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

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**ABSTRAK**

Lima mata wang ASEAN telah diselidiki demi menentukan samada pertukaran wang asing negara-negara ASEAN lepas krisis kewangan lebih tepat diramal oleh dollar US ataupun yen Jepun. Keputusan kajian ini mencadangkan kesemua pertukaran asing sebelum berlakunya Krisis Kewangan 1997 lebih tepat diramali dollar US. Mata wang Singapura selepas krisis lebih tepat diramal oleh dollar US, sementara lain-lain mata wang ASEAN lebih tepat diramal oleh yen Jepun, sebab perhubungan ekonomi negara-negara tersebut dengan negara Jepun bertambah rapat. Namun begitu, sedangkan negara Jepun sedang mengalami kemerosotan ekonomi serius, ia tidak mengalami ketidakstabilan politik yang melampau sepertimana berlaku di segelintir negara ASEAN.

**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 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, as these countries had closer economic ties with Japan. However, while Japan is undergoing serious recession it does not experience dramatic political instability experienced by some ASEAN countries.

**Keywords: exchange rate, depreciation, ARIMA, ARFIMA, forecasting**

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## 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 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. 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 (Berkowitz and Giorgianni, 1997). This is 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 time series. We note that, to this date, there is no clear superiority of time series analysis over other econometric analysis or vice-versa[1].

In this study, we dealt with the forecasting of the exchanges rates by employing the ARIMA model since ARIMA modeling 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 too neglected in comparing forecast performance (Mélard and Pasteels, 2000). The 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 time 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 US$1 on 2 September 1998, while other ASEAN countries maintain their exchange rate regime as before.

Recently, there are evidences to suggest that the ASEAN countries are tightening their exchange rate to the Japanese yen. For instance, Zhou (1998), found that weights assigned to yen in the currency baskets of Singapore and Malaysia are 0.13 and 0.16 respectively. Indeed, Zhou (1998) showed that the ASEAN newly industrialised economies (NIEs, Singapore included) yen play an important role in driving the ASEAN currencies. He concluded that as the financial markets of the Asian countries developed, their currencies are likely to be driven by economic fundamentals rather than being pegged to major currencies. A recent paper by Baharumshah and Goh (2001) showed that these is sufficient evidence to suggest that the Asian countries are forming a yen block.

## 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 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. Noteworthy, the presence of a break in the trend (due the crisis) during the forecasting period would make the prediction exercise more difficult, as suggested by 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):

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

where

$Y_t$ = observations at time $t$; $t = 1, 2, \ldots, T$

$d$ = number of differencing performed.

$\phi_i$ = autoregressive parameters to be estimated; $i = 1, 2, \ldots, p$.

$\theta_i$ = moving average parameters to be estimated; $i = 1, 2, \ldots, q$.

$B^j Y_t = Y_{t-j}$ 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. 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[3]. The out-sample forecasting performance of the appropriate models for each data set is then studied using RMSE, MAE and MAPE. A best-fitted model was then selected using the minimum MAPE criterion[4]. 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[5]. These models are utilized to generate eight out-of-sample quarterly exchange rate values (1997: Q3 to 1999: Q2).

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

| F. E. Rate | Model | Equation | var ($\mu_t$)[a] |
|---|---|---|---|
| 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 |
| MY/JPY | 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[b] |
| RP/JPY | ARIMA (0,2,0) | $RP_t = RP_{t-2} + \mu_t$ | 1.339 |
| BAHT/JPY | 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[b] |
| PESO/JPY | 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[b] |
| SD/YEN | ARIMA(1,1,0) | $SD_t = 0.210SD_{t-1} + \mu_t$ | 0.000[b] |

Note: [a] residuals variance, var ($\mu_t$) depends on the size of the exchange rate values.
[b] var ($\mu_t$) is very small in value.

The eight actual and forecasted exchange rate values are plotted in Figures 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. However, as revealed by Figure 1, this was only true for Singapore dollar (Figure 1a). Perhaps it suggests that Singapore's economic fundamentals remained unaffected by the recent financial crisis.

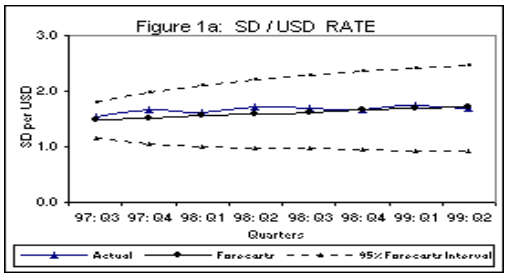
The best fitting model for SD/USD rate, ARFIMA (6, 0.2105,0) model had RMPSE values of 0.00014. Furthermore, the actual observations had the correct trend of depreciation over the first 2 years following the crisis, as predicted. Nevertheless, the ARFIMA (6, 0.2105,0) model tends to overestimate the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

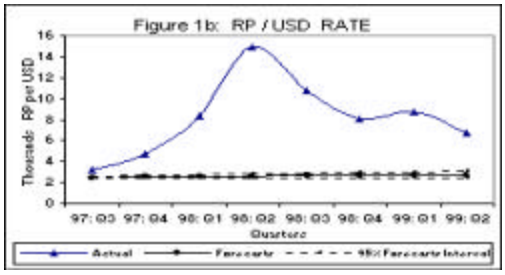
Judging from the plots of Indonesia rupiah (Figure 1b), Thailand baht (Figure 1c) and the Philippines peso (Figure 1d), these countries apparently had a different economic structure after the crisis, as their actual exchange rates during the forecasting period (after crisis) are totally beyond our expectation. Moreover, all these 3 currencies experienced an unexpectedly sharp depreciation, suggesting that most probably these countries were badly affected by the crisis.

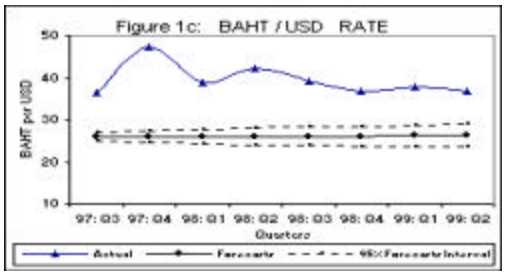
For the case of Malaysia, ringgit denominated in US dollar (Figure 1e) had also experienced a worse-than-expected depreciation within the first year after the crisis. However, from 2 September 1998 onwards, exchange rate was fixed at RM3.80 per US dollar, a value lying within our model's 95% forecast interval. This suggests that the fixed rate was then reasonable. We noted that under the free floating system, the predicted values for ringgit in term of US dollar would be RM2.94 in 1999: Q2 and RM3.27 in 2000: Q4.

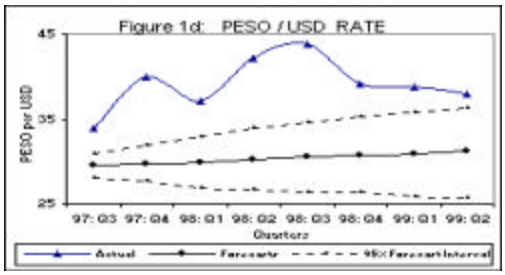
FIGURE 1 FIGURE 2

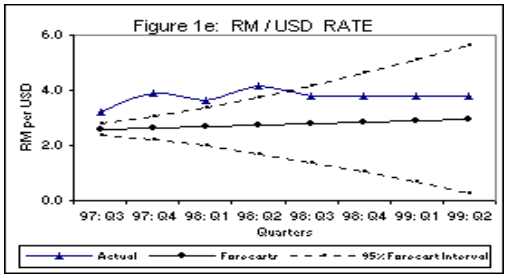
Interval Forecasts for USD-based Exchange Rates



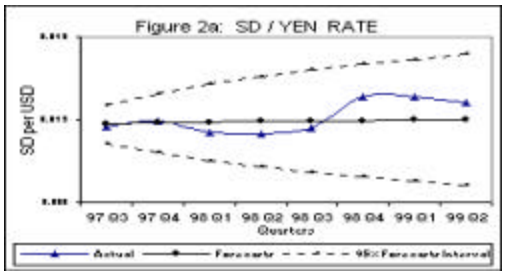



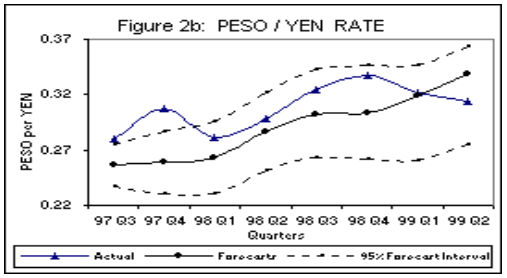



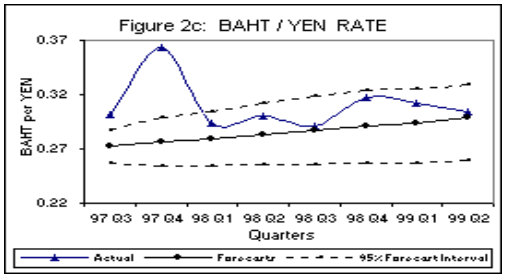



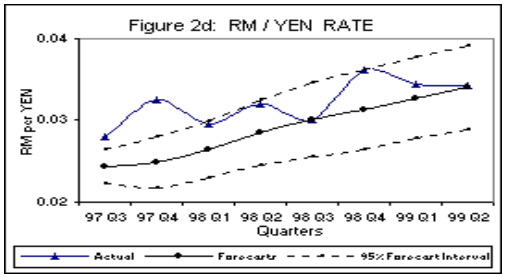



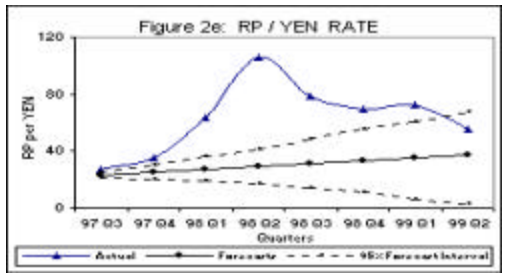

Interval Forecasts for YEN-based Exchange Rates



By comparing Figures 1 and 2, we find that in general, the forecasts using models based on yen outperformed the models based on US dollar. Figure 2a showed that the forecasted values of Singapore dollar denominated in yen fall in the 95% confidence interval. Singapore dollar is the only ASEAN currencies that remain predictable in both US dollar and Japanese yen bases models. It appears that exchange rate had little success in predicting the currencies crisis.

Figures 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 mis-predict by more than 25% in the short term. Particularly the models consistently over-predicts in the short term. 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 (Figure 2e) performed better than that of US dollar, only the forecast after 7-quarter horizon fall in the 95% confidence interval.

The performance of models based on US dollar and Japanese yen as determined by the root mean square percentage error (RMSPE) is summarized 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. Our analysis by the MAE and MAPE yield identical conclusion[6].

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

| | Currencies | | | | |
|---|---|---|---|---|---|
| Forecast Period[a] | 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.

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

Table 3 also showed that the yen could be a better denominator for the ringgit, peso, rupiah and baht but not for Singapore dollar, 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.

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

| | Currencies | | | | |
|---|---|---|---|---|---|
| Forecast Period[b] | 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.

It was obvious, that except for Singapore dollar, the forecasting performance of all other models for ASEAN currencies denominated in yen had outperformed those denominated in US dollar. Yen is therefore a better measurement unit of ASEAN exchange rates, as compare to US dollar, at least for the post-crisis period, a more recent time horizon. One of the plausible explanations for this would be Japan and the other ASEAN countries in this study (except Singapore), had undergone various degree of economical recession after the crisis. Similarly, US dollar could serve to measure Singapore dollar better mostly because both countries were large unaffected by the crisis. Yen, however remains a poor measurement unit for rupiah perhaps due to the fact that after the currency crisis, Japan although was caught in a serious recession in 1998 (Dunn

and Mutti, 2000) it did not experienced similar political instability as experienced by Indonesia. Similar view is expressed by McKibbin (1998)[7]. Amongst all ASEAN countries affected by the crisis, the period of free fall was largest and deepest in Indonesia, which was the only country to have experienced political turmoil as well. This free fall is reflected in Figures 1 and 2 in that the divergence between the predicted and the actual rates appears to be largest in Indonesia. This is not surprising since political uncertainties make financial stability hard to ascertain (see Mei, 1999). In all the countries (Indonesia, Malaysia, the Philippines and Thailand), the sharp depreciation ended by February 1998.

## 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 period. 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. This is probably because the financial crisis had little impact on the economy and the relative importance of US economy with Singapore. On the other hand, Japanese yen better predicted other post-crisis ASEAN exchange rates. We speculate this finding as the consequences of the closer economic ties with Japan as pointed out by Zhou (1998). Moreover, they were all to different extent badly hurt by the 1997 crisis. Nevertheless, However, while Japan had undergone serious recession after the crisis, it did not experience dramatic political instability experienced by Indonesia. Hence, the Indonesian rupiah remained unpredictable by yen.

From a policy perspective, our results suggest that for all the ASEAN countries (except Singapore), increased exchange rate uncertainties with respect to the US dollar would cause economic agents to reduce their holdings of domestic money and encourage currency substitution with respect to US dollar during period of anticipated depreciation. The other implication of this study is that our finding shows that although time series analysis dealt with economic fundamentals implicitly, its point and interval forecasts could be a powerful exchange rates forecasting tool, especially in the medium to long term. We note here that in further work it would be interesting to investigate whether the different pegging systems affect the predictability of these exchange rates[8].

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