

THE LONG-RUN RELATIONSHIP BETWEEN EXCHANGE RATE AND ITS DETERMINANTS

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Abstract

The paper examines the long-run relationship between exchange rate and its determinants in Malaysia using annually data spanning the period 1969 to 2014. Exchange rate plays an important role in international trade and finance. The exchange rate can be considered as a crucial channel that links the macroeconomic of an open domestic country to its trading partners. Through the Autoregressive-Distributed Lag (ARDL) approach, we find that there are a long-run relationships between nominal exchange rates and its determinants, namely relatives of money supply, income, interest rate and current account for Malaysia vis-à-vis United States. The notable results are only money supply shows significant impact on exchange rate while the other fundamentals do not have significant impact upon exchange rate.

JEL Classification: E51, F31

Keywords: Exchange rate, ARDL approach, Malaysia

1. Introduction

Most of the studies investigated the validity monetary model of the exchange rate (see Meese and Rogoff, 1983; MacDonald and Taylor, 1993; Baharumshah and Masih, 2005 and Baharumshah et.al, 2010). Some of studies found that mixed evidence of exchange rate determinations. They found that some variables could explain exchange rate movements. Moreover, for the majority of countries, namely Indonesia, the Philippines and Singapore there exhibit long-run relationship among variables regardless of whether the United States or Japan is used as base currencies. These results are consistent with those of Moosa (1994), MacDonald and Taylor (1994a,b), Makrydakis (1998), Husted and MacDonald (1999), Bahmani-Oskooee and Kara (2000), Miyakoshi (2000), Chinn (2000), Baharumshah et al. (2002), Baharumshah and Masih (2005), Lee et al. (2007), Morley (2007) and Long and Samreth (2008). They have all found that the fundamentals variables could explain exchange rate

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behavior. Meanwhile, for Thailand case, there is no long-run relationship among exchange rate with their determinants. Meese (1986), Ballie and Selover (1987), McNown and Wallace (1989), Kearney and MacDonald (1990), Nieh and Wang (2005) and others have also obtain the same conclusion about the fundamentals variables unable to explain exchange rate movements. In other words, these authors failed to find the link between exchange rate and its determinants.

As we know that, exchange rate plays an important role in international trade and international finance. Exchange rate is also one of the important factors that determine whether foreign direct investment (FDI) would go onto domestic or foreign countries. It depends on the value of exchange rate. Movements of exchange rate also have important impacts to exporters and importers. An increase in exchange rate will make domestic goods more expensive relative to foreign goods. Hence, this will lower the export of domestic goods. In contrast, decrease in exchange rate will increase exports of domestic goods. On the other hand, when the exchange rate rose, foreign goods will be relatively cheaper from the domestic point of view. Thus, imports of domestic countries will rise. In contrast, imports will decrease if exchange rate goes down (Yarbrough and Yarbrough, 2003).

Because of the importance of exchange rate, studying of the behaviour of exchange rate and the factors that determine the movement of exchange rate is popular among researchers, practitioners and policymakers. For example study by Islam and Hasan (2006) test monetary model through examining behavior of Dollar–Yen exchange rates. The results of this study provide empirical evidence of supporting predictability for Dollar-Yen exchange rate through monetary model determinants. Liew et al (2009) pointed out that the behavior of Baht (Thailand) and Yen (Japanese Currency) exchange rate are effectively determined by flexible price monetary model. Hsieh (2009) has used Mundell-Fleming model to examine the behavior of Indonesian Rupiah per unit of US Dollar. This study found that relatively more real money aggregate, a relatively higher domestic interest rate, or a relatively more expected inflation rate causes real depreciation for Indonesian Rupiah. Further, higher ratio of governmental spending to GDP or higher stock prices lead to real appreciation in IDR/USD exchange rate.

Theoretically, the exchange rate behaviour is determined by monetary fundamentals such as money supply, income and interest rate. For example, an increase in domestic money supply will induce depreciation of domestic currency. Instead, exchange rate will appreciate if foreign money supply increases. For the higher domestic real income, domestic currency will appreciate due to more demand for domestic money. In contrast, an increase in foreign real income will induce the lower demand for domestic money, thereby causing domestic currency to depreciate. Finally, higher domestic interest rate will induce domestic currency appreciation.

In contrast, domestic currency will depreciate when domestic interest rates fall. Previously, many researchers have investigated the relationship between exchange rate and these macro variables (see for instance, Frenkel, 1976; Dornbusch, 1976; Bilson, 1978; Frankel, 1978; Moosa, 1994; MacDonald and Taylor, 1993, 1994 and Rapach and Wohar, 2002, 2004). Karfakis (2003) study the Romanian Lei and US Dollar exchange rate and concludes that money is

positively related with the exchange rate. Increase in money is the source of depreciation in the domestic currency. Wilson (2009) examined the effective exchange rate of US Dollar based on the weighted average trading partner of USA. This study revealed that money supply is positively related to the effective exchange rate and increase in money causes decline in the value of currency.

Besides that, current account differential beyond the standard monetary framework is found to be important in explaining exchange rate movement. Theoretically, when export of goods and services is less than import, domestic current account deficit will occur. Then, home currency will depreciate. In contrast, domestic current account surpluses if export of goods and services exceed imports. Then, the home currency appreciates whereas foreign currency will depreciate (Levich, 2001; David et.al 2013 and Eun and Resnick, 2014). Most of these studies examine the United States Dollar and Japanese Yen based exchange rate.

Numerous literatures study about the determinants of exchange rate in Malaysia. Chin, Azali and Matthews (2007) pointed out that Malaysian ringgit against US dollar (MYR/USD) is specified as a function of the money supply, income, interest rate and inflation rate differentials. This study has used different type of exchange rate which purposely focuses on Malaysia ringgit against US dollar. Granger, Huang and Yang (2000) found that there exist a bilateral relationship between exchange rates and stock indexes or a significant link from stock markets to exchange rates in Malaysia. This result also found by Hussain and Liew (2005) and Lee, Doong and Chou (2011). Lin (2012) argues that the comovements between stock indexes and exchange rates in Asian emerging markets are strong during the crisis period which running from stock index changes to exchange rate changes.

Tsen (2010) has examines the exchange rate determination in the context of monetary model in Malaysia using autoregressive distributed lag (ARDL). This study found that there exist a long run relationship between exchange rate and its determinants, namely money supply, relative demand, interest rate differential and oil price. This study has added oil price as macroeconomic variables as Malaysia is oil exporter. In recent study, Hsing (2015) has used simultaneous-equation model to investigate the short run determinants of the US dollar against Malaysian ringgit (USD/MYR). This study found that USD/MYR exchange rate is positively associated with Malaysia real government Treasury bill rate, U.S. real GDP, the Malaysian real stock index and the expected exchange rate. Furthermore, this study found the evidence there exist negative relationship between the USD/MYR exchange rate and U.S. real Treasury bill rate, Malaysian real GDP and the U.S. real stock index.

In a nutshell, this study attempts to examine the long-run relationship between exchange rate and its determinants for Malaysian ringgit against US dollar by employing the autoregressive distributed lag approach (ARDL) to cointegration pioneered by Pesaran et al. (2001) and Narayan (2005). This study adopts the standard monetary model augmented by current account differential. Previous studies believed that current account differential is important in explaining exchange rate movement (see Levich, 2001; David et.al, 2013 and Eun and Resnick, 2014). Thus, it is crucial to investigate the impact of current account differential on exchange rate. As open economy, the contribution of current account to Malaysia's Gross Domestic Product (GDP)

has shown very significantly increases since 2000 (Malaysia Department of Statistics, 2014). As current account differential become very crucial as macro variable especially to investigate the determinants of exchange rate, this study would like to extend this variable in case of Malaysia against United States which become our concerned to develop this study.

2. Methodology and Data

Similar with previous studies, we attempt to examine several commonly accepted exchange rates and its determinants using reliable testing procedures. The exchange rate model to be tested is:

$$er_t = \beta_0 + \beta_1(m_t - m_t^*) + \beta_2(y_t - y_t^*) + \beta_3(i_t - i_t^*) + \beta_4(ca_t - ca_t^*) + e_t \quad (1)$$

Where er_t represents nominal exchange rate at time t , $(m_t - m_t^*)$ is relative money supply at time t , $(y_t - y_t^*)$ denotes relative real income at time t , $(i_t - i_t^*)$ is relative interest rate at time t , and $(ca_t - ca_t^*)$ is relative current account at time t , respectively. e_t denotes error term (residual) at time t . β 's are regression coefficients. $\beta_1 > 0$, $\beta_2, \beta_3 < 0$. This implies that, increase in relative money supply will cause domestic currency depreciate ($\beta_1 > 0$), while rise in relative income will induce demand for money increase and causes domestic currency appreciate ($\beta_2 < 0$). Besides that, an interest rate differential increase will lead to capital inflow. Consequently, domestic currency will appreciate ($\beta_3 < 0$). However, it could be home currency depreciate if inflation rate increases caused depress in relative interest rate ($\beta_3 > 0$). Lastly, for relative current account, when current account surpluses because of export of goods and services exceed its import. Consequently, home currency will appreciate ($\beta_4 < 0$).

The annually time series data covers the period from 1969 to 2014 for Malaysian. The data are taken from the International Monetary Fund and World Bank. Data on Ringgit Malaysia (RM) against United States Dollar (USD), M2, deposit rate, gross domestic product (GDP) and current account for Malaysia and United States. This part describes also about the integration order and cointegration tests. In section 2.1, it explains about integration order test that employs augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to check the integration order of the variables. The order of integration test is important to determine whether the variables integrated of order zero, one or more than one. Based on the test, the variables to be included in cointegration test can be identified. In section 2.2, the Autoregressive-distributed-lag (ARDL) bounds testing for cointegration, which is useful for variables that are integrated of order zero or one is discussed.

2.1 Integration Order Test

The first step in this analysis is to check the integration order of the exchange rate and its determinants. The augmented Dickey-Fuller (ADF) and Phillips-

Perron (PP) unit root tests will be applied in this study. For this purpose, firstly, this paper would like to explain the descriptions for unit root test of Augmented Dickey-Fuller (ADF) test proposed by Dickey and Fuller (1979, 1981) and Said and Dickey (1984). Usually, previous studies used a constant term and a linear trend or a constant term and no linear trend in testing ADF and PP test (see Baharumshah et al., 2002; Rapach and Weber, 2004; Baharumshah and Masih, 2005). In ADF test depending on situation, either one the following equations is estimated.

Model 1: A constant term and a deterministic linear trend in the model:

$$\Delta y_t = \beta_0 + \theta y_{t-1} + \gamma t + \sum_{i=1}^k \alpha_i \Delta y_{t-i} + \mu_t \quad (2)$$

Model 2: A constant term in the model:

$$\Delta y_t = \beta_0 + \theta y_{t-1} + \sum_{i=1}^k \alpha_i \Delta y_{t-i} + \mu_t \quad (3)$$

Where β_0 is a constant term, t denotes the time trend, $\Delta y_t = (y_t - y_{t-1})$, $\Delta y_{t-1} = (y_{t-1} - y_{t-2})$, $\Delta y_{t-2} = (y_{t-2} - y_{t-3})$, ..., $\Delta y_{t-k} = (y_{t-k} - y_{t-k-1})$ are lagged different terms to adjust for serial correlation, μ_t is serially uncorrelated error process with zero mean and constant variance, set $k = 8^2$. In order to check the variable contains the time trend, $\hat{\gamma}$ the estimated value of γ must be significant at the 10 percent. Otherwise, Model 2 will be used (Lardic and Mignon, 2006). The null hypothesis of this test is $\theta = 0$ (nonstationary, or y_t has a unit root) is tested against the one-sided (lower-tail), alternative hypothesis that $\theta < 0$ (corresponding to a stationary, no unit root in y_t).

If ADF test statistic is greater than critical value at 10 percent level derived by MacKinnon (1996). So then, the series rejects the null hypothesis, it means that the series is stationary. However, if the ADF test statistic is less than critical value in magnitude, the series cannot reject the null hypothesis, it means that the series is not stationary and a unit root is present. Some authors use Akaike information criterion (AIC) and Schwarz Bayesian information criterion (SBC) to select lag length (Makrydakis, 1998; Miyakoshi, 2000; Francis *et al.*, 2001; Ramirez, 2004; Narayan and Smyth, 2006). Thus, this study attempts to choose the optimal lag length based on SBC³.

Secondly, this study would like to describe another conventional unit root test pioneered by Phillips (1987) and Phillips and Perron (1988). The regression models can be expressed as follows:

² In order to select lag order k through top-down testing, this study follows Rapach and Weber (2004) to set maximum lag order of eight for quarterly data.

³ Ramirez (2004) points out that SBC is a better fit to the data as compare to AIC that could yield a bias result for the model. Sawa (1978) also suggest that adoption of AIC may result in overparameter.

Model 1: A constant term and a deterministic linear trend in the model:

$$y_t = a_0 + \theta t + \alpha y_{t-1} + u_t \quad (4)$$

Model 2: A constant term in the model:

$$y_t = a_0 + \alpha y_{t-1} + u_t \quad (5)$$

Where a_0 represents a constant term, t is a deterministic linear trend, u_t denotes error term. Model 1 is chosen if $\hat{\theta}$ is significant at the 10 percent level. Otherwise, Model 2 will be chosen (see Lardic and Mignon, 2006). In Equation 5, the null hypothesis of $\alpha = 1$ (nonstationary, y_t) is tested against the one sided (lower tail), alternative hypothesis of $\alpha < 1$ (y_t is stationary). If PP test statistics Z_α exceeds critical value at 10 percent significance level, y_t is stationary. Otherwise, y_t is not stationary. The test statistic is specified as:

$$Z_\alpha = T(\hat{\alpha} - 1) - 0.5(T^2 \hat{\sigma}_\alpha^2 / s^2)(\hat{\lambda} - \hat{\gamma}_0) \quad (6)$$

where $\hat{\alpha}$ is expected α that is obtained from the OLS estimate in Equations (5), $\hat{\sigma}_\alpha$ equals to standard error, $s^2 = (T - 2)^{-1} \sum_{t=1}^T \hat{u}_t^2$, \hat{u}_t equals to OLS residual, $\hat{\lambda}$ is long-run variance which means spectral density estimation at frequency zero of u_t that is based on covariance estimator and $\hat{\gamma}_v = T^{-1} \sum_{t=v+1}^T \hat{u}_t \hat{u}_{t-v}$. The long-run variance of u_t ($\hat{\lambda}$) can be formed using the quadratic spectral kernel in conjunction to the automatic bandwidth selection procedure based on Newey and West (1994). In case of the critical values, this study uses the critical values generated by MacKinnon (1996). Based on these two methods, the results must yield a series $I(0)$ or $I(1)$, then ARDL cointegration can be applied.

2.2 Cointegration Test

The study employs the autoregressive-distributed lag (ARDL) framework pioneered by Pesaran et al. (2001) to test for cointegration. There are several advantages of this bound testing procedure. First, the ARDL procedure lies in the fact that it can be applied irrespective of the variables are integrated of order zero or one ($I(0)$ or $I(1)$), unlike other techniques that require variables to be integrated of the same order to check the long-run relationship between variables (see Engle and Granger, 1987; Johansen, 1988; Johansen and Juselius, 1990; Philips and Oulirias, 2001). Secondly, ARDL model is appropriate for small sample sizes, whereas Engle and Granger' cointegration test is only suitable for large sample sizes (see Cheung and Lai, 1993; Tang, 2001; Choong et al., 2005)⁴. Besides, ARDL model can estimate the long-run

⁴ For instance, Cheung and Lai (1993) stated that finite sample size could yield a bias result in estimate likelihood ratio of Johansen's cointegration test.

and short-run dynamics simultaneously by using bounds testing procedures. In this aspect, it provides useful information on long-run and short-run elasticities. Besides, it allows to know whether the expected sign of each variables is consistent with the theory or not (see Pesaran and Pesaran, 1997; Jenkinson, 1986; Pesaran, Shin and Smith, 2001; Ang, 2008).

Because of these advantages, it has been widely applied recently in the empirical studies of economics and finance. In the area of exchange rate, in particular, Alimi (2014), Morley (2007), Nieh and Wang (2005), Bahmani-Oskooee and Kara (2000) and Long and Samreth (2008) have employed the ARDL model in their studies. It is noted that, these authors using a model with an intercept and no trend to testing their issues. Thus, this study attempts to apply the same model with an unrestricted intercept and no trend, which is referred to Narayan (2005)⁵ since our sample size is small. The bounds test is essentially based on an unrestricted error correction model (UECM) using OLS estimator. As such the model is also known as ARDL-UECM model. This study will be applied in the Hendry's general-to-specific of ARDL model. The purpose of using this procedure is to arrive at a parsimonious specification of ARDL-UECM model (Hendry and Ericsson, 1991). The ARDL-UECM representation of the exchange rate model in this study can be specified as follows:

$$\Delta er_t = \alpha + \sum_{i=0}^n b_{1i} \Delta m_{t-i} + \sum_{i=0}^n b_{2i} \Delta y_{t-i} + \sum_{i=0}^n b_{3i} \Delta i_{t-i} + \sum_{i=0}^n b_{4i} \Delta ca_{t-i} + \sum_{i=0}^n b_{5i} \Delta er_{t-i} + b_6 er_{t-1} + b_7 m_{t-1} + b_8 y_{t-1} + b_9 i_{t-1} + b_{10} ca_{t-1} + \mu_{1t} \quad (7)$$

Where Δ is the first difference operator, μ_{1t} is random error terms, $b_{1i}, b_{2i}, b_{3i}, b_{4i}$ and b_{5i} indicates the short-run dynamics of the model, b_6, b_7, b_8, b_9 and b_{10} denotes the long-run relationship. Meanwhile, n is the optimal lag lengths chosen by omitting sequentially the insignificant first difference variables⁶. The symbols of m, y, i and ca represents relatives of money supply, income, interest rate and current account respectively. The long-run elasticity is the coefficient of the one lagged explanatory variable (multiplied by a negative sign) divided by coefficient of the one lagged dependent variable (Pesaran *et al.*, 2001). The coefficient of the first difference variable represents short-run elasticity.

The Wald test or F-statistic can be used for testing the null hypothesis of no cointegration relationship among variables. In this study, the null hypothesis based on the UECM version of exchange rate model, is $H_0 : b_6 = b_7 = b_8 = b_9 = b_{10} = 0$. The alternative hypothesis is $H_0 : b_6 \neq b_7 \neq b_8 \neq b_9 \neq b_{10} \neq 0$ (there exists a cointegration relation) (see for

⁵ Atkins and Coe (2002) implement the bounds testing procedure in the examination of long-run Fisher effect in the United States and Canada. Payne (2003) estimate money demand function in Croatia. While, Narayan (2005) uses to examine the link between saving and investment in the case of Japan.

⁶ Some studies using optimal lag selection chosen by dropping the insignificant first difference variables (see Hendry and Ericsson, 1991; Pattichis, 1999 and Choong *et al.*, 2005)

instance, Pesaran *et al.*, 2001; Morley, 2007; Wang, 2008). The asymptotic distribution of the F-statistic is non-standard under the null hypothesis of no cointegration among the examined variables, irrespective of whether the explanatory variables are purely $I(0)$ or $I(1)$. So, the critical values have to be simulated (Narayan, 2005). This study selects an unrestricted intercept and no trend and then set number of repressors⁷ equals to 4 ($k=4$).

Thus, the variables can be known whether they are cointegrated or not. Let say, if the computed F-statistic exceeds the upper bound $I(1)$, then the null hypothesis of no cointegration can be rejected. Thus, it can be concluded that there is a long-run relationship among the exchange rate and its determinants. If the computed F-statistic falls below the lower bound $I(0)$, the null hypothesis of no cointegration cannot be rejected. Thus, no cointegration among variables can be concluded. However, if the F-statistic falls between the upper and lower bounds, a conclusive decision can be made. Furthermore, to check whether the estimated ARDL model is valid or not, this study will adopt a better of diagnostic tests. Particularly, Jarque-Bera statistics is used to test for normally distributed in residuals, Ramsey-RESET statistic is for model specification, LM statistic useful to know serial uncorrelated in residual, ARCH statistic is used to test for conditional homoscedasticity and CUSUMQ test proposed by Brown *et al.* (1975) are adopted to estimate the parameters for stability (see for instance, Pattichis, 1999; Atkins and Coe., 2002; Akinlo, 2006).

3. Empirical Results

3.1 Integration Order Test

This section attempts to investigate integration order for all variables for Malaysian case. Integration order test result is reported in Table 1. The series such as nominal exchange rate, income differential and relative current account appear to be $I(1)$ at the 1 percent significance level, while relative interest rate is integrated of order zero, $I(0)$ at 1 percent significance level based on ADF and PP test result appear to be $I(0)$ at 10 percent significance level for constant and $I(1)$ for constant and term at 1 percent significance level. In a nutshell, all variables are in mixed order, which are integrated of order zero, $I(0)$ and integrated of order one, $I(1)$. However, these variables may include in testing cointegration.

Since the integration order of variables exhibit $I(0)$ and $I(1)$, the ARDL approach is appropriated to further the test for cointegration. This study estimates the exchange rate and its determinants for Malaysia against United States. Because of the result of ARDL procedures is sensitive to the lag length, therefore the lag length is carefully selected. This study employed general to specific approach that the lag order selection of the first difference variables using the Hendry's general-to-specific method in order to achieve at a parsimonious specification (Hendry and Ericsson, 1991 and Pattichis, 1999). Reliable results are ensured through diagnostic checking. The estimated ARDL model for exchange rates and their determinants for each country are reported and described below.

⁷Regressors are a number of explanatory variables.

Table 1
Result of integration order test

	ADF Test		PP Test	
	<i>Intercept without trend</i>	<i>Intercept with trend</i>	<i>Intercept without trend</i>	<i>Intercept with trend</i>
	Level			
<i>er</i>	-1.157[0]	-2.256[0]	-1.157[0]	-2.372[0]
<i>m – m*</i>	-1.356[1]	-2.974[2]	-1.206[2]	-1.983[3]
<i>y – y*</i>	0.137[0]	-2.036[0]	0.154[1]	-2.153[3]
<i>i – i*</i>	-4.156[1]***	-4.788[1]***	-2.624[9]*	-2.690[12]
<i>ca – ca*</i>	-2.583[1]	-3.156[1]	-2.046[0]	-2.548[0]
	First Difference			
<i>er</i>	-5.125[0]***	-5.124[0]***	-5.042[0]***	-5.043[0]***
<i>m – m*</i>	-5.971[0]***	-6.085[0]***	-6.042[2]***	-6.144[2]***
<i>y – y*</i>	-6.714[0]***	-6.658[0]***	-6.732[2]***	-6.659[1]***
<i>i – i*</i>				-10.001[43]***
<i>ca – ca*</i>	-5.677[0]***	-5.619[0]***	-5.630[3]***	-5.552[4]***

Note: *, ** and *** denote significant at 10, 5 and 1 percents level, respectively. The numbers in square brackets are optimal lag selected automatically by Eviews using Schwartz Bayesian Information Criterion (SBC) (ADF test) and Newey-West Bandwidth (PP test). For intercept, the critical values of ADF test are -3.535 (1%), -2.907 (5%) and -2.591 (10%). For constant and with a trend, the critical values of ADF test are -4.106 (1%), -3.480 (5%) and -3.168 (10%). For constant, the critical values of PP test are -3.535 (1%), -2.907 (5%) and -2.591 (10%). For constant and with a trend, the critical values of PP test are -4.106 (1%), -3.480 (5%) and -3.168 (10%).

The estimated model for lag selection is reported in Table 2. For Malaysia, the results of the lag orders of relative money supply, income differential, interest rate differential and relative current account are three respectively, thereby yielding the ARDL (3, 3, 3, 3) model. Thus, this model is appropriate to be utilized to test for long-run relationship between exchange rate and the above stated determinants. To avoid invalid result, it is important to check that the model is well behaved in the sense that, there is no heteroscedasticity and no autocorrelation in residuals. Besides, the parameters must be stable, which implies stable relationship among exchange rate, relatives of money supply, income, interest rate and current account.

Table 2
Lag-length selection

Lag	AIC	SIC	Residual Test		Stability Test
			<i>LM test</i>	<i>ARCH test</i>	<i>CUSUMsq test</i>
			Lag=2	Lag=1	
1	-4.195	-3.627	3.234 [0.198]	0.002 [0.968]	Stable
2	-3.971	-3.152	0.745 [0.689]	0.064 [0.799]	Stable
3	-4.366	-3.332	2.527 [0.283]	0.690 [0.406]	Stable

4	-4.584	-3.330	13.119*** [0.001]	2.328 [0.127]	Stable
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Note: Number inside the parenthesis is the lag length and the probability value stated in square. *, ** and *** indicate significance at the 10, 5 and 1 percent levels. LM is the lagrange multiplier test for serial correlation (Ho: no autocorrelation in residuals; H1: error term has autocorrelation). ARCH test is the autoregressive conditional heteroskedasticity test statistic distributed (Ho: no conditional heteroskedasticity in residuals; H1: conditional of heteroskedasticity in error term). For CUSUMsq Tests can be used to test parameter stability (Ho: the parameters are constant over time; H1: the parameters are not constant over time).

3.2 Cointegration Test Result

The computed F-statistic of 4.080 that was obtained from Wald-Test is higher than the critical values of 3.772 tabulated by Narayan(2005) as shown in Table 3, rejecting the null hypothesis of no long-run relationship at the 10 percent significance level. Therefore, the result suggests that there is exhibits long-run relationship between exchange rate and its determinants for Malaysia. Recently, most empirical studies investigated the long-run relationship between exchange rate and other variables such as money supply, income, interest rate, stock price and current account, relatives of money supply, income, interest rate, stock price and current account as well as in Asian region (Makrydakis, 1998 and Miyakoshi, 2000 for Korea case; Husted and MacDonald, 1999 and Chinn, 2000 for selected Asian countries; Baharumshah et al., 2002 for Malaysia case; Baharumshah and Masih, 2005 for Malaysia and Singapore case; Nieh and Wang, 2005 for Taiwan; Lee et al., 2007 and Long and Samreth, 2008 for the Philippines case).

Table 3
The ARDL bound testing for cointegration analysis

Variables	F-Statistics	K	Cointegration
$m - m^*, y - y^*, i - i^*$ $, ca - ca^*$	4.080*	4	Cointegrated
Narayan (2005), Case III: Unrestricted intercept and no trend, Page: 1988, n=45			
Critical Value	Lower Bound	Upper Bound	
1%	4.394	5.914	
5%	3.178	4.450	
10%	2.638	3.772	

Note: *, ** and *** indicates significance at the 10, 5 and 1 percent levels.

3.3 Long-run Elasticity

Table 4 presents long-run elasticity result. This study has found the long-run relationships between nominal exchange rates and its determinants, namely relatives of money supply, income, interest rate and current account for Malaysia vis-à-vis United States. However, only money supply has significant impact on exchange rate at 10 percent level. It means that 1 percent increase in relative money supply will lead to exchange rate increase by 0.825 percent; whereas, other fundamentals have not significant impact upon exchange at 10 percent level.

Table 4
Estimated long-run coefficients

Variables	Coefficient	Std. Error	T-Stat	P-Value
$m - m^*$	0.825	0.420	1.965	0.058
$y - y^*$	-0.930	0.622	-1.495	0.145
$i - i^*$	-0.022	0.021	-1.058	0.298
$ca - ca^*$	-1.544	1.722	-0.897	0.377
Constant	0.327	0.471	0.694	0.493
Diagnostic Check				
CusumSq	Stable			
LM test	2.183[2]			
ARCH test	0.022[1]			

Note: *,** and *** indicates significance at the 10, 5 and 1 percent levels.

4. Conclusion

This study has examined the long-run relationship between nominal exchange rate and its determinants for Malaysia. In particular, the standard monetary model augmented by current account differentials to exchange rate determination was investigated for Malaysia against United States. The analysis was based on autoregressive distributed lag (ARDL) approach to cointegration. Our findings indicate that there was a long-run relationship between nominal exchange rate and its economic fundamentals for Malaysia vis-à-vis United States. This provides information that Malaysia and the United States have been closely related in terms of trade and finance.

In addition, we also found that there exist a positive long-run association between money supply and nominal exchange rate. In other words, currency depreciation is associated with the increase in the money supply. It seems that implementation of expansionary monetary policy could affect Malaysian currency tend to depreciate. The Economic Report of Malaysia reported that in 2008 to 2009, Malaysia has increased money supply (M2) to overcome the effect of global financial crisis. At the same time, this consequences influence Malaysian currency tends to depreciate. Thus, our notable results show that only money supply has significant impact on exchange rate whereas other fundamentals do not have significant impact upon exchange rate. As conclusion, central bank of Malaysia could monitor the exchange rate with reference to relative money supply and may use this economic fundamental as a tool in exchange rate policy decision. When money supply differentials increase, nominal exchange rate will tend to increase as consistent with the theory of exchange rate model.

References

- Alimi, R.S. (2014) ARDL bounds testing approach to cointegration: A re-examination of augmented fisher hypothesis in open economy. *Asian Journal of Economic Modelling*, 2(2), 103-114.
- Ang, J.B. (2008) What are the mechanism linking financial development and economic growth in Malaysia? *Economic Modelling* 25, 38-53.

- Atkins, F.J., Coe, P.J. (2002) An ARDL bounds test of the long-run fisher effect in the United States and Canada. *Journal of Macroeconomics*, 24, 255-266.
- Baharumshah, A.Z., Masih, A.M.M., Azali, M. (2002) The stock market and the ringgit exchange rate: A note. *Journal of Japan and the World Economy*, 14, 471-486.
- Baharumshah, A.Z., Masih, A.M.M. (2005) Current account, exchange rate dynamics and the predictability: The experience of Malaysia and Singapore. *Journal of International Financial Markets, Institutions & Money*, 15, 255-270.
- Bahmani-Oskooee, M., Kara, O. (2000) Exchange rate overshooting in Turkey. *Economics Letters*, 68, 89-93.
- Bilson, J.F.O. (1978) The monetary approach to the exchange rate: Some empirical evidence. *IMF Staff Papers*, 25, 48-75.
- Brown, R.J.M., Durbin, J., Evans, J.M. (1975) Techniques for testing the constancy of regression relations over time. *Journal of the Royal Statistical Society*, 37, 149-163.
- Cheung, Y.W., Lai, K.S. (1993) Finite sample sizes of Johansen's likelihood ratio tests for cointegration. *Oxford Bulletin of Economics and Statistics*, 55(3), 313-328.
- Chinn, M.D. (2000) Before the fall: Were East Asian currencies overvalued? *Emerging Market Review*, 1, 101-126.
- Choong, C-K., Yusop, Z., Soo, S-C. (2005) Foreign direct investment and economic growth in Malaysia: The role of domestic financial sector. *The Singapore Economic Review*, 50, 245-268.
- Dickey, D.A., Fuller, W.A. (1979) Distribution of the estimators for autoregressive time series with a unit root. *Journal of American Statistical Association*, 74(366), 427-431.
- Dickey, D., Fuller, W.A. (1981) Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49, 1057-1072.
- Dornbusch, R. (1976) Expectation and exchange rate dynamics. *Journal of Political Economics*, 6, 84.
- Dornbusch, R. (1976) The theory of flexible exchange rate and macroeconomic policy. *Scandinavian Journal of Economics*.
- Engle, R., Granger, C. (1987) Co-integration and error correction: Representation, estimation and testing. *Econometrica*, 55(22), 251-276.
- Francis, B., Hasan, I., Lothian, J.R. (2001) The monetary approach of exchange rates and the behaviour of Canadian dollar over the long-run. *Applied Financial Economics*, 11, 475-481.
- Frankel, J.A. (1978) On the mark: A theory of floating exchange rates based on the real interest differentials. *American Economic Review*, 4, 69.
- Frenkel, J.A. (1976) A monetary approach to the exchange rate: Doctrinal aspects and empirical evidence. *Scandinavian Journal of Economics*.
- Frenkel, J.A., Johnson, H.A. (1978) The economics of exchange rates: Selected studies, Addison-Wesley, Reading, Mass.
- Hendry, D.F., Ericsson, N.R. (1991) An econometrics analysis of U.K Money Demand in Monetary trends in the United States and the United Kingdom by Milton Friedman and Anna J. Schwartz. *American Economic Review*, 81, 8-38.

- Husted, S., MacDonald, R. (1999) The Asian currency crash: were badly driven fundamentals to blame? *Journal of Asian Economics*, 10, 537-550.
- Johansen, S. (1988) Statistical analysis of cointegrating vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.
- Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, 59, 1551-1580.
- Johansen, S., Juselius, K. (1990) Maximum likelihood estimation and inference on cointegration. *Oxford Bulletin of Economics and Statistics*, 52, 162-210.
- Kearney, C., MacDonald, R. (1990) Rational expectations, bubbles and monetary models of the exchange rate: The Australian/US Dollar rate during the recent float. *Australian Economic Papers*, 29, 1-20.
- Lee, C., Azali, M., Yusop, Z.B., Yusoff, M.B. (2007) The monetary model of exchange rate: Evidence from the Philippines. *Applied Economic Letters*, 14, 993-997.
- Levich, R.M. (2001) *International financial markets: Prices and policies*, McGraw-Hill International Edition.
- Long, D., Samreth, S. (2008) The Monetary model of exchange rate: Evidence from the Philippines using ARDL approach. *Munich Personal RePec Archive*.
- MacDonald, R., Taylor, M.P. (1991) The monetary approach to the exchange rate: Long-run relationships and coefficient restrictions. *Economic Letters*, 37, 179-85.
- MacDonald, R., Taylor, M.P. (1992) Exchange rate economics: A survey. *International Monetary Fund Staff Papers*, 39, 1-57.
- MacDonald, R., Taylor, M.P. (1993) The monetary model of the exchange rate: Long-run relationships and short-run dynamics. *International Monetary Fund Staff Papers*, 40, 89-107.
- MacDonald, R., Taylor, M.P. (1994) Reexamining the monetary approach to the exchange rate: The dollar-franc, 1976-1990. *Applied Financial Economics*, 4, 423-429.
- Makrydakis, S. (1998) Testing the long-run validity of the monetary approach to the exchange rate: The Won-US dollar case. *Applied Economics Letters*, 5, 507-511.
- McNown, R.A., Wallace, M. (1989) Cointegration tests for long-run equilibrium in the monetary exchange rate model. *Economics Letters*, 31, 263-267.
- Meese, R.A. (1986) Testing for bubbles in exchange markets: A case of sparkling rates? *Journal of Political Economics*, 2, 94.
- Meese, R.A., Rogoff, K. (1983) Empirical exchange rate models of the seventies: Do they fit out of sample? *Journal of International Economics*, 14, 3-24.
- Miyakoshi, T. (2000) The monetary approach to the exchange rate: Empirical observations from Korea. *Applied Economics Letters*, 7, 791-794.
- Moosa, I.A. (1994) The monetary model of exchange rates revisited. *Applied Financial Economics*, 26, 279-287.
- Morley, B. (2007) The monetary model of the exchange rate and equities: An ARDL bounds testing approach. *Applied Financial Economics*, 17, 391-397.
- Narayan, P.K. (2005) The saving and investment nexus for China: Evidence from Cointegration tests. *Applied Economics*, 37, 1979-1990.

- Narayan, P.K., Smyth, R. (2006) The relationship between the real exchange rate, real interest rates and foreign reserves: Empirical evidence from China. *Applied Financial Economics*, 16, 639-651.
- Nieh, C.C., Wang, Y.S. (2005) ARDL approach to the exchange rate overshooting in Taiwan. *Review of Quantitative Finance and Accounting*, 25, 55-71.
- Obstfeld, M., Rogoff, K. (1995) Exchange rate dynamics redux. *Journal of Political Economy*, 103, 624-660.
- Pattichis, C.A. (1999) Price and income elasticities of disaggregated import demand: Results from UECMs and an application. *Applied Economics*, 31, 1061-1071.
- Pesaran, M.H., Pesaran, B. (1997) *Working with microfit 4.0: Interactive econometric analysis*, Oxford University Press, Oxford.
- Pesaran, M.H., Shin, Y. (1999) An autoregressive distributed lag modelling approach to cointegration analysis. In S. Strom (ed.), *Econometrics and economic theory in the 20th century: The Ragnar Frisch centennial symposium*. Cambridge University Press, Cambridge.
- Pesaran, M.H., Shih, Y., Smith, R. (2001) Bounds testing approaches to the analysis of the level relationships. *Journal of Applied Econometrics*, 16, 289-326.
- Philips, P.C. (1987) Time series regression with a unit root. *Econometrica*, 55(2), 277-302.
- Phillips, P.S., Ouliaris, S. (1990) Asymptotic properties of residual based tests for cointegration. *Econometrica*, 58(1), 165-193.
- Phillips, P.C., Perron, P. (1988) Testing for a unit root in time series regression. *Biometrika*, 75(2), 335-346.
- Rapach, D.E., Weber, C.E. (2004) Are real interest rates really nonstationary? New evidence from tests with good size and power. *Journal of Macroeconomics*, 26, 409-430.
- Rapach, D.E., Wohar, M.E. (2002) Testing the monetary model of exchange rate determination: New evidence from a century of data. *Journal of International Economics*, 58, 359-385.
- Rapach, D.E., Wohar, M.E. (2004) Testing the monetary model of exchange rate determination: A closer look at panels. *Journal of International Money and Finance*, 23, 867-895.
- Said, S., Dickey, D.A. (1984) Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika* 71(3), 599-607.
- Tang, T.C. (2001) Bank Lending and inflation in Malaysia: Assessment from unrestricted error-correction models. *Asian Economic Journal*, 15, 3.
- Yarbrough, B.V., Yarbrough, R.M. (2003) *The world economy: Trade and finance*, South-Western College Publisher.