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The Macroeconomic Fundamentals of the Real Exchange Rate in Malaysia: Some Empirical Evidence

(Asas Makroekonomi Bagi Kadar Pertukaran Benar di Malaysia: Beberapa Bukti Empirikal)

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ABSTRACT

The aim of this paper is to estimate the equilibrium of exchange rates and identify the roles of macroeconomics fundamentals affecting exchange rates using Malaysian data spanning 1970 to 2019. This study adopts the Autoregressive Distributed Lag model to examine the long-run relationships or cointegration among variables and the dynamic effect within variables in the short-run over the sample period. The results suggest that inflation rate and national income growth rate play important roles in influencing exchange rate movement. The results also reveal that the misalignment of exchange rates is quite small and stable during 1988 to 2019, except for 2015 which was attributed to the weaker growth in China. Consecutively, this study suggests that the parity condition is only important in the long-run in explaining exchange rates behaviour for the sample country.

Keywords: Equilibrium exchange rates (EER); bound testing; exchange rates misalignment; autoregressive distributed lag (ARDL)
JEL: E43, E52, F31, F32, F33, F41

ABSTRAK

Kajian ini bertujuan untuk menganggarkan keseimbangan kadar pertukaran matawang serta mengenalpasti peranan asas makroekonomi yang mempengaruhi kadar pertukaran matawang di Malaysia sepanjang tempoh 1970 hingga 2019. Kajian ini mengadaptasi model Autoregressive Distributed Lag bagi mengkaji hubungan jangka panjang atau kointegrasi di antara pembolehubah, serta kesan dinamik (atau dynamic effect) dalam pembolehubah jangka pendek bagi tempoh sampel. Hasil kajian menunjukkan bahawa kadar inflasi dan kadar pertumbuhan pendapatan negara memainkan peranan penting dalam mempengaruhi pergerakan kadar pertukaran matawang. Hasil kajian juga menunjukkan bahawa ketidakseimbangan nilai pertukaran adalah kecil serta stabil bagi tahun 1988 hingga 2019, kecuali pada tahun 2015 yang berpunca dari pertumbuhan ekonomi yang lemah di negara China. Seterusnya, kajian ini juga menunjukkan bahawa keadaan pariti hanya penting dalam jangka panjang bagi menjelaskan turun naik kadar pertukaran matawang bagi sampel negara yang dikaji.

Kata kunci: Keseimbangan kadar pertukaran matawang (EER); pengujian sempadan; ketidakseimbangan kadar pertukaran; autoregressive distributed lag (ARDL)

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INTRODUCTION

The collapse of the Bretton Woods system was one of the most accurately and generally predicted of major economic events. However, the shifting policy from fixed to floating exchange rates emanating from the culmination of this regime produced high fluctuation in currency exchange, thus causing the exchange rates to be misaligned (Ho & Ariff 2012; Raza & Afshan 2017).

As a small country practicing open and newly industrialized economy, Malaysia cannot avoid the issue involving foreign exchange rates. In addition, liberalization in the financial system that led to a complete reduction or elimination of financial control, might in turn lead to currency instability especially in Southeast Asian countries. According to Ho and Ariff (2014) and Zainuddin and Zaidi (2020), capital liberalization in the 1980s introduced multilateral movements in capital and may cause to exchange rate instability. This might be the truth behind the Asian financial crisis in 1997, where some Southeast Asian nations, particularly Thailand, Malaysia, The Philippines, Indonesia and Singapore, were unable to avoid the impacts of speculative attacks on their currencies, which has led to the largest financial crisis in their modern history. However, Chin and Azali (2005) disagreed that exchange rates instability was the cause to financial crisis in this region.

Given this background the pertinent questions that are raised in this study are as follows: Why was Malaysia concerned on whether the *Ringgit Malaysia (RM)* was experiencing overvaluation or undervaluation? How can we measure the equilibrium exchange rates and its misalignment? And what are the fundamental factors that can influence exchange rate movements?

Firstly, according to Shukri, Habibullah, Yusop and Chin (2017), a country with currency appreciation should imply an increase in the competitiveness of its national currency in the currency markets. However, it won't be as such if the high appreciation causes domestic currency to be overvalued. The result in turn implies that the currency is becoming expensive thus inducing increase in imports and decrease in export demand, and consequent deficit in the trade balance.

Secondly, the basic theories in explaining exchange rate behaviour are based on purchasing power parity (PPP) and the law of one price (LOP) introduced by Gustaz Cassel in 1918. The PPP/LOP theories state that exchange rates between two currencies will adjust to reflect in the price levels of the two countries. In other words, these theories are price-based estimates and do not consider the importance of other macroeconomic fundamental factors. Thus, the assumptions in these theories are weak. Furthermore, the PPP approach does not take into account the real factors such as inflation, interest rate and national income growth. The pioneering study thus argued that these theories present very crude models that were unable to accurately predict especially in the short-run (Chin & Azali 2005; Chin, Azali, Yusop & Yusoff 2007; Ho & Ariff 2012; Shukri *et al.* 2017). FIGURE 1 describes the theory of PPP/LOP and the misalignment of exchange rates in Malaysia. Generally, the theory of PPP/LOP suggests that if one country's price level increases relative to that of another, its currency should depreciate. As a reciprocal to this change, the other country's currency should appreciate. This prediction does happen in the long-run. As shown in FIGURE 1, PPP/LOP often has little predictive power in the short-run. The relative price levels between the two trading countries fail to effectively track the actual exchange rates involved, thus creating a huge misalignment. Although PPP/LOP theory provides some guidance to the long-run movement of exchange rates, it is not perfect and in the short-run it is not a reliable predictor.

Thirdly, exchange rate fluctuations are very influential on various aspects of the economy, especially to a small, open and newly industrialized economy such as Malaysia's. The role of exchange rates becomes very significant when it involves international trades such those engaging multinational corporations and any other business related to import and export activities. The study conducted by Soon and Baharumshah (2021), disclosed the relationship between exchange rates and macroeconomic fundamentals, namely relative price and interest rate differential. It revealed that a small value of interest rate differential tends to appreciate the dollar exchange rate, and vice versa. Chou (2018) suggested that the relationship between exchange rate and interest rate differential are ambiguous. First, the positive relationship occurs under floating exchange rate system when higher interest rate causes surplus in balance of payments thus causing domestic currency to appreciate. Second, higher interest rate differential may also increase inflation. Thus, the domestic currency will depreciate against foreign currency. Furthermore, Andries et al. (2017) showed that there is negative relationship in short-term and a positive relationship in the long-term between interest rate and exchange rates during a period of turmoil or policy changes. Whereas in contrast, Ali et al. (2015), Abdurehman and Hacilar (2016) and Raza and Afshan (2017) showed that inflation rate has a positive and significant effect on exchange rates. However, Kamin (1997) and Necsulescu and Serbanescu (2013) provided evidence that inflation rate has an inverse relationship with exchange rates. Additionally, Ho and Ariff (2008) and Ho and Ariff (2014) showed that both inflation and interest rate are jointly significant factors in most of the tests conducted. Furthermore, Raza and Afshan (2017) found significant negative association between exchange rates and economic growth including two other variables, namely terms of trade and trade openness. Ho and Ariff (2014) believed that economic growth could affect exchange rates to be either overvalued or undervalued.

There were many earlier studies that forecasted exchange rate movements through the use of several models. However to date, there is no single generally accepted model that can accurately forecast exchange rates. The purpose of this study therefore is to identify the roles of macroeconomics fundamentals on exchange rates through estimating the equilibrium exchange rate models for Malaysia. In this study the autoregressive distributed lag (ARDL) approach is adopted to examine the long run relationships (or cointegration) among variables and the dynamic effect within variables in the short-run.

This paper is organized as follows. The overview of the determination of equilibrium exchange rates in Malaysia is discussed in the first section. The second section is dedicated to a brief discussion on the theoretical framework of equilibrium exchange rates, the research design and methodology to estimate the equilibrium exchange rates in Malaysia. The results on estimations and research findings are discussed in section three. Section four includes discussion on the misalignment of currency in Malaysia and finally, section five will summarize the main findings and conclude with some policy implications.

METHODOLOGY

MODEL (THEORETICAL FRAMEWORK)

In this study the general model on exchange rates adopted was as proposed by Chin and Azali (2012), Eun et al. (2011), Chin et al. (2009). The model is an estimation of macroeconomic fundamental variables based on econometrics that shows the equilibrium of exchange rates in both long-term and short-term. The long-run model can be written as follows:

$$ER_t = \theta_0 + \theta_1(\pi - \pi^*)_t + \theta_2(r - r^*)_t + \theta_3(\gamma - \gamma^*)_t + \mu_t \quad (1)$$

where ER_t, π_t, r_t and γ_t are nominal exchange rates, domestic inflation rate, domestic real interest rate (lending rate), and domestic national income growth rate respectively; an asterisk (*) denotes the corresponding foreign variables (United State of America); while t, θ_0 and μ_t denotes time, constant and disturbances term, respectively. Any disequilibrium in the model is reflected in the μ_t term, which includes both short-term influences and random disturbances; whilst, $\theta_{1,2,3}$ are vectors of coefficient. A prior precedent of the relationship between those variables is expected that $\theta_1 > 0$ and θ_2, $\theta_3 < 0$. All variables are not in logarithmic forms.

The study also followed Pesaran *et al.* (2001) in the ARDL approach for cointegration in estimating the model. According to them, and also Sanusi *et al.* (2018), the ARDL is applicable regardless of the stationary properties, or irrespective of whether the regressors are integrated at I (0) or I (1), or mutually co-integrated. Indeed, the ARDL bound testing is robust for cointegration analyses with small sample study, thus enabling it to determine the existence of long-run relationships amongst the variables.

Further analysis for model in Equation (1) can be conducted to examine whether $\left(\pi_t - \pi_t^*\right)_t$, $\left(r_t - r_t^*\right)_t$ and $\left(Y_t - Y_t^*\right)_t$ is a *long-run forcing* variables for ER_t. Therefore, a specified 'unrestricted error correction model' (UECM) of the ARDL model can be rewritten as per the following equations:

$$\begin{aligned}\Delta ER_t = {} & c_0 + \delta_1 ER_{t-1} + \delta_2\left(\pi - \pi^*\right)_{t-1} + \delta_3\left(r - r^*\right)_{t-1} \\ & + \delta_4\left(\gamma - \gamma^*\right)_{t-1} + \sum_{i=1}^{k}\xi_{1i}\Delta ER_{t-i} + \sum_{i=0}^{n}\xi_{2i}\Delta\left(\pi - \pi^*\right)_{t-i} \\ & + \sum_{i=0}^{n}\xi_{3i}\Delta\left(r - r^*\right)_{t-i} + \sum_{i=0}^{n}\xi_{4i}\Delta\left(\gamma - \gamma^*\right)_{t-i} + \varepsilon_t \end{aligned} \quad (2)$$

where c_0 and ε_t are constant and disturbance term at time t. The F-test was used to identify the existence of the long-run relationship for exchange rates model, where the null hypothesis can be defined as: $H_o: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ against $H_a: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$. According to Pesaran *et al.* (2001) the bounds F-test must be valid. To ensure that there was no serial correlation the LM statistics were employed for testing the hypothesis of no serial correlation of order 1. Meanwhile, the Schwartz-Bayesian information criterion (SBC) was used to determine the optimal lag length and was subsequently automatically selected. From Equation (2), the long run equation presented in Equation (1) can be derived, when we have: $\theta_0 = \frac{-c_0}{\delta_1}$, $\theta_1 = \frac{-\delta_2}{\delta_1}$, $\theta_2 = \frac{-\delta_3}{\delta_1}$, and $\theta_3 = \frac{-\delta_4}{\delta_1}$.

Consecutively, the short-run dynamics can be estimated by using the following ARDL-Restricted Error Correction Model (RECM):

$$\begin{aligned}\Delta ER_t = {} & \Phi_0 + \sum_{i=1}^{k}\Phi_{1i}\Delta ER_{t-i} + \sum_{i=0}^{n}\Phi_{2i}\Delta\left(\pi - \pi^*\right)_{t-i} \\ & + \sum_{i=0}^{n}\Phi_{3i}\Delta\left(r - r^*\right)_{t-i} + \sum_{i=0}^{n}\Phi_{4i}\Delta\left(\gamma - \gamma^*\right)_{t-i} \\ & + \psi EC_{t-1} + \Delta_{1t} \end{aligned} \quad (3)$$

where Φ, Δ_{1t} and EC_{t-1} are vectors of coefficient, disturbance term at time t and the lagged residual from co-integration (the long-run equation) between dependent and independent variables in the level derived from ARDL model, respectively. The EC_{t-1} term was derived from Equation (1) where $EC_{t-1} = \mu_{t-1} = ER_{t-1} - [\theta_0 + \theta_1(\pi - \pi^*)_{t-1} + \theta_2(r - r^*)_{t-1} + \theta_3(y - y^*)_{t-1}]$. The null hypothesis for EC_{t-1} for different numbers of regressors (k) can be expressed as $H_o: \psi = 0$, against of $H_a: \psi \neq 0$. All the above explain that the significance of the error correction (EC_{t-1}) indicates cointegration, and ψ measures the speed of adjustment and the deviation from equilibrium. The negative value for ψ suggests that the model is stable and any deviation from equilibrium will be corrected in the long-run. According to Pesaran *et al.* (2001), the existence of an error correction model implies cointegration of the variables. Therefore, the long-run relationship is valid and free from spurious regression problem.

DATA

This study utilised the annual data for Malaysia spanning 1970 to 2019. The exchange rate (ER) is the nominal value calculated as an annual average based on monthly averages. An increase in the ER indicates depreciation

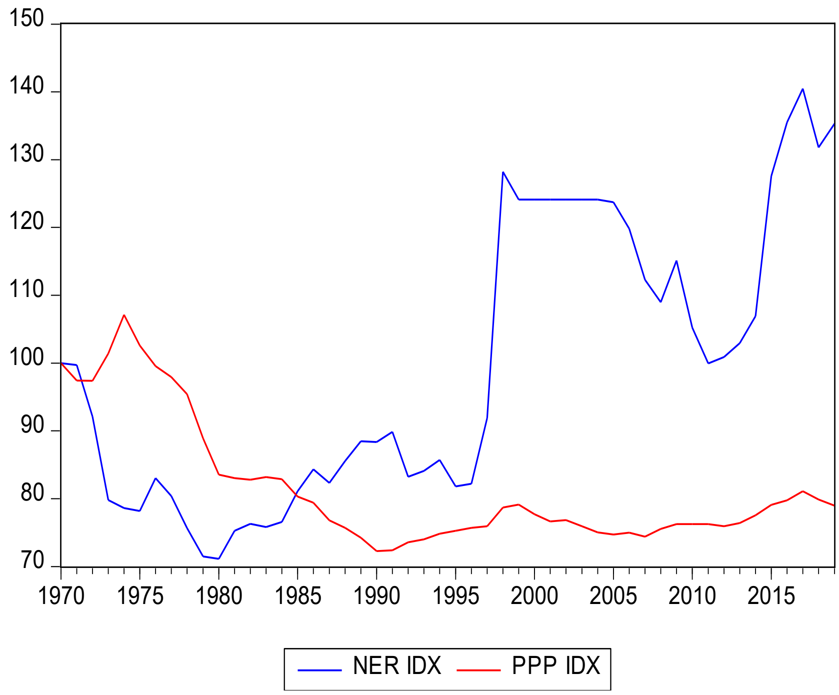


FIGURE 1. Purchasing Power Parity, Malaysia/United States, 1970-2019.
Source: Worldbank's World Development Indicator (WDI) and authors' computations.
Note: Index 1970=100; Rel_Price=CPI_{MAL}/CPI_{US}; and ER=RM/USD

of the domestic currency against the US dollar. The inflation rate (π) measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The real interest rate (r) is the lending value adjusted for inflation as measured by the GDP deflator. And national income growth rate (γ) is the annual percentage growth rate of GDP at market prices based on constant local currency. All the data can be obtained from the Worldbank's World Development Indicators (WDI).

EMPIRICAL RESULTS AND DISCUSSION

DESCRIPTIVE ANALYSIS

TABLE 1 displays the summary of descriptive statistics. The mean value of exchange rate is greater than the standard deviation thus indicating that the data has low variability, whereas the inflation rate differential, interest rate differential and growth rate differential show high variability.

The skewness in the outcome shows that these are mixed results obtained from the data distribution since there are both positive and negative values presented by the variables. If the data are positive, it will skew to the right whereas if they are negative it will then skew to the left. The skewness for the normal distribution is zero value. The result revealed that the variables, namely the exchange rate and interest rate differential, are skewed to the right because of the positive value obtained. The inflation rate differential and growth rate differential however are skewed to the left due to negative value of the data distribution.

Kurtosis is used to measure data distribution which is normally distributed or not normally distributed. It is also used as an indicator of peakedness or flattening of data distribution. It is at high peakedness if the value is greater than three, and conversely it flattens off if less than three. If the value centres around three the data distribution is normal. The result shows the exchange rate at less than three thus indicating that the data is flattened. All the explanatory variables however exceeded three indicating data distribution is at high peakedness.

TABLE 1. Data summary statistics

	ER	INF	RIR	GROWTH
Mean	2.0378	-0.5003	0.3753	3.4800
Maximum	3.3004	6.2742	16.7630	9.6537
Minimum	1.1769	-7.6000	-9.2086	-11.8408
Std. Dev.	0.6441	2.4375	5.0982	3.5724
Skewness	0.4201	-0.3177	1.1069	-1.7353
Kurtosis	1.7147	4.7524	4.9772	8.6407
Jarque-Bera	4.8143	7.0938	17.9881	89.5523
Observations	49	49	49	49

TABLE 2. Results of ADF and PP Unit Root Test.

Variable	ADF		PP	
	Trend	No Trend	Trend	No Trend
		Level		
ER_t	-1.615(0)	-1.156(0)	-1.807(1)	-1.156(0)
$(\pi - \pi^*)_t$	-8.674**(0)	-8.833**(0)	-8.370**(3)	-8.526**(3)
$(r - r^*)_t$	-7.210**(0)	-7.304**(0)	-7.098**(2)	-7.192**(2)
$(\gamma - \gamma^*)_t$	-4.213*(0)	-4.028**(0)	-4.230*(1)	-4.009**(2)
		First Difference		
ER_t	-4.122*(0)	-4.196**(0)	-4.127*(1)	-4.184**(2)
$(\pi - \pi^*)_t$	-8.341**(1)	-8.449**(1)	-19.78**(3)	-19.92**(3)
$(r - r^*)_t$	-7.152**(1)	-7.301**(1)	-16.23**(2)	-16.54**(2)
$(\gamma - \gamma^*)_t$	-6.197**(1)	-6.331**(1)	-17.6**(23)	-18.0**(23)

Note: The value in parentheses ( ) representing automatic lag length was selected by using Schwarz Information Criterion (SIC) for ADF, whilst the PP test values were obtained by automatic bandwidth, selected based on Newey-West method using Bartlett kernel. The ** and * indicate the statistically significant levels at 1% and 5% respectively. ER_t are exchange rates, $(\pi - \pi^*)_t$ the inflation rate differential, $(r - r^*)_t$ the real interest rate differential, and $(\gamma - \gamma^*)_t$ the national income growth rate differential. All variables are not in Logarithm.

RESULTS OF UNIT ROOT TEST

This study employed unit root test using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) to examine the existence of stochastic non-stationary in the series. TABLE 2 shows the empirical results of the unit root tests. All the variables in this study, such as exchange rates, inflation rate differential, real interest rate differential and national income growth rate differential were tested based on “no trend and constant”, and “trend and constant”. The outcomes of the unit root tests of ADF and PP shown in Table 1, clearly indicate that all variables are a mixture of *I(0)* and *I(1)*, and none is *I(2)*. Therefore, the ARDL modelling approach can be used in the estimation of exchange rate model in this study.

RESULTS OF COINTEGRATION TEST

The existence of a long-term cointegrating relationship between the exchange rates and the macroeconomic variables in Malaysia can be determined by using the ARDL bound test. TABLE 3 presents the empirical result of bound test for exchange rate model, and the lag length for this regression are ARDL(1,0,0,0), which were automatically selected based on Schwarz Bayesian Criterion (SBC). The result of bound test shows that the *F*-statistic for exchange rates model fall above the upper bound critical value at 10 percent significance level which thus suggests that cointegration exists among the variables in the model under investigation.

DIAGNOSTIC TESTS

The diagnostic tests such as serial correlation AR (1), functional form Reset (1), normality Norm (2) and heteroscedasticity ARCH (1) are also applied to the empirical model to gauge the adequacy of its specification. The Lagrange Multiplier (LM) test needs to be conducted in order to investigate the existence of serial correlation. Generally, the diagnostic tests for exchange rate model in Malaysia produce good results. TABLE 4 clearly indicates that the model is free from serial correlation and heteroscedasticity, whilst the functional form indicates that there is no specification errors and the residual is normally distributed.

TABLE 3. Cointegration bound test analysis.

F-statistic	%	Lower Bound	Upper Bound
(Narayan, 2005)	90	2.592	3.454
	95	3.100	4.088
Computed *F*-statistic		*F*=3.6298*	

Note: ** and * indicate statistical significance at 5% and 10% levels respectively. Narayan (2004) critical values are tabulated for a sample size ranging from 30 to 80 observations (Case II: intercept and no trend).

TABLE 4. Results of Diagnostic Tests for ARDL.

Diagnostic Checking	*p*-value
Serial Correlation	0.158
Functional Form	0.089
Normality	0.523
Heteroscedasticity	0.560

Note: ARDL(1,0,0,0) was automatically selected on the basis of SBC. Asterisk ** and * denote statistical significance at 1% and 5%, respectively.

ESTIMATES OF LONG-RUN MODEL

The results in Table 5 clearly indicate that the inflation rate differential and the national income growth rate differential are statistically significant at 5 percent level, whilst real interest rate differential is statistically

FIGURE 2. CUSUM and CUSUMSQ
Note: The straight lines represent critical bounds at 5% significant level.

not significant. In the long run, the model explains that the higher level of inflation rate differential and the national income growth rate differential could lead to appreciation, whilst higher level of national income growth rate differential could lead to depreciation in the exchange rates in Malaysia. According to Ho and Ariff (2011) and Zainuddin and Zaidi (2020), the higher domestic inflation rate relative to those in foreign countries causes the domestic currency to appreciate, and *vice versa*. This is due to the fact that Malaysian consumers and firms when faced with cheaper imported products tend to increase the demand on foreign currency (US dollar). In addition to this, the demand for exported local products tend to decrease due to the high price or costs of domestic production. Furthermore, Chin and Azali (2005) and Eun *et al.* (2011) explained that higher national income growth rate relative to those in foreign countries (other things being equal) will cause domestic purchasing power to increase, thus encouraging the demand on imported foreign products. Conversely, a country with lesser purchasing power relative to Malaysia's will reduce the demands on imported products from Malaysia, thus subsequently causing a decrease in demand on her currency. This drop in demand may cause Malaysia's domestic currency to depreciate in the foreign exchange.

TABLE 5. Results of Long-run Coefficient.

Variable	Exp Sign	Coeff.	S.E.	*t*-stat
$(\pi - \pi^*)_t$	+	0.329	0.146	2.254*
$(r - r^*)_t$	-	-0.057	0.053	-1.073
$(\gamma - \gamma^*)_t$	-	-0.309	0.134	-2.303*
C		5.324	2.128	2.501*

Note: Asterisk ** and * denote statistical significance at 1% and 5%, respectively. $(\pi - \pi^*)_t$ is inflation rate differential, $(r - r^*)_t$ the real interest rate differential, and $(\gamma - \gamma^*)_t$ the national income growth rate differential. All variables are not in Logarithm.

ESTIMATES OF ERROR CORRECTION MODEL (ECM)

According to Engle and Granger (1987), the error correction model (ECM) is the short-run model with long-run information. If the ECM is negative and significant, it implies that there is long-run relationship between independent variable and dependent variable, and these are cointegrated. With reference to Table 6, the error correction term in the model shows that it is significant at 5 percent level and it also carries the expected negative sign. The results firstly suggest that the inflation rate differential and national income growth rate differential are causal to the movement of exchange rates and both are cointegrated. The result is found consistent with that from bound testing (refer to Table 3). Secondly, the results also indicate that the model is stable and any deviation from equilibrium will be corrected in the long-run (Habibullah, Din & Abdullah 2012). Thirdly, the coefficient of the error correction term implies the speed of adjustment. Based on the results, the coefficient of the error correction term for exchange rate model in this study is at 0.11 thus indicating that 11 percent of the previous year's shocks was adjusted back to long-term equilibrium in the current year. The results also provide further evidence of the existence of a stable long-run relationship among the variables in the exchange rate model.

TABLE 6. Results of Short-run Coefficient and Error Correction Model (ECM).

Variable	Coeff.	S.E.	*t*-stat
$\Delta(\pi - \pi^*)_t$	0.037	0.013	2.827**
$\Delta(r - r^*)_t$	-0.006	0.006	-1.078
$\Delta(\gamma - \gamma^*)_t$	-0.035	0.008	-4.344**
ECM_{t-1}	-0.113	0.045	-2.524*

Note: Asterisk ** and * denote statistical significance at 1% and 5%, respectively. $(\pi - \pi^*)_t$ is inflation rate differential, $(r - r^*)_t$ the real interest rate differential, and $(\gamma - \gamma^*)_t$ the national income growth rate differential. All variables are not in Logarithm.

In addition, the plot from the statistics of the CUSUM and CUSUMSQ explains that all coefficients in the error correction model are stable over time. This should imply that the selected model adopted in this study appear efficient in estimating the long-run and short-run cointegration between exchange rates and macroeconomic variables in Malaysia (refer FIGURE 2).

MISALIGNMENT

Table 7 shows the percentage of misalignment in exchange rates and FIGURE 3.

Figure 3 displays the plot of residuals and two standard error bands. The result reveals that the misalignment of exchange rates is quite small and stable in Malaysia during 1988 to 2019. However, the weaker growth in China in 2015 induced a shock or spike of exchange rates in Malaysia causing the government to intervene and offset the significant upward pressure on the national currency.

Consequently, this study used the forecasting model to determine the accuracy which was popularized by Meese and Rogoff (1983). As such the in-sample and out-of-sample dynamic predictions for exchange rates in Malaysia were generated. The forecasts had small root mean squared errors (*RMSE*) implying goodness of fit that can be shown graphically in Figure 4. Generally, the results demonstrated that exchange rate model has small *RMSE* for In-Sample Dynamic Forecasting Errors. This proves that the model is likely to fit closely with the data

TABLE 7. The misalignment of exchange rates (%) in Malaysia, 1988-2019

Year	%	Year	%
1988	0.119	2004	0.048
1989	0.111	2005	-0.063
1990	0.124	2006	-0.147
1991	0.165	2007	-0.177
1992	-0.268	2008	-0.166
1993	0.035	2009	0.104
1994	-0.043	2010	-0.284
1995	-0.131	2011	-0.200
1996	-0.033	2012	-0.004
1997	0.150	2013	-0.016
1998	0.331	2014	0.025
1999	-0.162	2015	0.490
2000	0.090	2016	0.232
2001	-0.030	2017	0.145
2002	0.0280	2018	-0.168
2003	0.058	2019	0.168

Note: A misalignment is the residual between actual and fitted values of exchange rates. Positive (or negative) value for the residual denotes an undervaluation (or an overvaluation).

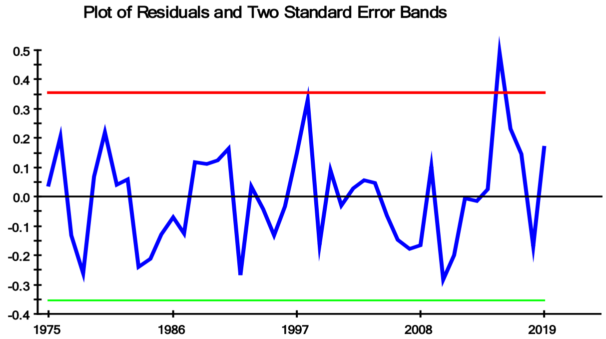
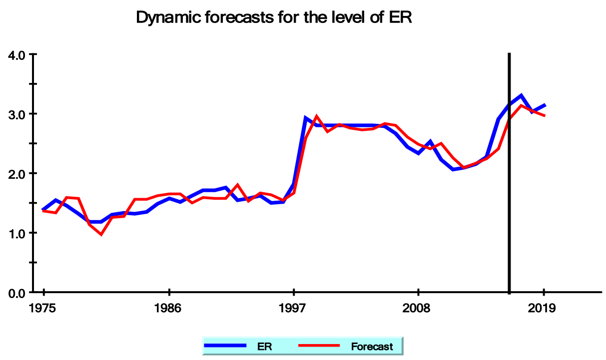


FIGURE 3. Residuals and two standard error bands for exchange rates model
Note: The positive value of the residuals (above zero) are associated with undervalued exchange rates, and *vice versa*.



Dynamic forecasts *RMSE* = 0.13421

FIGURE 4. In-sample dynamic forecasting.
Note: RMSE is root mean square error.

over the observed period and it is also able to correctly track the actual exchange rates over a considerable number of turning points.

CONCLUSION

This study used exchange rate model as suggested by Chin and Azali (2012), Eun et al. (2011), and Chin et al. (2009) in order to give an in-depth understanding of the exchange rates behaviour in Malaysia using the dataset spanning 1970 to 2019. By adopting the ARDL model, this study analyses the short-run and long-run relationships between exchange rates and its macroeconomic fundamentals, namely inflation rate differential, real interest rate differential and national income growth rate differential. The results showed that inflation rate differential and national income growth rate differential play an important role in influencing the exchange rate movement in this country. Even though the short-run model shows both inflation rate differential and national income growth rate differential produce the same results, this study in contrast however suggests that the parity condition is only important in the long-run in explaining the exchange rate behaviour for Malaysia. This judgement is based on the findings of Ho and Ariff (2011) and Ho and Ariff (2012) who revealed that the parity condition may hold only in the long-run.

Further, this study evaluates the misalignment of exchange rates by evaluating the residuals between real exchange rates and the estimated exchange rates. The results established that there was only a small misalignments of exchange rates that occurred in Malaysia under the period of study, except for 2015. The finding is consistent with studies conducted by Chin and Azali (2005); and (Shukri et al. 2017). According to Holtemöller and Mallick (2012), one possible explanation of such a small misalignment of exchange rates is the flexibility of the currency regime, where the higher the flexibility, the lower is the misalignment. In addition, Chin and Azali (2005) stated that the misalignment of the national currency in Malaysia was not causal to her being embroiled in the financial crisis of 1997/1998.

The policy implications of this study are suggested as follows: Firstly, the long-run and short-run relationships between exchange rates and its macroeconomic variables indicate that there are statistically significant links between exchange rates and its independent variables such as inflation rate and national income growth rate. Additionally, the result showed that the forecasts of exchange rates generated by the fitted model was able to closely predict the actual data. This suggests that the exchange rates in Malaysia are driven by macroeconomic variables such as inflation rate and national income growth rate. Therefore, it is important for the policy makers, investors, bankers, exporters-importers and researchers to consider inflation rate and national income growth rate in predicting future exchange rate movements. Secondly, the central bank of Malaysia must pay attention to strengthen the financial institutions and market in the long run, in order to avoid exchange rate misalignment. A managed floating exchange rate regime should thus be implemented continuously in emerging countries including Malaysia.

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