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Current account, exchange rate dynamics and the predictability: the experience of Malaysia and Singapore

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Abstract

The East Asian financial crisis indicated that one of the factors that played a critical role in affecting the exchange rate of a country was its current account balance. This paper attempts to investigate this hypothesis. The Singaporean dollar (SD) and the Malaysian ringgit (RM) against the yen are taken as case studies. Our analysis is based on the recent cointegration method and we examine two issues. First, whether the exchange rates are cointegrated with the fundamentals as predicted by economic theory. Our focus was to investigate whether the exchange rate movements are affected by the economic fundamentals, particularly the current account balance. Our findings suggest that the model fits the data well. Secondly, we wanted to test the validity of our model for forecasting future exchange rates. The findings show that the model does produce good in-sample as well as out-of-sample forecasts.

JEL classification: F31; F47

Keywords: Exchange rates; Cointegration; Out-of-sample forecast

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1. Introduction

The East Asian crisis has been attributed largely to a combination of cumulative and trigger factors. The cumulative factors boil down to the vulnerabilities of the domestic financial and corporate systems as well as those of the external sector of the economies as reflected in their current account imbalances. Those East Asian economies whose foreign exchange reserves were large relative to their short-term borrowing were in a much better position to withstand speculative attacks. For example, Hong Kong, Singapore, Taiwan, and China faced these attacks much better than others, such as Thailand, Malaysia, Indonesia, and South Korea.[1] This paper attempts to investigate the role of current account balance in affecting the exchange rate of a country. The Singaporean dollar (SD) and the Malaysian ringgit (RM) against the Japanese yen (JY) are taken as case studies.

The theoretical basis of our investigation is the monetarist model augmented by the current account balance. Despite its theoretical appeal, the empirical validity of the monetarist model is surrounded by controversy (see, e.g., Meese and Rogoff, 1983).[2] In general, the data up to the end of 1978 tend to be supportive of the asset market approach to exchange rate determination. In contrast, the models for the period beyond 1978 produced poor results in terms of the signs and significance of the coefficients as well as the within-sample predictive power, not to mention the poor out-of-sample predicting performance.

The empirical studies in the 1990s (MacDonald and Taylor, 1993, 1994b; McNown and Wallace, 1994; Moosa, 1994, to name a few) that utilized a more sophisticated econometric method to deal with non-stationary data found that the monetary model is a valid framework to analyze movements in major currencies. For example, the influential papers by MacDonald and Taylor (1993) found evidence that the monetary model not only produces sensible long-run relationships but also outperforms a random walk in out-of-sample forecasting exercise. Hence, these studies rekindle the hope that a simple set of monetary fundamentals[3] – relative money supplies and relative output – are useful for predicting major traded currencies such as the US dollar.

Research progressing along this line (e.g., see Berg and Jayanetti, 1993; Makrydakis, 1998; Diamandis et al., 1996; Chinn, 2000; Husted and MacDonald, 1999 among others) that focused on the less significant currencies showed that the exchange rate of the smaller economies cointegrate with the fundamental variables. It is worth noting that the papers by Husted and MacDonald (1999) and Chinn (2000), that covered a comparable period to that of the present study, found that a fundamental-based exchange rate model is appropriate for the Asian countries.

There are two major objectives of this paper. The first is to determine whether a long-run relationship exists between exchange rates and their fundamental variables for two of the ASEAN countries, namely Singapore and Malaysia. In the case of these two countries, the

[1] The literature on the recent East Asian crisis is large and growing. See, for example, Masih and Masih (1999, 2000) and Pomerleano (1998), to quote only a few.

[2] In their seminal paper, Meese and Rogoff (1983) find that a naïve random walk model outperforms an array of structural models, including those based on monetary fundamentals in predicting US dollar exchange rates at horizons of up to 12 months during the late 1970s and early 1980s.

[3] In this paper the term *fundamental variables* refers to money, interest rate and income. For example Flood et al. (1991) adopted the same term for these three variables.

currencies are pegged to a basket with the US dollar receiving a dominant basket weight. The RM and the SD appear to be the most flexible currencies among the ASEAN countries, particularly against the currencies that have smaller weights in the basket. Unlike most of the earlier studies, this paper contributes to the existing literature by including an important forcing variable—the current account variable in the exchange rate equation. The second objective is to evaluate the forecasting ability of the model. The purpose is to show that our model has good predictive power for in-sample as well as out-of-sample forecasts.

The remainder of the paper is organized as follows. A very brief discussion of the methodology and data used in this paper follows. The empirical results are explained in Section 2 and the paper ends with the concluding remarks in Section 3.

1.1. Methodology and data

We employed the standard cointegration methodology provided by Johansen (1988, 1991) and Johansen and Juselius (1990). In employing this methodology, we have taken special care with a couple of aspects. In line with Johansen (1991), the intercept term in the VECM should be associated with the existence of a deterministic linear time trend in the data. If, however, the data do not contain a time trend, the vector error-correction model (VECM) should include a restricted intercept term associated with the cointegrating vectors. It has also been pointed out by, for example, Cheung and Lai (1993) that the trace and maximum eigenvalue statistics may be subjected to size distortions depending on the chosen data generating process (DGP) and sample size. To take care of such a possibility, we follow Reimers (1992) and report the small sample correction formulas:

$$\mathrm{TR} = (T - np)\sum_{i=r+1}^{N} -\ln(1-\lambda_i)\ \text{and}\ \mathrm{LR} = (T - np)\ln(1-\lambda_{r+1}),$$

where T is the sample size, n is the number of variables entering vector autoregression (VAR) and p is the VAR's lag order.

The above methodology is applied to Singapore dollar/yen (SD/JY) and Malaysian ringgit/yen (RM/JY) rates. Quarterly frequency data from 1976:Q1 to 1999:Q2 are utilized in the analysis. The data are from the *International Financial Statistics* of the International Monetary Fund (IMF). The exchange rate used is the nominal exchange rate using the Japanese yen (JY) as the base currency; the income is proxied by GDP, the interest rate is the treasury bills for Malaysia and the 3-month inter-bank rate for Singapore; and money supply is M2 (broad money). Bilateral current accounts in level form for Singapore and Malaysia are sourced from IMF. We follow Cushman et al. (1996) in constructing the cumulative accounts (ca–ca*). Specifically, the variable (ca–ca*) is the difference in the share of the cumulative current accounts relative to GDP. Cushman et al. (1996) note that the level (cumulative) bilateral account between domestic and foreign countries (in our case, Japan) should be used if the variable is nonstationary (stationary). All the data are seasonally unadjusted series.

Table 1
Augmented Dickey–Pantula and Phillips–Perron unit root test results

	Tests for three unit roots		Tests for two unit roots		Tests for single unit roots		Phillips–Perron (1988)			
	α_3	LM(5)	α_2	LM(5)	α_1	LM(5)	Levels		First difference	
							No trend	Trend	No trend	Trend
A: SD/JY										
e	−9.32*	1.01	−3.44*	0.80	−1.92	0.80	−1.50	−1.29	−6.86*	−6.82*
$m–m^*$	−10.13*	0.01	−5.83*	0.68	−0.51	0.75	−1.34	−2.53	−11.86*	−11.77*
$y–y^*$	−10.32*	3.25	−7.27*	0.49	1.53	2.76	0.43	−1.31	−9.59*	−9.77*
ca	−5.63*	1.01	−4.06*	0.69	−0.41	0.67	−0.77	−2.92	−6.49*	−6.44*
$i–i^*$	−6.11*	0.50	−3.41*	0.87	−1.58	1.11	−2.24	−2.64	−9.47*	−9.43*
B: RM/JY										
e	−10.00*	1.68	−3.39*	1.50	−1.40	1.56	−1.31	−1.27	−7.16*	−7.13*
$m–m^*$	−9.78*	0.86	−4.10*	0.07	0.46	0.11	0.19	−1.16	−9.88*	−9.96*
$y–y^*$	−11.86*	2.58	−3.81*	1.66	1.40	1.85	1.56	−0.78	−6.98*	−7.43*
ca	−5.01*	0.11	−2.82*	0.97	−1.65	0.25	−1.68	−1.68	−4.46*	−4.32*
$i–i^*$	−6.50*	0.09	−3.71*	0.44	−0.88	0.61	−1.95	−3.42*	−6.81*	−6.78*

Notes: The letters e, m, y, ca and i denote the exchange rate, the index of money supply (M2), GDP, current account and interest rate. An asterisk denotes the corresponding foreign variables. Lag length n was chosen based on Akaike Information Criteria (AIC). Asterisk (*) denotes statistically significant at 5% significance level: −2.91 (no trend) and −3.49 (trend).

2. Empirical results

Five variables are tested for unit roots: exchange rates, real money supply (M2), real income, interest rate and current accounts. All variables are in logarithms except for interest rate and current account balance. Table 1 displays both the PP test statistics and Dickey–Pantula tests. The PP unit root tests for the variables in the exchange rate model were done first on the level variables and then on first differences of the variables.[4] The statistics for each country suggest that the level variables are each integrated of order one (except for interest rate differential in Malaysia). The possibility that the series is integrated of higher order has also been explored by using the approach suggested in Dickey and Pantula (1987). As shown in Table 1, the tests are able to reject the null hypothesis of two unit roots at the 5% level or better but unable to reject the null hypothesis of a single unit root. All the variables under investigation, with the exception of interest differential ($i–i^*$) for the RM/JY rate, were in accord with the PP tests. Given the low power of these tests to discriminate between $I(1)$ and a mean/trend stationary process in small samples such as ours (see Blough, 1992), we proceeded by treating all the variables (including interest

[4] The ADF statistics are not informative enough on the stationary status of some of the variables in the model since they produce conflicting results. Some of the variables in the RM/JY model were found to be non-stationary even after first difference (e.g., $m–m^*$ and $y–y^*$). These results are not shown for the sake of brevity, but are available from the first author upon request. The Dickey–Pantula test rejects stationarity in the level for all the variables supporting our specification.

Table 2
Testing for cointegration using the Johansen–Juselius method

Tests		Unconditional		Conditional	
H_0	H_A ($k=6$ $r=2$)	SD/JY ($k=3$ $r=2$)	RM/JY ($k=3$ $r=2$)	SD/JY ($k=3$ $r=1$)	RM/JY
λ_{max}					
$r=0$	=1	36.83*	51.84*	29.63*	35.22**
$r\leq 1$	=2	30.36*	35.27*	16.74*	8.222
$r\leq 2$	=3	14.90	18.28	5.43	–
$r\leq 3$	=4	9.58	12.23	–	–
$r\leq 4$	=5	4.19	5.12		
Trace					
$r=0$	≥1	95.86*	122.75*	51.8**	43.44**
$r\leq 1$	≥2	59.03*	70.91*	22.17*	8.222
$r\leq 2$	≥3	28.67	35.63*	5.43	–
$r\leq 3$	≥4	13.77	17.35	–	–
$r\leq 4$	≥5	4.19	5.12		

Notes: The reported values of the trace and λ_{max} statistics are corrected for degrees of freedom following Reimers (1992). Asterisks (**) and (*) denote statistically significant at the 1% and 5%, respectively. Dummy used: RM/JY (86:Q1, 93: Q3 and 95:Q1) and SD/JY (94:Q2 and 95:Q1).

rate differential) as being integrated of order one.[5] The vector of endogenous variables is specified as $X=[e, m–m^*, y–y^*, i–i^*, \text{ca}–\text{ca}^*]'$. The trace test and maximum eigenvalue (λ_{max}) test determine the number of cointegrating vectors.[6] The appropriate critical values required for these tests are obtained from Osterwald-Lenum (1992).

The system for the two bilateral rates is constructed with three lags for RM/JY and six lags for SD/JY based on the Akaike Information Criterion (AIC). Both the trace and λ_{max} statistics strongly reject the null hypothesis of no cointegrating vectors for the SD/JY and RM/JY rates. In fact, two or more cointegrating vectors were identified based on the results from the unconditional model. These results are presented in Table 2. However, the results from the single equation and system diagnostic tests based on the unconditional VAR model suggest that some equations (including exchange rate) suffer from serial correlation, non-normal residuals, and incorrect functional forms (RESET), perhaps suggesting inappropriateness of the model. We did not report the single equation and vector specification tests here to conserve space. Attempts to increase the lag length of the unconditional VAR model as well as adding dummy variables failed to produce white noise residuals.

We then tested the stability of parameters of our model using the computer package PcFiml by Doornik and Hendry (1997b). The VAR model is re-estimated recursively, and

[5] There is no consensus in the literature on the statistical property of interest rate or interest rate differentials. We relied on the last procedure to verify the nonstationarity of our data. Nonetheless, some authors (e.g., Fedderke and Liu, 2002) have argued that interest differential might not be $I(0)$ if the risk premium changes over time.

[6] The trace statistic is used for testing the null hypothesis. These are of at most r cointegrating vectors against the alternative of m cointegrating vectors. The λ_{max} statistic is used in testing the null of $r-1$ against the alternative of r cointegrating vectors. As pointed out by a reviewer, the trace test is more reliable, particularly in cases where the residuals are non-normal, such as ours.

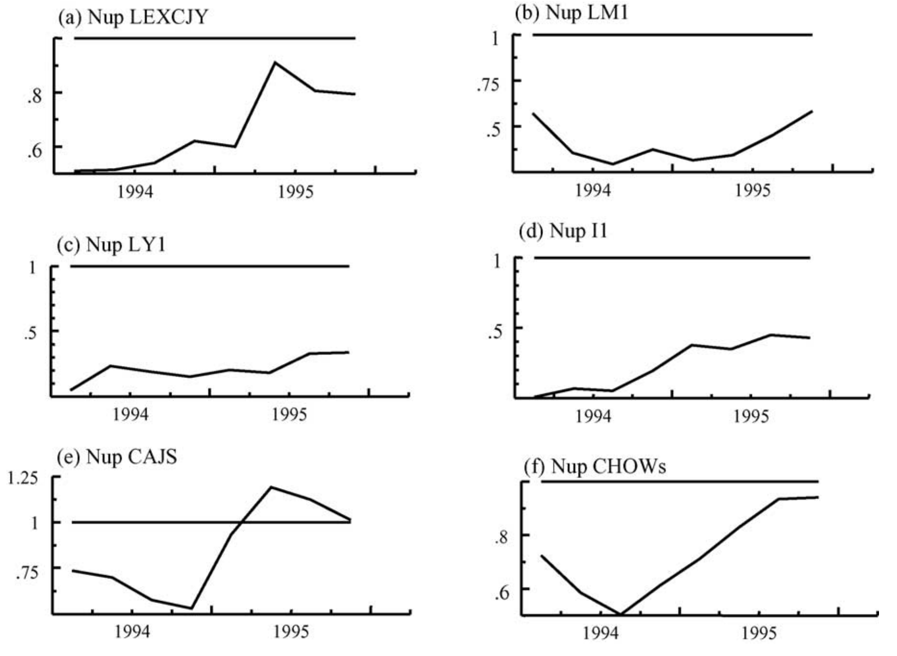

Fig. 1. Forecast Chow test (SD/JY)-5%.

the stability of its parameters is tested by means of sequential Chow-type tests.[7] The main purpose is to identify variable(s) that may yield instability in the VAR model. Results for the tests using SD/JY data are plotted in Fig. 1a–d for each of the equations and for the system as a whole in Fig. 1f. Results for the RM/JY model are also graphed in Fig. 2a–f. Note that the critical values for this test appear in the plot as a straight line at unity.

Visual inspection of the plot clearly indicates that current accounts exhibit instability in around the 1994–1995 periods for the SD/JY model (Fig. 1d). However, the behavior of current account process in the SD/JY model did not produce instability in the VAR model as a whole (Fig. 1f). For RM/JY, the plots clearly show that both income and interest rate processes are unstable in the 1994–1995 period and again these variables have no effect on the stability of the VAR system as whole.[8] Estimating the model with longer lag-length produced almost the same results.

[7] Briefly, sequential tests for parameter stability are conducted using the one-step ahead Chow-type tests. Starting with a minimum sample of size, say two, we augment it by one recursively, thus resulting in a sequence of F-statistics $F(1, t-k-1)$, $t = T_0 + 1, \ldots, T$, given by $(\mathrm{RSS}_t - \mathrm{RSS}_{t-1})/\mathrm{RSS}_{t-1}$. The critical values appear in the plots to be a straight line at unity. This is because the statistics reported above are by one-off critical values from the F-distribution at the selected probability level as an adjustment for changing degrees of freedom (See Banerjee and Urga, 1995).

[8] The break in 1985 is not surprising as it corresponds to the second oil shock as well as the financial reforms that took place after the 1984 recession. The second shock in the 1994 corresponds to the portfolio and other capital inflows. In this period, we observed that stock trading was very active with the stock price index reaching

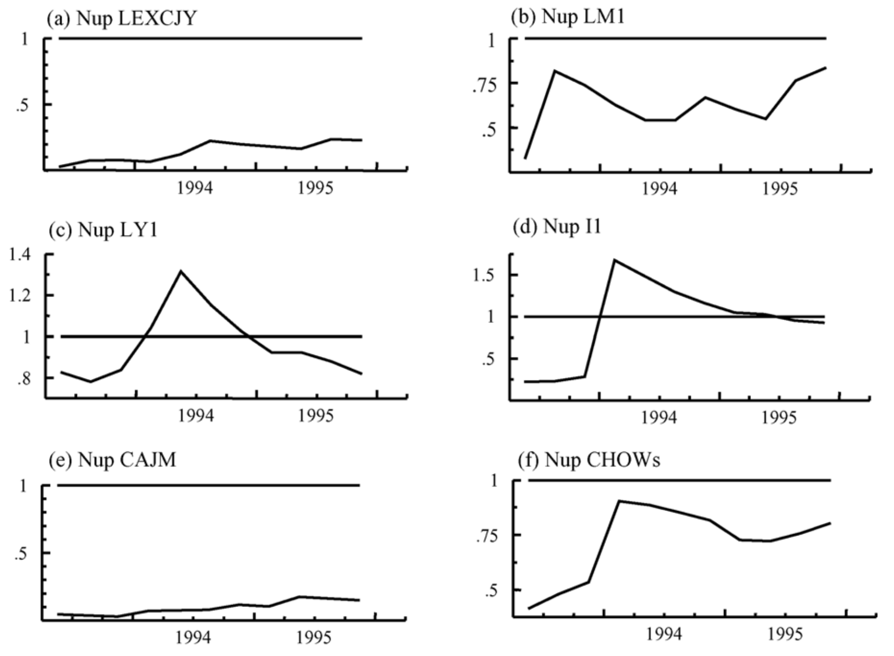

Fig. 2. Forecast Chow test (RM/JY)-5%.

To further investigate whether the observed instability of the parameters of the model can be attributed to the specific variables in the system, the stable part of the VAR model conditional on the variables is estimated.[9] For the RM/JY model, the conditional variables are income and interest rate and in the case of the SD/JY model, the conditional variables are current account and the money supply, respectively (see Fig. 2c and d). In addition, three dummies (D86:Q1, D93:Q3 and D95:Q1) are also included in the RM/JY model and two dummies are introduced (D94:Q2 and D95:Q1) in the SD/JY model. D93:Q1 and D95:Q1 (D94: Q2 and D95: Q1) are two dummies introduced to capture the structural change in the Malaysian (Singaporean) economy due to the surge of foreign capital in Malaysia.[10] The variable D86: Q1 is introduced to capture the effect of the second oil shock and the financial reforms that took place in the mid-1980s.

Table 2 also presents the results of Johansen's cointegration for the conditional VAR model. The model with the dummy variables yields two significant vectors at the 5% level for SD/JY based on the λ_{max} test and one significant vector for the RM/JY. Notice also that the analysis shows that the trace test yields qualitatively the same results as the λ_{max} test for the

an all time high in 1993:Q4 (INDEX = 1275). In order to remove these effects from our data, we have added two shift dummies. However, the addition of these variables did not significantly change our empirical results.

[9] All estimation is carried out using PcGive and PcFiml version 9.0. See Doornik and Hendry (1997a,b).

[10] The addition of dummies in the two models was based on the examination of the standardized residuals plot from the VAR model.

Table 3
Diagnostic checking

Variable	χ^2-statistics [p-value]			
	Port.	AR(5)	ARCH(4)	Norm(2)
A: SD/JY				
e	6.90	6.50 [0.26]	2.96 [0.56]	8.11 [0.02]*
m–m^{*}	8.21	8.82 [0.12]	6.47 [0.17]	0.43 [0.81]
y–y^{*}	46.68	30.17 [0.00]**	7.14 [0.13]	0.84 [0.66]
B: RM/JY				
e	9.09	9.92 [0.08]	1.42 [0.84]	0.39 [0.82]
i–i^{*}	5.44	8.61 [0.13]	3.84 [0.43]	9.40 [0.01]**

Notes: e, m, y, i, ca are the exchange rate, money supply, GDP, interest rate, and current account. Asterisks (**) and (*) denote statistically significant at the 1% and 5%, respectively. Figure in parenthesis is p-values. AR(n) is the n-th order LM test for serial correlation, Norm(2) is a test for normality in the residuals; ARCH(m) is a m-order test for autoregressive conditional heteroskedasticity.

RM/JY rate. Hence, both test statistics reveal strong support of at least one vector for each of the countries at the 5% level. Several authors have pointed out that the more vectors the more stable is the relationship. In addition, Berg and Jayanetti (1993) have also pointed out that deviations from equilibrium are likely to be smaller and shorter in countries where multiple vectors are found.[11] Hence, we have found strong evidence of a long run relationship between the exchange rate and its determinants including the current account variable.

In many respects, the results of the conditional VAR model are much superior to those obtained from the unconditional VAR model. As shown in Table 3, the Ljung-Box Q-test verifies that the model did not violate the autocorrelation assumption. All the equations perform well with the Bruesch–Godfrey's Lagrange Multiplier test, except for autocorrelation in the income differential equation in RM/JY model. Attempts to increase the number of lags did not eliminate the autocorrelation. The test of normality shows that the model did not violate the assumption except for the SD/JY model.[12]

Having established the cointegrating rank r, we proceeded with the exogeneity tests on the individual variables using the conditional VAR for SD/JY and RM/JY rates. The null hypothesis that the variable is weakly exogenous with respect to the cointegrating vector is equivalent to the hypothesis that the variable in question is not error correcting. Thus, imposing zero restriction on the coefficient of the error-correction term serves as a test of weak exogeneity.[13] Table 4 contains the outcome of the Wald tests and the results may be summarized as follows. They reveal that the SD/JY model contains three endogenous variables: exchange rate, money supply and income. The restricted model for the RM/JY

[11] The finding of more than one significant vector in the monetary model is not uncommon in the literature. For instance, a recent article by Miyakoshi (2000) finds one vector for the Korean won–Japanese yen rate and two vectors for the Korean won–US Dollar and Korean won–German mark rates. This result contrasts sharply with the finding of Meese (1986) but agrees with the findings of MacDonald and Taylor (1994a,b), Chinn (2000) and Miyakoshi (2000), to name a few.

[12] Gonzalo (1994) shows that the performance of the maximum likelihood estimator of the cointegrating vectors is little affected by non-normal errors.

[13] If the coefficient of the dependent variable is weakly exogenous, the VECM should be reformulated conditional on this variable.

Table 4
Weak exogeneity tests

	e	$m–m^*$	$y–y^*$	$i–i^*$	ca–ca*
SD/JY	13.36 [0.00]**	12.64 [0.00]**	16.59 [0.00]**	–	–
RM/JY	4.20 [0.04]**	–	–	19.37 [0.00]**	–

Notes: Figures in parenthesis are p-values. Asterisks (**) and (*) denote statistically significant at the 1% and 5%, respectively.

Table 5
Test of exclusion restrictions

Variables	SD/JY	RM/JY
e	12.18 [0.00]	26.42 [0.00]
$m–m^*$	17.26 [0.00]	19.08 [0.00]
$y–y^*$	15.93 [0.00]	19.06 [0.00]
$i–i^*$	7.78 [0.02]	16.12 [0.00]
ca–ca*	15.41 [0.00]	24.30 [0.00]
Constant	16.09 [0.00]	13.07 [0.00]

Note: For the tests of exclusion restrictions figures are χ^2 statistics with one degree of freedom, and the critical value at the 5% significance level is 3.84.

has two endogenous variables, namely exchange rate and interest rate. Money is weakly exogenous in the RM/JY model, while interest rate is found to be weakly exogenous in Singapore. Importantly, the weak exogeneity of exchange rate is rejected for both countries. The results also suggest that the current account variable appears as weakly exogenous in the cointegrating space for the two currencies. One practical implication of the findings is that money (interest rate) can now be targeted as a policy variable in Malaysia (Singapore). However, more importantly, the results tend to suggest that in both countries current accounts affect exchange rate significantly. These findings also demonstrate that the two countries may not share the same set of policy variables to manage the exchange rate.

Clearly, the evidence suggests that using a VAR in first difference to model [e, $m–m^*$, $y–y^*$, $i–i^*$, ca–ca*]′ constitutes a misspecification. The finding of at least one significant vector with all five variables indicates that the model appears to have some long-run validity. Johansen has shown that the standard chi-square test might be applied to determine the significance of the individual variable in the model. Results of exclusion tests in Table 5 suggest that all the variables, including the current account variable, enter significantly in the long-run relationship in both countries. In other words, current account exhibits a long-run relationship with the remaining four variables and cannot be excluded from the cointegrating vector.[14]

To summarize, using the 5% significance level and the conditional VAR model, we find two cointegrating vectors for the SD/JY rate and one for the RM/JY rate. The sign on the error-correction term (ECT) is negative and statistically significant, implying that exchange rate converges to its long-run equilibrium. It is noteworthy that the weak exogeneity of

[14] The exclusion test is based on a likelihood ratio test and has a $\chi^2_{(r)}$ distribution, where the degree of freedom is r, the number of cointegrating vector.

Table 6
Estimated cointegrated vectors in Johansen estimation

	Variables					
	e	m–m^*	y–y^*	i–i	ca–ca*	Constant
A: SD/JY	−1.00	−18.44	20.95	−0.04	−15.45	38.88
	−1.00	1.11	−3.11	0.02	−2.10	−25.93
B: RM/JY	−1.00	3.00	−.01	0.12	−3.16	−7.20

Note: All the coefficients on the estimated cointegrating vector(s) is normalized on exchange rate.

the exchange rate in the model would be inconsistent with the monetary model since the adjustment toward equilibrium in this case would not be carried out by the exchange rate. Thus, the exchange rate can be considered as driving the dynamics of the system as a whole.[15] The rejection of the hypothesis of no error–correction in the exchange rate equation in the two countries further supports the conclusion that the variables are cointegrated as reported in the Johansen–Juselius tests. Hence, overlooking the cointegrating relationship of the variables would have introduced misspecification in the underlying dynamic structure.

While most of the series employed in this study seems to contain unit root, it should be borne in mind that some series (e.g. interest rate differential) may be $I(0)$. More rigorous testing might yield some variables as $I(0)$. This poses some problems with the Johansen method. It is well-known by now that wrongly modeling $I(0)$ in Johansen VAR as $I(1)$ would bias the results in favor of an overestimation of the number of cointegrating vectors by one. To overcome this issue, we re-estimated the model by assuming $r = 1$ (i.e., one vector) for the SD/JY rate.[16] The empirical results were unsatisfactory in terms a priori signs and magnitude of the coefficients, and hence we did not proceed with the forecasting exercise.

Normalizing the vector on the exchange rate facilitates our interpretation of the results. Table 6 summarizes the results for the two bilateral rates. For the single-vector case (RM/JY rate), all the signs on the coefficients of the variables are as expected. For Singapore, there is more than one vector and hence the interpretation is not obvious. Nevertheless, the second vector appears to yield all four coefficients that are correctly signed, but the first vector has only one correct sign (interest rate differential). Therefore, the second (first) vector

[15] Hall and Milne (1994) argued that weak exogeneity in a cointegrated system is equivalent to the notion of long-run causality. Following this line of argument, one may conclude that all the variables (m, y, i, and ca) Granger-cause exchange rate in the long run in every country examined. For a more specific discussion of the concept of weak exogeneity, see Engle et al. (1983).

[16] A reviewer pointed out that in the case of multiple cointegrating vectors, these should be given both statistical and economic interpretations. We have done so in line with Long Run Structural Modeling (LRSM) by imposing identifying and overidentifying restrictions on the cointegrating vectors based on economic theories (see, for example, Pesaran and Shin, 2002). In this study, we found that the unconditional and conditional models yield two vectors for Singapore, even after adjusting for the small sample correction factor. To interpret both statistically and economically, we proceeded with the estimation assuming one vector ($r = 1$). The results from the single vector were found to be unsatisfactory based on the expected a priori signs as well as the magnitude of the coefficients. These results are not reported here but are available from the first author upon request.

can be interpreted as defining the long-run exchange rate model for Singapore (Malaysia). The coefficient of domestic–foreign money stock is significantly different from unity, as predicted by theory. This finding is consistent with Miyakoshi (2000), who found the coefficient is significantly different from unity for the East Asian economies. The coefficient of domestic–foreign income differential is negative and significant at the conventional significance level for both bilateral rates. The coefficient on income is 3.01 and 3.02 for Malaysia and Singapore, respectively. This result is consistent with Chinn (2000), who reported the long-run coefficient for income at 3.008 for Singapore.[17]

Interest differential enters with a positive sign, as predicted by theory, and is statistically significant. This is in line with the results of previous studies that have shown that interest rate is an important variable in the demand for money (e.g., Arize et al., 1999). Hence the model predicts that an increase in interest rate, *ceteris paribus*, leads to an appreciation of the two ASEAN countries. In other words, interest rate differential induces capital inflows and movement in domestic currency. This result implies that current account balance is crucial in the exchange rate equation. The negative sign on the current account variable implies that a rise in the two ASEAN countries' current account relative to Japan's external balance leads to a depreciation of the Singapore dollar and the ringgit against the yen. The magnitude of the current account differential balance in Malaysia appears to be larger than that of Singapore, suggesting that the ringgit (−3.16) is more sensitive to the external balance than the Singapore dollar (−2.10). For the RM/JY (SD/JY) rate, a one-percent point increase in the current account differential induces a 3.16 (2.10) percentage-point depreciation of the ringgit (Singapore dollar) against the yen. Several authors have also reached the same conclusion about the importance of current account in the exchange equation (See Cushman et al., 1996, Jhy-Liu, 1999 and Edison and Melick, 1999, to name a few).

We view the results presented above as providing empirical support for the exchange-rate model. These findings reflect the closer economic ties of the two ASEAN currencies with the yen during the last few decades. The coefficient of the current account is negative, revealing that current account deficits result in the depreciation of the currencies of the two ASEAN countries. Indeed, Baharumshah (2002) found that long-run purchasing power parity (PPP) received more favorable empirical support for ASEAN data using the yen as the numeraie currency. Several authors have argued that the empirical support of the monetary model can be deemed as indirect support for PPP hypothesis.

2.1. Forecasting strategy

Since the seminal paper by Meese and Rogoff (1983), the benchmark by which a fundamental-based exchange rate model is assessed is by comparing it to a simple random walk model. The VAR models are initially estimated using data from 1976:Q1 to 1995:Q4, with the period 1996:I–1999:II (14 quarters) utilized for examining the accuracy of out-of-sample forecasts. The forecast is truly out-of-sample and uses actual data rather than forecast values. In this respect, the choice as to where to begin forecasting is based on the

[17] In Chinn (2000), the model was estimated using the US dollar as the base currency. Due to the missing data, Chinn did not estimate the model for the ringgit.

Table 7
Dynamic forecasting

	1996:Q1–1997:Q4	1996:Q2–1998:Q1	1996:Q3–1998:Q2	1996:Q4–1998:Q3	1997:Q1–1998:Q4	1997:Q2–1999:Q1	1997:Q3–1999:Q2
SD/JY							
RMSE	0.0576	0.0659	0.0647	0.0595	0.0686	0.0582	0.0378
MAE	0.0423	0.0510	0.0503	0.0485	0.0578	0.0740	0.0358
Theil	0.0066	0.0075	0.0073	0.0067	0.0078	0.0097	0.0044
RM/JY							
RMSE	0.1594	0.1345	0.1145	0.1050	0.1156	0.1867	0.1331
MAE	0.1352	0.1097	0.0936	0.0882	0.1034	0.1739	0.1224
Theil	0.0216	0.0182	0.0155	0.0143	0.0158	0.0255	0.0185

Notes: RMSE and MAE are root mean square error and mean absolute error, respectively. Theil's *U*-statistics is the ratio of RMSE from two competing models-monetary versus random walk. Msia: 1997:Q2–1998:Q4, 1997:Q3–1998:Q4.

objective to produce reasonable forecasts for a medium-term horizon (eight-quarters-ahead forecasts) and have a sufficient number of observations forecast steps.

We sequentially re-estimated the model for every data point from 1995:Q4 onwards, computing the dynamic forecasts for an eight-quarter forecasting horizon. Recursively updating in this fashion leaves us with seven overlapping forecasts. The period 1996:I–1999:II was characterized by a major episode, the 1997–1998 Asian currency crises. Therefore, the crisis should provide a severe test for any model. The relative accuracy of the forecasts is measured by the standard root mean square error (RMSE) and Theil-*U* statistics. The Theil-*U* statistic is the ratio of the RMSE for the estimated monetary model to the RMSE for the random walk model. Hence if $U < 1$, the monetary model performs better than random walk, otherwise, the random walk outperforms the monetary model.

For this study, only the forecasting performances of the exchange rate equations are considered. The prediction results are displayed in Table 7. Judging from the RMSE and the Theil-*U* criteria, we conclude that the structured model performed better than the random walk for the two exchange rates. Another important observation is that the *U*-statistic is smaller than unity for all the forecasted periods. This finding holds true even if the forecast is extended to include the crisis period, since this period may include non-monetary factors into the pricing of exchange rates. Our result is consistent with MacDonald and Taylor (1993, 1994a), among others, in terms of the ability of the monetary model to detect exchange rate movement for the major currencies, but is different from the perceived wisdom that the random walk model outperforms the monetary model. This result holds true in the post crisis period as well.

In general, the out-of-sample forecasts produced by the monetary model appear to fit the data satisfactorily. Could these results be due to the inclusion of the current account? To answer the question, we dropped the current account variable from the model and produced a new set of out-of-sample forecasts using the same procedure as before. Broadly, the model with the current account variables performed better in terms of RMSE and RMAE. These results are not reported here but are available upon request.

Table 8
Correlation between predicted value and actual value

	SD/JY	RM/JY
Corr (full)	0.633	0.594
Corr (before)	0.775	0.607
Corr (during)	−0.379	0.284

Notes: Corr (full), Corr (before) and Corr (during) denote the correlation between actual and forecasted. Values for the full sample period, before and during the financial crises, respectively.

To further evaluate the performance of the model, we computed the correlation between the predicted and actual values of the exchange rates. The correlations between the predicted and actual values for the full sample period (ending in 1999; Q2) are 0.63 and 0.59 for the SD/JY and RM/JY rates, respectively. Interestingly, the correlation between the two variables increases significantly for both Singapore (0.78) and Malaysia (0.61) when data during and post-crisis period are excluded from the sample. Meanwhile, during the post-crisis period the correlations fall sharply to −0.38 and 0.28 for Singapore and Malaysia, respectively (see Table 8). Hence, our results indicate that the predictability of the model somewhat declines when data are extended to the post crisis period.

Finally, Figs. 3 and 4 display the out-of-sample forecasts using the fixed coefficient from our final model. Notice that the out-of sample forecasts for the RM/JY and interest rates are within the 95% confidence level. Similarly, the out-of-sample forecasts for exchange rate, money supply and income are all within the 95% confidence level, except for the SD/JY rate (1997:Q2) and money supply (1997: Q1). Technically, this means that the parameters of the model are invariant to time, except for the currency crisis period.

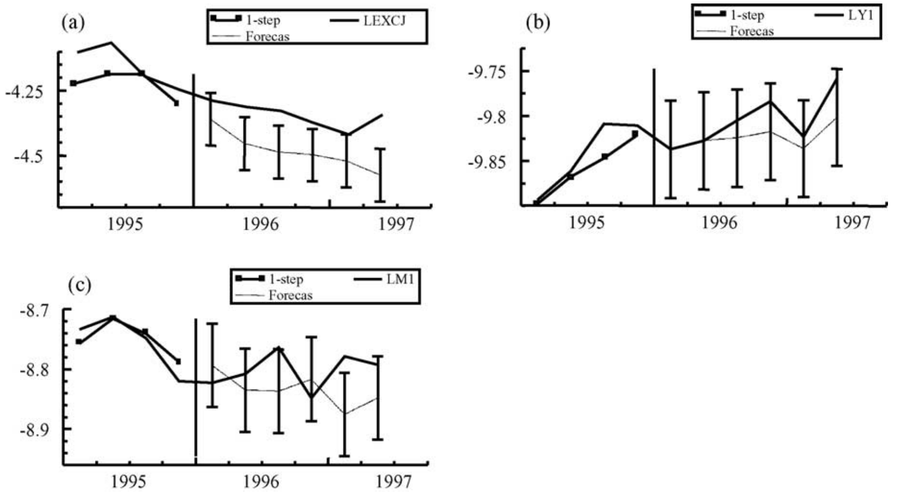

Fig. 3. Dynamic forecasting (SD/JY).

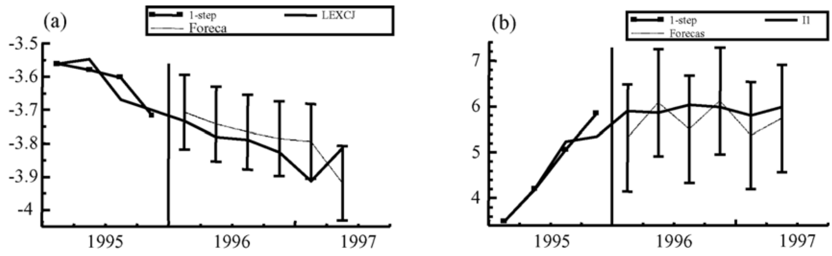

Fig. 4. Dynamic forecasting (RM/JY).

3. Conclusion

This study has examined the exchange-rate dynamics of the Singapore dollar and the Malaysian ringgit against the yen—the two bilateral rates that have received relatively less attention in the literature. The analysis based on the Johansen–Juselius technique indicates a strong cointegration relationship between exchange rate, money supply, income, current account and interest rate. We uncovered that exchange rates and fundamental variables are cointegrated when current accounts are included in the model. Our empirical evidence suggests that exchange rates adjust to changes in current accounts as well as the underlying variables that affect them. We also demonstrated that the instability of the model is due to a specific variable in the system, and once it is accounted for, the monetary model yields sensible results in terms of the sign and magnitude of the coefficients in the model. This suggests that there may be a structural change when the foreign capital inflows surged into these economies in the early 1990s.

The findings reveal that the two ASEAN countries have more flexible exchange rates to incorporate changes in fundamental variables as well as current accounts. The inclusion of current account in the standard monetary model appears to improve the out-of-sample forecast accuracy of the exchange-rate model. Therefore, our study suggests that to improve the predictive power of the standard monetary model, it should consider the current account balances as well. The results suggest that the monetary model works well for low-inflation countries. This is in sharp contrast with the findings that have shown the monetary model fared better if tested for high-inflation countries where monetary factors would be dominant.

It may be worth mentioning that the error–correction term in the exchange rate equation enters as a significantly negative coefficient, implying that exchange rate converges to the equilibrium path. We viewed these results as reflecting the close economic ties of Japan with the ASEAN countries. From the policy perspective, the empirical results tend to suggest that managing the current account balances is important for the exchange rate determination. Interest rate appears to be an effective candidate to stabilize the exchange rate in Singapore, while for Malaysia the policy variable appears to be the money supply. Thus, in this paper we have made an attempt to demonstrate that a well specified econometric model could produce good in-sample and out-sample forecasts and can easily outperform the simple random walk model. Finally, the model appears to work well for both the ASEAN countries under study. The next question is: what about the other developing countries? We leave this question for future research.

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