How Well Did the Forward Market Anticipate the Asian Currency Crisis: The Case of Four ASEAN Currencies

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HOW WELL DID THE FORWARD MARKET ANTICIPATE THE ASIAN CURRENCY CRISIS: THE CASE OF FOUR ASEAN CURRENCIES

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EXECUTIVE SUMMARY

1 This paper evaluates the relative proportions of the bias in exchange rate forecasts attributed to expectation error and a time-varying risk premium, using monthly survey data for the Malaysian Ringgit, the Indonesian Rupiah, the Philippine Peso and the Thai Baht over the period December 1996 to December 1998 as a direct measure of exchange rate expectations.

2 Our analysis shows that although the forward markets anticipated the fall of the currencies, they failed to predict the timing and relative magnitudes of the subsequent depreciations. The inability of currency traders to use information optimally resulted in biased predictions of future changes in spot exchange rates. This bias is attributed to systematic forecast errors as well as variation in currency risk premia. The persistence of forecast errors suggests that the market found it difficult to read rapidly-changing economic fundamentals. This is borne out by the fact that the magnitude of the forecast error for each currency varied with the extent of macroeconomic deterioration in its respective country. In addition, we find that considerable variation in the currency risk premia over time is another source of the biased forecasts of future exchange rates. In general, the more volatile a currency is, the larger is its risk premium.

3 Large variances of expected changes in future spot rates indicate that market participants' exchange rate expectations are far from static. We test various expectation formation schemes, and find that market participants focussed mainly on recent changes in spot rates in forecasting exchange rates over a shorter term horizon. Agents on average tended to expect the future spot rate to appreciate when the current spot rates depreciated further below the spot rate of the previous period, or when the spot rate fell by more than anticipated in the previous period.

1 INTRODUCTION

1.1 The Southeast Asian currency crisis, which is characterised by simultaneous sharp depreciation of the regional currencies and extreme volatility, provides an opportunity to evaluate the efficiency of the foreign exchange market during a period of unprecedented turmoil. Specifically, forward contracts are supposed to allow economic agents to hedge their exchange rate risk more effectively, thereby reducing the impact of exchange rate instability on trade and capital flows. Hedging costs would be higher if the forward market failed to incorporate relevant market information, or if a significant risk premium is attached to the forward rate. Even in the best of times, the ability of the forward market to accurately forecast the future spot rate has been poor.

1.2 This paper seeks to evaluate how accurately the forward rates of the regional currencies anticipated the massive depreciation in exchange rates during the Asian currency crisis, and to determine the relative proportions of the bias in the forward rate forecasts attributed to expectation errors and the presence of a time-varying currency risk premium. We employed data from a survey of exchange rate expectations to provide a direct measure of exchange rate expectations. The survey data also allowed us to test how the market participants formed their expectations of future changes in currency exchange rates, in the face of rapidly deteriorating economic fundamentals as the crisis unfolded.

1.3 The paper proceeds as follows. Section 2 provides the descriptive statistics on the forward discount, expected rate of depreciation, and the exchange rate risk premium of the four Southeast Asian currencies under study, namely the Thai Baht, the Malaysian Ringgit, the Indonesian Rupiah and the Philippine Peso. Section 3 discusses econometric tests of the forward discount as an unbiased predictor of future spot rate changes, along with the decomposition of the forward discount bias. Section 4 evaluates different expectation formation models in an attempt to explain the presence of systematic forecast errors. Section 5 concludes.

2 THE FORWARD DISCOUNT, EXCHANGE RATE EXPECTATIONS, AND THE RISK PREMIUM

2.1 This section analyses the extent to which forward exchange rates anticipated the currency crisis that broke out following the abandonment of the exchange rate peg for the Thai Baht on 2 July 1997, and how they predicted future changes in spot rates during the period of unprecedented turmoil in the foreign exchange market as the crisis unfolded.

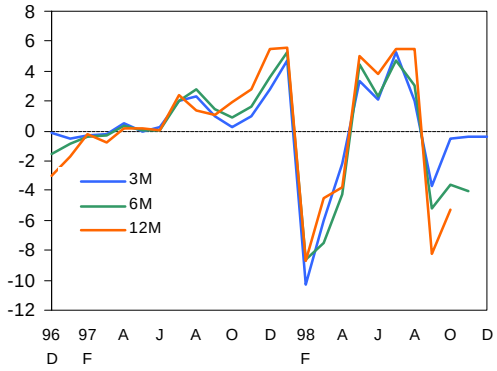
2.2 The *k*-period forward discount is made up of two components: (i) the expected rate of depreciation of the spot rate over the *k* periods, and (ii) a risk premium. The foreign exchange risk premium represents the compensation required by risk averse investors for holding an asset whose risk arises only from its currency of denomination. The problem in quantifying the exchange rate expectation and the risk premium is that the expected future spot rate is not generally observable. We therefore resort to the use of currency survey data to provide a model-free measure of overall market expectations.[1] The currency forecast data are taken from the *Economist Intelligence Unit (EIU) Currency Consensus Forecast*. The EIU survey is conducted on a monthly basis by polling a sample of participating multinational companies and banking institutions for their forecasts of specific exchange rates for various currencies against the US dollar.

2.3 Figures 1 to 4 display plots of the risk premium, forward discount and expected rate of depreciation for each of the four regional currencies. The 3-month risk premium is calculated as ${}_tf_{t+3} - {}_ts_{t+3}^e$, where ${}_tf_{t+3}$ is the natural logarithm of the forward rate at time *t* for delivery three months hence and ${}_ts_{t+3}^e$ is the natural logarithm of the EIU consensus forecast of the spot exchange rate three months ahead.

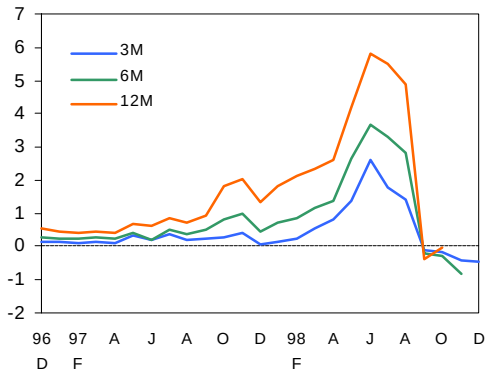
[1] The use of survey data in studies of exchange rate expectations can be traced back to the works of Frankel and Froot (1987, 1989). Other studies that have relied on survey data include Taylor (1989), MacDonald and Torance (1990), Cavaglia et al (1993, 1994), Chinn and Frankel (1993,1994).

Figure 1: Malaysian Ringgit

(a) Risk Premium (%)



(b) Forward Discount (%)



(c) Expected Depreciation (%)

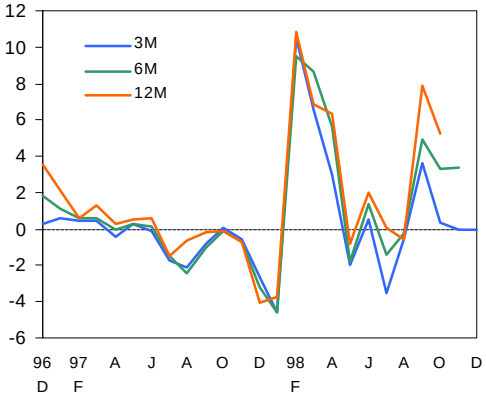
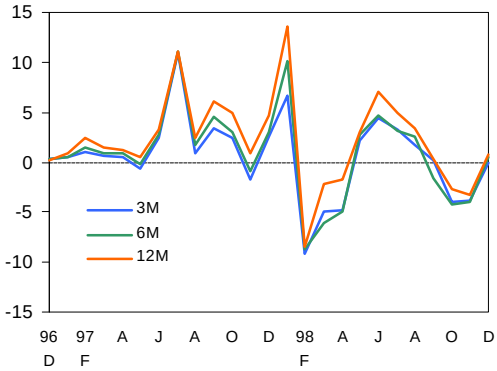
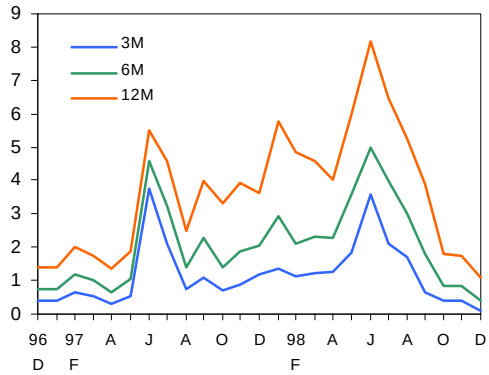


Figure 2: Thai Baht

(a) Risk Premium (%)



(b) Forward Discount (%)



(c) Expected Depreciation (%)

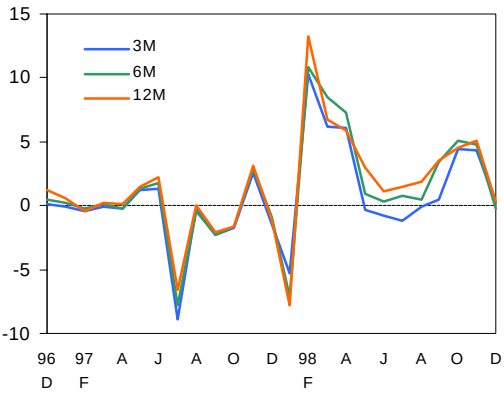
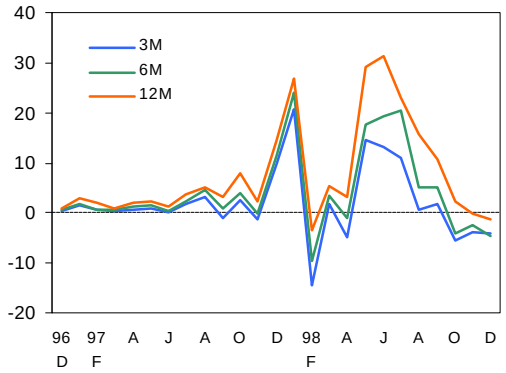
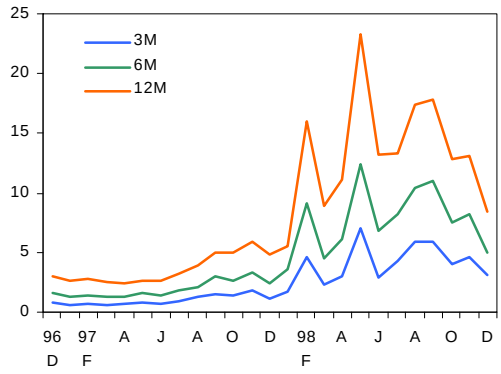


Figure 3: Indonesian Rupiah

(a) Risk Premium (%)



(b) Forward Discount (%)



(c) Expected Depreciation (%)

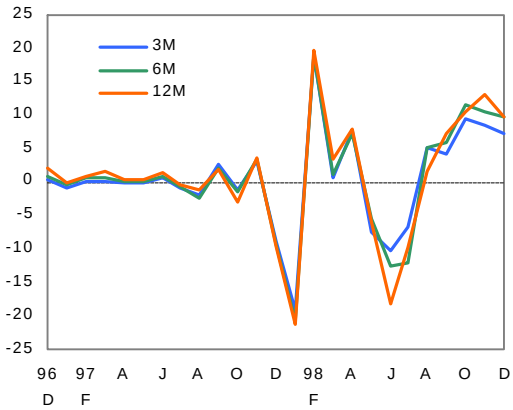
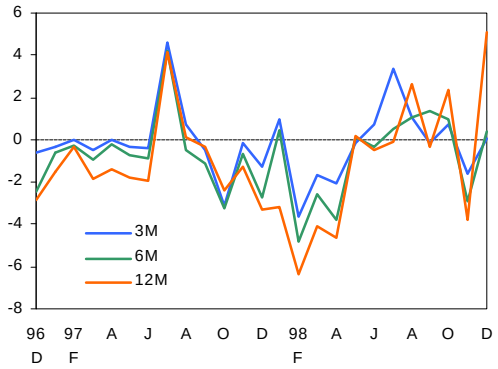
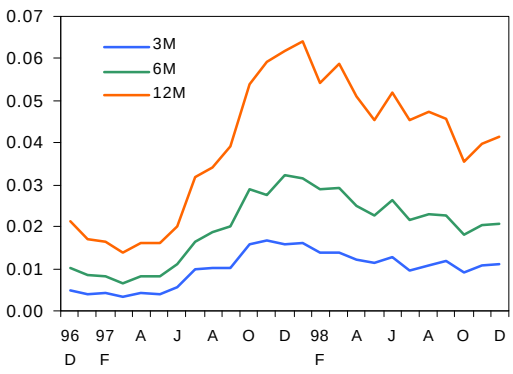


Figure 4: Philippine Peso

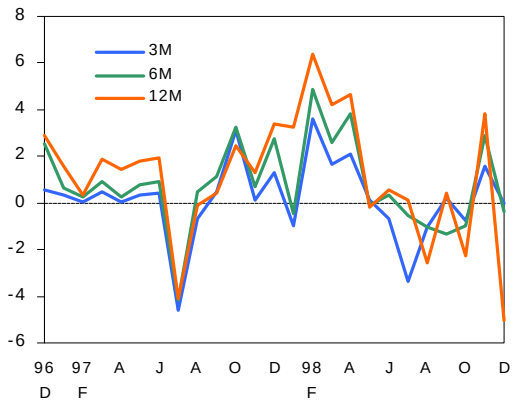
(a) Risk Premium (%)



(b) Forward Discount (%)



(c) Expected Depreciation (%)



2.4 In general, the forward rates of the four currencies were trading at discounts to the spot rates, even at the end of 1996, with a fairly large discount for the Thai Baht. The Baht forward discount rose from February 1997, when the currency first came under speculative attack, and it continued to rise as the solvency of a large number of finance and property development companies were increasingly doubted. However, the forward discount did not fully anticipate the magnitude of the actual depreciation that took place following the abandonment of the exchange rate peg.

2.5 The increase in the forward discount of the currencies until early 1998 reflected mainly rising risk premia on the currencies, while the survey data showed that the market, for most of the time, was expecting the currencies to appreciate following the excessive fall in spot rates.

2.6 The summary statistics of the forward discount, risk premium, expected and actual rate of depreciation for all the currencies, in terms of their annualised means and standard deviations, are shown in Tables 1 to 4. Over the entire sample, the mean and standard deviation of the actual depreciation of each currency were substantially larger than the means and standard deviations of the forward discount and the expected depreciation. The large standard deviation of the actual exchange rate changes relative to that of the forward discount indicates that the latter had moved too little to capture the variation in the actual exchange rate changes.

Table 1
Summary Statistics of Forward Discount, Dec 1996 - Dec 1998

(% pa)

	3 Months		6 Months	
Currencies	Mean	Std Deviation	Mean	Std Deviation
Indonesian Rupiah	10.008	7.764	9.444	7.024
Malaysian Ringgit	1.696	2.776	1.734	2.276
Philippine Peso	0.040	0.024	0.040	0.016
Thai Baht	4.652	3.772	4.094	2.550

Table 2
Summary Statistics of Risk Premium, Dec 1996 - Dec 1998

(% pa)

	3 Months		6 Months	
Currencies	Mean	Std Deviation	Mean	Std Deviation
Indonesian Rupiah	8.157	29.061	8.290	16.591
Malaysian Ringgit	0.434	12.947	-0.145	7.506
Philippine Peso	-0.679	6.869	1.573	3.824
Thai Baht	2.373	16.139	1.837	8.921

Table 3
Summary Statistics of Expected Depreciation, Dec 96 - Dec 1998

(% pa)

	3 Months		6 Months	
Currencies	Mean	Std Deviation	Mean	Std Deviation
Indonesian Rupiah	1.854	30.022	1.156	16.702
Malaysian Ringgit	1.261	12.342	2.033	6.888
Philippine Peso	0.717	6.870	1.614	3.826
Thai Baht	2.277	15.032	4.515	8.219

Table 4
Summary Statistics of Actual Depreciation, Dec 1996 - Dec 1998

(% pa)

	3 Months		6 Months	
Currencies	Mean	Std Deviation	Mean	Std Deviation
Indonesian Rupiah	28.779	68.552	39.303	45.657
Malaysian Ringgit	9.944	18.876	12.427	13.099
Philippine Peso	10.423	15.311	12.701	9.284
Thai Baht	8.518	27.054	11.351	19.778

2.7 For all the currencies, the mean of the forward discount was larger than the mean of the expected depreciation, the difference being the exchange rate risk premium. The risk premium was particularly large for the

Rupiah. The ranking of the size of the risk premium follows closely the relative magnitude of the volatility of the currency.

2.8 In the case of the Ringgit, the Baht and the Peso, the survey data indicate a larger expected depreciation over a larger horizon of six months, whereas the currency forecasters expected the initial depreciation of the Rupiah, which was much larger than the other currencies, to be partially reversed over the six-month period.

2.9 The unconditional standard deviation of the risk premium is almost comparable in size to the standard deviation of the expected rate of depreciation of the currencies. This finding is at variance with the Fama (1984) and Hodrick and Srivastava (1986) hypothesis that typically, the variance the expected depreciation of a currency is substantially smaller than the variance of the risk premium. Implicit in the hypothesis is the view that exchange rate expectation is essentially static, and therefore, changes in the forward discount reflect primarily changes in the risk premium. However, during a period of turbulence in the forward exchange market, market participants can be expected to continuously revise their forecasts of spot rates. Hence, it can be expected that the variance of the expected change in the exchange rate will be relatively large.

3 TESTING THE INFORMATION EFFICIENCY OF THE FORWARD DISCOUNT

3.1 In this section, we formally test the ability of the forward discount to provide an unbiased forecast of future changes in the spot rate. The standard procedure for testing the efficiency of the forward market is to evaluate a regression of the form:

$$s_{t+k} - s_t = a + b\,({}_tf_{t+k} - s_t) + e_{t+k} \qquad (1)$$

where s_t is the natural logarithm of the spot exchange rate at time t, expressed as the number of units of domestic currency per US dollar, ${}_tf_{t+k}$ is the natural logarithm of the forward rate at time t for delivery at time $(t + k)$, and e_t is the forecast error of the spot rate, namely $({}_ts_{t+k}^{e} - s_{t+k})$. ${}_ts_{t+k}^{e}$ is the natural logarithm of the expected spot rate at time $(t + k)$ formed at time t.

3.2 The null hypothesis that the forward discount is an unbiased predictor of the future depreciation of the spot rate is tested by evaluating the joint restrictions $a = 0$ and $b = 1$, assuming that e_{t+k} has zero mean and is orthogonal to any relevant information known at time t. Underlying the null hypothesis are the assumptions that investors are risk-neutral and that they form their expectations rationally. A risk-neutral investor is one who is not willing to pay an additional risk premium for the forward rate beyond the expected spot rate at time $(t + k)$ when he enters into a forward contract at time t. Under risk neutrality, speculation would drive ${}_tf_{t+k}$ into equality with ${}_ts_{t+k}^{e}$, so that expected profits from forward market speculation would be zero. If ${}_ts_{t+k}^{e}$ represents the mathematical expectation conditional on information available to the investors at time t, then $s_{t+k} = {}_ts_{t+k}^{e} + e_{t+k}$.

3.3 Numerous studies that have been summarised by Froot and Thaler (1990) and Engel (1995) have rejected the null hypothesis that the forward rate is an unbiased predictor of the future spot rate. The estimates indicate that b was less than one. In a large number of cases, b was found

to be negative. A negative b implies that, on average, the forward discount mispredicts the *direction* of the change in the future spot rate.

3.4 One group of researchers, namely Fama (1984), Hodrick and Srivastava (1984) and others, have argued that the foreign exchange market is typically rational and the bias in the forward rate is caused by the significant presence of a time-varying risk premium. Other researchers have maintained that investors are mainly risk-neutral and favour the view that the biased estimate of the forward discount is primarily due to the failure of the market to use information optimally.

3.5 The use of exchange rate expectations survey data, which allows researchers to quantify the respondent's expectations directly, enables one to decompose and apportion the sources of the biased forecast of the forward discount into the systematic forecast error and the risk premium.

3.6 The decomposition procedure is illustrated as follows. The probability limit of b in equation (1) is:

$$b = \frac{\mathrm{cov}(e_{t+k}, {}_tf_{t+k} - s_t) + \mathrm{cov}({}_ts_{t+k}^{\,e} - s_t, {}_tf_{t+k} - s_t)}{\mathrm{var}({}_tf_{t+k} - s_t)} \qquad (2)$$

Following Frankel and Froot (1986), b can be expressed as:

$$b = 1 - b_1 - b_2 \qquad (3)$$

where $$b_1 = \frac{\mathrm{cov}(e_{t+k}, {}_tf_{t+k})}{\mathrm{var}({}_tf_{t+k} - s_t)} \qquad (4)$$

and $$b_2 = \frac{\mathrm{var}({}_tf_{t+k} - {}_ts_{t+k}^{\,e}) + \mathrm{cov}({}_ts_{t+k}^{\,e} - s_t, {}_tf_{t+k} - {}_ts_{t+k}^{\,e})}{\mathrm{var}({}_tf_{t+k} - s_t)} \qquad (5)$$

3.7 Under rational expectations, the forecast error, e_{t+k}, is independent of known information at time t, and is hence uncorrelated with the forward discount, $({}_tf_{t+k} - s_t)$, a variable readily known to currency traders. Hence $b_1 = 0$. A non-zero b_1 would therefore indicate the breakdown in rational expectations, since the forecast error is systematically correlated with the forward discount. If the investors are risk neutral, and hence do not require a compensating risk premium, $({}_tf_{t+k} - {}_ts_{t+k}^e)$, b_2 would equal zero. This influence holds independent of how expectations on the future spot rate are formed. Therefore, under the joint assumptions of rational expectations and risk neutrality, $b_1 = b_2 = 0$, and hence $b = 1$ under (3).

3.8 We estimated equation (1) to test for the unbiasedness in the forward discount as a predictor of actual depreciation in the spot rate three months ahead. The equation was estimated using panel data formed by pooling the monthly time series observations from December 1996 to December 1998 with cross-section observations for four currencies. Table 5 reports the GLS and random effect model estimates of equation (1). The GLS estimates correct for both cross-section heteroscedasticity and contemporaneous correlation, and is sometimes referred to as the Parks estimator. For the GLS estimates, both a and b are assumed to be constant across all countries. The random effects model is employed to allow for country-specific shocks to impact on each currency through the intercept a in a random manner.

3.9 As indicated in Table 5, the estimates of b are negative and statistically not different from zero. A test of joint restrictions that $a = 0$ and $b = 1$ performed on the GLS estimates is rejected at a p-value of zero.

Table 5
Testing for Unbiasedness of the Forward Discount

	GLS	Random Effects Model
a	0.048 (0.017)	0.095 (0.027)
b	-0.016 (0.010)	-0.011 (0.016)
R^2	0.041	0.035
χ^2	13455.1	

Note: Figures in parentheses are standard errors. c^2 is the Wald Test for the null hypothesis that $a = 0$ and $b = 1$.

3.10 We next determined the extent to which the failure of the forward rate to forecast the actual depreciation three months ahead is due to systematic expectational errors by estimating the equation:

$$s_{t+k} - {}_t s_{t+k}^e = a_1 + b_1 ({}_t f_{t+k} - s_t) + u_{t+k} \quad (6)$$

As discussed earlier, under rational expectations, the forecast error $(s_{t+k} - {}_t s_{t+k}^e)$ should be orthogonal to the forward discount. Table 6 shows the results of our estimates of equation (6). A test of the rational expectations hypothesis restrictions $a_1 = b_1 = 0$ is rejected at the p-value of 0.002, indicating that one reason for the inability of the forward discount to predict future changes in the spot rate arose from the currency traders failing to use information optimally to price the forward rate.

3.11 However, an alternative explanation for the presence of systematic forecast errors is that during the period of unprecedented currency turmoil, the earlier rules used to manage the exchange rates by the regional central banks changed rapidly as the countries sought to find suitable 'exit strategies' from regimes of relative exchange rate fixity toward regimes of greater flexibility, together with their attendant volatility.[2] During

[2] For a detailed analysis of different forms of exit strategies, see IMF (1997).

such periods, the market is constantly learning to form reasonably reliable expectations about government policy responses to rapidly changing fundamentals. During the Asian currency crisis, fundamentals continuously shifted as private short-term capital inflows that helped to finance part of the current account deficits of some countries reversed themselves, as corporations and banks were found to have substantial unhedged foreign liabilities, runs on banks led to insolvencies[3], and governments found that it was hard to convince the market on the credibility of their policies. These country-specific shocks together with the contagion impact of bad news from other Asian economies [Baig and Goldfajn (1998)] made forecasts of future exchange rate developments, even by forward-looking agents, extremely difficult.

Table 6
Testing the Rationality of Exchange Rate Expectations

	GLS	Random Effects Model
a_1	2.215 (0.835)	4.348 (1.345)
b_1	-0.769 (0.503)	-0.752 (0.778)
R^2	0.030	0.001
χ^2	12.801	

Note: Figures in parentheses are standard errors. c^2 is the Wald Test for the null hypothesis that $a_1 = b_1 = 0$.

3.12 As the market participants continuously revised their views on market fundamentals and government policy intentions, perhaps through some form of Bayesian information updating process, persistent systematic forecast errors could arise, even if the participants were rational agents [Lewis (1989,1995)].

[3] For an analysis of the linkages between currency and banking crises in emerging economies, see Kaminsky and Reinhart (1996), and Eichengreen and Rose (1998).

3.13 In Figure 5, we plot the autocorrelations of the three-month ahead exchange rate forecast errors for the four currencies. The forecast errors of the currencies show signs of considerable persistence[4], with the forecast errors of the Indonesian Rupiah exhibiting the most persistence and those of the Philippine Peso showing the least signs of persistence. The Ljung-Box Q-statistic for the Rupiah at 20 degrees of freedom is 42.9, while that for the Peso is 26.4. The persistence of the forecast errors of the different currencies corresponded with the degree of severity to which the currency crisis and macroeconomic deterioration were felt in the respective countries. Such evidence is consistent with the view that the exchange rate forecast errors are a result of the market seeking to learn from rapidly-changing market economic fundamentals.

3.14 The contribution of the exchange rate risk premium to the biasedness of the forward discount can be evaluated by estimating the equation:

$$ {}_tS_{t+k}^{e} - s_t = a_3 + b_3 ({}_tf_{t+k} - s_t) + v_{t+k} \qquad (7) $$

The null hypothesis of risk neutrality can be evaluated by testing the joint restrictions of $a_3 = 0$ and $b_3 = 1$. When $b_3 = 1$, all the variation in the forward discount is attributed to expectations of depreciation, with no contribution from the time-varying risk premium. Note that evaluating $b_3 = 1$ is equivalent to testing $b_2 = 1$ in equation (5), since:

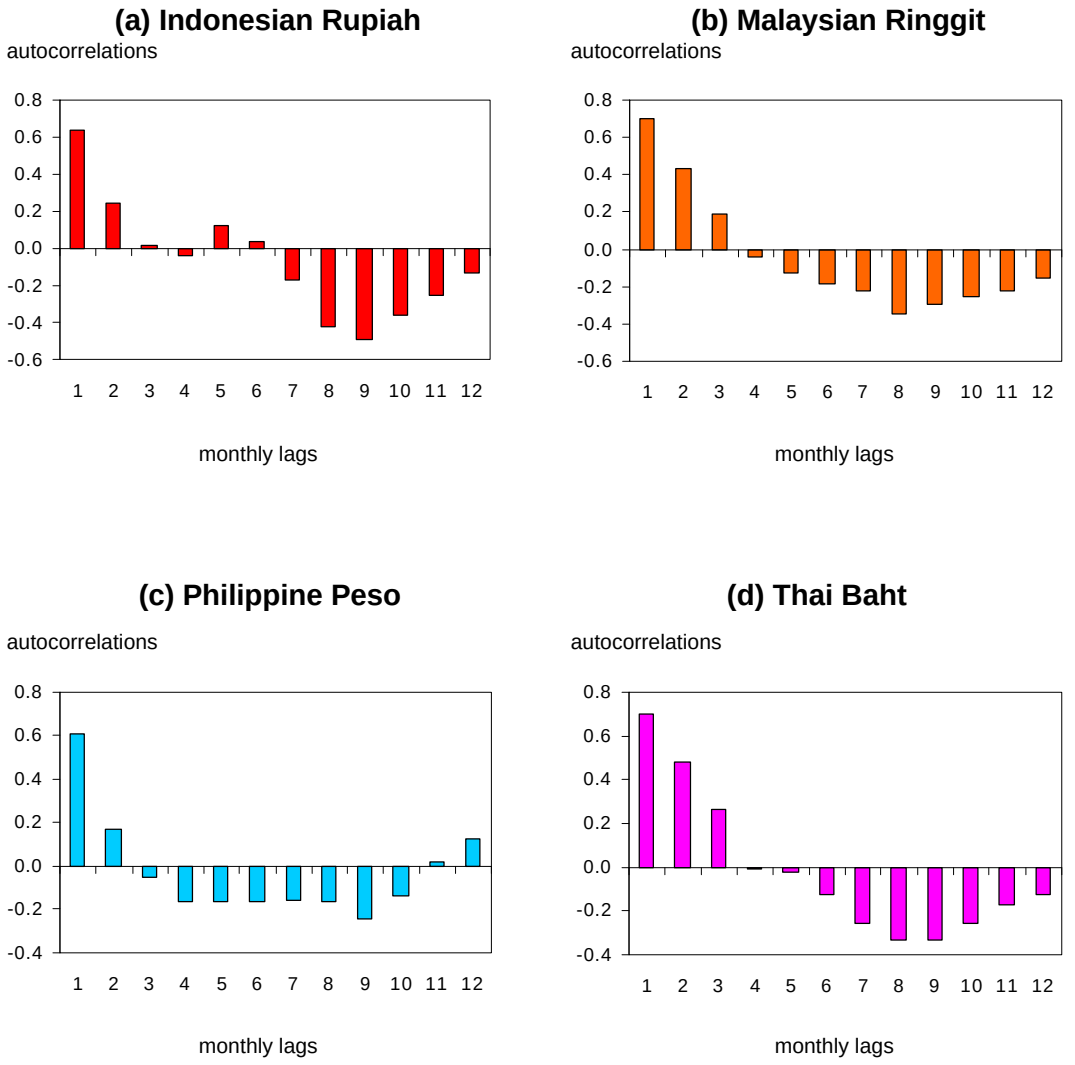
$$ b_3 = \frac{\mathrm{var}({}_tf_{t+k} - {}_tS_{t+k}^{e}) + \mathrm{cov}({}_tS_{t+k}^{e} - s_t, {}_tf_{t+k} - {}_tS_{t+k}^{e})}{\mathrm{var}({}_tf_{t+k} - s_t)} \qquad (8) $$

$$ = 1 - b_2 $$

[4] For evidence of persistence of exchange rate forecast errors in other currencies, see Evans and Lewis (1993).

From (3), a non-zero b_2 implies that part of the bias in the forward discount predicting future changes in the spot rate is due the presence of a time-varying risk premium.

Figure 5
Autocorrelations of 3-Month Exchange Rate Forecast Errors



3.15 Table 7 shows the estimates of equation (7). The estimates of b_3 are well below unity, and a formal test of the null hypothesis that $b_3 = 1$ is rejected at the p-value of 0.01. A joint test of the hypothesis that $a_3 = 0$ and $b_3 = 1$, which implies the absence of a constant as well as a time-varying risk premium, is also rejected with a p-value of 0.03.

3.16 Overall, the test results indicate that both systematic forecast errors as well as the variation in the currency risk premia resulted in the failure of the forward discount to provide an unbiased forecast of the future depreciation of the spot exchange rate.

Table 7
Testing for the Presence of a Risk Premium

	GLS	Random Effects Model
a_3	0.190 (0.324)	0.254 (0.109)
b_3	0.369 (0.260)	0.125 (0.077)
R^2	0.012	0.771
χ^2	7.012	

Note: Figures in parentheses are standard errors. c^2 is the Wald Test for the null hypothesis that $a_3 = 0$ and $b_3 = 1$.

4 THE FORMATION OF EXCHANGE RATE EXPECTATIONS

4.1 The large variance of the expected change in the future spot rate of each of the regional currencies noted in Section 2 indicates that exchange rate expectations is far from static, and foreign exchange market participants revise their expectations in the face of new information. The statistical results in Section 3 show that the participants tend to commit systematic forecast errors. In this section, we test several alternatives to the rational expectations model in order to characterise how agents form their forecasts of future spot exchange rates and, in the process, appraise the role played by the current spot rate in the expectation formation process at a time when the currencies were depreciating rapidly.

4.2 The first model that we consider is the extrapolative expectation mechanism, where agents extrapolate the most recent trend into the future:

$$ {}_{t}s_{t+k}^{e} - s_t = l_0 + l_1 (s_t - s_{t-1}) + d_t \qquad (9) $$

If $l_1 > 0$, the exchange rate expectation is said to follow a bandwagon effect, in which a depreciation of the current spot rate gives rise to expectations of future depreciation. Such expectations are said to be destabilising. On the other hand, if $l_1 < 0$, then a current depreciation generates expectations of an appreciation in the future. A value of l_1 that is not significantly different from zero would imply that expectations are static.

4.3 Table 8 reports our estimates of equation (9). The estimated value of l_1 is negative and statistically significant, indicating that investors expect spot rates to appreciate in three months time, after the currencies had depreciated for the past month. Our results are consistent with the findings of Frankel and Froot (1987), Cavaglia et al (1993) and Gan and Wong (1996). The two earlier studies analysed the exchange rate expectations for the industrial countries using data covering various periods

that span the 1980-90 decade. Gan and Wong studied exchange rate expectation formation for the Singapore-US Dollar exchange rate during 1984 to 1991.

Table 8
Test of Extrapolative Expectations

	GLS	Random Effects Model
l_0	0.661 (0.302)	1.054 (0.132)
l_1	-29.577 (2.411)	-28.128 (2.396)
R^2	0.640	0.244

Note: Figures in parentheses are standard errors.

4.4 The next expectation formation scheme that is tested is the adaptive expectations model, in which agents adjust the direction of their forecast according to past forecast errors:

$$ {}_{t}s_{t+k}^{e} - s_t = l_2 + l_3 (s_t - {}_{t-k}s_t^{e}) + j_t \qquad (10) $$

$l_3 > 0$ implies that investors would expect further depreciation of the currencies if they had, in the past, underestimated the extent to which the currencies had actually depreciated. The estimates of equation (10) which are presented in Table 9 show that l_3 is negative. This implies that any unanticipated depreciation over a three-month horizon gives rise to an expected appreciation over the next three months.

4.5 The nature of the extrapolative and adaptive expectations models tends to give rise to persistent under-prediction of the actual depreciation of the currencies, as has been noted in previous sections. It is well known that where agents have signal extraction problems in distinguishing between permanent and transitory components of a given

shock, adaptive behaviour (with the attendant forecast error persistence) is consistent with rational forecasts [Lewis (1995), Buiter et al (1998)].

Table 9
Test of Adaptive Expectations

	GLS	Random Effects Model
l_2	-0.001 (0.0002)	-0.001 (0.0004)
l_3	-43.430 (0.002)	-43.431 (0.003)
R^2	1.000	1.000

Note: Figures in parentheses are standard errors.

4.6 We next evaluate whether the exchange rate expectations are also anchored around some notion of the fundamental value of these currencies. One proxy for the equilibrium value is the exchange rate that is implied by the long-term purchasing power parity (PPP) relationship. We tested the following model:

$$ {}_tS_{t+k}^{e} - s_t = l_4 + l_5 (s_t - s_t^*) + h_t \qquad (11) $$

where s_t^* is the value of the spot rate at time t that is implied by the PPP relationship, i.e., $s_t^* = s_0 + \log(\frac{P_t^i / P_0^i}{P_t^{US} / P_0^{US}})$. s_0 is the natural logarithm of the average nominal value of the i-th currency per US Dollar for the period January 1990 to December 1998, P_t^i and P_t^{US} are the current consumer price index levels of country i and the US respectively, P_0^i and P_0^{US} are the average consumer price index levels of country i and the US respectively over the period January 1990 to December 1998.

4.7 Table 10 presents the estimates of equation (11). The coefficient l_5 is not statistically significant. This suggests that agents did not

consider the deviation of current exchange rates from their PPP values a significant factor in forming their forecasts of spot rates three months ahead.

Table 10
Test of Reversion to PPP

	GLS	Random Effects Model
l_4	0.287 (0.570)	0.282 (0.216)
l_5	-0.056 (0.157)	0.025 (0.048)
R^2	0.001	0.455

Note: Figures in parentheses are standard errors.

4.8 We tried another proxy for the equilibrium value of the exchange rate around which the short-term exchange rates may be expected to revert to. We assume that the equilibrium value of a currency at time *t* is the expected value of the exchange rate one year from *t*. The expected change in the spot exchange rate over the next three months would then evolve according to the following model:

$$ {}_tS_{t+k}^{e} - S_t = l_6 + l_7 ({}_tS_{t+12}^{e} - {}_{t-1}S_{t+11}^{e}) + y_t \qquad (12) $$

Estimates of equation (12) are presented in Table 11. The GLS estimates of l_7 are not statistically significant.

Table 11
Test of Reversion to Long-run Expected Rate

	GLS	Random Effects Model
l_6	0.058 (0.329)	0.319 (0.129)
l_7	4.096 (2.818)	2.775 (3.181)
R^2	0.001	0.440

Note: Figures in parentheses are standard errors.

4.9 Overall, our analysis of exchange rate expectation formation mechanisms indicates that in forecasting the exchange rate over a shorter term horizon, the market participants focussed mainly on recent changes in spot rates as the basis for making projections into the future. Fundamental values, as represented by our proxies, do not seem to play a role in determining market expectations of exchange rates three months ahead.

4.10 The above observations are consistent with the questionnaire survey findings of Taylor and Allen (1992) for the UK foreign exchange market, and Lui and Mole (1998) for the Hong Kong market, which polled foreign exchange dealers employing fundamental and technical analysis in forming their forecasts of exchange rate movements. The findings showed that traders in these two markets relied mainly on technical analysis in predicting exchange rate changes over shorter time horizons. Over longer time horizons, forecasts of exchange rate trends based on fundamentals tend to dominate. The importance of technical signals is crucial during periods of extreme turbulence, during which market participants are unsure of rapidly-changing fundamentals as a currency crisis evolves.

5 SUMMARY AND CONCLUSIONS

5.1 This paper sets out to investigate an old issue – the efficiency of the forward market for foreign exchange – in the context of the recent Asian currency crisis. The analysis of the data has shown that the forward market anticipated the impending crisis before the mayhem broke out following the devaluation of the Thai Baht. As the crisis unfolded, the forward rates of the regional currencies, although trading at discounts to the prevailing spot rates, failed to predict the timing and relative magnitude of the subsequent depreciations.

5.2 Our analysis indicates that part of the failure of the forward rates to predict future spot rates was due to the manner in which market participants formed their expectations regarding future changes in spot rates. Tests of expectation formation mechanisms indicate that agents on average tend to expect the future spot rate to appreciate when the current spot rate depreciates further below the spot rate of the previous period, or when the spot rate falls more than anticipated during the previous period. Such non-rational exchange rate forecasts can be explained by the market learning as it seeks to understand the process generating the spot rate under conditions where fundamentals are constantly changing. Equally important in accounting for the bias in the forward rate is the presence of a time-varying risk premium. We find that in general, the more volatile the currency is, the larger is its risk premium.

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