strengthened the dollar which had led many investors to believe that ASEAN currencies were overvalued.

Despite many commentators have argued that the exchange rate overvaluation is the prominent cause of Asian crisis, there are only limited research has been done on this issue. Those have come to our notice are those reported by Husted and MacDonald (1999), Furman and Stigliz (1998), Sazanami and Yoshimura (1999), Chinn (2000), Saxena (2002) and Kwek and Yoong (2002). Given the lack of empirical studies of the currency misalignment for ASEAN countries before the currency crisis, this paper attempts to extend the pool of empirical evidence further by addressing the issue using a theoretical baseline model as well as employing an up to date methodology. Generally, this paper aims to determine the exchange rates for ASEAN countries before the currency crisis to see whether there is any currency misalignment by using the sticky-price monetary model and vector error-correction techniques.

The outline of the remainder of the paper is as follows. Section 2 reviews some empirical analyses on ASEAN exchange rates misalignment before the currency crisis. Section 3 describes the model, methodology and data set used. Empirical results are presented in Section 4. Finally, Section 5 gives the concluding remarks.

2. Literature Reviews

There is a wealth of both theoretical and empirical literature on the determinants of exchange rates or exchange rate misalignments. Regardless of the specific approach in modelling exchange rate determination, to measure misalignment the equilibrium exchange rate must be ascertained. This section reviews some empirical studies of Asian exchange rate misalignments before the 1997 crisis.

Husted and MacDonald (1999) employed panel cointegration in the unrestricted version of flexible price monetary model to estimate the equilibrium exchange rates for nine Asian countries. They found little evidence of misalignment among nine Asian currencies. They report only the Malaysian ringgit was overvalued and the Indonesian rupiah was undervalued at end of 1996.

Similar studies have been done by Furman and Stigliz (1998) and Sazanami and Yoshimura (1999) where they employed purchasing power parity (PPP) in long-run averaging to estimate the exchange rate misalignments for Indonesia, Malaysia, Philippines, Singapore, Thailand and other developing countries Both studies found that Thai baht, Philippines peso and Malaysia ringgit were overvalued on the eve of the currency crisis. Furman and Stigliz (1998) found Indonesia rupiah was overvalued while Sazanami and Yoshimura (1999) found Indonesia rupiah was undervalued in 1997. In addition, Furman and Stigliz (1998) found Singapore dollar was overvalued at January - June 1997.

Chinn (1998), Chinn and Dooley (1999) and Chinn (2000) measured Asian currencies overvaluation with different approaches. First, they tested PPP model using producer price indices (PPI) deflated and consumer price indices (CPI) deflated estimates. Both models provide consistent results of overvaluation for Malaysia ringgit, Philippine Peso and Thai baht but contradict results for Singapore dollar and Indonesia rupiah where PPI deflated indicated that Singapore dollar and Indonesia rupiah were undervalued while CPI deflated suggests that Singapore dollar and Indonesia rupiah were overvalued. Secondly, by utilizing the productivity-based model i.e. augmented Balassa-Samuelson model, they found overvaluation for Philippine Peso, Singapore dollar and Thai baht, and undervaluation for Indonesia rupiah and Malaysia ringgit. Finally, augmented productivity trends in monetary model, they found rupiah was overvalued and Singapore dollar was undervalued on the eve of the currency crisis.

Using intertemporal optimization model (cointegration technique); unobserved component trend and cyclical model (Kalman Filter technique); and Blanchard and Quah macroeconomic model (structural vector autoregressive technique), Saxena (2002) found little overvaluation of rupiah against USD in 1997. Employing equilibrium real exchange rate model, Kwek and Yoong (2002) found that ringgit was undervalued before the currency crisis.

Several arguments can be offered to the apparent mixed results ranging from the different sample periods, models and methodologies to various proxies for the variables. However, the studies using price-based model are unrealistic. As a practical matter prevailing exchange rates are rarely observed to be PPP exchange rates due to differences in representative commodity bundles, transportation costs, tariffs and other barriers to trade, imperfect or incomplete markets and imperfect information. Moreover, the methods of simple averaging or linear regression are too simplistic and the models might suffer from non-stationarity.

This paper extends the existing literatures in two directions. The issue of exchange rate misalignment is taken seriously from economics and econometric perspectives. First, we derived the exchange rate misalignment by incorporated the macroeconomic fundamentals into the estimation process. Many studies had taken the deviation from mean as the exchange rate misalignment. This was the first attempt of estimating exchange rate misalignment using more complicated model or not using price-based estimates for the Philippines and Thailand. Second, instead of simple averaging or linear regression, we employed the up to date multivariate cointegration and VECM techniques in our estimation.

3. Model, Methodology and Data

The equilibrium exchange rate is often associated with an international version of the Law of One Price and the model in used are such as purchasing power parity (PPP) and its variants. These models that use the price based estimates are relatively easy to implement, but do not address the economically interesting question of whether a particular exchange rate is driven by economics fundamental. Therefore, in this paper the knowledge of macroeconomic fundamentals is incorporated into the process of estimating equilibrium exchange rates. We use the monetary approach to estimating exchange rates in which changes in the relative foreign and domestic monetary aggregates, income differential, interest rate differential and expected inflation differential are the important determinants of the exchange rate.

3.1 Model

The reduced form of the sticky-price monetary model models of exchange rate determination can be written as follows (for a comprehensive discussion see Civcir, 2004; Frenkel and Koske, 2004):

$$e_t = \gamma_0 + \gamma_1(m_t - m_t^*) + \gamma_2(y_t - y_t^*) + \gamma_3(r_t - r_t^*) + \gamma_4(\pi_t - \pi_t^*) + \mu_t \tag{1}$$

while $\gamma_1 = 1$, $\gamma_2 < 0$, $\gamma_3 < 0$, and $\gamma_4 > 0$. e_t is the spot exchange rate (defined as the price of a unit of foreign money in terms of domestic money), m_t is the domestic money supply, y_t is the domestic real income, r_t is the domestic interest rate, π_t is the domestic expected inflation rate, μ_t is the error term, while an asterisk denotes the corresponding foreign variables, and all variables except for interest rate and expected inflation rate, are expressed in natural logarithms.

3.2 Methodology

In this study we first examine the time series properties. In order to determine the order of integration, the standard Augmented Dickey-Fuller (ADF) unit root test will be used for testing the null of nonstationarity. If the series are of same order, then we may proceed to test the existence of cointegrating relations between the exchange rate and its fundamentals using Johansen multivariate cointegration techniques. If we are able to reject the null hypothesis of no cointegrating vectors, this indicates the exchange rate and its monetary fundamentals have a stable long run relationship (Enders, 2004 and Tawadros, 2001). According to the Granger Representation Theorem, if a cointegrating relationship exists between a series of $I(1)$ variables, then an error-correction model (ECM) also exists (Enders, 2004; Tawadros, 2001 and Maish and Masih, 1997). This suggests that there should exist an exchange rate equation of the form:

$$\Delta e_t = c + \sum_{i=0}^{n} \Gamma_{1i} \Delta e_{t-i-1} + \sum_{i=0}^{n} \Gamma_{2i} \Delta (m - m^*)_{t-i} + \sum_{i=0}^{n} \Gamma_{3i} \Delta (y - y^*)_{t-i} + \sum_{i=0}^{n} \Gamma_{4i} \Delta (r - r^*)_t$$
$$+ \sum_{i=0}^{n} \Gamma_{5i} \Delta (\pi - \pi^*)_{t-i} + \Pi Z_{t-1} + \nu_t \tag{2}$$

where c denotes a constant, ν_t denotes an error term, Z_t represents the cointegrating vector normalized on e_t and Π-matrix captures the adjustment of the exchange rate towards its long-run equilibrium value. $\Pi = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium while β is a matrix of long-run coefficients such that the term $\beta' Z_t$ embedded in Equation (2) represents up to (n - 1) cointegration relationships in the multivariate model which ensure that the Z_t converge to their long-run steady-state solutions.

Next, following the general-to-specific methodology, the final parsimonious VECM monetary models are obtained[1]. Finally, the estimated vector error-correction models are used to determine the exchange rates before the currency crisis to see whether there is any currency misalignment for ASEAN five countries.

3.3 Data

All the data series were obtained from various issues of the International Monetary Fund's International Financial Statistics yearbook. The data were collected at the quarterly frequency from the first quarter of 1980 to the second quarter of 2003 (1980:1 to 2003:2). Data during the flexible exchange rate period and before any evidence of currency misalignment i.e. 1980:1 to 1995:1 were used to formulate models (except 1985:4 to 1995:1 for Thailand), while the data from 1995:2 onwards were set aside for comparison and for out-sample forecasting exercises[2].

Exchange rates (*ER*) are quarterly averages in terms of RM/USD, Rupiah/USD, Peso/USD, Singapore Dollar/USD and Baht/USD. The chosen monetary aggregates are broad money stock (*M2*). The industrial product indices (*IPI*) are utilized as proxies for domestic income. The interest rates are the short-term market rates (*MR*) (except quarterly averages of three-month treasury bill rates (*TB3*) is used in the case of Philippines where the *MR* is not available). Preceding four quarters growth in consumer price indices (*CPI*) are used for the unobservable expected inflation rate. All variables are in natural logarithmic form (except interest rate and expected inflation rate), while an asterisk denotes a series corresponding to the US.

4. Results and Discussion

Table 1 reports the Augmented Dickey-Fuller (ADF) unit root test results. For all five countries, the results clearly show that all variables are nonstationary in their levels as the null hypothesis of unit root cannot be rejected even at 10% significance level by the ADF test statistics. Instead these variables are first-differenced stationary at 5% or better significance level, indicating that they are integrated of order one, $I(1)$. Since the series are of same order, we may proceed to test the existence of cointegrating relations between the exchange rate and its fundamentals using Johansen multivariate cointegration techniques. The results of Johansen-Juselius likelihood cointegration test are reported in Table 2.

[1] These final parsimonious specifications can be achieved by removing the insignificant regressors. In order to avoid mispecification, at least one of the lag variable (with largest *t*-ratio) will be retained in the case of all the lagged variables are not significant.

[2] Sazanami and Yoshimura (1999) found that the misalignment of the East Asian currencies started since April 1995.

Table 1
Augmented Dickey-Fuller Unit Root Tests

Series	Lag Length	Level	Lag Length	First-Difference
A: Indonesia				
e_t	4	-1.1523	2	-4.6664[a]
$m_t - m_t^*$	1	-2.9567	2	-4.5542[a]
$y_t - y_t^*$	4	-1.6843	2	-6.0209[a]
$r_t - r_t^*$	5	-2.0331	4	-5.4249[a]
$\pi_t - \pi_t^*$	9	-1.3565	8	-6.5817[a]
B: Malaysia				
e_t	1	-2.0865	2	-4.6186 [a]
$m_t - m_t^*$	1	-2.2151	2	-4.8107 [a]
$y_t - y_t^*$	8	-2.5200	1	-8.0023 [a]
$r_t - r_t^*$	3	-2.3840	2	-4.5454 [a]
$\pi_t - \pi_t^*$	9	-2.5062	7	-5.1739 [a]
C: Philippines				
e_t	2	-1.7000	1	-2.9429 [b]
$m_t - m_t^*$	9	-3.4284	2	-4.6887 [a]
$y_t - y_t^*$	3	-1.4263	2	-3.0376 [b]
$r_t - r_t^*$	1	-2.4119	3	-4.8297 [a]
$\pi_t - \pi_t^*$	7	-3.1017	7	-3.6641 [a]
D: Singapore				
e_t	2	-0.4307	1	-6.8436 [a]
$m_t - m_t^*$	1	-3.4062	2	-4.3336 [a]
$y_t - y_t^*$	8	-3.1497	4	-3.3054 [b]
$r_t - r_t^*$	5	-3.2350	4	-3.1055 [b]
$\pi_t - \pi_t^*$	5	-3.4429	7	-5.4014 [a]
E: Thailand				
e_t	4	-3.1963	4	-4.1531 [a]
$m_t - m_t^*$	5	-3.2525	2	-3.0954 [b]
$y_t - y_t^*$	1	-1.9583	1	-4.2106 [a]
$r_t - r_t^*$	6	-2.0699	5	-3.9554 [b]
$\pi_t - \pi_t^*$	4	-3.0968	8	-4.3952 [a]

Notes: Figures are the pseudo *t*-statistics for testing the null hypothesis that the series is nonstationary. Superscripts a and b denote significant at 1% and 5% levels respectively. For series in level (constant with trend), the critical values for rejection are -4.11, and -3.48 at 1% and 5% respectively. For series in first-difference (constant without trend), the critical values for rejection are -3.54 and -2.91 at 1% and 5% respectively. e_t, m_t, m_t^*, y_t and y_t^* series are log transformed. The lag length is determined by the Akaike Information Criterion (*AIC*).

Table 2
Johansen-Juselius Likelihood Cointegration Tests

Null Hypotheses	Eigenvalue	Trace Statistic	Critical Value (5%)	Critical Value (1%)
A. Indonesia				
$(r = 0)$ [a]	0.588955	114.7486	68.52	76.07
$(r \leq 1)$ [a]	0.465224	65.85067	47.21	54.46
$(r \leq 2)$ [b]	0.282298	31.42575	29.68	35.65
$(r \leq 3)$	0.211880	13.18220	15.41	20.04
$(r \leq 4)$	0.001570	0.086400	3.76	6.65
B. Malaysia				
$(r = 0)$ [a]	0.610479	102.0625	68.52	76.07
$(r \leq 1)$	0.324670	44.54945	47.21	54.46
$(r \leq 2)$	0.181162	20.60366	29.68	35.65
$(r \leq 3)$	0.124548	8.411612	15.41	20.04
$(r \leq 4)$	0.004868	0.297670	3.76	6.65
C. Philippines				
$(r = 0)$ [a]	0.837129	174.3355	68.52	76.07
$(r \leq 1)$ [a]	0.497084	63.63281	47.21	54.46
$(r \leq 2)$	0.166683	21.70557	29.68	35.65
$(r \leq 3)$	0.146387	10.58273	15.41	20.04
$(r \leq 4)$	0.015095	0.927843	3.76	6.65
D. Singapore				
$(r = 0)$ [a]	0.692758	157.3696	68.52	76.07
$(r \leq 1)$ [a]	0.578810	85.38228	47.21	54.46
$(r \leq 2)$ [b]	0.317258	32.63729	29.68	35.65
$(r \leq 3)$	0.138731	9.357341	15.41	20.04
$(r \leq 4)$	0.004043	0.247097	3.76	6.65
E. Thailand				
$(r = 0)$ [b]	0.500524	72.19497	68.52	76.07
$(r \leq 1)$	0.415107	45.81557	47.21	54.46
$(r \leq 2)$	0.349695	25.43518	29.68	35.65
$(r \leq 3)$	0.200716	9.083256	15.41	20.04
$(r \leq 4)$	0.014882	0.569755	3.76	6.65

Notes: r indicates the number of cointegrating vectors. Subscripts a and b denote rejection of the hypothesis at 1% and 5% critical values respectively. Model included 4 lags on each variable for Indonesia, Malaysia, Singapore and Thailand and 6 lags for the Philippines. Trend and seasonal dummies are not included in this test since they had been dropped in the parsimonious model although they had been considered in the preliminary analyses.

Table 2 shows that in all five countries, there is evidence of cointegrating vector(s) according to the asymptotic critical values. For Indonesia and Singapore (Table 2 Panel A and D), the cointegration results indicate that the null hypothesis of zero, at most one and at most two cointegrating vector(s) are rejected using the 95% critical value. This implies that the exchange rate, money differential, income differential, interest rate differential and expected inflation differential are cointegrated with three cointegrating vectors. Using the 95% critical value, the cointegration results for Malaysia and Thailand (Table 2 Panel B and E) were able to reject the null hypotheses of zero cointegrating vector. This suggests that the variables in this model are cointegrated with one cointegrating vectors. In the case of Philippines, we found evidence of two cointegrating vectors since both the null hypotheses of $r = 0$ and $r \leq 1$ are clearly rejected.

Table 3 reports the estimates of the long run parameters of the monetary models among ASEAN five countries. For Indonesia and Singapore, most of the estimated coefficients are statistically significant and are consistent with monetary model. Generally, the results indicated that: First, an increase in domestic money supply relative to U.S. money supply leads to a depreciation of domestic currency in the long-run and vice versa, and second, an increase in domestic income relative to U.S. income leads to appreciation of domestic currency in the long-run and vice versa. In practice, not all of the coefficients in cointegrating vector may be correctly sign and statistically significant. In the case of Malaysia, although the cointegration analysis supports the existence of long run relationship among variables stipulated by monetary model, many of these variables are wrongly signed. The money and income differentials do not have the expected sign. We would expect an increase in relative money supply lead to a depreciation of the ringgit. However, the relationship was not consistent. The ringgit depreciated strongly during the early 1980s despite the slower monetary growth in Malaysia (Chua and Bauer, 1995). This was due to the economy of Malaysia was badly influence by worldwide recession resulting excess supply for money. In the early 1990s, the Malaysian economy began to recover from the recession. The economy booming and high inflow of foreign direct investment increased the demand for money. As a result of excess demand for money, the ringgit appreciated dramatically during the early 1990s, even though money supply growth was relatively strong (Chua and Bauer, 1995). The positive correlation between exchange rate and income differential as contradict to the prediction of monetary model implies that rapid growth experience in the past two decades tends to weaker the RM/USD rate. One possible explanation is that the demand for imports will increase substantially with domestic growth and this would lead to depreciation in the domestic currency and therefore a low spot exchange rate is expected (Soon, 1995). These explanations do explain some of the implausible signs for the Philippines and Thailand. In particular, the estimated coefficient of money differential for Thailand and the estimated coefficient of income differential for the Philippines carried the wrong signed.

Table 3
Estimated Long Run Parameters of the Monetary Models

Coefficient (SE)	Expected Sign	Indonesia	Malaysia	Philippines	Singapore	Thailand
e_t	1	1.00	1.00	1.00	1.00	1.00
$m_t - m_t^*$	-	-0.22[a]	0.02	-0.10[b]	-0.54[a]	0.05[a]
		(0.01)	(0.08)	(0.05)	(0.06)	(0.01)
$y_t - y_t^*$	+	0.17[a]	-0.27[b]	-0.41[a]	1.03[a]	0.20[a]
		(0.05)	(0.13)	(0.10)	(0.11)	(0.04)
$r_t - r_t^*$	+	-0.35[a]	0.04	-0.88[b]	2.90[b]	-0.35[a]
		(0.10)	(0.08)	(0.42)	(1.14)	(0.07)
$\pi_t - \pi_t^*$	-	0.001[c]	0.05[a]	0.01[a]	0.04[a]	0.004[a]
		(0.00)	(0.01)	(0.00)	(0.01)	(0.002)

Notes: Coefficient is the β coefficient from monetary cointegrating vector normalized on the exchange rate. SE is the standard error. Superscripts a, b and c denote significant at 1%, 5% and 10% levels, respectively. Models included 4 lags for Indonesia, Malaysia, Singapore and Thailand and 6 lags for the Philippines. Trend and seasonal dummies are not included in this test since they had been dropped in the parsimonious model although they had been considered in the preliminary analyses.

Table 4 reports the final parsimonious VECM models for ASEAN five countries from 1980:1 to 1995:1. Overall, the models passed all the diagnostics tests as reported in Appendix A. The results also show that all the coefficients for error-correction term (*ECT*) are correctly sign and statistically significant. The exchange rates respond to the error correction terms by moving to reduce the disequilibrium. The rates of response are very rapid in the cases of Indonesia (0.84), Thailand (0.72) and Philippines (0.44). The speed of adjustments for Malaysia and Singapore slower: 0.10 and 0.08 respectively.

In order to determine the equilibrium exchange rates before the currency crisis to see whether there is any currency misalignment, out of sample forecast for exchange rates are made using the actual data for the explanatory variables. Using the final parsimonious models obtained the in sample and out of sample predictions for Indonesia rupiah, Malaysia ringgit, Philippines peso, Singapore dollar and Thai baht are generated. Evidences of the goodness of fit are revealed in Table 5. The model's forecasts have small root-mean squared errors (*RMS*E) and mean absolute percent error (*MAPE*). Figure 1 – Figure 5 show the actual and predicted exchange rates along with 95% forecast interval. In virtually, the models fit the data very closely through out the period before currency crisis. The models track the actual exchange rate well and manage to get a considerable number of turning points correct.

Table 4
Final Parsimonious VECM Models for ASEAN-5 Countries

Variable	Expected Sign	Coefficient				
		Indonesia	Malaysia	Philippines	Singapore	Thailand
ECT	-	-0.838 [a]	-0.102 [a]	-0.437 [a]	-0.083 [a]	-0.722 [a]
e_{t-1}	-	-0.166 [a]	-0.341 [a]	0.237 [b]		
e_{t-2}	-	-0.106 [a]		0.732 [a]		-0.147 [c]
e_{t-3}	-	-0.087 [a]			0.141	
$(m-m^*)_{t-1}$	+	-0.142 [a]				
$(m-m^*)_{t-2}$	+	-0.092 [a]			0.038	-0.121 [a]
$(m-m^*)_{t-3}$	+	-0.064 [a]	0.178 [a]			
$(m-m^*)_{t-4}$	+			-0.044		
$(y-y^*)_{t-1}$	-	0.078 [a]				
$(y-y^*)_{t-2}$	-				0.099 [c]	
$(y-y^*)_{t-3}$	-		0.008			0.136 [b]
$(y-y^*)_{t-4}$	-			0.391 [a]		
$(r-r^*)_{t-1}$	-	-0.241 [a]	0.184 [c]	-0.546 [a]		-0.212 [a]
$(r-r^*)_{t-2}$	-	-0.140 [a]		-0.465 [a]	0.520 [c]	
$(r-r^*)_{t-3}$	-	-0.076 [a]				
$(\pi-\pi^*)_{t-1}$	+			0.002 [b]	-0.004 [c]	0.004 [a]
$(\pi-\pi^*)_{t-2}$	+			0.002 [a]	0.005 [c]	
$(\pi-\pi^*)_{t-3}$	+	-0.0002	0.009 [a]	0.002 [a]		
$(\pi-\pi^*)_{t-4}$	+			0.002 [b]		
constant		-0.368 [a]		-0.152 [a]	-0.006 [c]	-0.018 [a]
D832		0.329 [a]				
D834				0.192 [a]		
D864		0.266 [a]				
FL892						0.021 [a]
FL921						0.015 [a]
D1		0.018 [a]				
D2			0.060 [a]			
D3						0.015 [a]

Note: See Appendix A for diagnostic tests' results.

The resulting residuals between the actual and the estimated equilibrium exchange rates are the estimated misalignment. Table 6 shows the results of exchange rate misalignments for ASEAN five countries before the currency crisis. The results show that the Indonesia rupiah was overvalued from 1995:1 to 1997:2, Malaysia ringgit was overvalued from 1996:1 to 1997:2, except for 1996:4, Philippines peso was overvalued from 1996:1 to 1997:2, Singapore dollar was overvalued from 1996:1 to 1997:2, except for 1997:1 and Thai baht was undervalued from 1995:2 to 1997:2[3].

[3] All of the misalignments are statistically significant except for Malaysia.

However, they suffered only modest misalignment. Very little evidence of exchange misalignment is found to exist in 1997:2. In particular, Indonesia rupiah, Malaysia ringgit, Philippines peso and Singapore dollar were only overvalued about 4%, 1%, 3% and 4%, respectively, against USD while the Thai baht was only 2% undervalued against USD.

Table 5
In-Sample and Out-of-Sample Forecasting Errors

	Indonesia	Malaysia	Philippines	Singapore	Thailand
In-sample Forecast					
RMSE	0.004	0.016	0.037	0.020	0.004
MAPE	0.048	1.470	0.999	2.754	0.115
Out-of-sample Forecast					
RMSE	0.433	0.044	0.059	0.026	0.218
MAPE	2.196	2.265	1.268	3.788	3.452

Notes: *RMSE* and *MAPE* are root-mean squared errors and mean absolute percent error of the in-sample and out-of-sample forecasts.

Table 6
ASEAN Five Countries Exchange Rate Misalignments (%) before Crisis

	Indonesia	Malaysia	Philippines	Singapore	Thailand
1995:2	-1.11	-3.64	0.18	-3.22	0.08
1995:3	-0.47	1.14	-2.93	0.52	0.06
1995:4	-0.28	2.35	1.71	1.47	1.20
1996:1	-0.30	-0.47	-3.94	-0.86	2.04
1996:2	-1.55	-3.15	-2.31	-1.79	3.22
1996:3	-3.84	-2.16	-1.90	-3.18	3.58
1996:4	-4.05	1.38	-4.29	-2.08	3.94
1997:1	-3.77	-1.98	-2.33	0.75	3.04
1997:2	-3.24	-0.18	-2.80	-3.25	1.94
t-statistic	-3.796	-1.057	-3.251	-2.101	4.388
(probability)	(0.005)	(1.321)	(0.012)	(0.069)	(0.002)

Notes: Figures are exchange rate misalignments in percentage (%). Misalignment is the residual between actual and predicted values of exchange rate. Positive (negative) value for residual denotes an undervaluation (overvaluation). *t*-statistic is testing the null hypothesis of misalignments are statistically indifferent from zero.

Figure 1: Actual and Estimated Equilibrium Exchange Rates for Indonesia

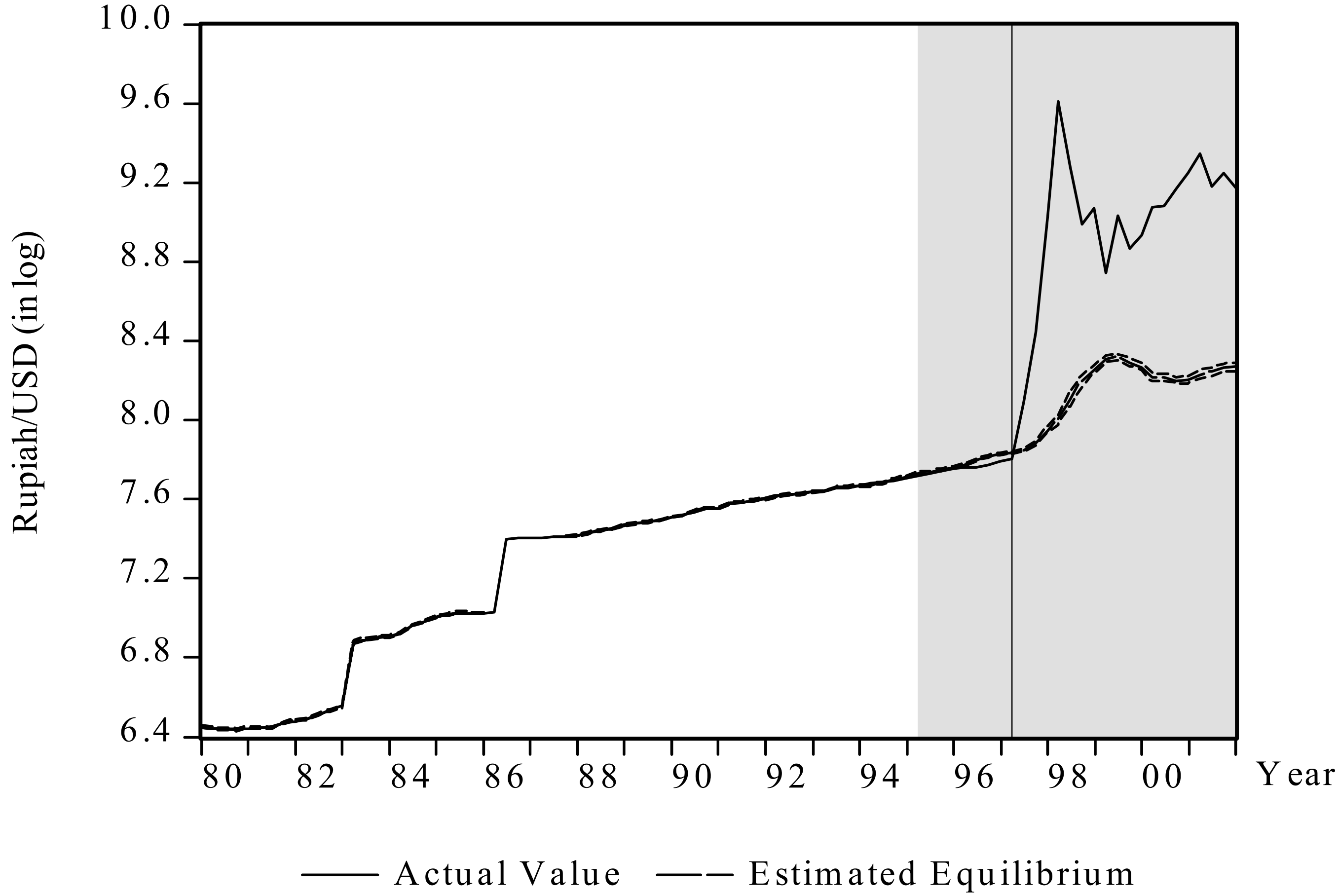

Figure 2: Actual and Estimated Equilibrium Exchange Rates for Malaysia

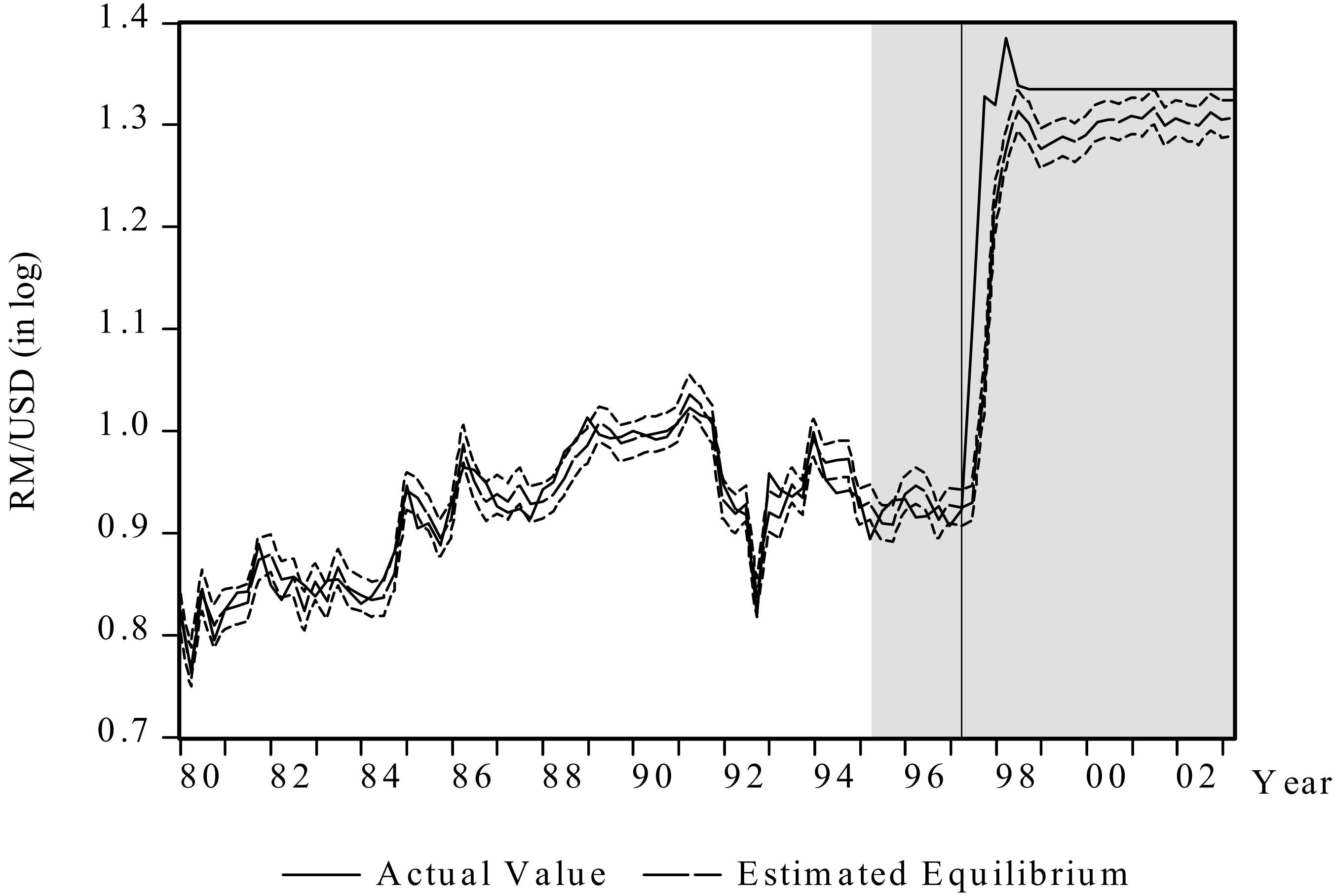

Figure 3: Actual and Estimated Equilibrium Exchange Rates for the Philippines

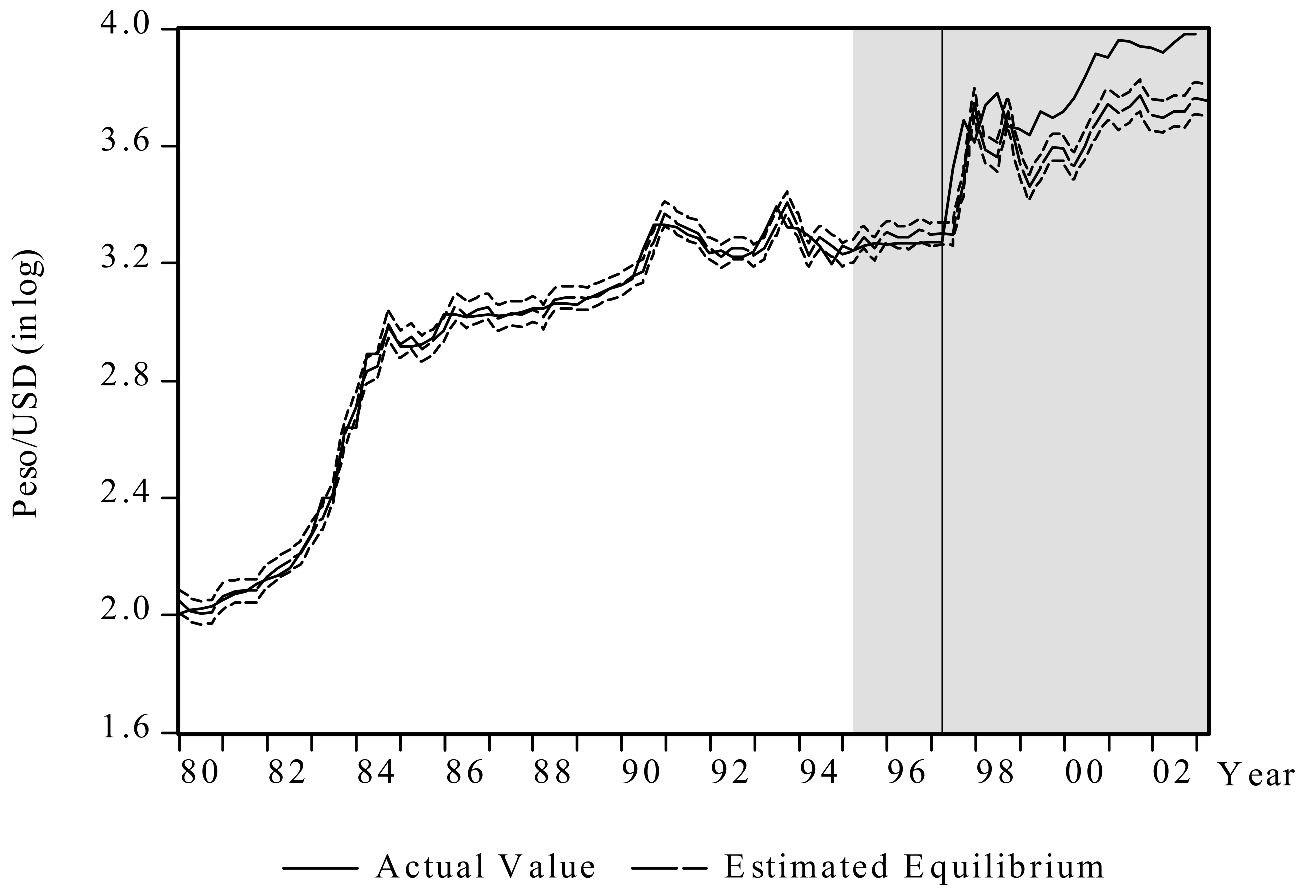

Figure 4: Actual and Estimated Equilibrium Exchange Rates for Singapore

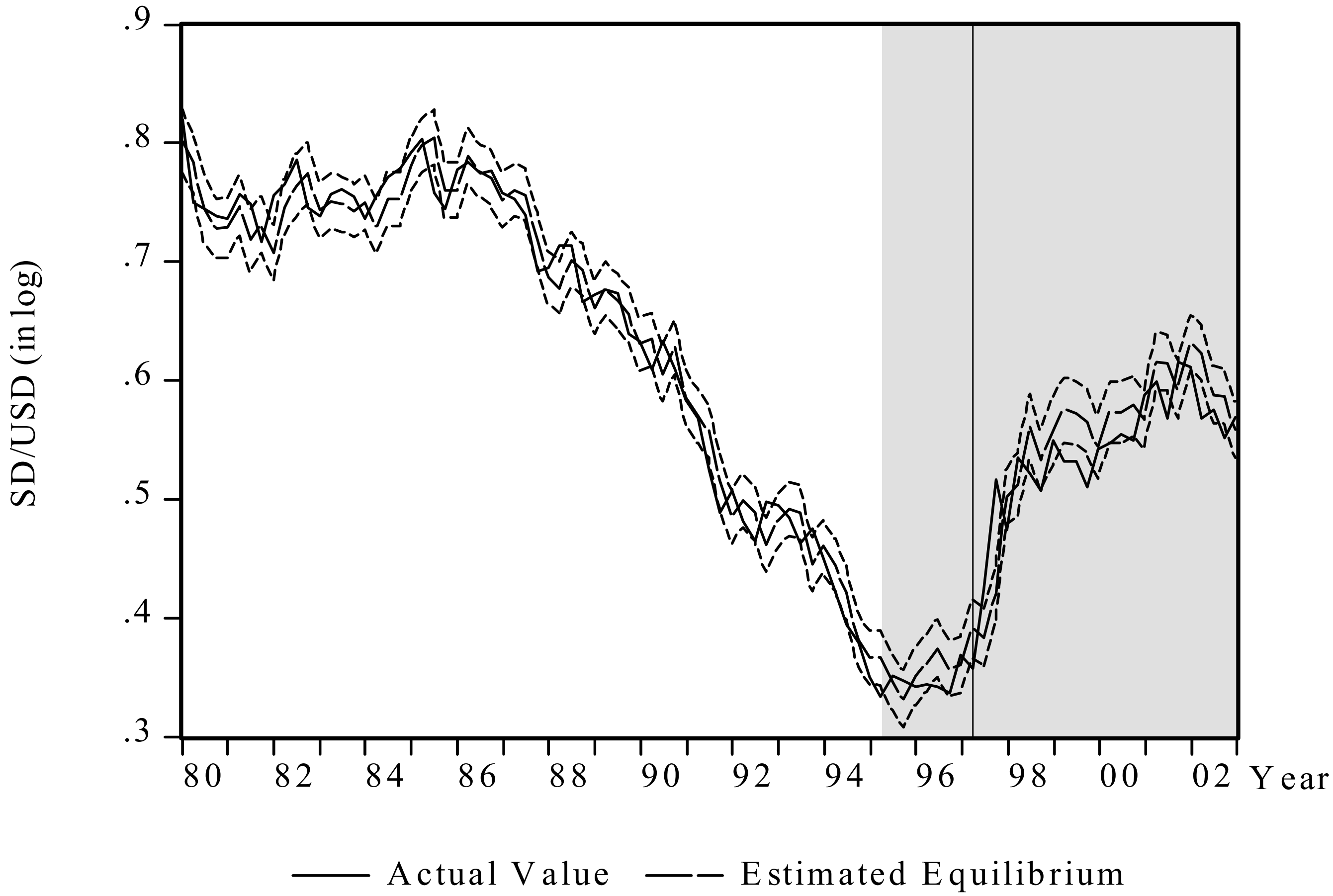

Figure 5: Actual and Estimated Equilibrium Exchange Rates for Thailand

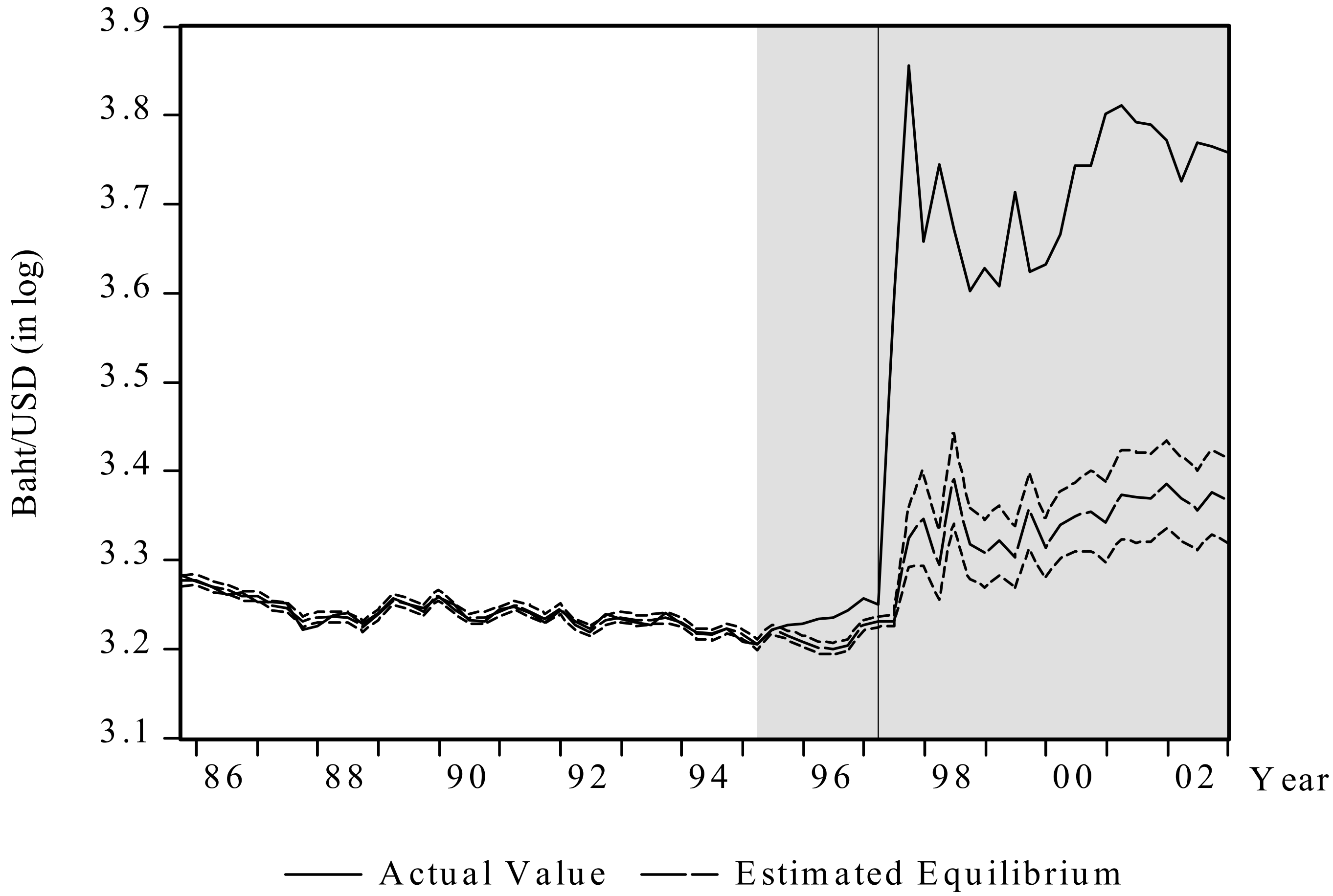

Table 7
Comparison Studies of ASEAN Exchange Rate Misalignments

Study	Model (Technique)	Indonesia	Malaysia	Philippines	Singapore	Thailand
F&S (1998)	PPP (long-run averaging)	Over	Over	Over	Over	Over
S&Y (1999)	PPP (long-run averaging)	Under	Over	Over		Over
H&M (1999)	Monetary model (panel cointegration)	Under	Over			
Chinn *et al.*	1. (a) PPP model using PPI	Under	Over	Over	Under	Over
	1. (b) PPP model using CPI	Over	Over	Over	Over	Over
	2. Augmented Balassa-Samuelson model (Deviation from mean)	Under	Under	Over	Over	Over
	3. Augmented productivity trends in monetary model (VECM)	Over			Under	
Saxena (2002)	1. Intertemporal optimization model (cointegration)	Over				
	2. Unobserved component trend and cyclical model (Kalman Filter)	Over				
	3. Blanchard and Quah macroeconomic model (structural VAR)	Over				
K&Y (2002)	Equilibrium real exchange rate model		Under			
This study	Monetary model (VECM)	Over	Over	Over	Over	Under

Notes: Exchange rates are domestic currency against USD. Over (Under) stands for overvaluation (undervaluation). F&S (1998) refers to Furman and Stigliz (1998); S&Y (1999) refers to Sazanami and Yoshimura (1999); H&M (1999) refers to Husted and MacDonald (1999); Chinn *et al.* refers to Chinn (1998), Chinn and Dooley (1999) and Chinn (2000); and K&Y (2002) refers to Kwek and Yoong (2002).

Table 7 shows the comparison studies of ASEAN exchange rate misalignments. Our result of Indonesia rupiah was overvalued is consistent with the findings of Furman and Stigliz (1998), Chinn *et al.* (1998, 1999 and 2000) and Saxena (2002) but contradict with the findings of Husted and MacDonald (1999) and Sazanami and Yoshimura (1999). Our finding of Malaysia ringgit was overvalued on the eve of the currency crisis is in consonant with the findings of Chinn *et al.* (1998, 1999 and 2000), Furman and Stigliz (1998), Husted and MacDonald (1999) and Sazanami and Yoshimura (1999). However, it is in conflict with Kwek and Yoong (2002). Our result of overvaluation Philippines peso before the currency crisis is supported by the findings of Furman and Stigliz (1998), Chinn *et al.* (1998, 1999 and 2000) and Sazanami and Yoshimura (1999). The result of Singapore dollar was overvalued on the eve of the currency crisis is in accord with the finding of Furman and Stigliz (1998) but is different from the findings of Chinn *et al.* (1998, 1999 and 2000). The finding of Thai baht was undervalued is in variance with the findings of Furman and Stigliz (1998), Sazanami and Yoshimura (1999) and Chinn *et al.* (1998, 1999 and 2000).

5. Conclusion

Building upon the theoretical framework of sticky price monetary model, this paper estimates the equilibrium exchange rates of five ASEAN countries. Using the residuals between real and equilibrium exchange rates, these ASEAN countries' exchange rate misalignments relative to the USD are derived. It is shown that before crisis Indonesia rupiah, Malaysia ringgit, Philippines peso and Singapore dollar were overvalued about 1 to 4 percent against USD while the Thai baht was 2 percent undervalued against USD. The misalignments are quite small. This suggests that the ASEAN crisis was not due to exchange rate is misaligned or inconsistent with the economy fundamentals. Thus, evidences do not support the cause of the ASEAN crisis was attributed to traditional fundamental.

The policy implications of this study are straightforward. First, the existence of cointegrating vector may be interpreted to mean that the exchange rates of the ASEAN countries are related to the fundamental variables. Hence, an important conclusion that can be drawn here is that the Asian currencies are all driven by fundamental variables. Since the economics fundamentals have clear and significant roles in determining the behaviour of ASEAN currencies, interest rate policy and domestic monetary policy can be use as a stabilization policy in these countries. Second, exchange rate management policies are designed to contribute to macroeconomic stabilization goals. The results of exchange rates misalignment before the crisis show that the ASEAN exchange rates relative to USD do not misalign with the fundamental. This revealed that the ASEAN countries' systems of nominal exchange rate anchor to the US dollar are biased. The weight of US currency in the basket does not reflect the relative economic important of the two countries. The exchange rate determination systems could be improved by reducing the weight of USD in the basket and by increasing the weight of other important currency such as yen in the basket.

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Appendix A
Diagnostic Tests for Final Parsimonious VECM Models for ASEAN-5 Countries

	Country				
	Indonesia	Malaysia	Philippines	Singapore	Thailand
Diagnostic Test					
SER	0.005	0.017	0.037	0.022	0.005
JB	0.120	3.252	1.142	1.016	1.534
LM	0.644	2.019	0.211	0.271	1.458
RESET	2.021	1.538	1.669	0.966	0.542
WHITE	1.295	1.395	1.157	1.302	1.750
RMSE	0.004	0.016	0.033	0.020	0.004

Notes: See Table 4 for the estimated models. *SER* is the standard error of regression. *JB* is Jarque-Bera statistic for normality. *LM* is the Breusch-Godfrey Lagrange multiplier test for serial correlation up to 4 lags (except 6 lags for Philippines), RESET is Ramsey *RESET* test for functional misspecification and White is White's test for general heteroskedasticity. The *F*-statistics reported for *LM*, *RESET* and *WHITE* are under the relevant null hypothesis that absence of serial correlation, functional misspecification and heteroskedasticity. *RMSE* refers to the root-mean squared errors of the in-sample forecast. a, b and c denotes significance at 1%, 5% and 10% level, respectively. Model included 4 lags on each variable for Indonesia, Malaysia, Singapore and Thailand and 6 lags for the Philippines. *D832*, *D834* and *D864* are dummy variables to account for exchange rate devaluation while *FL892* and *FL921* are dummy variables to account for financial liberalization (which take on the value of one from that date onwards and zero otherwise). *D1*, *D2* and *D3* are dummy variables introduced to correct for normality (Details of the technique are available upon request from the authors; discussion of such technique could be found in Thomas (1997). (*D1* = 1 in 1981:1, 1983:1, 1994:2, 1994:3; *D1* = -1 in 1981:3, 1984:2, 1991:1, 1992:4, 1993:1, 1993:2 and zero in all other quarters). (*D2* = 1 in 1985:1, 1986:2, 1991:2, 1993:1, 1994:1; *D2* = -1 in 1980:2, 1986:4, 1992:1, 1992:2, 1992:4 and zero in all other quarters). (*D3* = 1 in 1990:1, 1991:2, 1992:1; *D3* = -1 in 1987:4, 1994:3 and zero in all other quarters). Trend and seasonal dummies are not included in this test since they had been dropped in the parsimonious model although they had been considered in the preliminary analyses.