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Predictability of ASEAN-5 Exchange Rates in the Post-Crisis Era

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ABSTRAK

Lima mata wang ASEAN telah diselidiki demi menentukan sama ada pertukaran wang asing negara tersebut selepas krisis kewangan lebih tepat diramal oleh dolar US ataupun yen Jepun. Keputusan kajian ini mencadangkan kesemua pertukaran asing sebelum berlakunya Krisis Kewangan 1997/1998 lebih tepat diramal oleh mata wang dolar US. Mata wang Singapura selepas krisis lebih tepat diramal oleh dolar US, sementara mata wang ASEAN yang lain lebih tepat diramal oleh yen Jepun.

ABSTRACT

Five ASEAN currencies are investigated in an attempt to determine whether the post-crisis ASEAN exchange rates are more predictable by the US dollar or Japanese yen. Results suggest that prior to the 1997/1998 Financial Crisis, all exchange rates were better predicted by the US dollar as the base currency. The post-crisis Singapore exchange rate continues to be better predicted in US dollar. On the other hand, Japanese yen better predicted other post-crisis ASEAN exchange rates.

INTRODUCTION

Exchange rates play an important role in the international trade because they allow us to compare prices of goods and services produced in different countries. One of the characteristics of exchange rate in the post-Bretton Woods era is that it tends to be more volatile than the macroeconomic (fundamental) variables. The fluctuations in exchange rates due to the changes in the market fundamentals and market expectations have damaging effect on less developed countries (LDCs) trade flows (Ian and Amusa 2002; Law and Tan 2000; Arize *et al.* 2000). These fluctuations have crucial impact on decisions of policy-makers, traders, speculators, households and firms. Hence, it is important to forecast the future exchange rates with some accuracy. Unfortunately, exchange rates are difficult to forecast with any precision and empirical evidence has so far proven illusive (Meese and Rogoff 1983a,b; Berkowitz and Giorgianni 1997). This is simply because economic factors that affect exchange rates through a variety of channels are complex and measurements are either costly or problematic in nature (Carbaugh 2000).

In the past decades, many researchers who seek to predict exchange rates by econometric techniques have faced the same problem: while the results help to explain the past movements of exchange rates, the number of explanatory variables introduced on the right-hand side of the equations make them difficult to use for projection (Six 1989). To overcome this difficulty, various attempts had been made by employing advanced time-series analysis to gain further insights into the properties of exchange rate series. We note that, to this date, there is no clear superiority of time series analysis over other econometric analysis or vice-versa[1].

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[1] Earlier work of Wallis (1982), Lupoletti and Webb (1986), Litterman (1986), Keller (1989), Montogomery *et al.* (1990), Brooks (1997), Berkowitz and Giorgianni (1997), Palma and Chan (1997), Fildes *et al.* (1998) and others has demonstrated the superiority of (linear) time series model over other econometric models in terms of their predictability. However, recent empirical evidence shows mixed conclusion. For instance, Najand and Bond (2000), and Darbelly and Slama (2000), among others, suggest that advanced econometric models are able to outperform linear time series models. Nevertheless, Sarno (2000), Baum *et al.* (2001), Clement and Smith (2001) and others using nonlinear frameworks have rekindled the usefulness of time series analysis.

In this study, we dealt with the forecasting of the exchanges rates by employing the ARIMA model since ARIMA modelling is deemed one of the most powerful approaches to the solution of many forecasting problems.[2] Besides utilising the point forecasts, we also generate interval forecasts of ARIMA model, which are often neglected in comparing forecast performance (Mélard and Pasteels 2000). The seminal paper by Palma and Chan (1997) shows that ARFIMA model can produce predictions that are more efficient and reliable. For this reason, this paper also attempted to fit ARFIMA to our exchange rate of the ASEAN-5 countries series.

The remainder of this paper is organized as follows. The next section briefly explains the exchange rate system of the ASEAN-5. This is followed by brief descriptions of the data and methodology employed in our analysis of the exchange rate time series. Results and discussions are presented before we conclude in the final section.

EXCHANGE RATE SYSTEM IN ASEAN-5

In this study we attempt to model the currencies of five neighbouring ASEAN countries – Singapore, Malaysia, Thailand, Indonesia and the Philippines. The ASEAN-5 can be classified into two broad categories according to the IMF's classification. The first group of countries, namely Singapore, Malaysia and Thailand are classified to have exchange rates pegged to a basket of currencies or to a single currency. The second group, namely, Indonesia and the Philippines follow a managed float during the period of investigation. However, our data revealed that Indonesia pursued a mixed policy of pegging against the US dollar. The time plot of the rupiah against the US dollar displays the RP/USD rate is ladder-like and has an upward trend and with three large devaluations in 1978, 1983 and 1986. The exchange rates of Singapore, Malaysia and Thailand appear quite stable prior the 1997 financial crisis. After two large devaluations in 1981 and 1984, the Thais baht was pegged to US dollar and fluctuates narrowly within a small range. The Singapore dollar appears to be most stable among the five currencies. The Monetary Authority of Singapore (MAS) frequently intervenes the exchange rate to keep the Singapore dollar within a range determined by a basket of currencies set on a horded weighted basis.

In the midst of 1997, the declaration of insolvency of various financial institutions in Thailand followed by the failure of a large Korean conglomerate, South Korea together with 4 ASEAN countries, namely Malaysia, Indonesia, Thailand and the Philippines were in trouble (Dunn and Mutti 2000). Currencies of these countries plunged to its record low. For instance, Indonesian rupiah was more than 80 percent down against the U. S. Dollar, and the currencies of Thailand, South Korea, Malaysia and the Philippines all dived by 35 to 50 percent (Carbaugh 2000). However, the Singapore dollar appears to be largely unaffected by the crisis. To mitigate the sharp depreciation of exchange rate, Malaysia choose to fix the ringgit at RM3.80 to USD1 on 2 September 1998, while other ASEAN countries maintain their exchange rate regime as before.

DATA DESCRIPTION

The exchange rate series considered in the present study are Malaysian ringgit (RM), Indonesian rupiah (RP), Thai baht (BAHT), Philippines peso (PESO) and Singapore dollar (SD), all denominated in US dollar (USD) as well as the Japanese yen (YEN). It is well known that both the US and Japan are the two largest ASEAN trading partners. Each series, consists of 114 quarterly observations running from 1971: Q1 to 1999: Q2, is divided into two portions for the purpose of this study. The first 106 observations beginning in 1971: Q1 and ended in 1997: Q2 (before Asian Financial Crisis) are used to fit the model, while the remaining observations from 1997: Q3 to 1999: Q2 (post-crisis period) are kept for the out-sample forecasts. Our quarterly exchange rate data are averages of the underlying monthly data. In this study, we examine the predictive power of our model during the post-crisis period. We viewed a good model as model that can produce an accurate forecast. It is worth pointing out here that the presence of a break in the trend (due the crisis) during the forecasting period would

[2] For instance, the development of automatic ARIMA modeling expert system by Mélard and Pasteels (2000) certainly reflects the usefulness of ARIMA models.

make the prediction exercise more difficult. Similar view is found in García-Ferrer *et al.* (1997).

METHODOLOGY

The process of time series modeling involves transformation of data in order to achieve stationarity, followed by identification of appropriate models, estimation of parameters, model checking and finally forecasting. Generally, a univariate time series could be expressed in the Autoregressive Integrated Moving Average, ARIMA (p, d, q) specification (see for example Brockwell and Davis 1996, 178 – 200):

$$(1 - \phi_1 B^1 - \phi_2 B^2 - \dots - \phi_p B^p)(1 - B)^d Y_t = (1 + \theta_1 B^1 + \theta_2 B^2 + \dots + \theta_q B^q)\mu_t \quad (1)$$

where

Y_t = observations at time t; $t = 1, 2, \dots, T$
d = number of differencing performed.
ϕ_i = autoregressive parameters to be estimated; $i = 1, 2, \dots, p$.
θ_i = moving average parameters to be estimated; $i = 1, 2, \dots, q$.
$B^j Y_t = Y_{t-j}$ and $\mu_t \sim$ iid $(0, \sigma^2)$.

The process as defined in (1) is a weakly stationary process. A weakly stationary process is a process with constant mean and covariance. If a non-stationary series is transformed to a stationary series by using classical decomposition approach, rather than method of differencing, we have Autoregressive Moving Average, ARMA (p, q) model, i.e., $d = 0$ in equation (1). For non-integer d, (1) becomes fractionally intergrated autoregressive moving average, ARFIMA model. We employed 'Iterative Time Series Modeling (*ITSM*)' (Brockwell *et al.* 1996) to estimate the model.[3] For more detailed on these models and their important characteristic, the readers are referred to Brockwell and Davis (1996).

We have fitted 6 to 12 tentative models to each set of data. Various methods, which are available in *ITSM*, had been employed to check the appropriateness of the specified models.[4] The out-sample forecasting performance of the appropriate models for each data set is then studied using root mean squared percentage error (RMSPE), mean absolute error (MAE) and mean absolute percentage error (MAPE). A best-fitted model was then selected using the minimum MAPE criterion.[5] Finally, the performance of models for exchange rates denominated in US dollar was compared with models of the corresponding rates denominated in Japanese yen.

RESULTS AND DISCUSSIONS

Table 1 presents the empirical results of the best fitting model for each of the transformed zero-mean stationary foreign exchange rate series. These models have passed through a battery of diagnostic tests and thus are appropriate for the forecasting purpose of this study.[6] These models are utilized to generate eight out-of-sample quarterly exchange rate values (1997: Q3 to 1999: Q2).

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[3] Briefly, the *ITSM* estimation procedures involved (1) the transformation of non-stationary series into stationary series via differencing or variance decomposition; (2) the estimation of autoregressive or/and moving average parameters; (3) diagnostic checking; and (4) forecasting. *ITSM* allows us to model the transformed series for the purpose of forecasting the original series.

[4] They include the examination of ACF and PACF of residuals, Ljung-Box (1978) Q-statistic, McLeod-Li (1983) Q-statistic, Turning Point Test, Difference-Sign Test and Rank Test. Only models that have passed all these diagnostic tests are kept for forecasting.

[5] We used MAPE criterion instead of other criteria like FPE, BIC and AICC — which are also available in *ITSM* — for model selection for several reasons. FPE or Final Prediction Error criterion is asymptotically inconsistent because there remains a non-zero probability of overestimating the order of a model as the sample size grows indefinitely large (Akaike 1970; Beveridge and Oickle 1994). Bayesian Information Criterion or BIC, although is consistent, is found to be not asymptotically efficient (Hurvich and Tsai 1989; Brockwell and Davis 1996). On the other hand, the biased-corrected Akaike's Information criterion, AICC, while having a more extreme penalty to counteract the tendency of overfitting, as well as the property of asymptotically efficient, it was noted (Lalang *et al.* 1997; Shitan and Liew 2000) that the minimum AICC model does not have to be the best model in term of forecast accuracy. In addition, Liew and Shitan (2000) had found empirical evidence to suggest that minimum AICC model picks up the *true* model for only 62.63% of the time. Nevertheless, the most fatal deficiency in these criteria is that they are not suitable for inter-series comparison — the main purpose of this study.

[6] Results are not reported here but are available upon request from authors.

TABLE 1
Best fitting model for each foreign exchange rate (1971: Q1 – 1997: Q2)

F. E. Rate	Model[a]	Equation[b]	var (μ_t)[c]
RM/USD	ARIMA (0,2,0)	$RM_t = RM_{t-2} + \mu_t$	1.000
RP/USD	ARIMA (0,2,1)	$RP_t = RP_{t-2} + \mu_t - 0.99\mu_{t-1}$	3396
BAHT/USD	ARIMA (0,1,0)	$BAHT_t = BAHT_{t-1} + \mu_t$	0.249
PESO/USD	ARIMA (0,1,0)	$PESO_t = PESO_{t-1} + \mu_t$	0.640
SD/USD	ARFIMA (6, 0.2105, 0)	$SD_t = 0.756SD_{t-1} + 0.046SD_{t-2} - 0.003SD_{t-3} + 0.045SD_{t-4} + 0.014SD_{t-5} - 0.012SD_{t-6} + \mu_t$	0.028
RM/YEN	ARMA (5, 0)	$RM_t = 1.081RM_{t-1} - 0.326RM_{t-2} + 0.3884RM_{t-3} - 0.144RM_{t-4} - 0.164RM_{t-5} + \mu_t$	0.000[d]
RP/YEN	ARIMA (0,2,0)	$RP_t = RP_{t-2} + \mu_t$	1.339
BAHT/YEN	ARMA (5, 0)	$BAHT_t = 1.032BAHT_{t-1} - 0.304BAHT_{t-2} + 0.365BAHT_{t-3} - 0.037BAHT_{t-4} - 0.241BAHT_{t-5} + \mu_t$	0.000[d]
PESO/YEN	ARMA (10, 0)	$PESO_t = 1.118PESO_{t-1} - 0.368PESO_{t-2} + 0.150PESO_{t-3} + 0.327PESO_{t-4} - 0.592PESO_{t-5} - 0.227PESO_{t-6} - 0.280PESO_{t-7} - 0.479PESO_{t-8} + 0.412PESO_{t-9} - 0.245PESO_{t-10} + \mu_t$	0.000[d]
SD/YEN	ARIMA(1,1,0)	$SD_t = 0.210SD_{t-1} + \mu_t$	0.000[d]

Notes: [a] Specifications of models for the original series.
[b] We report the equation for each transformed zero-mean stationary series as given by *ITSM.*
[c] residuals variance, var (μ_t) depends on the size of the exchange rate values.
[d] var (μ_t) is very small in value.

The eight actual and forecasted exchange rate values are plotted in *Figs. 1* and *2* together with the forecast intervals. Bearing in mind that in using any fitted model for forecasting, we assumed the economic fundamentals during the forecasting period remain the same as before. If this assumption holds, 95% of the actual exchange rate during this forecasting period lies inside our forecast interval. In other words, the actual observations would be what we have expected. Otherwise, the forecast interval fails to contain the actual observations; thereby implying the underlying assumption of "economic fundamentals remain the same" is not valid. In such a case, we have indirectly shown that the economic fundamentals during the forecasting period have changed. As revealed by *Fig. 1,* the only forecast interval that managed to contain the actual observations is the SGD/USD (*Fig. 1a*). This finding shows formally that, with the exception Singapore, the economic fundamentals of all ASEAN-5 countries with respect to US are affected by the recent financial crisis.

The best fitting model for SD/USD rate, ARFIMA (6, 0.2105,0) model had RMPSE values of 0.00014. Furthermore, the actual observations had the correct trend of depreciation over the first 2 years following the crisis, as predicted. Nevertheless, the ARFIMA (6, 0.2105,0) model tends to overestimate the strength of Singapore dollar (*Fig. 1a*).

Judging from the plots of Indonesia rupiah (*Fig. 1b*), Thailand baht (*Fig. 1c*) and the Philippines peso (*Fig. 1d*), these countries apparently had a different economic structure after the crisis, as their actual exchange rates during the forecasting period (after crisis) are totally beyond our expectation. Moreover, all these 3 currencies experienced an unexpectedly sharp depreciation, suggesting that these currencies were badly affected by the crisis. For the case of Malaysia, ringgit denominated in US dollar (*Fig. 1e*) had also experienced a worse-than-expected depreciation within the first year after the crisis.

By comparing *Figs. 1* and *2,* we find that in general, the forecasts using models based on yen outperformed the models based on US dollar. *Fig. 2a* showed that the forecasted values of Singapore dollar denominated in yen fall in the 95% confidence interval. Singapore dollar is the only currencies in the sample that remain predictable in both US dollar and Japanese yen bases models. It is worth noting here that the Singapore dollar was not affected by the recent currency crisis.

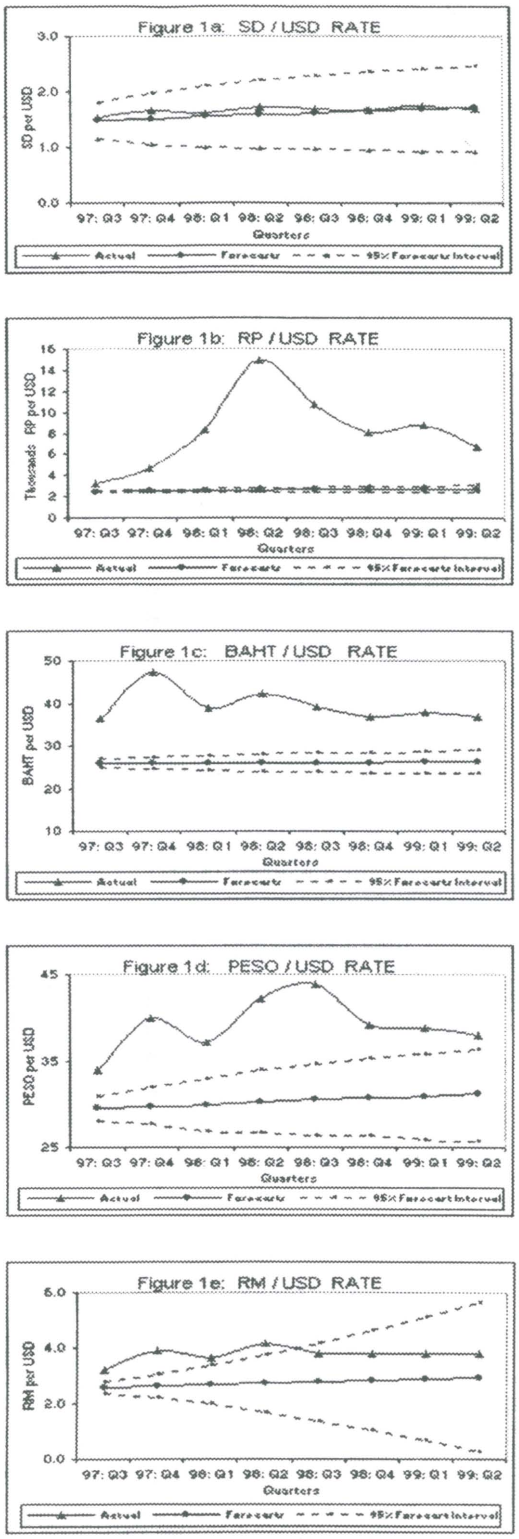

Fig. 1: Interval forecast for USD-based exchange rates

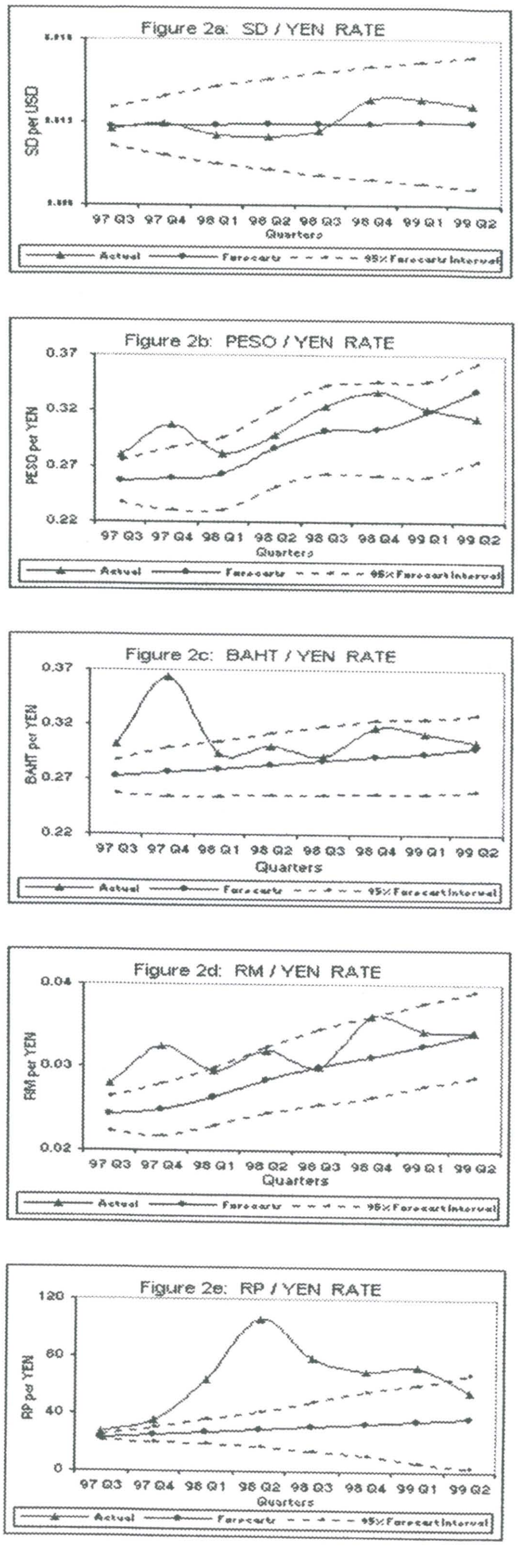

Fig. 2: Interval forecast for YEN-based exchange rates

Figs. 2b, 2c and *2d* revealed that the first two quarters after the crisis for the predicted peso, baht and the ringgit failed to be in the 95% confidence interval. Specifically, the models mispredict by more than 25% in the short term. Specifically, the models consistently over-predicts yen and dollar rate when it is used as the reference currencies in the short term.[7] We noted that the out-sample forecasts are within 95% confidence level after the third quarter, suggesting that our model based on Japanese yen is more appropriate in the medium to long term. As for rupiah, although model based on yen (*Fig. 2e*) performed better than that of US dollar, only the forecast after 7-quarter horizon fall in the 95% confidence interval. The Indonesia rupiah performed poorly in both the models. This finding is true due to the political turmoil that followed after the financial crisis.[8]

The performance of models based on US dollar and Japanese yen as determined by the root mean square percentage error (RMSPE) is summarised in Table 2. Two important conclusions may be drawn from this table. Firstly, a quick flash at the overall results showed that, the performance of the best fitting models had deteriorated in the post-crisis period. Upon comparing the performance term by term, it is clear that in fact all the models did not turn out to be as predictive as they were. As we have noted earlier, this phenomenon might be attributed to the set in of the Asian Financial crisis.

The second obvious feature in Table 2 is that models (except for Singapore dollar) denominated in Japanese yen outperformed their counterparts in the post-crisis period. In particular, quoted per US dollar, the RMSPE for ringgit, peso, rupiah, and baht were 0.00269, 0.00503, 0.00640, and 0.00340 respectively. These values were much higher than their corresponding values based on yen, i.e. 0.00103, 0.00086, 0.00621 and 0.00039 respectively. The RMSPE for SD/USD and SD/YEN were 0.00047 and 0.00064 respectively. However, for the pre-crisis period, obviously the US dollar denominator is better than the Japanese yen. This is because by the RMSPE all the exchange rates based on US dollar denominator had performed better prediction.

The correlation between the actual observations of each exchange rate series and their corresponding best fitting model's predicted values is depicted in Table 3. All the correlations for pre-crisis period are significant at 1% level, with values ranging from 0.887 for the case of RM/USD rate, to 0.997 for the case of RP/USD rate. However, for the post-crisis period, only 40% of the computed correlations are significantly at 5% level. These include RM/YEN (0.739), PESO/YEN (0.714), SD/YEN (0.734) and SD/USD (0.748) rates. This decrease in the degree of correlation for the post-crisis period is synonym to the deterioration of the performance of the model in terms of tracking

TABLE 2
RMSPE of best-fitting models for various exchange rates

Forecast Period[a]	Currencies				
	RM	PESO	RP	SD	BAHT
US dollar-based					
Pre-Crisis	0.00039	0.00007	0.00008	0.00014	0.00008
Post-Crisis	0.00269	0.00503	0.00640	0.00047	0.00340
Japanese yen-based					
Pre-Crisis	0.00061	0.00061	0.00070	0.00064	0.00062
Post-Crisis	0.00103	0.00086	0.00621	0.00064	0.00039

Note: [a] Pre-crisis and post-crisis periods refer to the periods 1971: Q1 to 1997: Q2 and 1997: Q3 to 1999: Q2 respectively.

[7] This coincides with the speculator attack that started with the Thai bath in July 1997. By the end of 1997, the Asian currency crisis solved the retinal currency of Thailand and Indonesia.

[8] Most of the currencies like Thai Bath became relatively stable in 1998, the Indonesian rupiah continue on its depreciation trend due mainly to political disturbance.

TABLE 3
Correlation between actual values and predicted values[a]

Forecast Period[b]	Currencies				
	RM	PESO	RP	SD	BAHT
US dollar-based					
Pre-Crisis	0.887 (0.000)	0.995 (0.000)	0.997 (0.000)	0.989 (0.000)	0.989 (0.000)
Post-Crisis	0.406 (0.318)	0.433 (0.283)	0.357 (0.385)	0.748 (0.033)	–0.428 (0.291)
Japanese yen-based					
Pre-Crisis	0.991 (0.000)	0.994 (0.000)	0.989 (0.000)	0.976 (0.000)	0.993 (0.000)
Post-Crisis	0.739 (0.036)	0.714 (0.047)	0.435 (0.281)	0.734 (0.038)	–0.224 (0.594)

Notes: [a] Values in brackets are p-values.
[b] See Table 2.

the movement of the exchange rates in the post-crisis period.

Table 3 also showed that the ringgit, peso, rupiah and baht but not for Singapore dollar, could be better predicted by YEN for the post-crisis period. This is consistent with results reported earlier. The correlations for the RM/YEN, PESO/YEN, RP/YEN and BAHT/YEN rates are respectively 0.739, 0.714, 0.435 and –0.224 and are higher than their correspondences, i.e. 0.406, 0.433, 0.357 and –0.428. The correlation for the SD/USD rate (0.748) is higher than SD/YEN rate (0.734), however.

To sum, with the exception for Singapore dollar, the forecasting performance of all other models for ASEAN currencies denominated in yen had outperformed those denominated in US dollar.

CONCLUSION

The purpose of this paper is to investigate whether ASEAN exchange rates are more predictable by US dollar or Japanese yen in the post Asian Financial Crisis era. Results suggest that all exchange rates are better predicted by the US dollar prior crisis. In the post-crisis period, Singapore dollar continues to be better predicted when denominated in US dollar. On the other hand, Japanese yen better predicted other post-crisis ASEAN exchange rates. One major implication of this study is that exchange rate forecasters, who are interested to trace the movement of exchange rates, may resort to YEN as a better predictor of post – crisis ASEAN exchange rates.

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